# Draft Study Material

# Cloud Computing Assistant

**(Qualification Pack: Ref. Id. NIE/ITS/Q1201, NSQF Level 3)**

**Sector: Information Technology-Information Technology Enable Services (IT-ITeS)**

## (Grade IX)

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एन सी ई आर टी
NCERT

**PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION**

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# Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives.

The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material.

Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material.



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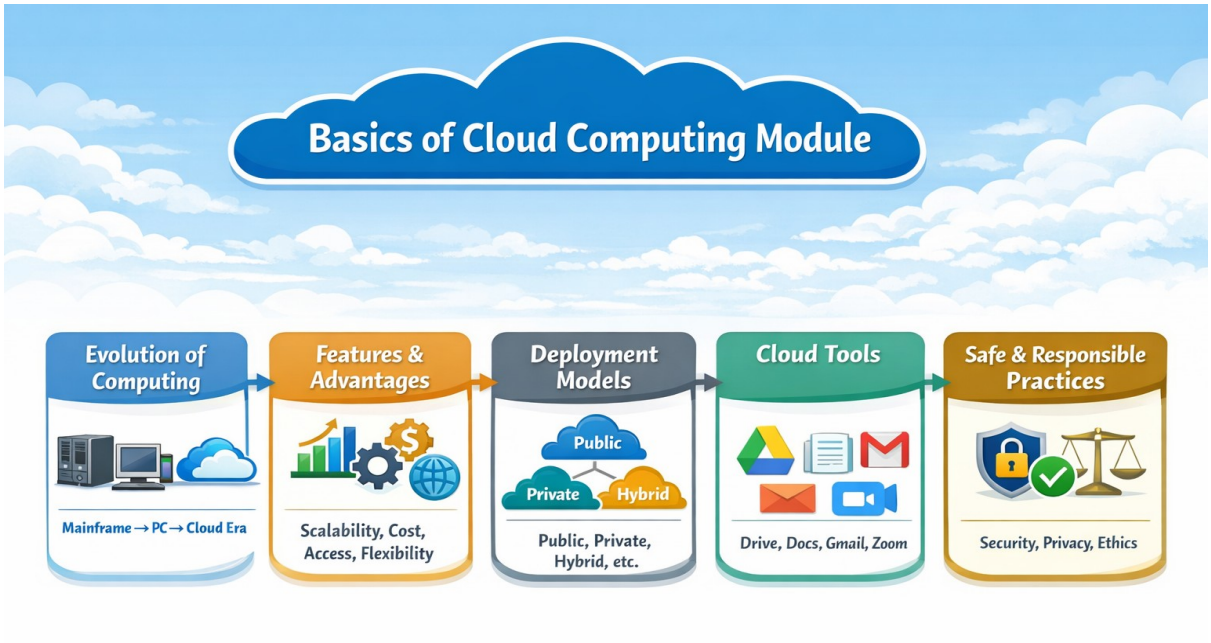
# Module 1. Basics of Cloud Computing

This module introduces the fundamental concepts of cloud computing, focusing on how computing resources such as storage, applications, and services are delivered over the Internet. It covers the evolution of computing, key features and advantages of cloud systems, different deployment models, and practical use of cloud tools for communication and collaboration. The module also emphasizes real-life applications and safe practices, enabling learners to understand and effectively use cloud technologies in everyday situations.



# Session 1. Evolution of Cloud Computing

Imagine a modern Smart school that uses cloud computing for all its operations. Dr. Meena is the Head of the School. Her school wants to make learning more flexible, digital, and efficient. Instead of setting up expensive servers and buying software licenses, they decide to move to the cloud. Students and teachers access materials anytime, anywhere. University saves hardware cost and energy. Cloud provides data security, scalability, and reliability. Figure 1.1 illustrates concept of smart school.

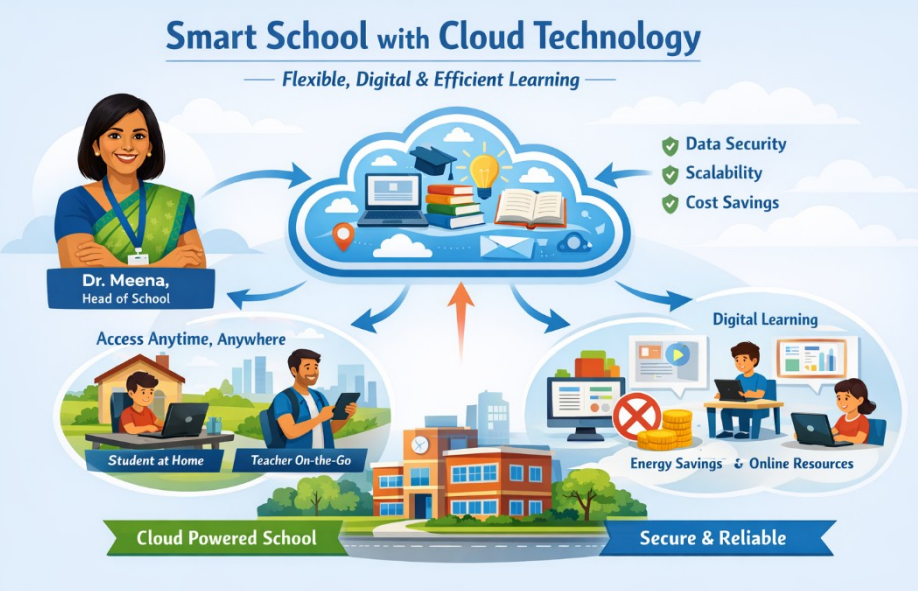



***Fig. 1.1 : Concept of Smart School***

## 1.1 Introduction to Computing

The term computing refers to the process of using computer technology to complete a given goal-oriented task. Over the decades, computing has evolved through several generations, improving in speed, size, cost, and performance. The journey of computing can be seen as the continuous quest to make machines more efficient, intelligent, and accessible.

***Major Milestones in Computing Evolution***

1. Mainframe Era (1950s–1970s): Centralized computing; used by large organizations.
2. Personal Computer Era (1980s): Computing became accessible to individuals.
3. Networking Era (1990s): Internet connected computers worldwide.
4. Mobile & Cloud Era (2000s–Present): Access to computing resources anytime, anywhere via internet and smartphones.

## 1.2. Cloud Computing

Cloud Computing is a modern computing model that delivers on-demand computing resources such as servers, storage, databases, networking, software, and analytics over the Internet — commonly known as "the cloud."

Instead of owning physical hardware or software, users rent or access resources via the internet from cloud service providers such as Amazon Web Services (AWS), Microsoft Azure, or Google Cloud.

Definition: Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort.

**Role of Internet in Cloud Computing**

The Internet acts as the backbone of cloud computing. It connects users to remote data centres, allowing them to access software, storage, and computing resources located anywhere in the world. Without the Internet, cloud computing would not exist. Table 1.2 shows role and importance of internet in cloud computing.

***Table 1.2 : Role and importance of internet in cloud computing***

| **Aspect** | **Explanation** |
|---|---|
| Connectivity | The Internet enables users to connect to cloud servers from any device (PC, tablet, smartphone). |
| Data Access | Files and applications stored on the cloud are retrieved via Internet protocols such as, Hyper Text Transfer Protocol (HTTP), Secure HTTP (HTTPS), and File Transfer Protocol (FTP). |
| Collaboration | Cloud-based tools like Google Docs or Zoom allow real-time collaboration among users. |
| Scalability | Cloud resources are allocated dynamically through the Internet depending on demand. |
| Global Availability | Cloud service providers maintain servers worldwide, accessible 24×7 over the Internet. |

***Example:*** When you use Google Drive, the Internet helps you upload a file to Google's data centre and later access it from any location.

### 1.3 Remote Storage and Online Access

In the traditional computing model, data was stored locally on a computer's hard drive or an external device such as a pen drive or CD. However, in the modern cloud-based computing environment, data can be stored remotely on servers located in data centres and accessed via the Internet. This is known as remote storage and online access.

### *1.3.1 Remote Storage*

***Definition:*** Remote storage means saving digital data on servers that are not physically located on your own computer but can be accessed through the Internet. There are various remote storage available for the use. These includes Google Drive, Dropbox, OneDrive, iCloud, Amazon S3. Their logos are shown in Figure 1.2.


***Fig. 1.2 : Logos of various remote storage***

***Working of Remote Storage***

The working of remote storage can be described in the form of following steps which is illustrated in Figure 1.3.

**Step 1.** A user uploads files from a local device to the cloud (remote server).

**Step 2.** The data is stored securely on multiple servers (to ensure backup and reliability).

**Step 3.** The user can retrieve or modify this data anytime through the Internet.

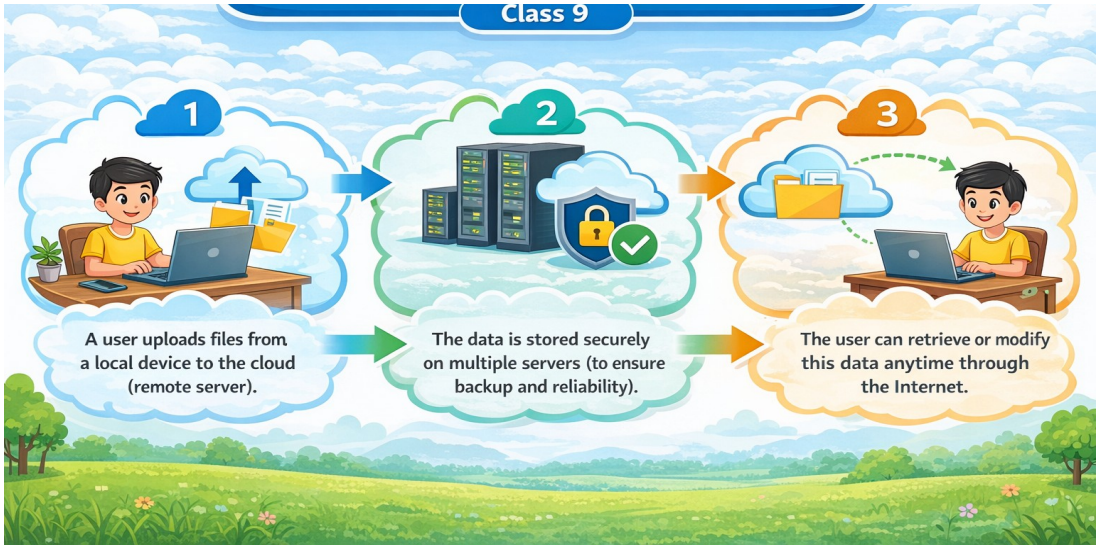



***Fig. 1.3 : Working of Remote Storage***

***Advantages:***

The advantages of remote storage can be listed as :

1. Data can be accessed from anywhere, anytime.
2. Data backup and recovery can be achieved.
3. Easy sharing and collaboration.
4. Saves local storage space.
5. Automatic synchronization across devices is possible.

***Disadvantages:***

The disadvantages of remote storage can be listed as :

1. Requires an Internet connection.
2. Data privacy and security concerns.
3. Limited free storage after which subscription is required.

### *1.3.2 Online Access*

***Definition:*** Online access means the ability to connect to remote resources—such as data, software, or applications—over the Internet in real time.

***Examples:***

- Accessing Gmail or Google Docs through a browser.
- Streaming videos from YouTube.
- Using cloud-based applications like Microsoft 365 or Canva.

***Working of Online Access***

The working of online access can be described in the form of following steps which is illustrated in Figure 1.4.

**Step 1.** The user sends a request via the Internet.

**Step 2.** The remote server processes it and sends the required data or service.

**Step 3.** The user interacts with that data or service online without downloading it permanently.

***Advantages:***

The advantages of online access can be listed as :

1. Instant availability of data and applications.
2. Enables real-time collaboration.
3. Reduces need for software installation and maintenance.

***Disadvantages:***

The disadvantages of online access can be listed as :

1. Dependent on Internet speed and reliability.
2. Possible risk of unauthorized access if not secured properly.

***Relationship between Remote Storage and Online Access***

Remote storage provides the place where data resides (the cloud server). Online access provides the means to reach and use that data from anywhere. Together, they form the foundation of cloud computing services.

***Real-Life Example***

A student saves an assignment on Google Drive (remote storage) and later edits it from another device through Google Docs (online access). The data is stored on Google's servers and can be accessed securely anytime with an Internet connection.

### 1.4 Advantages of Cloud Computing

There are several advantages of cloud computing. Some of them are mentioned below. Figure 1.5 shows advantages of cloud computing.

1. Cloud computing reduces hardware and maintenance costs.
2. It provides flexibility and scalability.
3. It is accessible anywhere, anytime.
4. Cloud computing offers data backup and disaster recovery.
5. It encourages collaboration and remote work.

Cloud computing is a modern technology that delivers computing services—such as storage, processing power, databases, software, and networking—over the Internet ("the cloud") instead of using local servers or personal computers.

It has transformed the way individuals, educational institutions, and businesses use and manage digital resources.

### 1.5 Importance of Cloud Computing

The importance of cloud computing can include the following areas.

***a) Cost Efficiency:*** It eliminates the need to buy and maintain expensive hardware and software. Users pay only for the resources they use ("Pay-as-you-go" model). It reduces IT infrastructure and maintenance costs.

***b) Scalability and Flexibility:*** Resources such as, storage, processing power can be increased or decreased as per demand. It is ideal for startups, schools, and enterprises with changing workloads.

***c) Accessibility Anywhere, Anytime:*** Data and applications are accessible from any location and device with an Internet connection. It enables remote work, online learning, and global collaboration.

***d) Reliability and Backup:*** Cloud providers maintain multiple copies of data on different servers. It ensures data recovery, business continuity, and high uptime even if one server fails.

**e) Security and Data Protection:** Most cloud services use encryption, authentication, and secure access controls. Professional cloud providers invest heavily in cybersecurity.

***f) Automatic Updates:*** Cloud applications are updated automatically by service providers. Users always have access to the latest software versions and features without manual installation.

***g) Supports Innovation and AI:*** Cloud platforms provide tools for Artificial Intelligence (AI), Machine Learning (ML), Big Data, and IoT (Internet of Things). Enables rapid development and deployment of intelligent applications.

### 1.6 Relevance of Cloud Computing in Modern Computing

The relevance of cloud computing in modern computing era can include the following areas.

***a) Digital Transformation:*** Cloud computing powers digital transformation across all sectors—education, healthcare, banking, government, and business—by offering efficient, scalable, and intelligent digital solutions.

***b) Remote Learning and Work:*** During and after the COVID-19 pandemic, cloud-based platforms like Google Classroom, Microsoft Teams, and Zoom became essential for education and work-from-home environments.

***c) Data-Driven Decision Making:*** Organizations use cloud-based analytics to collect, process, and visualize large volumes of data for better business and social decisions.

***d) Support for Startups and Small Businesses:*** Cloud computing removes the barrier of expensive IT setup, allowing startups to launch applications quickly and scale globally.

***e) Environmental Impact:*** By sharing computing resources in data centers, cloud computing reduces energy waste and lowers carbon footprint, promoting green computing.

***f) Integration with Emerging Technologies:*** Modern innovations like IoT (Internet of Things), AI (Artificial Intelligence), Blockchain, and Edge Computing depend heavily on cloud infrastructure for processing and storage.

## 4. Real-Life Examples

There are various examples of using cloud services in the daily use. The some of them are given in Table 1.3.

***Table 1.3: Real-Life Examples using Cloud Services***

| **Application Area** | **Cloud Service Example** | **Purpose** |
|---|---|---|
| Education | Google Workspace for Education | Online learning and collaboration |

| Application Area | Cloud Service Example | Purpose |
|---|---|---|
| Business | Amazon Web Services (AWS) | Hosting websites and apps |
| Personal Use | Dropbox / Google Drive | Remote data storage and sharing |
| Entertainment | Netflix / Spotify | Streaming using cloud servers |
| AI and Data | Microsoft Azure AI | Machine learning and analytics |

Cloud computing has become the backbone of modern computing. It provides speed, scalability, cost-effectiveness, and innovation, making it essential for individuals, organizations, and governments. In today's interconnected world, the cloud is not just an option—it is a necessity for digital growth and global connectivity.

**Practical Activity 1.1.** Identify Cloud Services Used by Students

**Objective**

To identify and understand different cloud computing services commonly used by students for learning, communication, storage, and collaboration.

**Materials Required**

- Computer / Laptop / Smartphone
- Internet connection
- Notebook for recording observations

**Procedure**

**Step 1.** Make a list of daily academic activities performed by students (e.g., attending classes, submitting assignments, group discussions).

**Step 2.** Identify the cloud services used for each activity.

**Step 3.** Open the respective cloud service and observe its main features.

**Step 4.** Note down the purpose of each cloud service.

**Step 5.** Classify the services based on their usage (storage, communication, learning platform, collaboration).

**Step 6.** Record your observations in a tabular format.

**Observation Table**

| S. No. | Cloud Service | Type of Service | Purpose / Usage |
|---|---|---|---|
| 1 | Google Drive | Cloud Storage | Store and share notes, assignments |

| S. No. | Cloud Service | Type of Service | Purpose / Usage |
|---|---|---|---|
| 2 | Google Classroom | Learning Platform | Online classes, assignments, announcements |
| 3 | Microsoft Teams | Collaboration | Online meetings, chats, file sharing |
| 4 | Zoom | Video Conferencing | Online lectures and webinars |
| 5 | Gmail | Cloud-based Email | Communication with teachers |
| 6 | OneDrive | Cloud Storage | Backup and access files anywhere |

**Result**

Students use various cloud services such as Google Drive, Google Classroom, Microsoft Teams, Zoom, and OneDrive for learning, communication, collaboration, and data storage. These services make education flexible, accessible, and efficient.

**Conclusion**

Cloud computing plays an important role in students' academic life by enabling online learning, secure data storage, and real-time collaboration. It supports learning anytime and anywhere.

## Summary

This session introduces the concept of cloud computing as a technology that allows users to access data, software, and services over the Internet instead of storing them on personal computers. It explains how cloud computing reduces the need for expensive hardware and enables access from anywhere. Real-life examples such as using Google Drive, YouTube, or online banking help students understand how cloud services are already part of daily life.

## Check your progress

### A. Multiple Choice Questions (MCQs)

1. A school decides to stop buying physical servers and instead uses online storage and software. This approach best represents: (a) Traditional computing (b) Cloud computing (c) Standalone computing (d) Offline computing
2. Which generation of computers introduced AI, Machine Learning, and Cloud Computing? (a) Third generation (b) Fourth generation (c) Fifth generation (d) Second generation
3. Which of the following is an example of remote storage? (a) Hard disk (b) Pen drive (c) Google Drive (d) CD

4. A student edits an assignment stored on Google Drive using Google Docs from another city. This shows: (a) Local storage (b) Online access (c) Offline processing (d) Hardware computing
5. Which Internet protocol is mainly used for secure data transfer in cloud computing? (a) FTP (b) HTTP (c) HTTPS (d) SMTP
6. Which feature of cloud computing helps an organization increase or decrease resources as per demand? (a) Accessibility (b) Scalability (c) Backup (d) Collaboration
7. During online classes, tools like Zoom and Microsoft Teams are used mainly for: (a) Data backup (b) Programming (c) Video conferencing and collaboration (d) Hardware maintenance

**B. Fill in the Blanks**

1. Cloud computing delivers computing resources over the _____.
2. Saving data on servers that are not physically located on a personal computer is called _____ storage.
3. Google Drive, Dropbox, and OneDrive are examples of _____ storage services.
4. The Internet acts as the _____ of cloud computing.
5. The ability to access cloud data from anywhere is known as __ access.
6. Cloud computing reduces _____ and maintenance costs.
7. The “Pay-as-you-go” model improves _____ efficiency.

**C. True or False**

1. Cloud computing requires users to buy expensive hardware.
2. Remote storage allows data backup and recovery.
3. Online access means downloading software permanently on a device.
4. Cloud providers store data on multiple servers for reliability.
5. Cloud computing cannot support AI and Machine Learning.
6. Internet connectivity is essential for cloud computing.
7. Google Classroom is a cloud-based learning platform.

**D. Short Answer Questions**

1. What is cloud computing?
2. Write two advantages of cloud computing.
3. What is remote storage? Give one example.
4. Define online access with one example.
5. How does cloud computing help students in learning?
6. Why is the Internet important for cloud computing?

## Session 2. Features and Advantages of Cloud Computing

Suppose a group of young entrepreneurs opened a small café called "Cup & Code" that not only served coffee but also offered free Wi-Fi and coding sessions.

They wanted a modern way to manage orders, payments, customer feedback, and online promotions without spending much money on hardware or IT staff. So, they decided to use cloud computing. Figure 2.1 illustrates the scenario.

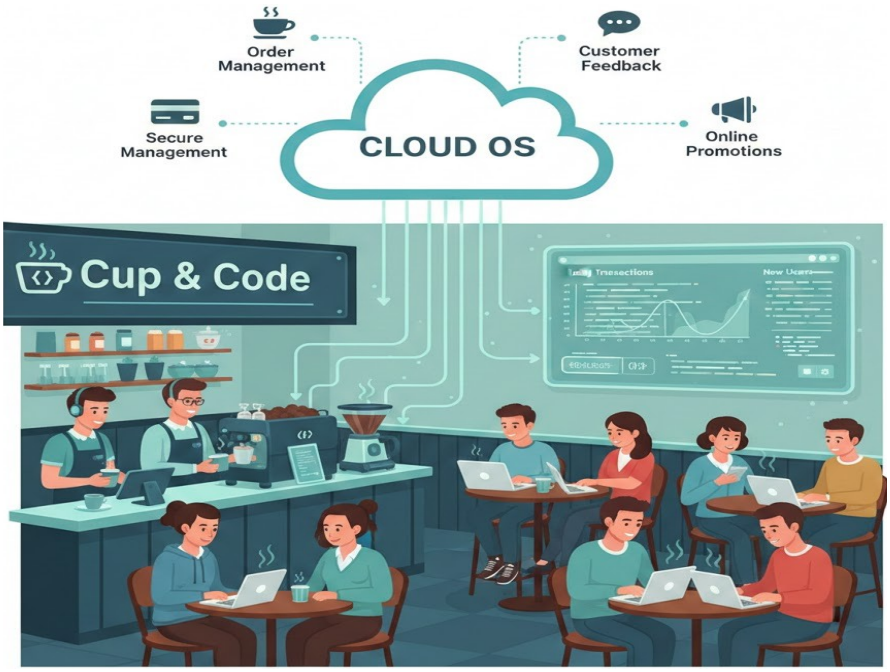



***Fig. 2.1 : Cloud-Powered Cafe Management***

In this session we will discuss about features and advantages of cloud computing. Cloud computing represents the next phase in the evolution of computing, transforming how individuals and organizations access technology. From the era of massive mainframes to today's virtualized, scalable cloud services, computing has become more efficient, affordable, and universally accessible. Cloud-based applications like Gmail, YouTube, and Zoom are now an integral part of daily life, demonstrating the power and convenience of this technology.

### 2.1 Features of Cloud Computing

There are various important features of cloud computing as explained in the Table 2.1.

***Table 2.1: Features of Cloud Computing***

| **Feature** | **Description** |
|---|---|
| On-Demand Self-Service | Users can access computing resources as needed, automatically, without human interaction with the |

| Feature | Description |
|---|---|
| | provider. |
| Broad Network Access | Services are available over the internet and accessible through standard devices (laptops, phones, tablets). |
| Resource Pooling | Cloud providers serve multiple customers using shared resources in a multi-tenant environment. |
| Rapid Elasticity | Resources can be quickly scaled up or down according to demand. |
| Measured Service | Users pay only for what they use, similar to utilities like electricity or water. |
| Reliability and Backup | Data and applications are stored in multiple servers ensuring redundancy and backup. |
| Security and Accessibility | Provides controlled access, data encryption, and user authentication. |

### 2.2 Real-Life Examples of Cloud Computing

There are various examples of cloud computing as shown in Figure 2.3 and summarised in the Table 2.2.

***Table 2.2: Examples of cloud computing***

| Application | Image/Logo | Description |
|---|---|---|
| Gmail |  | Users access email services via the internet without installing software locally. |
| YouTube |  | Stores and streams video content using Google's cloud servers worldwide. |
| Zoom |  | Provides online video conferencing, meetings, and webinars through cloud-based servers. |

| Application | Image/Logo | Description |
|---|---|---|
| Google Drive / Dropbox |   | Allows users to store, share, and sync data across devices. |
| AWS EC2 / Microsoft Azure |   | Offers cloud-based infrastructure and platforms for developers. |

### 2.3 Advantages of Cloud Computing

There are several advantages of cloud computing. Some of them are mentioned below.

- Cloud computing reduces hardware and maintenance costs.
- It provides flexibility and scalability.
- It is accessible anywhere, anytime.
- Cloud computing offers data backup and disaster recovery.
- It encourages collaboration and remote work.

Cloud computing provides computing resources such as storage, servers, software, and databases over the Internet ("the cloud") instead of using local computers. It brings several benefits that make it the backbone of modern digital systems for individuals, businesses, and educational institutions.

### 2.4 Major Advantages of Cloud Computing

***a) Cost Efficiency***

- No need to buy expensive hardware or software.
- Reduces maintenance and infrastructure costs.
- Users pay only for what they use (Pay-as-you-go model).

***Example:*** A small business can store files on Google Drive instead of buying physical servers.

***b) Accessibility and Mobility***

- Data and applications are accessible anytime, anywhere using an Internet connection.
- Supports remote work and online learning.

***Example:*** Students can edit and share documents through Google Docs from home.

***c) Scalability and Flexibility***

- Resources like storage and processing power can be easily increased or decreased as needed.
- Ideal for organizations with changing workloads.

***Example:*** An e-commerce website can handle more traffic during festivals by scaling up its cloud resources.

***d) Data Backup and Recovery***

- Cloud providers keep multiple copies of data across servers.
- Ensures data recovery even during hardware failure or natural disasters.

***Example:*** If a laptop crashes, files stored on OneDrive remain safe.

***e) Automatic Software Updates***

- Cloud applications are automatically updated by service providers.
- Users always have access to the latest features and security patches without manual installation.

***Example:*** Microsoft 365 updates happen automatically in the background.

***f) Collaboration and Sharing***

- Multiple users can work on the same file simultaneously from different locations.
- Promotes teamwork and productivity.

***Example:*** Teachers and students co-editing assignments on Google Sheets.

***g) Security***

- Cloud services use data encryption, firewalls, and user authentication to protect data.
- Professional cloud providers invest heavily in cybersecurity.

***Example:*** Two-factor authentication in cloud accounts adds extra security.

***h) Environment Friendly (Green Computing)***

- Cloud data centers are optimized for energy efficiency.
- It reduces the need for multiple physical servers, lowering carbon emissions.

***i) Integration with Emerging Technologies***

- Cloud platforms support advanced tools for AI, Big Data, IoT, and Machine Learning.
- It encourages innovation and development of smart applications.

***Example:*** Cloud-based AI tools like ChatGPT or Google Bard operate entirely on cloud infrastructure.

Table 2.3 summarise the major advantages with example.

***Table 2.3: Major advantages with example***

| **Advantage** | **Description** | **Example** |
|---|---|---|
| Cost Efficiency | Reduces hardware and software costs | AWS, Google Drive |
| Accessibility | Access from anywhere via Internet | Gmail, OneDrive |
| Scalability | Easy to expand resources | AWS Auto-scaling |
| Backup & Recovery | Data safely stored and recoverable | Dropbox restore |
| Auto Updates | Software updated automatically | Microsoft 365 |
| Collaboration | Multi-user editing | Google Docs |
| Security | Encrypted and protected data | 2FA login |
| Green Computing | Reduced energy use | Shared data centers |
| Innovation | Supports AI, IoT, ML | Cloud AI services |

Cloud computing has revolutionized the digital world by offering cost-effective, secure, and scalable solutions. Its advantages make it a crucial component of modern computing, supporting everything from online education to global business operations.

### 2.5 Traditional vs Cloud Computing

There is a key difference between traditional computing and cloud computing. The various features that makes the difference in traditional and cloud computing are given in the Table 2.4.

***Table 2.4: Traditional vs Cloud Computing***

| **Feature** | **Traditional Computing** | **Cloud Computing** |
|---|---|---|
| Infrastructure | Local servers and desktops | Internet-based servers (cloud) |
| Data Storage | Stored on local hard drives | Stored on remote servers |
| Accessibility | Limited to office network | Accessible from anywhere |

| Feature | Traditional Computing | Cloud Computing |
|---|---|---|
| Cost | High upfront hardware cost | Pay-as-you-go model |
| Maintenance | Done by in-house IT team | Done by cloud service provider |
| Scalability | Hard to expand quickly | Easily scalable (add more users/resources anytime) |
| Software Updates | Manual installation needed | Automatic updates |
| Security | Managed locally | Managed by cloud provider with advanced security |
| Backup & Recovery | Manual backups required | Automatic backup and recovery options |
| Example | Installing MS Office on each computer | Using Google Workspace or Office 365 online |

An illustrative example for this is shown in Figure 2.4.

Imagine a school that uses traditional computing and cloud computing features for managing the school.

In traditional computing, the school maintains its own computer lab, installs software, and stores student data locally.

In cloud computing, the school uses Google Classroom and Google Drive, accessing everything online without worrying about installation or maintenance.

Cloud computing provides flexibility, cost savings, and accessibility, making it more suitable for today's digital, mobile, and collaborative world. Traditional computing still exists in some cases for security or offline needs, but the future clearly belongs to the cloud. This is illustrated in Figure 2.4.

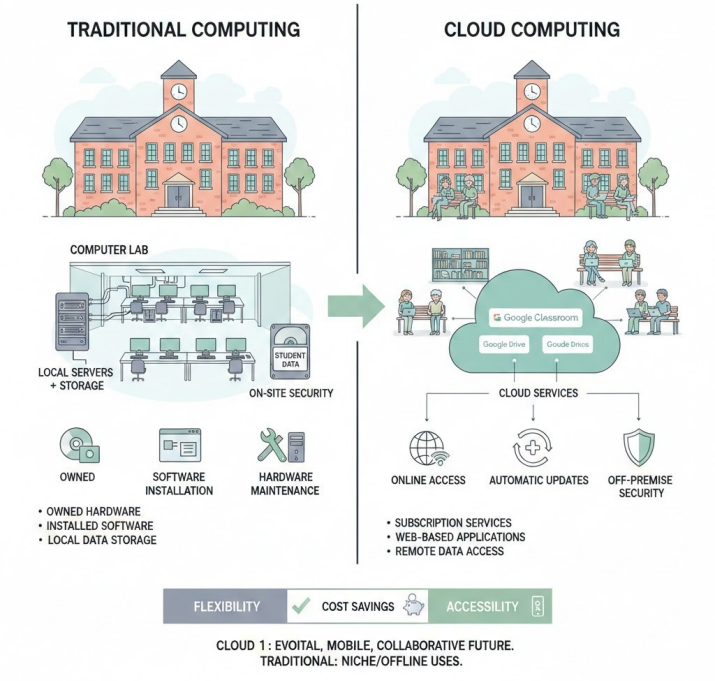



***Fig. 2.4 : Traditional computing vs cloud computing school (Redraw)***

## Summary

This session explains why cloud computing is widely used. It highlights benefits such as cost savings, scalability, flexibility, and accessibility. Students learn that users can increase or decrease storage as needed and can work from any location. Cloud services also reduce maintenance because updates are handled by the service provider.

## Check your progress

### A. Multiple Choice Questions

1. A startup wants to increase its storage capacity during festive sales and reduce it later. Which cloud feature best supports this requirement? (a) Measured Service (b) Broad Network Access (c) Rapid Elasticity (d) Security
2. A student edits a document at home and continues working on the same file at school without copying it manually. Which cloud advantage is being used? (a) Cost efficiency (b) Accessibility and mobility (c) Green computing (d) Resource pooling
3. An organization does not want to worry about installing software updates on each computer. Which cloud advantage solves this problem? (a) Scalability (b) Automatic software updates (c) Backup and recovery (d) Collaboration
4. Multiple companies use the same cloud infrastructure, but their data remains separate and secure. This situation describes: (a) Broad

network access (b) Rapid elasticity (c) Resource pooling (d) Measured service

5. Which cloud service would be MOST suitable for online meetings and webinars? (a) Google Drive (b) Zoom (c) Dropbox (d) AWS EC2

**B. Fill in the Blanks**

1. Paying only for the cloud resources used is known as the _____ model.
2. Accessing cloud services using laptops, tablets, and mobile phones is possible due to _____ network access.
3. Automatic data recovery after system failure is ensured through cloud _____ and recovery.
4. Working together on the same document from different locations shows the _____ feature of cloud computing.
5. Cloud computing reduces carbon emissions by promoting _____ computing.

**C. State whether the following statements are True or False**

1. Cloud computing allows organizations to avoid maintaining in-house IT infrastructure.
2. Data stored in cloud computing is always kept on a single server.
3. Resource pooling helps cloud providers serve multiple users efficiently.
4. Cloud computing is unsuitable for remote work and online learning.
5. Traditional computing offers easier scalability than cloud computing.

**D. Short Answer Questions**

1. Why is cloud computing more suitable than traditional computing for a startup company?
2. How does the pay-as-you-go model help organizations manage costs?
3. Give one real-life situation where broad network access is useful.
4. How does cloud computing support collaboration among users?
5. A laptop crashes, but all important files are still safe. Which cloud advantage explains this situation?

## Session 3. Cloud Deployment Models

Suppose your city has decided to become a Smart City. Different departments such as, education, healthcare, business, and government, needed cloud solutions to manage their digital services efficiently. They need to choose different types of clouds according to their needs. Figure 3.1 illustrates this scenario.

***Fig. 3.1: Smart City Cloud Project (Redraw)***

### 3.1 Cloud Deployment Models – Types, Comparison & Examples

A cloud deployment model defines how cloud services are made available to users and how infrastructure is managed. It determines the cloud's nature and purpose. Each model will offer advantages and disadvantages in areas such as governance, scalability, security, flexibility, cost, and management.

**Types of Cloud Deployment Models**

Cloud deployment models can be divided into five main types as shown in Figure 3.2.

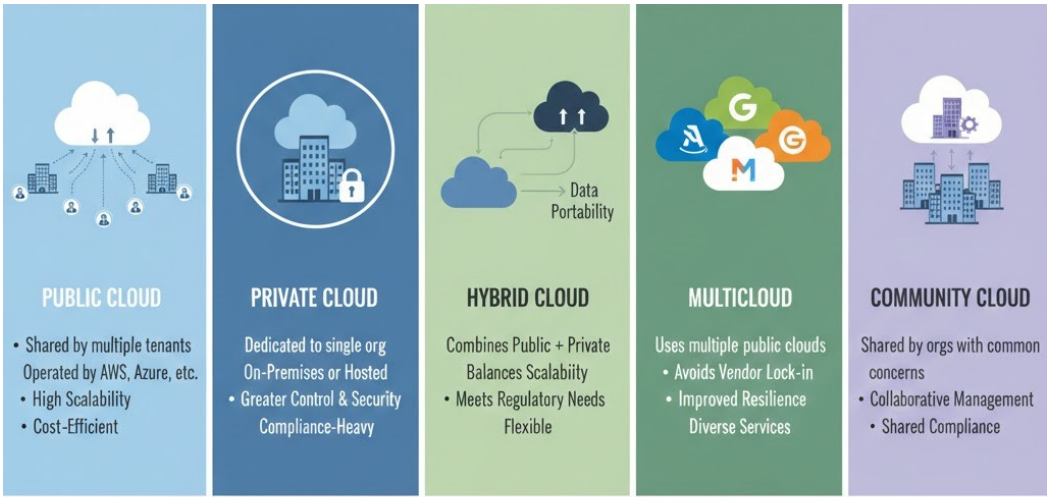



***Fig. 3.2: Types of Cloud Deployment Models (Redraw)***

6. **Public cloud** – Operated by third-party providers like AWS or Azure, resources are shared across multiple tenants. Ideal for scalability and cost-efficiency.
7. **Private cloud** – Dedicated to a single organization, either on-premises or hosted externally. Offers greater control and security, suitable for compliance-heavy environments.
8. **Hybrid cloud** – Combines public and private clouds, enabling data and application portability. Useful for balancing scalability with regulatory requirements.
9. **Multicloud** – Involves using services from multiple public cloud providers to avoid vendor lock-in and improve resilience.
10. **Community cloud** – Shared by several organizations with common concerns, such as industry-specific compliance. Typically managed collaboratively or by a third party.

### 3.1 Public Cloud Model

A cloud infrastructure available to the general public and owned by third-party providers is called as public cloud. It is a commonly adopted cloud model, where the cloud services provider owns the infrastructure and openly provides access to it for the public to consume.

The service provider owns the hardware and supporting networking infrastructure, which is under its full control. The service provider is responsible for the physical security, maintenance, and management of the data center where the infrastructure resides. Therefore, the underlying infrastructure is outside of the customer's control and away from the customer's physical location.

Commonly used public clouds include Microsoft Azure, Amazon AWS, Google Cloud, Oracle Cloud, and Alibaba Cloud as shown in Figure 3.2.


***Fig. 3.2: Global Public Cloud Providers***

***Features:***

- Public cloud is cost-effective and scalable.
- It has a shared infrastructure.
- It is accessible over the internet.

***Advantages of the public cloud model***

- ***Scalability:*** Resources can be scaled according to workload demands.

- ***Cost efficiency:*** aligns costs with actual usage.
- ***Reduced management overhead:*** The provider handles maintenance, updates, and infrastructure reliability
- ***Rapid deployment:*** New environments and applications can be made available.
- ***Flexibility:*** Ideal for variable workloads, testing environments, and disaster recovery solutions

***Disadvantages of the public cloud model***

- ***Security concerns:*** Shared infrastructure increases the security risks
- ***Limited control:*** Less visibility and customization compared to private or on-premises environments
- ***Unpredictable costs:*** Billing is based on usage, so need to be carefully monitored.

***Real life examples of Public Cloud Model***

In Daily Life when you store photos on Google Photos or documents on OneDrive, you're using a public cloud. It is like renting a flat in a large apartment complex — shared infrastructure but private access to your own space. Some of the examples of public cloud are shown in Figure 3.3.

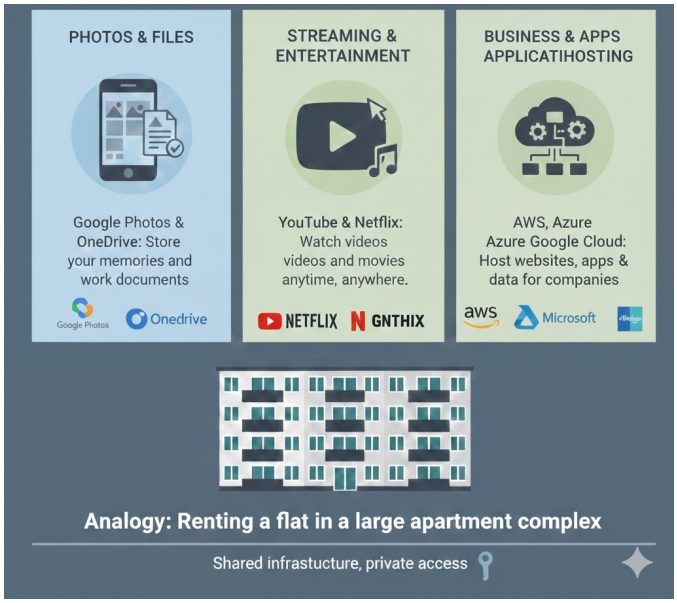



***Fig. 3.3: Real life examples of public cloud model (Redraw)***

***Google Drive, Gmail, YouTube –*** Google's public cloud services available to everyone.

***Amazon Web Services (AWS) –*** Used by startups and companies for hosting websites and apps.

***Microsoft Azure –*** Offers services like virtual machines and online databases to any user or organization.

### 3.2 Private Cloud Model

A cloud infrastructure exclusively used by a single organization is called as private cloud. It is fully owned and managed by a single tenant and can be more easily customized for higher performance. The responsibility to manage the infrastructure is on the part of client which require a large initial investment and skilled workforce to manage it. Examples of private cloud model as shown in Figure 3.4, includes, VMware Cloud, OpenStack-based private clouds.


***Fig. 3.4: Examples of Private Cloud Model***

***Advantages of the private cloud model***

- ***Enhanced security:*** Dedicated infrastructure reduces risks and enhanced the security.
- ***Performance and control:*** Resources are not shared with other others and hence available for every time and have full control to manage configuration, resources, and policies as per the needs
- ***Customization:*** Infrastructure and services can be customized as per the need.
- ***Regulatory compliance:*** Easier to meet industry standards for data residency, privacy, and auditing.

***Disadvantages of the private cloud model***

- ***High upfront cost:*** Significant investment is required for hardware, software, and data centre infrastructure
- ***Complex management:*** Organizations has to handle maintenance, upgrades, and security internally, increasing operational burden
- ***Limited scalability:*** Expanding capacity is slower and more expensive compared to the elasticity of public cloud services

***Features:***

- Private cloud has enhanced security and privacy.
- It has dedicated resources.
- It has higher cost but more control is offered to user.

***Real life examples of Private Cloud Model***

In Daily Life when an organization has its own server or data centre for employees only, it's a private cloud. It is like owning a private bungalow, full control and privacy. Some of the examples of private cloud are shown in Figure 3.5 and explained below that.

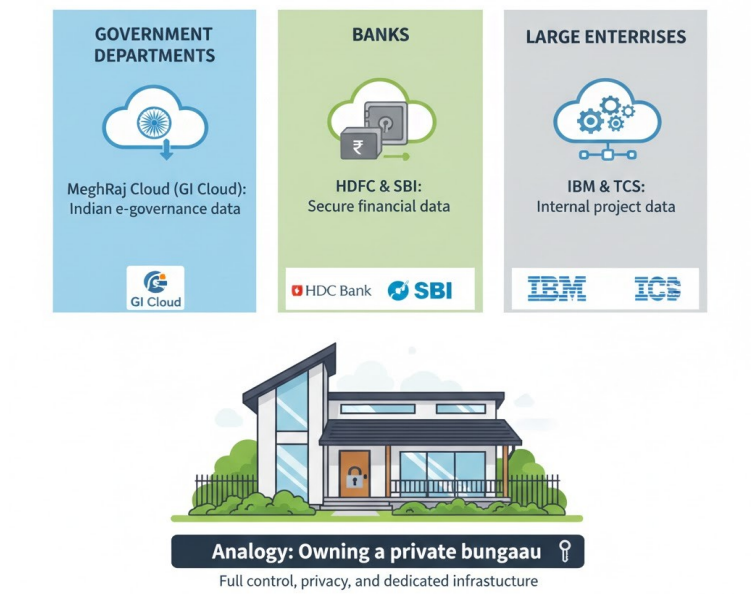



***Fig. 3.5: Real life examples of private cloud model (Redraw)***

***Government Departments*** **–** The Indian government's MeghRaj Cloud (GI Cloud) for e-governance data.

***Banks*** **–** HDFC Bank and SBI use private cloud systems for secure financial data management.

***Large Enterprises*** **–** Companies like IBM and Tata Consultancy Services (TCS) maintain internal private clouds for project data and client information.

### 3.3 Hybrid Cloud Model

Hybrid cloud combines both public and private clouds, allowing data and applications to move between them, as shown in Figure 3.6.

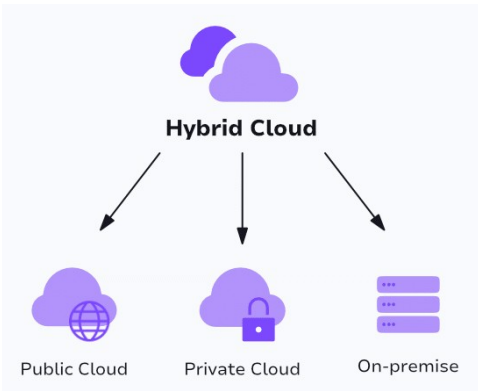



***Fig. 3.6: Hybrid Cloud Model***

It has increasing flexibility & deployment options. For example, applications with strict governance and data security requirements may be hosted in the business's private cloud, whereas applications without these concerns, which need to be scaled on demand, could be hosted in the public cloud.

The benefits of both the public and private cloud can be realized, as well as some of the disadvantages, such as increased management overhead and the initial challenge of setting up a hybrid infrastructure.

In the hybrid model, this can form part of the private cloud. Most businesses strive to alleviate the burden on the existing infrastructure by migrating to the public cloud where possible and effectively utilizing the hybrid deployment model during the migration period.

***Examples:*** Integration of Microsoft Azure (public) with an on-premises private cloud.

***Features:***

- Hybrid cloud has flexibility and optimization.
- Better workload management.
- Balances cost and control.

***Real life examples of Hybrid Cloud Model***

In Daily Life when a company uses public cloud for scalability and private cloud for security, that's hybrid cloud. It is like using both, your own car (private) for daily work and public transport when needed. Some of the examples of private cloud are shown in Figure 3.7 and explained below that.

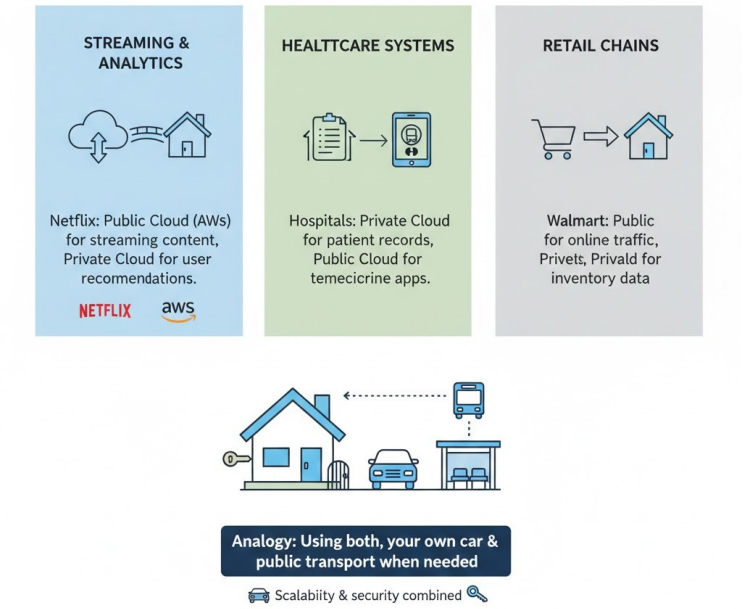



***Fig. 3.7: Real life examples of hybrid cloud model (Redraw)***

***Netflix*** – Uses Amazon Web Services (Public) for streaming content and a Private Cloud for user recommendations and analytics.

***Healthcare Systems*** **–** Hospitals keep sensitive patient records on private clouds and use public clouds for tele-medicine or appointment apps.

***Retail Chains*** **–** Walmart uses hybrid clouds to handle huge online traffic while keeping critical inventory data secure.

### 3.4. Multicloud model

The multicloud deployment model refers to using multiple public cloud providers to increase flexibility and fault tolerance, such as Microsoft Azure, Amazon AWS, and Google Cloud. The private cloud can also be added to the mix to provide extra reliability and flexibility.

Adopting multiple clouds gives a choice from the available options. For example, AWS could be used for production, and Google Cloud could be used for testing.

Multicloud can increase fault tolerance by spreading data and infrastructure between multiple cloud providers. However, with each option introduced, management becomes more complex, and staff requires more skills to fully realize the benefits of a multicloud deployment model.


***Fig. 3.8. Multicloud model***

***Features***

- Reduces reliance on a single provider,
- Workloads distribution across providers,
- Option to choose the best services from different providers to match specific workload requirements
- Requires advanced monitoring, and integration tools increases overall expenses

### 3.5 Community Cloud

The community cloud model is a cloud computing deployment model where infrastructure is shared between several organizations with common

concerns, such as regulatory requirements, security needs, or compliance standards. For example, the education sector could utilize a community cloud to enable a group of scholars and students to share academic content, making joint research easier. Example: Government or university cloud networks.

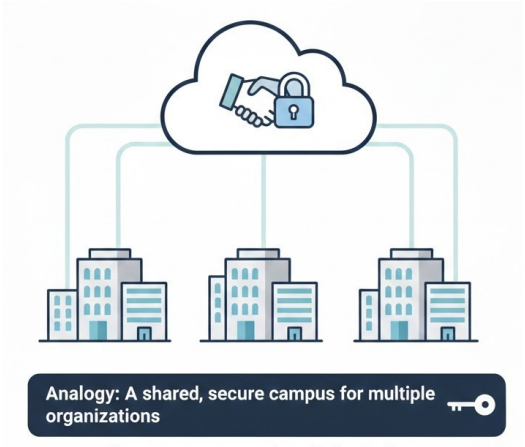



*Fig. 3.9 Community Cloud Model (Redraw)*

***Features:***

- It has shared infrastructure with common goals.
- Community cloud is a collaborative environment.
- Cost of the cloud is distributed among participants.

***Real life examples of Multi Cloud Model***

In Daily Life when a group of organizations with similar goals share a cloud system, it's a community cloud. It is like a cooperative housing society, shared resources, and shared responsibility. Some of the examples of private cloud are shown in Figure 3.10 and explained below that.

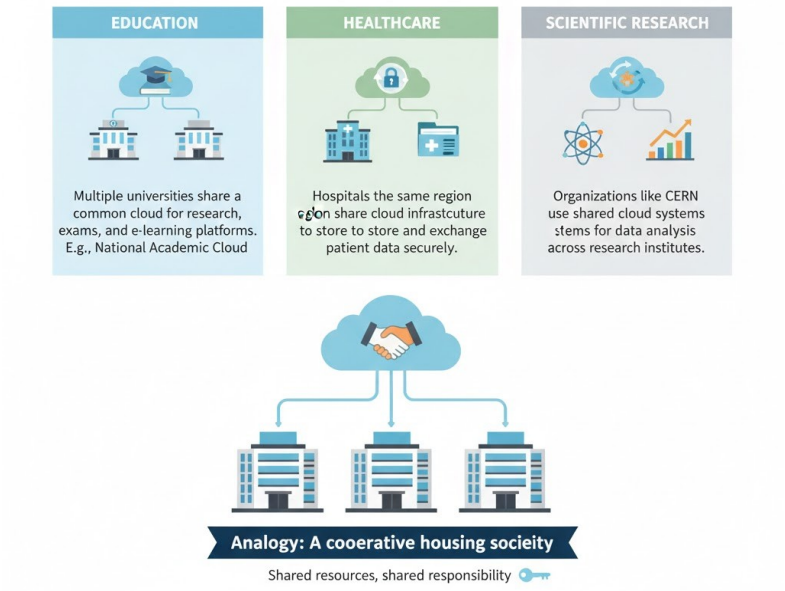



*Fig. 3.7: Real life examples of multi cloud model (Redraw)*

***Education:*** Multiple universities share a common cloud for research, exams, and e-learning platforms such as, National Academic Cloud.

***Healthcare:*** Hospitals in the same region share cloud infrastructure to store and exchange patient data securely.

***Scientific Research:*** Organizations like CERN use shared cloud systems for data analysis across research institutes.

The real life examples of various cloud models are summarised in Table 3.3

***Table 3.3: Real life examples of cloud models***

| **Type of Cloud** | **Access** | **Real-Life Examples** | **Analogy** |
|---|---|---|---|
| Public Cloud | Open for all | Google Drive, AWS, Azure | Public park |
| Private Cloud | Single organization | MeghRaj, HDFC, TCS | Private bungalow |
| Hybrid Cloud | Combination | Netflix, Hospitals, Walmart | Car + Public transport |
| Community Cloud | Shared by group | Universities, Hospitals, CERN | Cooperative society |

**Cloud deployment models comparison**

Table 3.4 shows the comparison of the cloud deployment models, so as to make decision about taking advantage of this modern infrastructure.

***Table 3.4: Comparison of the cloud deployment models***

| **Model** | **What it is** | **Strengths** | **Trade-offs** | **Cost model** | **Best for** | **Examples** |
|---|---|---|---|---|---|---|
| Public | Shared provider cloud | High scalability, pay-as-you-go pricing, low maintenance | Limited control, potential security concerns for sensitive data | OPEX pay-as-you-go | Startups, web apps, dynamic workloads, non-sensitive data | AWS, Microsoft Azure, Google Cloud Platform |
| Private | Single-tenant (on-prem/hosted) | High control, strong security, custom | High cost, complex maintenance | CAPEX + steady OPEX (or dedicate | Finance, healthcare, government, or | VMware Private Cloud, OpenStack |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | compliance | | d subscription) | any regulated environment | |
| Hybrid | Private + public combined | Flexibility, cost optimization, data locality | Complex integration, management overhead | Mixed CAPEX/ OPEX | Enterprises needing both control and scalability | Azure Arc, AWS Outposts |
| Multicloud | 2+ public clouds | Avoids vendor lock-in, optimizes performance | Increased complexity, higher governance needs | OPEX across providers | Organizations prioritizing resilience, performance, or service diversity | Combining AWS for compute and GCP for AI |
| Community | Shared by similar orgs | Shared cost, targeted compliance, collaborative focus | Limited scalability, shared control | Shared subscription/chargeback | Institutions with similar missions and security requirements | Government or healthcare consortium clouds |

**Use case examples**

Here are real-world use case examples for each cloud deployment model, illustrating how different industries apply them based on their operational and regulatory needs:

***Table 3.5 : Use case examples of cloud models***

| Cloud Model | Use case | Justification |
|---|---|---|
| Public cloud | A SaaS startup launches a web-based project | They need fast deployment, global reach, and low upfront |

| | | |
|---|---|---|
| | management tool using AWS Elastic Beanstalk. | costs. Public cloud allows them to scale with demand without managing infrastructure. |
| Private cloud | A national bank runs core banking systems in a VMware-based private cloud hosted in its data centers. | Strict data residency and compliance requirements mandate full control over infrastructure and sensitive customer data. |
| Hybrid cloud | A retail chain processes in-store transactions on-premises and uses Azure for analytics and backup. | Strict data residency and compliance requirements mandate full control over infrastructure and sensitive customer data. |
| Multicloud | A retail chain processes in-store transactions on-premises and uses Azure for analytics and backup. | Each cloud is chosen for its specific strengths, reducing dependency on one provider and optimizing performance |
| Community cloud | A group of European healthcare providers collaborates through a shared cloud environment for clinical data exchange, built to meet GDPR and regional health standards. | They share similar compliance needs and benefit from a cost-effective, jointly managed infrastructure. |

## Summary

In this session, students learn about the different types of cloud deployment models—Public Cloud, which is accessible to everyone (such as Google Drive); Private Cloud, which is used by a single organization for greater control and security; and Hybrid Cloud, which combines both public and private cloud features. The session also introduces the three main cloud service models: SaaS (Software as a Service), where users can access software applications online; PaaS (Platform as a Service), which allows developers to create and manage applications online; and IaaS (Infrastructure as a Service), where users can rent computing resources like servers and storage. By the end of this session, students are able to identify different cloud deployment types, differentiate between service models, and understand their practical uses in real-life scenarios.

## Check your progress

### A. Multiple Choice Questions (MCQs)

1. Which cloud model is owned and operated by third-party providers and shared among users? (a) Private Cloud (b) Public Cloud (c) Hybrid Cloud (d) Community Cloud
2. A bank using its own dedicated infrastructure for secure financial data is an example of: (a) Public Cloud (b) Multicloud (c) Private Cloud (d) Community Cloud
3. Which cloud model combines both public and private clouds? (a) Community Cloud (b) Hybrid Cloud (c) Multicloud (d) Private Cloud
4. Using services from AWS, Google Cloud, and Azure together is called: a) Hybrid Cloud (b) Public Cloud (c) Multicloud (d) Community Cloud
5. A cloud shared by organizations with similar goals (e.g., universities) is known as: (a) Public Cloud (b) Community Cloud (c) Private Cloud d) Hybrid Cloud
6. Which of the following is a key advantage of the public cloud? (a) High upfront investment (b) Limited scalability (c) Cost efficiency and scalability (d) Dedicated infrastructure
7. Which model offers the highest level of control and customization? (a) Public Cloud (b) Private Cloud (c) Community Cloud (d) Multicloud
8. Avoiding dependence on a single cloud provider is the main goal of: (a) Hybrid Cloud (b) Multicloud (c) Private Cloud (d) Public Cloud

### B. Fill in the Blanks

1. A cloud infrastructure exclusively used by one organization is called a _____ cloud.
2. Public cloud services are accessed over the _____.
3. Hybrid cloud provides a balance between _____ and control.
4. Multicloud helps reduce _____ lock-in.
5. Community cloud is shared by organizations with common _____.
6. AWS, Google Cloud, and Microsoft Azure are examples of _____ cloud providers.
7. Private cloud usually requires a high _____ investment.
8. Hybrid cloud allows _____ of data and applications between environments.

### C. True or False

1. Public cloud infrastructure is owned by the customer.
2. Private cloud provides enhanced security and dedicated resources.

3. Hybrid cloud uses only one cloud environment.
4. Multi-cloud improves flexibility by using multiple providers.
5. Community cloud is designed for unrelated organizations with no shared concerns.
6. Public cloud reduces management responsibility for users.
7. Private cloud is always cheaper than public cloud.
8. Hybrid cloud is useful for organizations needing both scalability and data security.

**D. Short Answer Questions**

1. Define a cloud deployment model.
2. Give two examples of public cloud services used in daily life.
3. Why do banks prefer private cloud?
4. What is the main advantage of hybrid cloud?
5. How does multicloud improve reliability?
6. Give one real-life example of a community cloud.
7. Write one advantage and one disadvantage of public cloud.
8. Differentiate between Public Cloud and Private Cloud (any two points).

## Session 4. Cloud Tools for Communication and Storage

At the School of Computer Science, a group of students — Riya, Aarav, Meena, and Kabir — were given a group project titled "The Impact of Cloud Computing in Daily Life." Instead of meeting every day in person, they decided to complete the entire project using cloud tools.

Riya created a shared folder on Google Drive named "***Smart Class Cloud Project"***. She uploaded reference articles, images, and notes there. Aarav wrote the main report using Google Docs so that everyone could edit and add information in real time. Meena prepared slides in Google Slides, embedding videos from YouTube about cloud computing. Kabir scheduled their weekly progress meetings on Zoom to discuss updates. So everyone uses a different cloud tool to do the project. Figure 4.1 illustrates this scenario. In this session we will discuss about different cloud based tools.

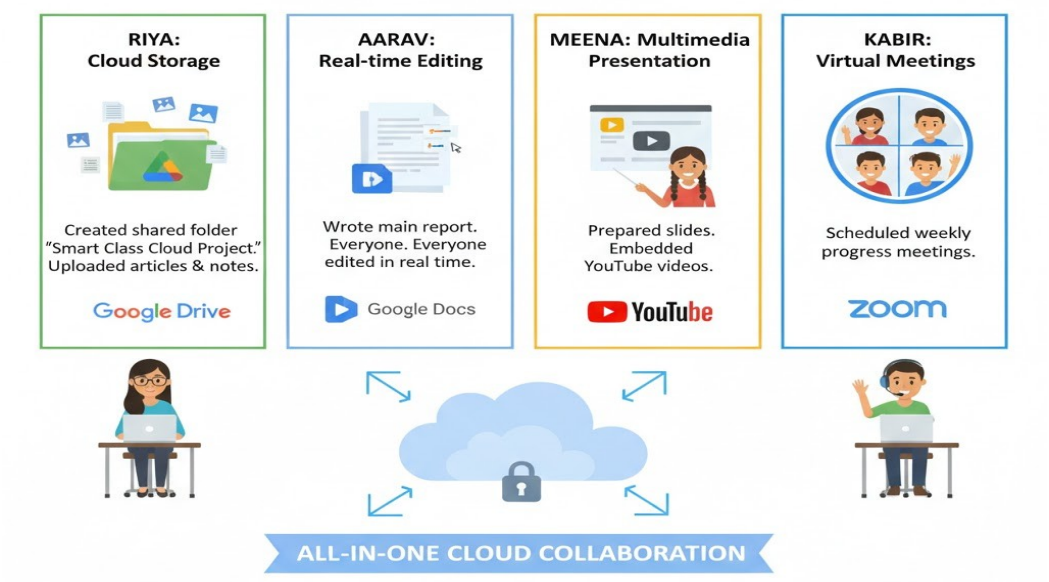



***Fig. 4.1: Collaborative Student Project Using Cloud Tools***

### Cloud Tools and Safe Cloud Practices

Cloud tools are online applications that store and process data on the internet rather than on a personal computer. They enable users to access files, communicate, and collaborate from anywhere using any device with an internet connection.

***Common Cloud Tools:***

***Gmail:*** It is a cloud-based email service by Google. It allows users to send, receive, and organize emails, and access them from any device.

***Example:*** Students can submit assignments or communicate with teachers via Gmail.

**Google Drive:** An online storage service that lets users upload, store, and share files such as documents, images, videos, and presentations.

**Example:** Teachers can store study materials and share them with students through links.

**Google Docs:** A cloud-based word processing tool that allows multiple users to work on the same document at the same time.

**Example:** Group projects where several students edit the same file simultaneously.

**YouTube:** A video-sharing platform hosted on the cloud where users can upload, watch, and share educational or entertainment videos.

**Example:** Watching tutorials, lectures, and educational content online.

**Zoom:** A cloud-based video conferencing tool used for online meetings, classes, and webinars.

**Example**: Conducting virtual classrooms and discussions in real-time.

Figure 4.2 shows some common cloud tools.

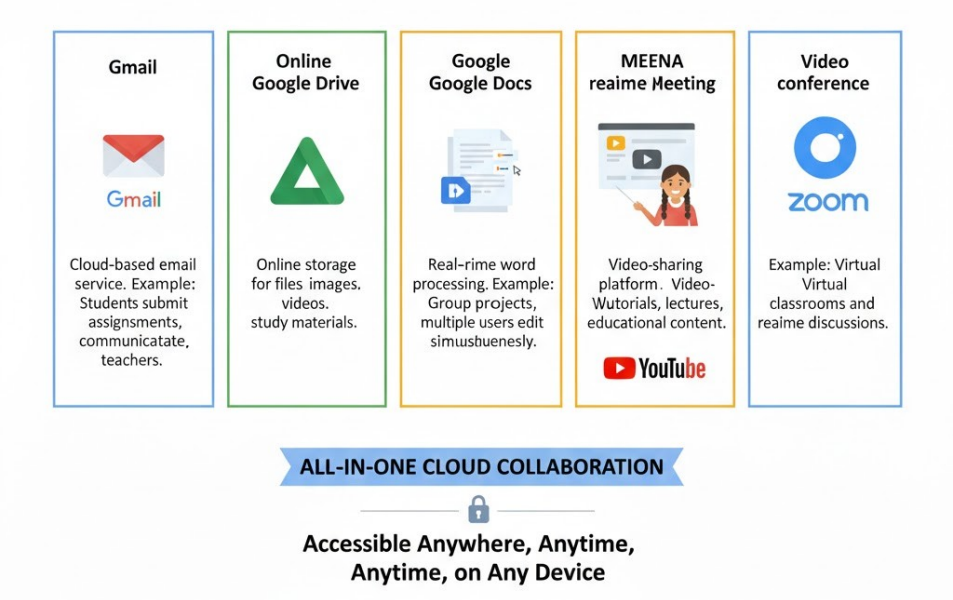



***Fig. 4.2: Common Cloud Tools (Redraw)***

**File Upload, Sharing, and Collaboration Basics**

***File Upload:*** Uploading a file means transferring it from your local computer to a cloud storage platform like Google Drive or OneDrive. Once uploaded, files are stored securely and can be accessed anytime.

***File Sharing:*** Cloud platforms allow users to share files or folders with others via links or email invitations. You can control who can view, comment, or edit your files.

***Example:*** A teacher can share notes as "View only" while allowing editing for group assignments.

***Collaboration:*** Cloud tools enable real-time collaboration where multiple users can work on the same file together. Changes are saved automatically and instantly visible to all contributors.

***Example:*** Students preparing a joint presentation using Google Slides.

***Responsible and Safe Cloud Practices***

Using the cloud wisely ensures data safety, privacy, and digital responsibility.

***Best Practices:***

- ***Use Strong Passwords:*** Protect accounts with unique, complex passwords and enable two-factor authentication.
- ***Check Sharing Settings:*** Always review who has access before sharing a file or document.
- ***Avoid Public Wi-Fi for Sensitive Data:*** Use secure networks while uploading or downloading important files.
- ***Backup Important Data:*** Keep a local copy of critical documents in case of accidental deletion or service outages.
- ***Be Aware of Privacy Policies:*** Understand how cloud service providers store and use your data.
- ***Log Out from Shared Devices:*** Especially when using public computers in schools or labs.
- ***Report Misuse:*** If you see inappropriate content or misuse of shared data, report it immediately.

| **Concept** | **Description** | **Example** |
|---|---|---|
| Cloud Tools | Online applications that work via the Internet | Gmail, Drive, Docs, Zoom |
| Upload | Sending files from your device to the cloud | Uploading assignments |
| Sharing | Giving access to others with specific permissions | Teacher sharing study notes |
| Collaboration | Working together on cloud documents | Group project in Google Docs |
| Safe Practices | Responsible use to protect data | Strong passwords, secure sharing |

Cloud computing tools simplify our work, learning, and communication. However, it's equally important to use them safely and responsibly to protect personal and institutional data.

**Practical Activity 1.1. Exploring Cloud Tools for Collaboration**

**Material Required**

- Computer/Laptop or Smartphone
- Internet connection
- Google Account / Microsoft Account
- Cloud tools such as: Google Docs, Google Drive, Google Slides, Microsoft OneDrive, Microsoft Teams (optional)

**Procedure**

**Step 1. Accessing Cloud Storage**

- Open a web browser.
- Go to **Google Drive (drive.google.com)** or **OneDrive (onedrive.live.com)**.
- Log in using your account credentials.

**Step 2. Creating a Document**

- Click on **"New"** in Google Drive.
- Select **Google Docs**.
- Create a new document and type a short paragraph on any topic (e.g., "Importance of Technology in Education").

**Step 3. Sharing the Document**

- Click on the **"Share"** button.
- Enter the email addresses of your classmates.
- Set permission: Viewer, Commenter, Editor
- Click **Send**.

**Step 4. Real-Time Collaboration**

- Ask your classmates to open the shared document.
- Observe multiple users editing at the same time.
- Use the **Comment** feature to give suggestions.
- Use the **Chat option** (if available) to communicate.

**Step 5.** Demonstrate Communication through Gmail or Zoom

Via Gmail:

- Compose a new email.
- Attach or link the Google Drive file.

- Write: “Hi team, please update your section in the shared document.”

Via Zoom:

- Schedule a meeting and share the invite link.
- Discuss project updates and divide tasks.

**Step 6.** Set Permissions (View/Edit)

In the Google Drive file:

- Click Share → under “General access,” choose:
- Viewer: can only read.
- Editor: can edit content.
- Example: Give Riya Editor access, give Aarav Viewer access.

**Step 7. Exploring Version History**

- Click on **File** → **Version History** → **See Version History**.
- Observe the changes made by different users.
- Restore a previous version if required.

**Step 8. Creating a Collaborative Presentation**

- Create a **Google Slides** presentation.
- Assign each group member one slide to complete.
- Add text, images, and animations.
- Present the slides together.

**Step 9.** Discuss Safe Cloud Habits

- Use strong, unique passwords (combine letters, numbers, and symbols).
- Turn on 2-Step Verification in Google Account.
- Never share confidential info on open links.
- Review shared files regularly and remove unnecessary access.
- Log out after using public or shared computers.

## Summary

This session focuses on practical use of cloud tools such as Gmail, Google Drive, Google Docs, and Zoom. Students learn how to upload, store, share, and collaborate on files. It also emphasizes teamwork through real-time editing and communication. Basic safety practices like strong passwords and controlling sharing permissions are discussed.

## Check your progress

### A. Multiple Choice Questions (MCQs)

1. Cloud tools store data primarily on (a) Personal computer (b) Internet servers (c) USB drives (d) Printed documents
2. Which cloud tool is mainly used for sending and receiving emails? (a) Google Drive (b) Gmail (c) YouTube (d) Zoom
3. Uploading a file means (a) Deleting a file permanently (b) Sending a file from local device to cloud (c) Printing a document (d) Saving a file offline
4. Which tool allows multiple users to edit the same document at the same time? (a) Google Docs (b) Gmail (c) YouTube (d) Paint
5. Zoom is mainly used for (a) Video conferencing (b) File storage (c) Image editing (d) Gaming
6. Sharing settings help users to (a) Delete files automatically (b) Control who can view or edit files (c) Increase internet speed (d) Block the cloud
7. A strong password should include (a) Only letters (b) Only numbers (c) Letters, numbers, and symbols (d) Your name only
8. Collaboration in cloud computing means (a) Working alone (b) Working together online (c) Storing files offline (d) Printing documents

### B. Fill in the Blanks

1. Cloud tools are online applications that work through the _____.
2. _____ is an online storage service used to store and share files.
3. Sending a file from your device to the cloud is called _____.
4. _____ allows users to schedule online meetings.
5. Working together on the same document is called _____.
6. We should always use _____ passwords to protect accounts.
7. Google _____ is used to create documents online.
8. Always _____ from shared devices after using cloud services.

### C. True or False

1. Cloud computing requires users to store all data on their personal computers.
2. Google Drive allows users to share files using links.
3. Public Wi-Fi is always safe for sharing sensitive data.
4. Collaboration allows multiple users to work on the same file simultaneously.
5. YouTube can be used as a cloud-based learning platform.

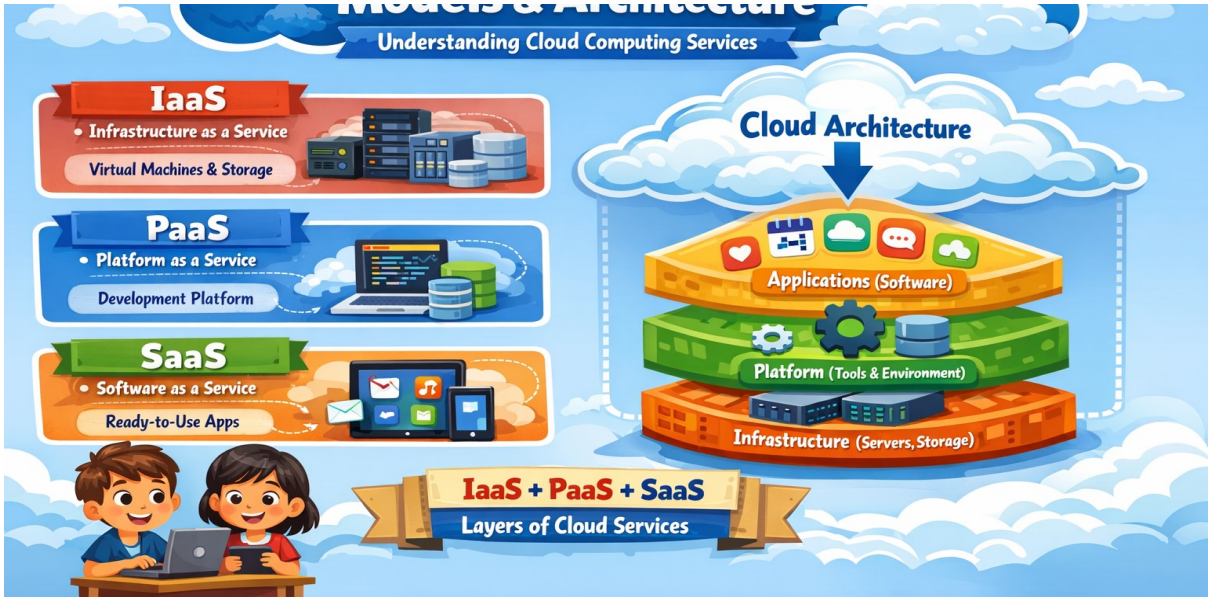
6. Two-factor authentication improves account security.
7. Files uploaded to the cloud cannot be accessed later.
8. Logging out from shared computers is a safe practice.

**D. Short Answer Questions**

1. What are cloud tools? Give two examples.
2. Explain the term file sharing in cloud computing.
3. How does cloud collaboration help students in group projects?
4. What is the use of Google Drive?
5. Why should we avoid using public Wi-Fi for sensitive work?
6. What are two safe practices for using cloud services?
7. Differentiate between Viewer and Editor permissions.
8. How does Zoom help in communication?

# Module 2. Cloud Service Models & Architecture

This module introduces cloud service models—Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS)—and explains how cloud systems are structured and function. It develops understanding of different levels of control, real-world applications, and the basic architecture that enables cloud-based services over the Internet.



# Session 1. Introduction to Cloud Service Models

It is Monday morning at Sunrise Public School, Pune. Priya rushes into the computer lab, panicking — her home computer crashed last night and she could not save her group science report. Her friend Aarav calmly opens a browser, signs in with Priya's school account, and the entire report appears — perfectly intact. "It was in Google Docs," Aarav grins, "saved on Google's servers far away." Teacher Dr. Meena walks over: "What you just experienced is a cloud service. The storage, the software, even the editing app — none of it lives on your machine. It all runs as a service over the Internet." Figure 1.1 illustrates how Priya's device connects through the Internet to Google's cloud servers to retrieve her work.

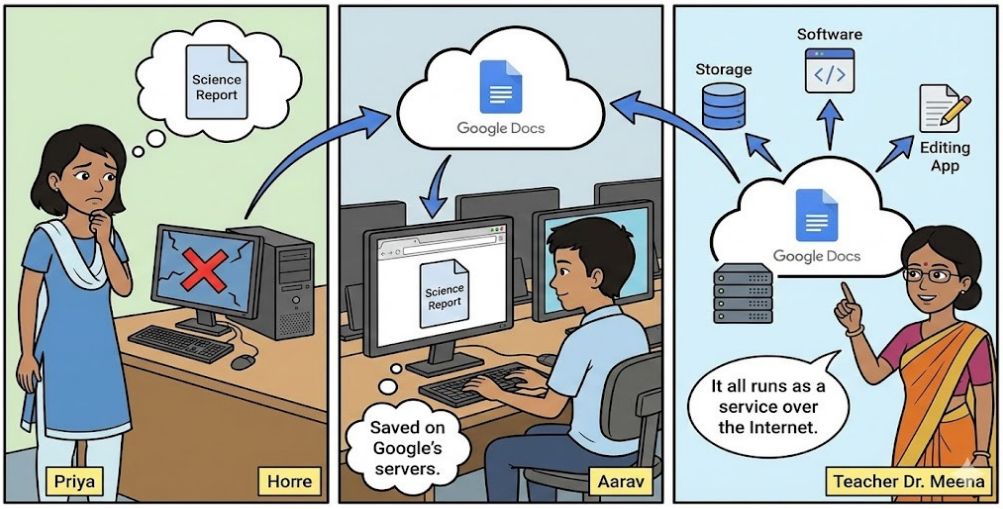



***Fig. 1.1: A real-world example of Cloud Service***

## 1.1 Introduction

Cloud computing lets users access computing resources — storage, software, and processing power — over the Internet instead of installing and maintaining everything locally. Cloud service models define how services are packaged and who is responsible for what. The three universally recognised models are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Each offers a different balance of control and convenience.

## 1.2 Cloud Service

Cloud service is a computing resource — storage, software, or processing power available over the Internet on demand, without the user owning or managing the physical hardware.

***Example:*** Google Drive, you access storage on Google's servers from any device, without owning a single hard disk.

Table 1.1 lists the NIST characteristics that define any true cloud service.

***Table 1.1: Key Characteristics of Cloud Services***

| # | Characteristic | What It Means (School Example) |
|---|---|---|
| 1 | On-demand provisioning | Create or remove resources instantly — like adding seats in a digital classroom with one click. |
| 2 | Broad network access | Accessible from any device via Internet — open Google Classroom on phone or laptop equally. |
| 3 | Resource pooling | Provider's servers are shared across many users; each user's data stays private. |
| 4 | Rapid elasticity | Scale up on exam result day; scale down the next day automatically. |
| 5 | Measured service | Pay only for what you use — like an electricity meter, not a flat annual fee. |

## 1.3 Need of Cloud Services

Traditional on-premises computing requires a school to buy servers, hire IT staff, take manual backups, and replace ageing hardware — all representing heavy capital expenditure (CAPEX). Cloud services eliminate most of this by shifting costs to pay-as-you-go operational expenditure (OPEX) and handing maintenance to the provider. Table 1.2 shows the key differences.

***Table 1.2: Traditional Computing vs. Cloud Services***

| Feature | Traditional (On-premises) | Cloud Services |
|---|---|---|
| Cost model | High upfront CAPEX | Pay-as-you-go OPEX |
| Maintenance | In-house IT team | Provider-managed |
| Scalability | Slow — buy new hardware | Instant — provision on demand |
| Accessibility | Local network only | Global via Internet |
| Backup | Manual / local | Automated, geo-redundant |

## 1.4 Cloud Service Models

The three models form a stack: IaaS at the bottom provides raw infrastructure; PaaS in the middle adds a managed development platform on top of IaaS; SaaS at the top delivers a complete application. The higher the layer, the more the provider manages and the less technical skill the user needs. Figure 1.2 shows this layered view with a food-ordering analogy: each layer adds provider management and reduces user responsibility.


***Fig. 1.2: Model Stack: IaaS → PaaS → SaaS***

### 1.5 Infrastructure as a Service (IaaS)

IaaS provides fundamental virtualised computing resources — virtual machines, storage, and networks — over the Internet. The user controls the OS and all software; the provider manages the physical hardware and virtualisation layer.

***Example:*** A university rents cloud virtual machines (VMs), installs a custom Linux OS and research software — without buying a single physical server.

A hypervisor runs on physical servers to create multiple isolated VMs. Users choose the OS, configure networks, install applications, and manage security at the OS level. Table 1.3 shows the responsibility split.

***Table 1.3: Responsibility Matrix — IaaS***

| Component | Provider ✔ | User ✔ |
|---|---|---|
| Physical hardware & data centre | ✔ | ✖ |
| Hypervisor / virtualisation | ✔ | ✖ |
| VM operating system | ✖ | ✔ |
| Applications & middleware | ✖ | ✔ |
| Data, backups, network (inside VM) | ✖ | ✔ |

***Advantages:*** Full control, flexible OS choice, no hardware cost.

***Considerations:*** Requires admin skills; OS and app security is entirely the user's job.

### 1.6 Platform as a Service (PaaS)

PaaS delivers a complete managed environment — OS, runtime, databases, and middleware — over the Internet. The developer deploys only application code; the platform handles running, scaling, and monitoring.

***Example:*** Kabir pushes his Python code to Google App Engine; the platform deploys it, scales it for 10,000 users, and restarts it on crashes — Kabir never touches a server.

***Table 1.4: Responsibility Matrix — PaaS***

| Component | Provider ✔ | Developer ✔ |
|---|---|---|
| Physical infra, OS & runtime | ✔ | ✖ |
| Managed databases & middleware | ✔ | ✖ |
| Application code & business logic | ✖ | ✔ |
| Application data & content | ✖ | ✔ |

***Advantages:*** Faster development, no OS patching, integrated services.

***Considerations:*** Risk of vendor lock-in; limited low-level configuration.

### 1.7 Software as a Service (SaaS)

SaaS delivers a fully functional application over the Internet via a browser or mobile app. The provider manages everything — infrastructure, software, updates, and security. The user only controls settings and data.

***Example:*** Priya opens Google Docs in a browser, creates a document, and collaborates with Aarav in real time — no software installed, no server configured.

***Table 1.5: Responsibility Matrix — SaaS***

| **Component** | **Provider ✔** | **User ✔** |
|---|---|---|
| Infrastructure, platform & application | ✔ | ✖ |
| Security patches & feature updates | ✔ | ✖ |
| User preferences & configuration | ✖ | ✔ |
| User data & content | ✖ | ✔(backup policy varies) |

***Advantages:*** Zero setup, immediate access, auto-updates.

***Considerations:*** Requires Internet; limited customisation; check data privacy policies.

### 1.8 Basic Cloud Architecture

Every cloud application connects your front-end device to a back-end cloud system through the Internet. Figure 1.3 shows these layers. When Priya opens an online quiz, her browser (front-end) sends a request → the API Gateway

checks her identity → the Application Server gets quiz data from the Database → the response returns to her browser in milliseconds.

Cloud architecture has several important layers:

***Front-end Layer (User Side)***

This is the part you use directly. It includes web browsers, mobile apps, and desktop applications. It acts as the user interface.

***Example:*** When you open Google Classroom in Chrome, Chrome is the front-end.

***API and Gateway Layer (Security and Entry Point)***

This layer works like a security gate. It checks your login, verifies your identity, and controls access. It also prevents misuse by limiting too many requests.

***Example:*** When you enter your Gmail password, this layer verifies it before allowing access.

***Application Layer (Processing Layer)***

This layer contains application servers. These servers process your request and perform the main task.

***Example:*** When you open an online quiz, this layer prepares the quiz questions for you.

***Data Layer (Storage Layer)***

This layer stores and manages data. It includes databases, file storage, and cache systems.

***Example:*** Your quiz questions, answers, and scores are stored in databases.

***Infrastructure Layer (Foundation Layer)***

This layer includes virtual machines, networking, load balancers, and security systems. It provides the computing power and connectivity needed to run applications.

***Example:*** This layer ensures the quiz system works smoothly even when many students use it.

***Operational Layer (Management Layer)***

This layer monitors system health, records activity logs, manages updates, and tracks usage for billing.

***Example:*** Cloud architecture works like a restaurant system:

- You (front-end) place an order.
- The waiter (API Gateway) checks and forwards the order.
- The kitchen (Application Layer) prepares the food.
- The storage room (Data Layer) provides ingredients.

- The building and utilities (Infrastructure Layer) support everything.
- The manager (Operational Layer) monitors and manages operations.

This layered design makes cloud applications fast, secure, and reliable.

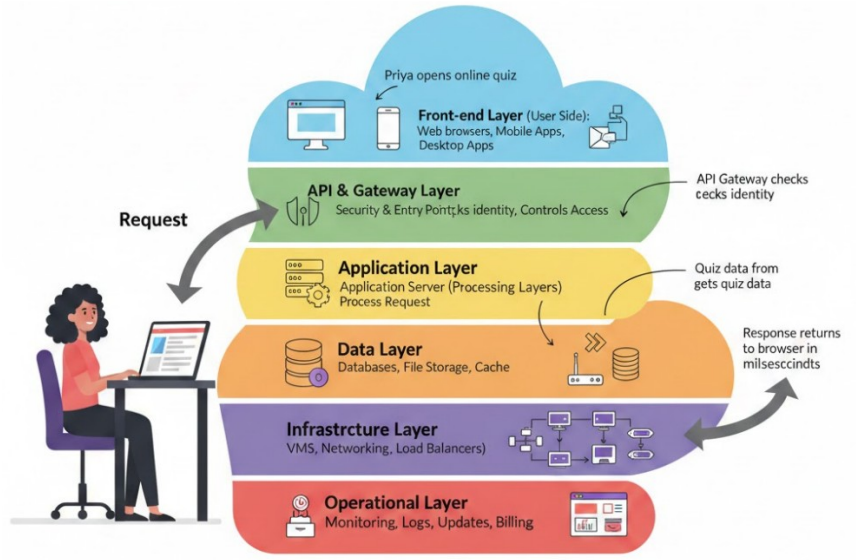



***Fig. 1.3: Data flow through a cloud application's layered architecture (Redraw)***

## 1.9 Comparison of Service Models

Table 1.6 compares IaaS, PaaS, and SaaS across practical decision factors.

***Table 1.6: Comparison of Cloud Service Models***

| **Dimension** | **IaaS** | **PaaS** | **SaaS** |
|---|---|---|---|
| Control level | High (OS + apps) | Medium (apps only) | Low (use only) |
| Typical user | Sysadmin/DevOps | App developer | End user (student, staff) |
| Technical skill | High | Medium | Low |
| Time to deploy | Medium | Short | Immediate |
| Scalability | User-configured | Platform-managed | Provider-managed |
| Examples | VM, object storage | App Engine, Heroku | Gmail, Classroom, Zoom |

## 1.10 Real-World Applications

Cloud service models are applied across sectors. The following short paragraphs explain typical applications and explain which service model they use.

***Education:*** Schools use SaaS for email and online classrooms. Universities use IaaS for virtual labs. Students use PaaS to run programming projects easily.

***Business:*** Small businesses use SaaS for accounting and payroll. Startups use PaaS to build apps faster and IaaS to host their services.

***Everyday Life:*** You use SaaS for photo backup, video streaming, and online document editing.

Table 1.7 maps common services you already use to their cloud model.

***Table 1.7: Real-World Cloud Service Examples***

| **Service / App** | **Model** | **Why** |
|---|---|---|
| Gmail, Google Docs, Outlook | SaaS | Complete apps in browser; no installation |
| Google Meet, Zoom | SaaS | Ready-to-use video conferencing |
| Google App Engine, Heroku | PaaS | Deploy code without managing OS |
| Amazon EC2, Google Compute Engine | IaaS | Rent VMs with full OS control |
| Google Cloud Storage / Amazon S3 | IaaS | Raw object storage via APIs |
| Google Classroom, MS Teams Edu | SaaS | Delivered LMS for students/teachers |
| MeghRaj / GI Cloud (India) | IaaS+PaaS | Govt. cloud for Indian public sector |

## 1.11 The Shared Responsibility Model

Shared responsibility model divides security tasks between provider and customer. The provider secures the cloud infrastructure; the customer secures what they put into the cloud.

Example: Like a flat in an apartment building — the building society secures the entrance gate; you must lock your own flat door.

Table 1.8 shows how responsibility shifts across models.

***Table 1.8: Security Responsibilities by Service Model***

| **Security Area** | **IaaS** | **PaaS** | **SaaS** |
|---|---|---|---|
| Physical data centre & hypervisor | Provider | Provider | Provider |
| OS patching | Customer | Provider | Provider |
| Application security | Customer | Customer | Provider |
| Data encryption | Customer | Customer | Provider |

| | | | |
|---|---|---|---|
| | configures | configures | offers; Customer enables |
| Identity & Access Management (IAM) | Customer | Customer | Customer |

**Key rule:** IAM is always the customer's responsibility, regardless of the service model. Never share your login credentials.

**Practical Activity 1.1. Classify Cloud Services**

**Objective:** Correctly identify whether a service is IaaS, PaaS, or SaaS and justify the classification.

**Materials:** Notebook, pen, this textbook (optional: any Internet-connected device).

**Theory:** Ask: Does the user install an OS? → IaaS. Deploy code only? → PaaS. Just open and use an app? → SaaS.

**Procedure**

**Step 1.** Draw a 3-column table: Service Name | Model | Reason.

**Step 2.** Read the 8 services listed below, one by one.

**Step 3.** Apply the theory question above to decide the model.

**Step 4.** Fill in your classification and a one-sentence reason.

**Step 5.** Compare with a classmate and check against Table 3.1.7.

Services to classify: Gmail | Google Docs | Amazon EC2 | Google App Engine | YouTube | Google Cloud Storage | Microsoft Teams | Zoom

**Observation Table**

| # | Service Name | Model (IaaS/PaaS/SaaS) | Reason |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |

**Result:** Services where users install an OS = IaaS; deploy code = PaaS; just open and use = SaaS.

**Conclusion:** The key question is always: how much does the user manage? More management = IaaS; code only = PaaS; pure usage = SaaS.

**Practical Activity 1.2.** Scenario Decisions — Cloud, PC, or Hybrid?

**Objective:** Apply cloud model knowledge to real-life scenarios and choose the best computing approach.

**Material Required**

- Notebook and pen

**Procedure**

**Step 1.** Read each scenario below.

**Step 2.** Decide: Cloud Service / Home-School PC / Hybrid. Write your choice.

**Step 3.** Write 1–2 sentences justifying your decision.

**Step 4.** Discuss disagreements in a group and share two answers with the class.

**Scenarios**

- Aarav and three classmates in different parts of Pune need to write and edit a report simultaneously.
- Priya lost all study notes when her hard disk crashed — she wants to prevent this from happening again.
- Kabir's startup needs to deploy a web app for 10,000 users but has no server management skills.
- Dr. Meena needs to run a 3-day data analysis job — but only once.
- A bank must keep customer records inside India under its direct control for regulatory reasons.

**Observation Table**

| # | Scenario (brief) | Your Choice | Justification |
|---|---|---|---|
| 1 | Group report, different locations | | |
| 2 | Hard disk crash — data loss | | |
| 3 | Deploy app, no server skills | | |
| 4 | Heavy compute, one-time job | | |
| 5 | Regulated bank data — India only | | |

**Conclusion:** Collaboration, accessibility, and scalability favour cloud. Strict data residency or offline needs may favour local or hybrid approaches.

## Summary

In this session, you learned that cloud services provide computing resources over the Internet whenever needed. Cloud computing reduces high hardware costs and follows a pay-as-you-use model. The three service models — IaaS, PaaS, and SaaS — offer different levels of control and management. You also understood that security is a shared responsibility between the cloud provider and the user.

**Key Terms:** Cloud service, IaaS, PaaS, SaaS, CAPEX, OPEX, elasticity, shared responsibility.

## Check Your Progress

### A. Multiple Choice Questions

1. A student uses Google Docs without installing any software. This is an example of:
   (a) IaaS (b) PaaS (c) SaaS (d) Hybrid
2. A developer uploads code and the platform manages everything else. This represents:
   (a) IaaS (b) PaaS (c) SaaS (d) Private Cloud
3. A company rents virtual machines and installs its own OS. This is:
   (a) SaaS (b) PaaS (c) IaaS (d) Community Cloud
4. Paying only for the resources used is called:
   (a) CAPEX (b) OPEX (c) Manual billing (d) Fixed pricing
5. Which model requires the least technical knowledge?
   (a) IaaS (b) PaaS (c) SaaS (d) Hybrid

### B. Fill in the Blanks

1. IaaS provides _____ resources like virtual machines and storage.
2. In PaaS, developers focus only on _____.
3. SaaS applications are accessed through a _____.
4. Cloud services follow a _____-as-you-go model.
5. The provider manages hardware in _____ model.

### C. True or False

1. In SaaS, users manage the infrastructure.
2. PaaS reduces the need for managing operating systems.
3. IaaS gives maximum control to the user.
4. Cloud services require buying physical servers.
5. Security is only the provider's responsibility.

### D. Short Answer Questions

1. What is a cloud service?

2. Name the three cloud service models.
3. Give one example of SaaS.
4. What is the main benefit of PaaS?
5. Who manages hardware in IaaS?

## Session 2. Infrastructure as a Service (IaaS)

Meera runs an online coaching institute and bought her own physical servers. One day, during admission season, her servers crashed and her website stopped working.

Her friend Kabir uses cloud servers instead. He adds more servers when traffic increases and removes them later. He pays only for what he uses.

Meera then learned about Infrastructure as a Service (IaaS). Figure 2.1 shows the difference between owning servers and using cloud servers.

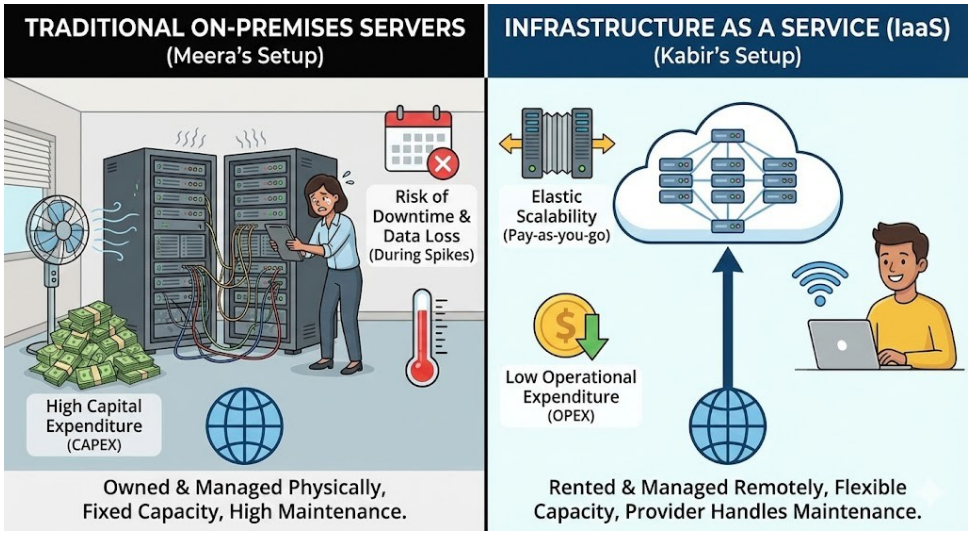



***Fig. 2.1: Traditional on-premises servers vs. IaaS (Redraw)***

### 2.1 Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) is a cloud service model that provides virtualised computing resources — virtual machines, storage, and networking — over the Internet. The cloud provider owns and manages all physical hardware; the user rents only what is needed and controls the operating system and applications.

***Example:*** Renting a fully equipped office cabin in a business centre instead of buying land and constructing a building. The building owner handles electricity, security, and maintenance — you just run your business inside.

In traditional computing, an organisation must purchase servers, storage devices, networking cables, routers, and switches. All this hardware sits in a dedicated room (called a data centre), and the organisation pays for electricity, cooling, maintenance, and IT staff — regardless of whether the hardware is being used or sitting idle. IaaS eliminates this by letting organisations rent virtual equivalents of all this hardware through the Internet, paying only for what they consume, just like a monthly electricity bill rather than buying a power plant.

The responsibility boundary in IaaS is clear. Table 2.1 shows which tasks belong to the provider and which belong to the user.

***Table 2.1: IaaS Shared Responsibility Matrix***

| **Component** | **Provider manages ✔** | **User manages ✔** |
|---|---|---|
| Physical servers & data centre hardware | ✔ | ✖ |
| Virtualisation layer (hypervisor) | ✔ | ✖ |
| Virtual machine operating system | ✖ | ✔ |
| Applications & middleware installed | ✖ | ✔ |
| Data stored on virtual disks | ✖ | ✔ |
| Virtual network configuration | ✖ | ✔ |
| Security of OS & applications | ✖ | ✔ |

## 2.2 Key Features of IaaS

IaaS delivers several features that make it a practical, cost-efficient choice for schools, startups, hospitals, and government departments alike. Table 2.2 summarises these features before each is explained.

***Table 2.2: Key Features of IaaS***

| **Feature** | **What It Means** | **Example** |
|---|---|---|
| Scalability | Add or remove resources instantly based on demand | Extra VMs added when CBSE result website gets millions of hits |
| Pay-as-you-go | Pay only for resources actually consumed | Coaching institute can pays only during the 3-month admission season |
| High availability | Multiple data centres ensure no single point of failure | Hospital booking portal stays live even if one server fails |
| Resource pooling | Physical hardware is shared safely across many tenants | Many schools sharing one data centre securely |
| Self-service provisioning | Users create or delete resources via a web console without calling the provider | Admin creates a new VM in 2 minutes through a browser dashboard |

| | | |
|---|---|---|
| Geographic reach | Data centres available in multiple regions/countries | A Delhi school can store data in any data centre |

Think of scalability like adding extra chairs to a school dining hall on Sports Day. Normally 200 chairs are enough, but on Sports Day you bring in 300 more. After the event, you return them. You pay the rent only for the hours you needed those extra chairs. IaaS does exactly this with virtual servers — elastically expanding capacity when demand spikes, then releasing it when demand falls.

***Consideration:*** IaaS gives maximum control but also maximum responsibility. You must patch the OS, manage firewalls, and back up data. If you forget to update your operating system, your virtual machine becomes a security risk — and that is entirely your responsibility, not the provider's.

### 2.3 Virtualisation and Virtual Machines

Virtualisation is the technology that creates multiple independent virtual computers, called virtual machines (VMs), on a single physical computer using special software called a hypervisor. Each virtual machine works like a separate computer with its own operating system and applications.

***Example:*** Imagine your school has one large hall. The school installs strong partitions and converts the hall into 20 separate classrooms. Each classroom has its own teacher, students, and subject. Each class works independently. However, all classrooms share the same building, electricity, and security.

In this example:

- The large hall is the physical server.
- The partitions are the hypervisor software.
- The classrooms are virtual machines.

Before virtualisation, one physical server ran one operating system and one set of applications. This was extremely wasteful — a powerful server might use only 10–15% of its actual capacity. Virtualisation allows the same server to run 20 or more virtual machines simultaneously, each with its own OS, applications, and data, all completely isolated from each other. This dramatically increases hardware utilisation and reduces cost per user.

Figure 2.2 shows how one physical server hosts multiple virtual machines through a hypervisor.

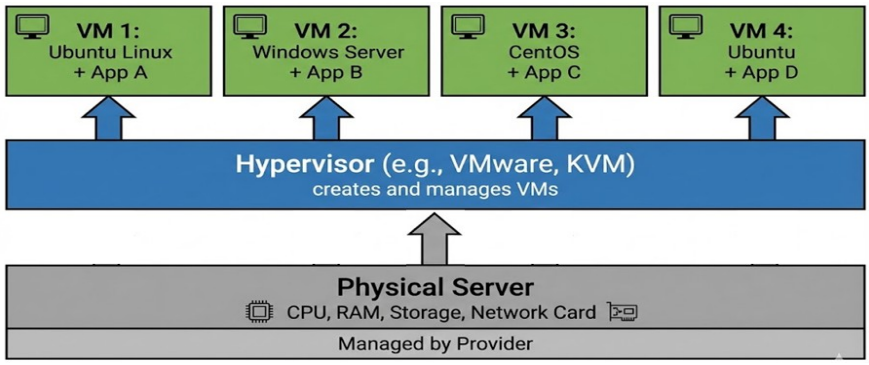



***Fig. 2.2: Multiple isolated virtual machines on one physical server (Redraw)***

Figure 2.3 compares a virtual machine with a physical computer.

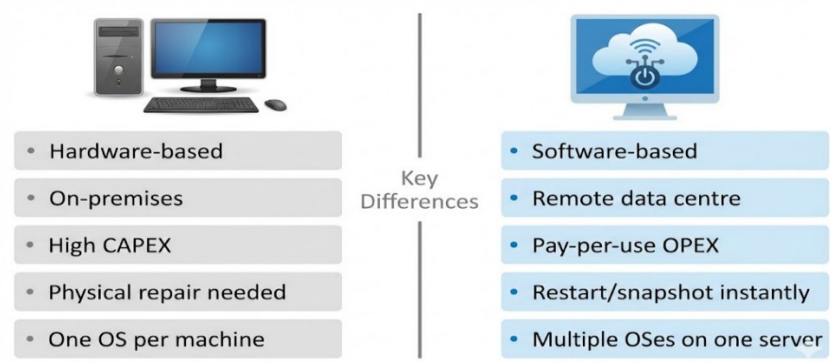



***Fig. 2.3: Physical Computer vs Virtual Machine***

## 2.4 Storage in IaaS

Cloud storage is a service that allows users to save, retrieve, and manage data on remote servers maintained by a cloud provider, accessible over the Internet at any time from any device.

***Example:*** Like a bank — your cash (data) are kept safely at the bank (cloud data centre), not at home (your local computer). You access them whenever you need, from any branch (device).

IaaS offers three distinct types of storage, each suited to different use cases. Figure 2.4 illustrates all three types visually.

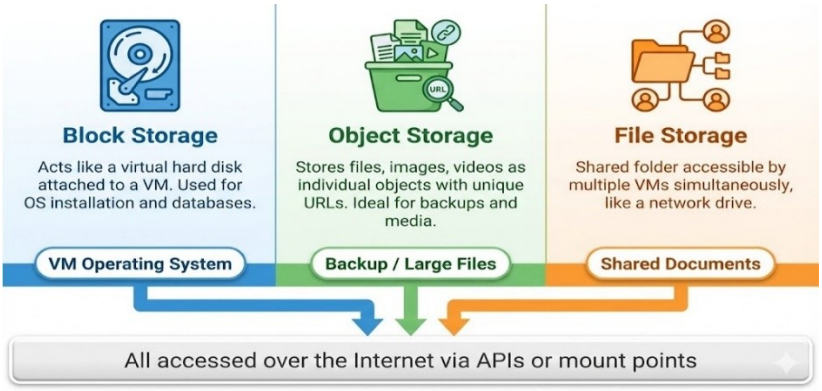



***Fig. 2.4: Block, object, and file storage (Redraw)***

**Tip:** Block storage is like your personal notebook — only you use it. Object storage is like the school notice board — anyone can read it. File storage is like a shared project folder — many people write to it together.

### 2.5 Networking in IaaS

Networking in IaaS connects virtual machines to each other, to the Internet, and to users. Without networking, a virtual machine would be completely isolated — like a powerful computer with no Internet connection. IaaS providers offer a complete set of virtual networking components that replicate everything a traditional physical network provides, but entirely in software.

The four key networking components in IaaS are described below. Figure 2.5 then shows how they work together when a student opens a school website.

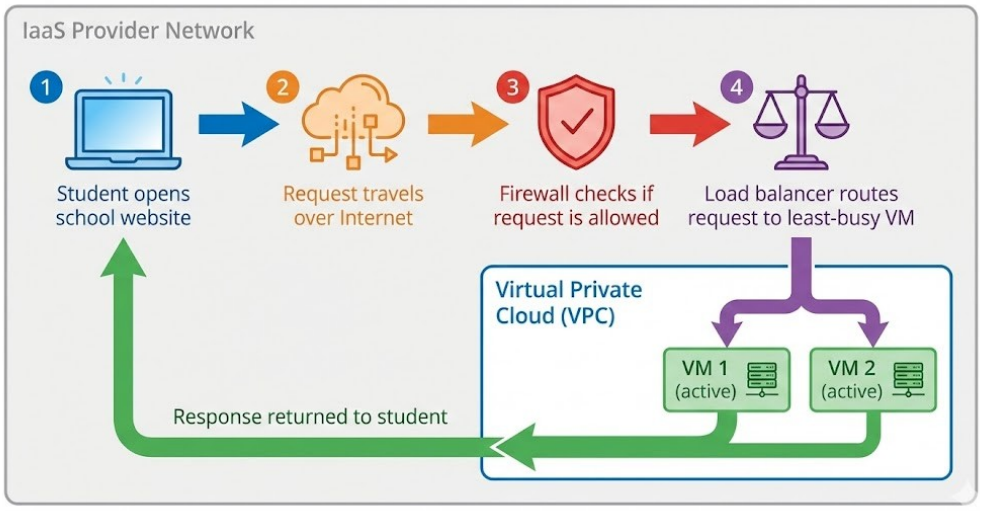



***Fig. 2.5: Working of Virtual networking components***

***Virtual Private Cloud (VPC):*** A logically isolated section of the provider's network assigned to you. Think of it as your own private lane on a shared highway — other traffic cannot enter your lane.

***Load Balancer:*** Distributes incoming Internet traffic across multiple VMs so no single VM gets overloaded. Like a railway booking counter with multiple windows — you are directed to the least busy one.

***Firewall / Security Group:*** A set of rules that controls which network traffic is allowed in or out of your VMs. Like a school gate guard who checks IDs before letting anyone in.

***IP Address:*** A unique address assigned to each VM, allowing other computers to find and communicate with it, just like a house address on a street.

***Subnet:*** A subnet is a smaller network section created inside a Virtual Private Cloud (VPC) to organise and manage virtual machines efficiently. Like floors in an apartment building, each floor groups certain rooms together while still being part of the same building.

## 2.6 Real-World Use Cases of IaaS

IaaS serves organisations across every sector. Table 3.2.3 maps common real-world scenarios to specific IaaS resources, so you can recognise IaaS in everyday life.

***Table 2.3: Real-World IaaS Use Cases***

| **Scenario** | **IaaS Resource Used** | **Why IaaS?** |
|---|---|---|
| School website hosting | Virtual machines + load balancer | Handles traffic spikes during admissions; no physical server needed |
| Online exam platform (CBSE/state boards) | Auto-scaling VMs | Millions of simultaneous logins handled elastically |
| Government e-services (MeghRaj/GI Cloud) | IaaS VMs + storage + networking | Indian government departments access computing without CAPEX |

**Note on Providers:** Major IaaS providers include Amazon Web Services (AWS: EC2 for VMs, S3 for object storage), Microsoft Azure (Azure Virtual Machines), and Google Cloud Platform (Compute Engine). India's MeghRaj / GI Cloud provides IaaS to government organisations within India.

**Practical Activity 2.1.** Map Physical Hardware to IaaS Cloud Equivalents

**Objective:** Identify the IaaS cloud equivalent for each piece of traditional physical computing hardware.

**Materials:**

Notebook and pen

**Theory:** IaaS provides virtual equivalents of every physical computing resource. A physical server becomes a VM. A hard disk becomes block or object storage. A router and firewall become virtual networking components. Recognising these mappings is a foundational IaaS skill.

**Procedure**

**Step 1.** Copy the observation table below into your notebook, leaving space in column 3 and 4.

**Step 2.** For each physical item in column 1, write its IaaS cloud equivalent in column 2 using this session's content.

**Step 3.** In column 3, write why IaaS is better for that resource (one reason

each).

**Step 4.** In column 4, name one real provider that offers this IaaS resource.

**Step 5.** Compare answers with a classmate and discuss any differences.

**Observation Table**

| # | Physical Hardware | IaaS Cloud Equivalent | One Advantage | Provider Example |
|---|---|---|---|---|
| 1 | Physical server (rack) | | | |
| 2 | Hard disk drive | | | |
| 3 | Network router | | | |
| 4 | Computer lab (20 PCs) | | | |
| 5 | Physical firewall appliance | | | |
| 6 | Data centre room | | | |

**Result:** Each physical hardware item has a direct IaaS equivalent that is cheaper, scalable, and requires no physical maintenance by the user.

**Conclusion:** IaaS replaces the entire physical hardware stack with virtual, on-demand equivalents — shifting maintenance responsibility to the provider and cost from CAPEX to OPEX.

## Summary

In this session, you learned that Infrastructure as a Service (IaaS) provides virtual machines, storage, and networking over the Internet without buying physical servers. The cloud provider manages hardware, while you control the operating system, applications, and data. Virtualisation allows one physical server to run many virtual machines. You also studied storage types — block, object, and file — and networking tools like VPCs and load balancers. IaaS supports web hosting, online exams, backups, and government platforms like MeghRaj.

**Key Terms:** IaaS, virtual machine (VM), hypervisor, block storage, object storage, file storage, VPC, load balancer, scalability, snapshot.

## Check Your Progress

### A. Multiple Choice Questions (MCQs)

1. Meera's server crashed during heavy admission traffic. Which IaaS feature could prevent this problem? (a) Local storage (b) Scalability (c) Offline processing (d) Manual networking

2. In Infrastructure as a Service, who manages the physical servers and data centre hardware? (a) User (b) Cloud provider (c) Internet service provider (d) Application developer
3. Which technology allows multiple virtual machines to run on a single physical server? (a) Encryption (b) Virtualisation (c) Compression (d) Firewall
4. A school website receives millions of hits during result day. Which IaaS feature helps handle this load? (a) Pay-as-you-go (b) Scalability (c) Local storage (d) Hyperlinking
5. In IaaS responsibility, who manages the operating system of the virtual machine? (a) Cloud provider (b) Government (c) User (d) ISP
6. Which IaaS networking component distributes traffic across multiple servers? (a) Firewall (b) Load balancer (c) IP address (d) Subnet
7. A unique address assigned to each virtual machine is called: (a) Port (b) IP Address (c) URL (d) Gateway
8. Which type of storage is best for sharing files among multiple users? (a) Block storage (b) File storage (c) Object storage (d) RAM storage

**B. Fill in the Blanks**

1. Infrastructure as a Service provides virtualised computing resources over the _____.
2. A virtual computer created using virtualisation is called a _____.
3. The software that creates virtual machines is called a _____.
4. In IaaS, users pay only for resources they _____.
5. A _____ distributes incoming network traffic across multiple servers.
6. A _____ controls which network traffic can enter or leave a virtual machine.
7. Cloud storage allows data to be accessed from any device through the _____.
8. A logically isolated network inside the cloud is called a _____.

**C. True or False**

1. In IaaS, the user manages physical servers.
2. Virtualisation increases hardware utilisation.
3. A hypervisor creates virtual machines on a physical server.
4. Load balancers protect systems from viruses.
5. Scalability allows resources to increase or decrease based on demand.
6. Cloud storage allows users to access data from anywhere with Internet.

7. Subnets help organise networks inside a VPC.
8. In IaaS, the cloud provider manages the operating system.

**D. Short Answer Questions**

1. Why did Meera's website crash while Kabir's cloud website continued working during high traffic?
2. How does IaaS reduce the cost of maintaining physical servers for organisations?
3. Explain how virtualisation improves server efficiency.
4. Why is scalability important for websites during events like exam results or admissions?
5. Explain the role of a load balancer in cloud computing.
6. How does cloud storage make data access easier for users?
7. Why is a Virtual Private Cloud (VPC) important in IaaS networking?
8. What responsibility does the user have in IaaS security?

## Session 3. Platform as a Service (PaaS)

Aarav, a Class XI student from Bengaluru, wanted to build a website for his school's science fair. He tried to set up everything on his laptop — a web server, database, and programming tools. After two days, he only saw error messages and had not written any real code.

His cousin Riya visited and showed him an easier way. She opened a cloud platform in the browser, selected the programming language, connected a database, and launched a website in minutes — without installing anything.

"This is Platform as a Service (PaaS)," she explained. "You write the code. The platform manages the rest." Figure 3.1 shows how PaaS hides the technical setup and lets you focus only on building the application.

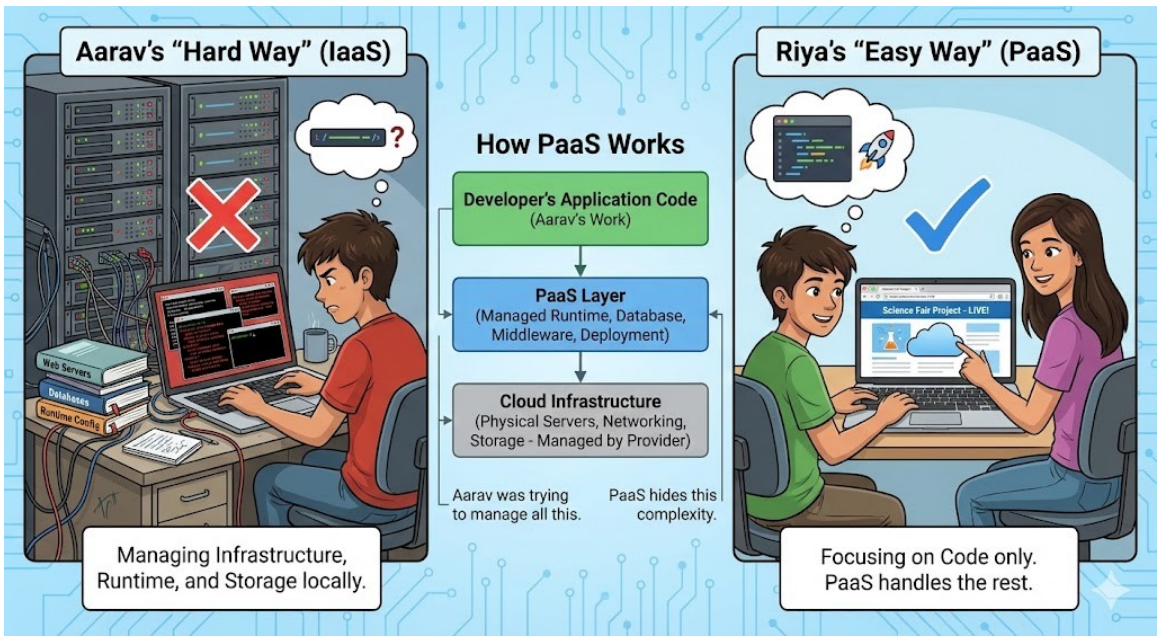



***Fig. 3.1: PaaS sits between the developer and cloud infrastructure***

### 3.1 Platform as a Service (PaaS)

Platform as a Service (PaaS) is a cloud service model that provides a complete, managed application development and deployment environment over the Internet. The provider manages the infrastructure, operating system, runtime, and middleware; the developer only writes, tests, and deploys application code.

***Example:*** Renting a fully equipped cooking studio — stoves, utensils, ingredients, and cleaning staff are all provided. You just cook. In PaaS, the 'cooking studio' is the managed platform; your 'dish' is the application.

Before PaaS existed, building even a simple web application required an organisation to purchase servers, install an operating system, configure a runtime environment (such as Python or Java), set up a database, manage backups, and apply security patches — all before a single line of application

code could run. This setup could take days or weeks and required deep infrastructure knowledge.

PaaS collapses all of that into a single managed service.

Key principle: In PaaS, the developer's job is to write great code. Every other concern — servers, patching, scaling, middleware — is handled invisibly by the platform. This is the fundamental shift PaaS creates.

### 3.2 Key Features of PaaS

Platform as a Service (PaaS) gives developers a ready-made platform to build and run applications without managing servers. The key features are:

***Ready platform:*** Tools and databases are already set up. ***Example:*** Aarav logs in and starts coding in Python immediately.

***Autoscaling:*** Resources increase automatically when users increase. ***Example:*** A school app handles 100 users normally and 5,000 on result day.

***Team collaboration:*** Many developers can work on the same project together online.

***Managed database:*** Backup and updates are handled by the provider.

***Automatic deployment (CI/CD):*** New code is tested and published automatically.

***Automatic updates:*** The provider updates security and system software.

***Advantage:*** Saves time — students and startups can build apps quickly.

***Limitation:*** Depending too much on one provider may cause vendor lock-in, making it hard to switch later.

### 3.3 PaaS Compared: Traditional, IaaS, and PaaS

Understanding PaaS is clearest when you compare the developer experience across three approaches: traditional on-premises development, IaaS, and PaaS. Table 3.1 shows this comparison across practical dimensions.

***Table 3.1: Traditional Development vs. IaaS vs. PaaS***

| **Dimension** | **Traditional** | **IaaS** | **PaaS** |
|---|---|---|---|
| Infrastructure setup | Buy and configure physical servers | Rent VMs; configure OS yourself | Fully provided — zero setup |
| OS management | Install, patch, maintain yourself | Install and patch yourself on VM | Provider manages automatically |
| Runtime & middleware | Install manually (Python, Java, | Install manually on the VM OS | Pre-installed and managed by |

| | | | |
|---|---|---|---|
| | Node.js…) | | provider |
| Database | Install, configure, back up manually | Install on VM or use managed DB separately | Managed DB: provision with one click |
| Deployment | Manual upload/FTP to server | Manual or scripted deployment to VM | One command or auto-deploy via CI/CD |
| Scaling | Buy more servers | Provision more VMs manually | Platform scales automatically |
| Best suited for | Enterprises with full IT teams | Sysadmins needing full OS control | Developers wanting to focus on code |

### 3.4 The PaaS Development Workflow

Building an application on PaaS follows a simple, repeatable cycle. Figure 3.2 shows this workflow before each step is explained.

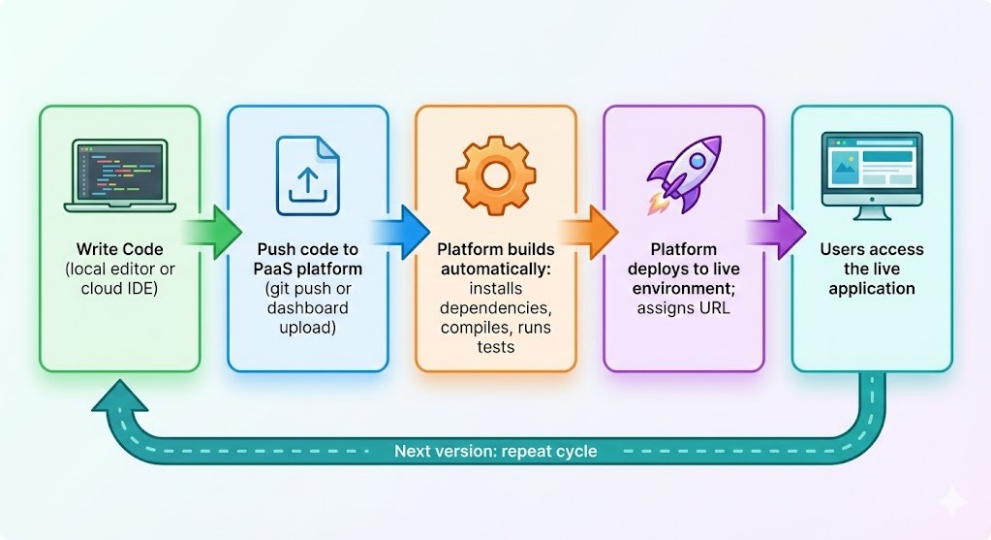



***Fig. 3.2: PaaS development workflow (Redraw)***

***Write:*** The developer writes application code locally or in a cloud-based IDE (Integrated Development Environment) provided by the PaaS platform.

***Push:*** The code is uploaded to the PaaS platform — typically with a single command (like git push) or through a dashboard button.

***Build:*** The platform automatically installs required libraries (dependencies), compiles the code if needed, and runs automated tests.

***Deploy:*** If all tests pass, the platform deploys the application to a live URL accessible on the Internet — no manual server configuration required.

***Monitor & Scale:*** The platform monitors application performance and automatically scales resources up or down based on the number of users.

This workflow is sometimes called a CI/CD pipeline — Continuous Integration (automatic testing of new code) and Continuous Deployment (automatic release of tested code to users). PaaS platforms make CI/CD accessible even to individual student developers.

### 3.5 Real-World Use Cases of PaaS

PaaS is used across education, business, government, and everyday digital life. Because PaaS provides ready-to-use tools and frameworks, developers rely on it to quickly build a diverse range of applications, as shown in Figure 3.3. These applications range from simple websites to complex, high-traffic EdTech and Fintech platforms.


***Fig. 3.3: Common application types on PaaS (Redraw)***

**Note:** India's MeghRaj / GI Cloud also offers a PaaS layer for government departments to build citizen-facing applications without managing infrastructure.

**Practical Activity 3.1.** Compare Development Approaches — Traditional vs. PaaS

**Objective:** Compare the steps and time needed to deploy a simple web application using traditional on-premises setup versus PaaS.

**Material Required**

- Notebook and pen;

**Procedure**

**Step 1.** In your notebook, create a two-column table with headings

'Traditional Setup Steps' and 'PaaS Equivalent Step'.

**Step 2.** List every step needed to set up a web application the traditional way (refer to Section 3.3.1 and Table 3.3.3).

**Step 3.** For each traditional step, write the PaaS equivalent in column 2. If PaaS eliminates the step entirely, write 'Handled by provider — developer does nothing'.

**Step 4.** Count the total traditional steps and compare with total PaaS steps. Record the difference.

**Step 5.** In 2–3 sentences below your table, explain: where is the biggest time saving? Which type of developer benefits most from PaaS?

**Observation Table**

| # | Traditional Development Step | PaaS Equivalent (or 'Provider handles — zero effort') |
|---|---|---|
| 1 | Purchase/rent physical server | |
| 2 | Install operating system | |
| 3 | Install and configure runtime (Python/Java/Node.js) | |
| 4 | Install and configure database server | |
| 5 | Configure web server (Nginx / Apache) | |
| 6 | Set up backup system | |
| 7 | Configure firewall and security patches | |
| 8 | Write and upload application code | |
| 9 | Test and fix deployment errors | |
| 10 | Scale when traffic increases | |

**Result:** Most infrastructure steps (1–7, 10) are fully handled by PaaS. The developer only needs to perform steps 8 and 9 — writing and deploying code. Traditional development requires managing all 10 steps.

**Conclusion:** PaaS reduces developer effort by eliminating all infrastructure management tasks, enabling individual developers and small teams to build and deploy production-quality applications rapidly.

## Summary

In this session, you learned that Platform as a Service (PaaS) provides a ready-to-use environment for developing and deploying applications over the Internet. The cloud provider manages the servers, operating system, scaling,

and updates, while you focus only on writing code and managing data. PaaS includes tools like managed databases, autoscaling, and CI/CD pipelines that speed up development. It helps launch applications quickly, but depending too much on one provider can make switching difficult.

## Check Your Progress

### A. Multiple Choice Questions

1. Platform as a Service (PaaS) mainly allows developers to (a) buy physical servers (b) write and deploy application code (c) repair computer hardware (d) manufacture software chips
2. In PaaS, who manages the servers and operating system? (a) Developer (b) Cloud provider (c) School administrator (d) End user
3. Autoscaling in PaaS means (a) automatic deletion of data (b) automatic increase or decrease of resources (c) manual installation of software (d) permanent storage of files
4. The process of automatically testing and deploying code is called (a) FTP (b) HTML (c) CI/CD (d) BIOS
5. One limitation of PaaS is (a) low internet speed (b) vendor lock-in (c) high electricity usage (d) hardware failure

### B. Fill in the Blanks

1. PaaS provides a complete _____ environment over the Internet.
2. In PaaS, the developer mainly focuses on writing _____.
3. The cloud provider manages the _____ and operating system.
4. Continuous Integration and Continuous Deployment is called _____.
5. When developers depend too much on one provider it is called _____.

### C. True or False

1. In PaaS, developers must install the operating system themselves.
2. PaaS allows multiple developers to collaborate on the same project.
3. Autoscaling helps applications handle sudden increase in users.
4. PaaS requires buying physical servers before coding.
5. Managed databases in PaaS handle backups automatically.

### D. Short Answer Questions

1. What is Platform as a Service (PaaS)?
2. Write two features of PaaS.
3. How does PaaS save time for developers?
4. What is autoscaling?
5. Give one real-life use of PaaS.

# Session 4. Software as a Service (SaaS)

Priya, a Class IX student in Lucknow, had to finish a science project with her partner Kabir. But she left her laptop at school. At home, she only had her father's old Android phone with very little storage. She felt worried.

Then she remembered her teacher's advice. She opened Chrome on the phone, went to Google Docs, and logged in. The project was already there. She added the conclusion and corrected mistakes. At the same time, Kabir saw her changes on his laptop.

This is Software as a Service (SaaS). The software and files stay on cloud servers. You do not need to install anything. Any device with Internet can be used. Figure 4.1 shows how both Priya and Kabir connect to the same cloud software from different devices.


***Fig. 4.1: Priya and Kabir using a cloud-based SaaS platform***

## 4.1 Software as a Service (SaaS)

Software as a Service (SaaS) is a cloud service model in which fully functional software applications are delivered over the Internet and accessed through a web browser or mobile app. The provider manages the entire technology stack — servers, OS, runtime, application, and updates — while the user only controls settings, data, and access permissions.

Example: Watching a film on Hotstar or JioCinema. You do not download or own the movie file. You press play in a browser or app and it streams instantly from the provider's servers. The moment you close the tab, nothing remains on your device — the software and content both live in the cloud.

In traditional software, every computer needed its own licensed copy installed locally. When the computer was lost, stolen, or replaced, the software had to be purchased and installed again. If a newer version released, each computer needed manual updating. In a school of 500 students, maintaining 500 individual software installations became an IT nightmare.

SaaS eliminates every one of these problems. The software runs entirely on the provider's cloud servers. You access it through any browser — on any device, from any location — simply by logging into your account. The provider handles installation, maintenance, updates, backups, and security patches for every user simultaneously. Table 4.1 shows the complete shared responsibility picture in SaaS.

***Table 4.1: SaaS Shared Responsibility Matrix***

| **Component** | **Provider manages ✔** | **User controls ✔** |
|---|---|---|
| Physical servers and data centre | ✔ | ✖ |
| Operating system and runtime | ✔ | ✖ |
| Application software and features | ✔ | ✖ |
| Security patches and updates | ✔ | ✖ |
| Application uptime and availability | ✔ | ✖ |
| User account and access permissions | ✖ | ✔ |
| User preferences and settings | ✖ | ✔ |

***Key insight:*** SaaS gives users the maximum benefit with the minimum technical responsibility. The provider manages everything underneath; you control only what matters to your work — your account, your settings, and your data. This is why SaaS is the most widely used cloud model for everyday users.

### 4.2 Key Features of SaaS

SaaS delivers a set of features that directly benefit students, teachers, and everyday users. Real-time collaboration is one of SaaS's most powerful features for education.

***Example:*** When Priya and Kabir edit the same Google Doc simultaneously, they each see the other's cursor and changes appear character by character in real time — as if sitting at the same desk, even if one is in Lucknow and the other is in a different part of the city. Comments, suggestions, and version history are all built in, giving Dr. Meena full visibility into who contributed what. Table 4.2 summaries all features before each is explained in depth.

***Table 4.2: Key Features of SaaS***

| **Feature** | **What It Means** | **Example** |
|---|---|---|
| Access from any device | Works on laptop, phone, tablet — any device with a browser | Priya writes a report on her father's phone; Kabir edits it on his laptop simultaneously |
| Automatic updates | Provider updates the software for all users at once — no manual downloading | Google adds a new feature to Docs; every user across India sees it the next morning automatically |
| Real-time collaboration | Multiple users edit the same file simultaneously; changes visible instantly | Dr. Meena's class of 40 students all contribute to one shared spreadsheet during class |
| Cloud storage | All data saved on provider's servers; accessible anytime, never lost on crash | Teacher's lesson notes survive even when the school computer's hard disk fails |
| Subscription pricing | Pay monthly/yearly per user — no large upfront license purchase | School pays ₹150/student/year for Google Workspace instead of ₹5,000/PC for MS Office |
| Zero local installation | No storage used on device; no compatibility issues between OS versions | Works identically on Windows, Android, iOS, and Chromebook — no installation on any |
| Centralised data | All data in one place; easily searchable, shareable, and auditable | Principal searches all student submissions from one admin dashboard |

***Consideration:*** SaaS's biggest limitation is its complete dependence on Internet connectivity. If your connection drops, you lose access to the software immediately. In areas with unreliable connectivity — many rural schools in India, for example — this is a real constraint. Some SaaS apps (like Google Docs) offer limited offline mode, but full functionality requires a live

connection. Always keep a local backup of critical documents when working in low-connectivity environments.

### 4.3 Working of SaaS

Understanding what happens technically when Priya opens Google Docs helps you appreciate how SaaS delivers software through the Internet. The sequence is fast — the entire process completes in under a second — but several sophisticated steps happen behind the scenes. Figure 4.2 shows this complete request-response flow before each step is described.

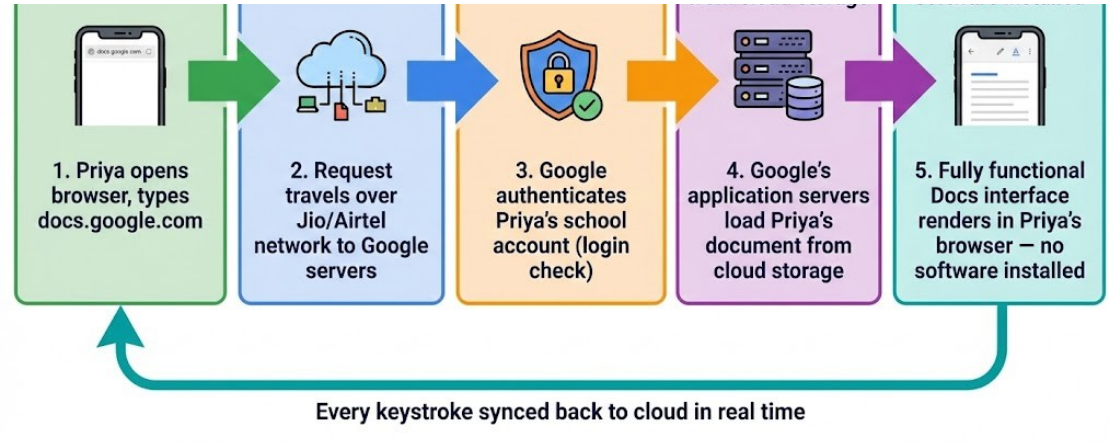



***Fig. 4.2: How SaaS delivers software (Redraw)***

***Step 1. Request:*** You open a browser and type the SaaS application's URL (e.g., docs.google.com). Your browser sends a request over the Internet to the provider's servers.

***Step 2. Authentication:*** The provider's servers verify your identity — checking your username and password against their user database. This is why logging in is the only 'installation' SaaS requires.

***Step 3. Application delivery:*** The provider's application servers send the software interface (the Google Docs editor) to your browser as a web page. Your browser renders it — turning code into a usable word processor on your screen.

***Step 4. Data retrieval:*** Your documents are fetched from cloud storage and displayed within the application. If you have 50 documents, they all appear in your file list instantly.

***Step 5. Real-time sync:*** Every change you make (every keystroke, every formatting change) is immediately sent back to the provider's servers and saved. This is why your work is never lost even if your phone battery dies mid-sentence.

This entire cycle repeats continuously while you work, creating the seamless experience of using software that feels local — but actually runs entirely in the cloud.

### 4.4 SaaS vs. Traditionally Installed Software

The clearest way to understand SaaS's advantages is to compare it directly with traditional software that must be installed on each computer. Table 4.3 provides this comparison across dimensions that matter most for schools and everyday users.

***Table 4.3: Installed Software vs. SaaS — Detailed Comparison***

| **Dimension** | **Traditionally Software** | **SaaS** |
|---|---|---|
| Installation | Must be installed on every device separately | No installation — open browser and log in |
| Updates | Each user must download and install updates manually | Provider updates simultaneously for all users — zero effort |
| Storage used | Uses significant local storage (gigabytes per app) | Zero local storage — everything on cloud servers |
| Accessibility | Works only on the device where installed | Works on any device with Internet and a browser |
| Collaboration | Files must be emailed/shared manually; no real-time co-edit | Real-time co-editing; all collaborators see changes instantly |
| Cost model | High upfront license purchase (CAPEX) per device | Low monthly/yearly subscription per user (OPEX) or free |
| Data safety | Data lost if computer crashes, stolen, or hard disk fails | Data stored in cloud; survives any device failure |
| IT maintenance | School IT team must manage each device's software | Provider manages all maintenance; school IT effort minimal |
| Customization | High — install plugins, change settings deeply | Limited — only what provider allows through settings/APIs |
| Offline access | Fully functional without Internet | Limited or none — requires Internet for full functionality |

Figure 4.3 illustrates the "iceberg effect" of traditional software, where the burden of maintenance, storage, and updates remains hidden below the surface for the user, unlike SaaS, where the cloud provider handles all that complexity.

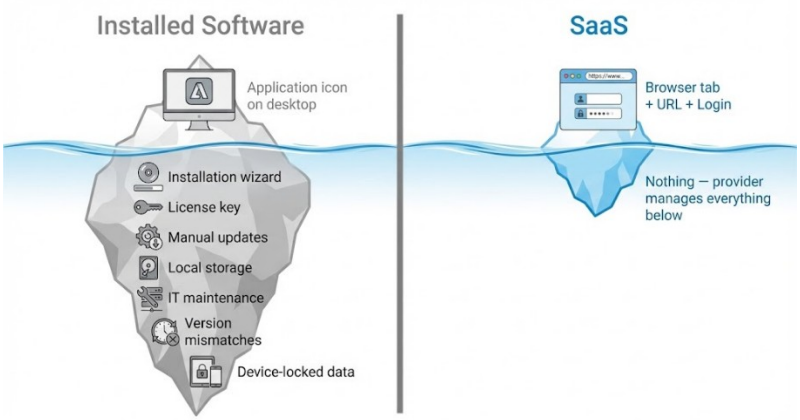



***Fig. 4.3: Installed software vs SaaS (Redraw)***

### 4.5 SaaS Applications in Daily Life

SaaS is the most common cloud model in everyday experience. Every time you open Gmail, join a Zoom call, watch YouTube, or pay using a UPI app, you are using SaaS.


***Fig. 4.4: SaaS covers every category of software (Redraw)***

As illustrated in Figure 3.4.4, SaaS applications cover almost every digital category we interact with daily, spanning from education and productivity to video calls and digital payments.

The Table 4.4 below breaks down these familiar tools, mapping out exactly how Indian students and teachers use them in their everyday routines.

***Table 4.4: Common SaaS Applications for Students and Schools***

| Application | Provider | SaaS Category | How It Is Used in Schools |
|---|---|---|---|
| Gmail | Google | Email | School communication between teachers, students, and parents |
| Google Docs/Sheets / Slides | Google | Productivity / Office | Assignments, reports, group projects — all collaborative |
| Google Classroom | Google | Learning Management | Assignment submission, grading, announcements |
| Zoom / Google Meet | Zoom / Google | Video Conferencing | Online classes, parent-teacher meetings, seminars |
| YouTube | Google | Media Streaming | Educational videos, science demonstrations, lectures |
| WhatsApp Web | Meta | Messaging | Group communication for class projects and announcements |
| DigiLocker | Govt. of India | Document Storage | Students store and share marksheets, certificates digitally |
| DIKSHA | Govt. of India (NCERT) | EdTech Platform | Free learning content, e-textbooks, and teacher training |

**Note:** India's government-run SaaS platforms — DIKSHA (education), DigiLocker (document management), and the UMANG app (government services) — demonstrate that SaaS is not just a corporate tool. The Government of India uses SaaS at massive scale to deliver public services to hundreds of millions of citizens.

### 4.6 Privacy, Security, and Smart SaaS Usage

Because SaaS stores your data on a provider's servers, privacy and security become important responsibilities for every user — even at the student level. The shared responsibility model (Table 4.5) shows that the provider secures the infrastructure and application, but you are responsible for your account, your sharing permissions, and understanding where your data lives.

***Table 4.5: SaaS Security Best Practices for Students***

| **Security Area** | **Risk if Ignored** | **Best Practice** |
|---|---|---|
| Password strength | Weak password = account takeover; attacker accesses all your documents | Use a strong unique password; enable two-factor authentication (2FA) |
| Sharing permissions | Accidentally set document to 'Anyone with link can edit' — strangers modify your work | Always check sharing settings; use 'View only' unless editing is needed |
| Third-party app access | Unknown apps connected to your Google/Microsoft account can read all files | Regularly review and revoke access for apps you no longer use |
| Data residency | Your data may be stored on servers outside India — relevant for sensitive info | Understand the provider's data centre location; prefer Indian or compliant providers for sensitive data |
| Public Wi-Fi | Open networks allow attackers to intercept login credentials | Avoid logging into SaaS accounts on public Wi-Fi without a VPN or HTTPS |
| Account sharing | Sharing your school SaaS login violates terms and risks your data | Never share your school account credentials — use the collaboration feature instead |

**Data residency:** This term means where — in which country or city — the data centre storing your data is physically located. For most student work this is not a concern. However, for hospitals, banks, or government departments, Indian regulations may require data to be stored inside India. This is why India's DigiLocker and DIKSHA platforms store data in Indian data centres.

**Practical Activity 4.1.** Create, Share, and Collaborate Using Google Docs (SaaS)

**Objective:** Experience key SaaS features — cloud storage, real-time collaboration, automatic saving, and sharing permissions — by creating and sharing a live document using Google Docs.

**Materials Required**

A computer, tablet, or smartphone with Internet access;

Google account of self and classmate

**Procedure**

**Step 1.** Open any web browser on your device and go to docs.google.com. Sign in with your school or personal Google account.

**Step 2.** Click '+ Blank' to create a new document. Title it: 'My First SaaS Document — [Your Name]'.

**Step 3.** Type the following paragraph: 'SaaS allows me to use software without installing it. My document is stored in the cloud and can be accessed from any device.'

**Step 4.** Observe the status bar at the top — it should show 'All changes saved to Drive' within 2–3 seconds of you stopping typing. This confirms automatic cloud saving.

**Step 5.** Click the blue 'Share' button (top right). Enter your classmate's Gmail address. Set permission to 'Editor'. Click 'Send'.

**Step 6.** Ask your classmate to open the shared document on their own device (phone, tablet, or computer).

**Step 7.** Both of you type in the document simultaneously. Observe each other's coloured cursors and see changes appear in real time without refreshing the page.

**Step 8.** Click File → Version History → See version history. Observe the list of all automatic saves. Click any earlier version to see what the document looked like at that moment.

**Step 9.** Fill in the observation table below based on what you experienced.

**Observation Table**

| **Observation Item** | **Your Record** |
|---|---|
| SaaS application used (name and URL) | |
| Device type used (phone / tablet / laptop) | |
| Did software require any installation? (Yes / No) | |
| Auto-save message observed (write exact text shown) | |
| Classmate's Gmail shared with | |
| Permission type set for classmate | |

| | |
|---|---|
| Did you see classmate's cursor in real time? (Yes / No) | |
| Number of versions shown in Version History | |
| One feature you found most useful — and why | |

**Result:** Google Docs (SaaS) worked entirely in the browser with zero installation. Documents saved automatically to the cloud, were accessible from any device via login, and allowed two users to edit simultaneously in real time — demonstrating all core SaaS features in a single session.

**Conclusion:** SaaS eliminates the need for local software installation by running the entire application on the provider's servers and delivering it through the browser, enabling instant access, automatic saving, and real-time collaboration from any device.

## Summary

In this session, you learned that Software as a Service (SaaS) delivers ready-to-use applications through a web browser without installation or manual updates. The provider manages servers, software, and security, while you manage your account and data. SaaS allows real-time collaboration, automatic updates, and access from any device with Internet. It reduces IT maintenance but depends on connectivity and proper password management. Common examples include Gmail, Google Docs, Google Classroom, Zoom, DigiLocker, and UPI apps.

**Key Terms:** SaaS, real-time collaboration, subscription pricing, cloud storage, data residency, two-factor authentication (2FA), sharing permissions.

## Check Your Progress

### A. Multiple Choice Questions (MCQ)

1. Software as a Service (SaaS) allows users to access software through (a) web browser (b) CD/DVD (c) pen drive (d) local installation
2. In SaaS, the provider manages (a) only user data (b) servers and software updates (c) internet connection (d) user passwords
3. Which of the following is an example of SaaS? (a) Google Docs (b) Keyboard (c) Printer (d) Hard disk
4. Real-time collaboration in SaaS means (a) users edit the same file together (b) files saved in USB (c) manual updates (d) software installation

5. SaaS applications mainly depend on (a) electricity (b) internet connection (c) keyboard (d) printer

**B. Fill in the Blanks**

1. SaaS stands for _____ as a Service.
2. SaaS applications are accessed using a _____.
3. In SaaS, data is stored on _____ servers.
4. Google Docs allows _____ collaboration between users.
5. Weak passwords may lead to _____ takeover.

**C. True or False**

1. SaaS applications require installation on every computer.
2. SaaS software can be accessed from different devices.
3. In SaaS, the provider manages updates and security patches.
4. SaaS works without internet connection.
5. Google Classroom is an example of SaaS.

**D. Short Answer Questions**

1. What is Software as a Service (SaaS)?
2. Write two features of SaaS.
3. Why is SaaS useful for students?
4. What is real-time collaboration?
5. Give two examples of SaaS applications used in schools.

# Module 3. Basics of Operating System and Computer Network

This module on ***Basics of Operating System and Computer Network*** introduces students to fundamental concepts related to digital devices, operating systems, networking, and the role of the Internet in modern computing. In Session 1, students learn about different digital devices and the concept of an operating system, including its functions, types, and features. The session also explains the boot process and how the operating system acts as a bridge between the user and hardware while managing processes, memory, files, and devices. Session 2 focuses on the operating system environment, where students explore file and folder management, user interface configuration, storage and disk management, system information, services, and environment variables. It also provides an understanding of how operating systems manage hardware through device drivers. In Session 3, students are introduced to computer networks, including types such as LAN, WAN, and VPN, along with concepts like data transmission, IP addressing, protocols, and the OSI model. The session also covers network performance parameters and common network devices. Session 4 explains the role of the Internet in cloud computing, highlighting how the Internet enables communication, data transfer, and access to cloud services. It also introduces components required for Internet access and explains how various applications use cloud computing through the Internet. Overall, the module develops a strong foundation in operating systems, networking, and Internet-based technologies, preparing students to understand and use modern digital and cloud-based systems effectively.

# Session 1. Digital Devices and Operating System

Rohit came home from school one afternoon, dropped his bag, and immediately picked up his tablet to check the homework his teacher had shared on Google Classroom. His younger sister was watching cartoons on a smart TV in the other room, and his mother was transferring money through UPI on her phone. Three devices, three tasks, three different screens - all happening at the same time, without anyone thinking twice about it. As shown in Fig. 1.1, digital devices are part of nearly every situation in daily life.

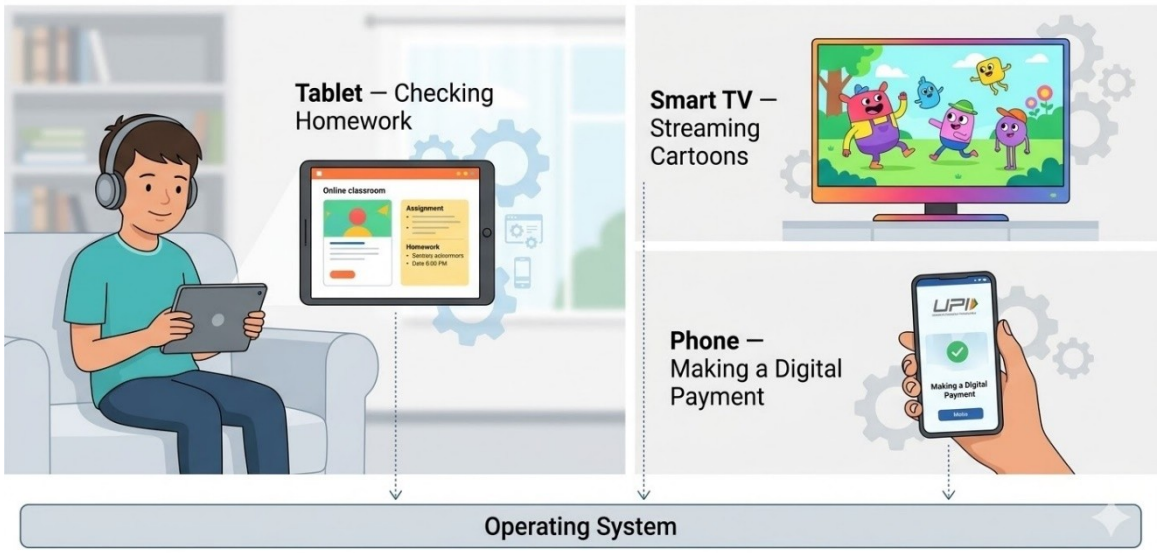



***Fig. 1.1: Common Digital Devices***

## 1.1 Digital Devices in Daily Life

Walk into any school, market, or railway station in India and you will find digital devices everywhere.

A digital device is any machine that processes data in the form of numbers - specifically, the binary digits 0 and 1. Unlike older machines that performed one fixed task, digital devices can be programmed to do many different things. That flexibility is what makes them so widely used.

***Mobile Phones :*** Mobile phones are the most widely used digital devices in India today. A basic smartphone like those running on Jio's 4G network can browse the internet, take photos, run apps, and make video calls.

***Tablets :*** Tablets are larger than phones but smaller and lighter than laptops. Tablets work well for reading, drawing, and watching educational content – the bigger screen makes text easier to read.

***Laptops :*** A laptop is a portable computer with a built-in keyboard, screen, and battery. Students use laptops for typing documents, running programming software, and attending online classes.

***Desktop Computers :*** Desktop computers sit on or under a table and connect to a separate monitor, keyboard, and mouse. You find them in school labs, cyber cafes, and offices. They are not portable, but they are powerful, affordable, and easy to repair.

## 1.2 The Boot Process

Press the power button on any device and something remarkable happens. The screen lights up, a logo appears, and within seconds you are looking at a working environment ready to use. That startup sequence has a name: the boot process.

***Boot process:*** the sequence of automatic steps a device performs from the moment it receives power until it is fully ready for use.

Think about how a KSRTC bus prepares before its first trip of the day. The driver checks the engine, fuel, lights, and doors - in a fixed order – before allowing any passengers on board. A device does something similar. First, a small built-in program called the BIOS (Basic Input Output System) or UEFI (Unified Extensible Firmware Interface) checks that the hardware is working. Next, it finds the operating system stored on the hard disk. Finally, it loads that OS into memory so you can start using the device. Figure 1.2 shows how these steps connect.

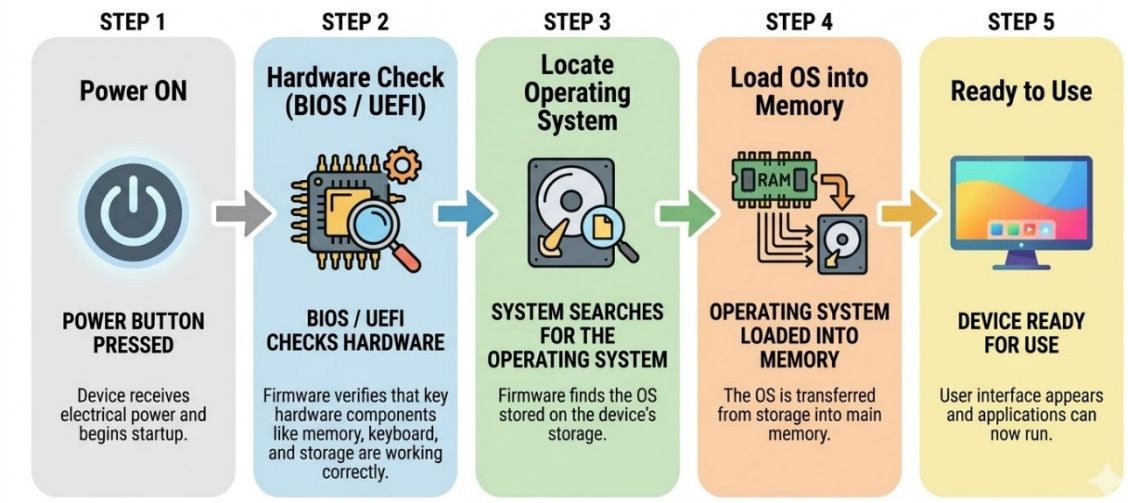



***Fig. 1.2: Steps in the Boot Process***

## 1.3 Operating System

Hardware alone cannot do anything useful. A keyboard is just plastic and metal. A hard disk is just a magnetic platter. Without software to control them, none of those parts would respond to you at all.

An operating system is the core software that starts when a device powers on, manages all its hardware and memory, and creates the environment in which other applications run.

### 1.3.1 Purpose of Operating System

***1. Provide a Platform for Applications:*** It creates an environment where software applications can run smoothly.

***2. Manage Hardware Resources:*** It controls and coordinates hardware components such as the CPU, memory, storage, keyboard, and display.

***3. Enable User Interaction :*** It allows users to interact with the computer through inputs like keyboard, mouse, or touch.

***4. Control Access and Security :*** It manages permissions and ensures that only authorised users or programs can access system resources.

***5. Organise and Manage Data :*** It keeps track of files and folders stored on the device and allows users to retrieve them easily.

### 1.3.2 OS as Bridge

Not always obvious, but every tap or click you make on a touchscreen travel through the OS before anything visible changes. You tap an icon; the OS receives that signal, identifies which app it belongs to, loads it into memory, and tells the screen to display it. You never directly touch the hardware. The OS stands between you and the machine, translating one language into another.

When Meera types her essay in Google Docs on a school computer, she is interacting with the browser, which talks to the OS, which talks to the keyboard hardware, which sends signals to the processor. The OS is the invisible translator in the middle of every action she takes.

## 1.4 Types of Operating Systems

Not all devices use the same OS. A phone, a laptop, and a school server might each run a completely different system - and yet each one manages hardware, runs software, and accepts user input. The difference lies in what each OS was designed for, as summarised in Table 1.1.

***Table 1.1: Common Operating Systems and Their Typical Use***

| Operating System | Typical Device | Made By | One Notable Feature |
|---|---|---|---|
| Windows | Laptops and desktops | Microsoft | Widely used in offices and school labs; familiar Start menu interface |
| Android | Smartphones and tablets | Google | Powers most Indian smartphones; Google Play Store for apps |
| iOS | iPhone and iPad | Apple | Runs only on Apple hardware; |

| | | | |
|---|---|---|---|
| | | | known for a smooth, uniform experience |
| Linux | Servers and technical computers | Open community | Free to use and modify; backbone of most cloud and server systems worldwide |

**Windows :** Windows is the operating system you are most likely to encounter in a school computer lab. Microsoft developed it, and it runs on computers from many different manufacturers - Dell, HP, Lenovo, and others. The desktop, taskbar, and Start menu are its recognisable features.

**Android :** Most smartphones sold in India run Android. Google develops the core system, but phone makers like Samsung, Xiaomi, and Realme customise it for their devices. Jio phones, which brought affordable internet to millions of Indians, also run a version of Android.

**IOS :** Apple's iOS runs exclusively on iPhones and iPads. You cannot install iOS on a non-Apple device. That tight control gives iOS a reputation for consistent performance, but it also means fewer device choices and higher prices.

**Linux :** Linux is free and open-source - anyone can read its code, modify it, and distribute it. It runs most of the world's web servers, including those hosting IRCTC and SBI. Ubuntu is one of the most popular versions of Linux.

### 1.5 Features of an Operating System

An Operating System performs many important tasks in the background while you use a computer or smartphone. These tasks help the device run smoothly and allow different applications to work properly. Some basic features of an operating system are explained below.

***Process Management:*** Process management controls the programmes that run on a device. Every application - such as a browser, music player, or game - is called a process. Many processes can run at the same time. The OS decides which process gets processor time and for how long.

If you are listening to music while browsing the internet, the OS manages both activities so they run smoothly without interfering with each other.

***Memory Management:*** Memory management controls how the device uses its RAM. RAM is the temporary workspace where programmes run. The OS allocates memory to each programme and ensures one programme does not interfere with another. When a programme closes, the OS frees that memory for something else.

***File System Management:*** File management helps store and organise data on a device. The OS creates and manages files and folders, and allows you to

save, rename, move, or delete them. When you save a photo in a folder on your phone, the OS decides exactly where on the storage that photo goes.

***Device Management:*** Device management allows the OS to communicate with hardware such as keyboards, printers, cameras, and USB drives. Small programmes called device drivers handle this communication. The OS loads and manages these drivers so that hardware works correctly as soon as you connect it.

Fig. 1.3 shows these features surrounding the hardware core.

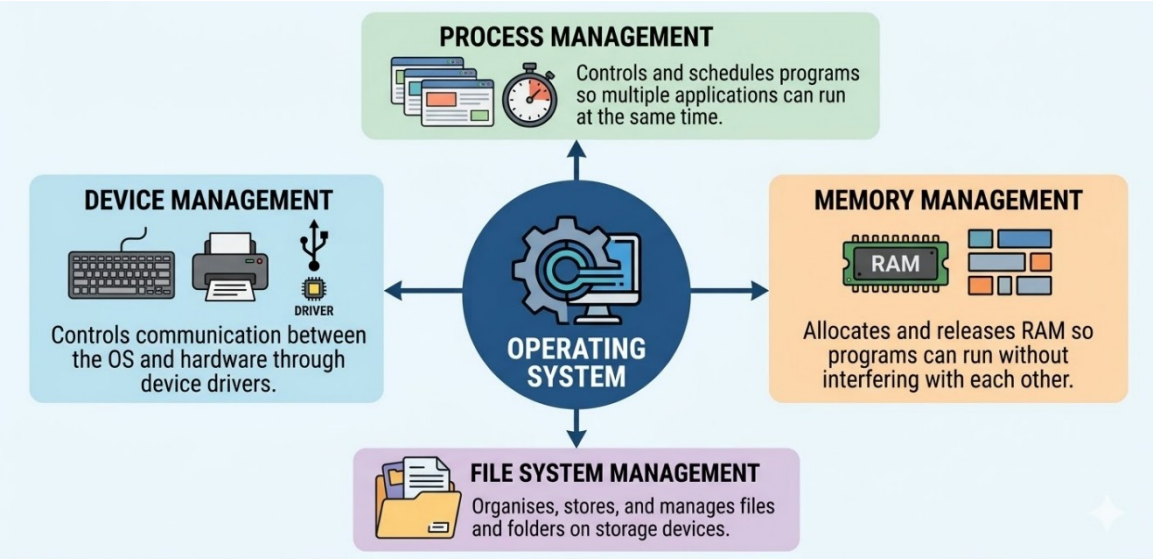



***Fig. 1.3: Core Features of an Operating System***

**Practical Activity 1.1:** Identifying an OS on a Device

**Objective:** Find and record the operating system details on a device available to you.

**Materials Required:**

- A smartphone, tablet, laptop, or desktop computer
- A notebook and pen to record findings
- Optional: access to a browser to verify information found

**Theory (Brief):** Every device that powers on runs an operating system. The OS version tells you what features are available and whether the device can run newer software.

**Procedure**

**Step 1.** On an Android phone, go to Settings, scroll to About Phone, and note the Android version and device model.

**Step 2.** On a Windows computer, press the Windows key, type 'winver', and press Enter. A window will show the Windows version and build number.

**Step 3.** On an iOS device, go to Settings, then General, then About, and note

the iOS version.

**Step 4.** Write down what you find in the observation table below.

**Step 5.** Compare your findings with a classmate who used a different device.

***Table 1.2: OS Observation***

| Device Type | OS Name | Version / Build | One Difference Noticed |
|---|---|---|---|
| Smartphone | | | |
| Tablet / Laptop | | | |
| Desktop Computer | | | |

**Result:** By completing this activity, you confirmed that different devices run different operating systems, and that even the same OS can appear in different versions across devices. This variation affects which apps you can install and how the device behaves.

## Summary

Digital devices - phones, tablets, laptops, and desktops - are part of daily life and each one runs an operating system that makes it usable. The boot process is the automatic startup sequence that loads the OS into memory when a device is switched on. An OS manages hardware, runs applications, and acts as a bridge between you and the machine's physical components. Windows, Android, iOS, and Linux are four widely used operating systems, each suited to different types of devices. The four core features of any OS are process management, memory management, file system management, and device management.

## Check Your Progress

### A. Multiple Choice Questions (MCQs)

1. A student uses a laptop to attend classes while listening to music simultaneously. Which feature of the operating system enables this?
   (a) File management (b) Device management (c) Process management (d) Security management
2. When a computer is switched on, it first checks hardware and then loads the operating system. What is this sequence called?
   (a) Processing cycle (b) Boot process (c) Execution cycle (d) Storage cycle
3. A user saves photos in different folders and retrieves them later. Which function of the operating system is being used?
   (a) Memory management (b) File system management (c) Device management (d) Security

4. A smartphone allows users to interact through touch screen inputs. Which purpose of OS is shown here?
   (a) Manage hardware (b) Enable user interaction (c) Control security (d) Data storage
5. A school computer lab uses Windows OS because it supports many applications. Which purpose of OS does this highlight?
   (a) Security control (b) Platform for applications (c) Device management (d) File storage
6. A printer starts working immediately after being connected to a computer. Which OS feature is responsible?
   (a) Process management (b) Memory management (c) Device management (d) File management
7. A program is closed and the RAM it was using becomes available again. Which function of OS is responsible?
   (a) File system management (b) Memory management (c) Device management (d) Security
8. Linux is widely used in servers because users can modify it freely. Which feature does this represent?
   (a) Proprietary software (b) Open-source system (c) Paid software (d) Limited access system

**B. Fill in the Blanks**

1. A _____ device processes data in binary form.
2. The _____ is the first program that checks hardware during startup.
3. The operating system acts as a _____ between user and hardware.
4. _____ management ensures multiple programs run smoothly.
5. _____ OS is commonly used in smartphones in India.
6. The OS loads into _____ during the boot process.

**C. True or False**

1. The boot process starts after the operating system loads.
2. An operating system controls hardware resources.
3. Tablets are larger than laptops.
4. Process management allows multiple applications to run at the same time.
5. iOS can run on any device.
6. Device drivers help hardware communicate with the OS.

**D. Short Answer Questions**

1. Define a digital device. Give one example.

2. What is the boot process?
3. State any two functions of an operating system.
4. Why is an operating system called a bridge between user and hardware?
5. Differentiate between memory management and file management (any two points).
6. Name any two operating systems and their typical devices.
7. What is the role of device drivers in a computer system?
8. Why is Linux widely used in servers?

# Session 2. Operating System Environment

Seema joined the school computer club and on her very first day, the teacher asked everyone to open the file manager and create a folder with their name. Half the class was on Windows computers and the other half on Ubuntu machines. Seema was on Ubuntu and had never used it before. She looked at the screen, took a breath, and realised that even though the two systems looked different, the basic tasks - creating, renaming, moving folders - worked on the same logic. That moment of recognition is exactly where this session begins.

Whether you work on Windows Server or Ubuntu, the core ideas of managing files, configuring your workspace, and controlling hardware remain consistent. Figure 2.1 shows what a typical OS desktop environment looks like.

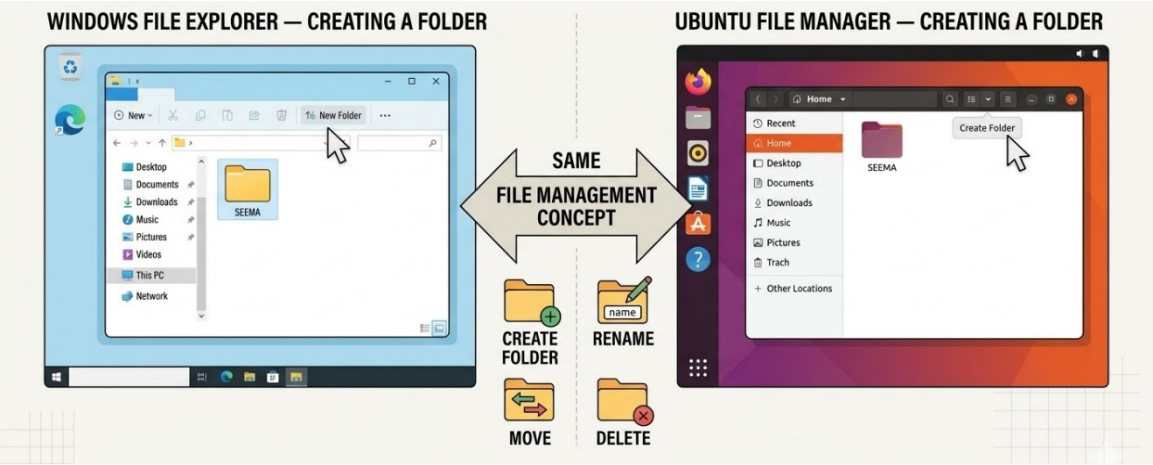



***Fig. 2.1: Windows Server and Ubuntu Desktop Environments***

## 2.1 OS Environments

A server operating system (OS) is used to manage many users and resources in a network (like a school or office). A normal OS (on phone/laptop) is mainly for a single user.

***Windows Server:*** It is used in schools and offices. It manages users, files, and networks. It looks similar to Windows but has extra features.

***Ubuntu Server:*** It is a free Linux-based server OS. It is used in many cloud systems. It works using commands instead of clicking.

***File and Folder Management:*** Files and folders help organize data on a computer. It is like keeping documents in labeled files in a cupboard, proper organization helps you find information quickly.

Table 2.1 shows the equivalent commands for common file tasks in Windows and Ubuntu.

***Table 2.1: File and Folder Tasks in Windows and Ubuntu***

| Task | Windows Method | Ubuntu Terminal Command |
|---|---|---|
| Create a new folder | Right-click desktop > New > Folder | mkdir folder_name |
| Rename a file or folder | Right-click > Rename, then type new name | mv old_name new_name |
| Move a file to a new location | Cut (Ctrl+X) and Paste (Ctrl+V) | mv file.txt /destination/path/ |
| Delete a file permanently | Select file, press Delete key, empty Recycle Bin | rm file.txt (irreversible - no bin) |

### 2.3 Configuring the Working Environment

Every computer user works inside a digital workspace created by the operating system. This workspace is called the working environment. It includes the visual interface, storage organisation, running services, system identification information, and system variables that influence how programs operate.

#### 2.3.1 User Interface Configuration

The user interface is the part of an operating system that allows a user to interact with the computer. Through the user interface, a user can open applications, manage files, change settings, and control system functions.

Operating systems provide tools that allow users to customise the interface according to their preferences. This process is called user interface configuration. By configuring the interface, users can make the system easier to read, easier to navigate, and more comfortable to use for long periods of time. Figure 2.2 Configuring the User Interface in an Operating System.

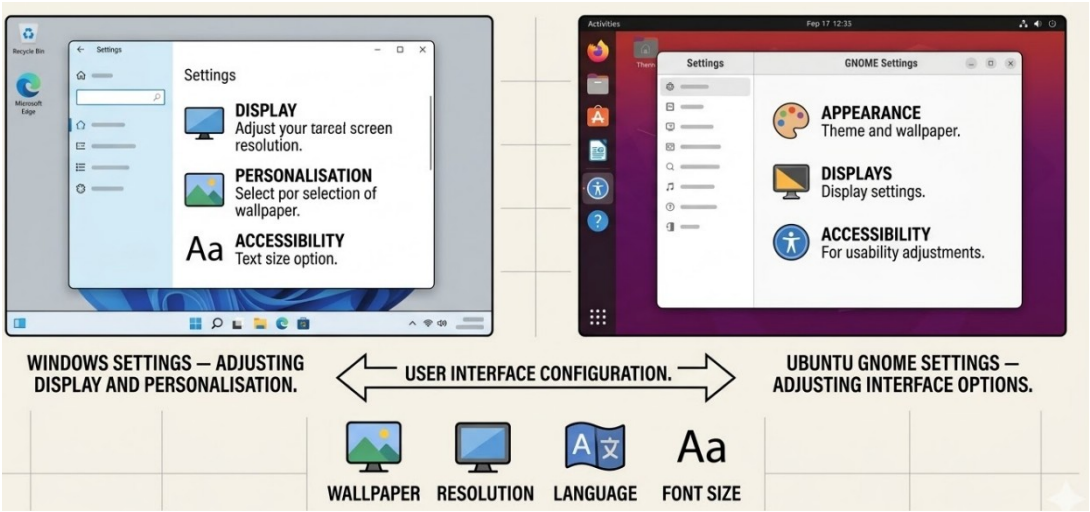



***Fig. 2.2: user interface configuration in Windows & Ubuntu***

**A. User Interface Configuration in Windows**

Right-click on desktop → Personalize → Background → Choose a picture, colour, or slideshow.

**B. User Interface Configuration in Linux (Ubuntu)**

- Click Activities (or press Super key) → Settings → Appearance → Select a new wallpaper.

### 2.3.2 Storage and Disk Management

Storage devices store the operating system, applications, and user files. Common storage devices include Hard Disk Drives (HDD), Solid-State Drives (SSD), USB drives, and memory cards. The operating system organises these devices so users can store, access, and manage data efficiently.

Storage and disk management refers to viewing, organising, and maintaining storage devices and their partitions. A disk can be divided into logical sections called partitions. Each partition acts like a separate storage unit with its own file system where files and folders are stored.

**Storage and Disk Management in Windows**

- Open File Explorer → This PC → See all drives (C:, D:, USB, etc.) and check free space.

**Storage and Disk Management in Linux (Ubuntu)**

df -h → Shows disk usage in easy-to-read format (human-readable)

lsblk → Lists all disks and partitions

Ubuntu also has a graphical tool called “Disks” (search in Activities).

### 2.3.3 Viewing System Information

Every computer contains hardware components such as the processor, memory (RAM), storage devices, and graphics hardware. The operating system also stores details about installed software, system configuration, and device drivers. This collection of technical details is known as system information.

**Viewing detailed system information in windows**

- Press Windows key → type “System Information” → Open msinfo32 for detailed view.

**Viewing System Information in Linux (Ubuntu)**

uname -a → Shows OS name, version, and kernel

free -h → Shows RAM usage in human-readable format

lscpu → Shows processor (CPU) details

### 2.3.4 Service Management

A service is a program that runs in the background to support system operations and applications. Unlike regular programs that open visible

windows, services usually run silently without direct user interaction. They start automatically when the system boots or when a particular function requires them.

**Service Management in Windows**

Window + R Ⓟ Services.msc Ⓟ Enter

**Service Management in Linux (Ubuntu)**

systemctl status ssh → Check if SSH service is running

### 2.3.5 Environment Variables

Environment variables are system settings that store information used by the operating system and applications while they run. They act as named values that programs read to understand system configuration, file locations, and other settings. Instead of storing the same information in multiple places, the system keeps it in variables that can be accessed when needed.

Common environment variables include PATH (directories where programs are stored), HOME/USERPROFILE (user's home directory), and TEMP/TMP (location for temporary files).

**A. Environment Variables in Windows**

Start menu → Search "Environment Variables" → Edit the system environment variables → Environment Variables

Users can view, edit, or create user variables and system variables.

**B. Environment Variables in Linux (Ubuntu)**

To view all environment variables:

printenv

To display the value of a variable:

echo $PATH

These commands help users check system configuration settings.

### 2.4 Device Management

Device management refers to the process by which an operating system controls and communicates with hardware devices connected to a computer. These devices include components such as printers, keyboards, mouse, storage drives, network adapters, and display devices.

The operating system uses device drivers, which are special software programs that allow the system to interact with hardware devices. Without drivers, the operating system cannot properly recognise or operate the hardware.

**A. Device Management in Windows**

To open Device Manager:

Start menu → Search “Device Manager” → Open Device Manager

**B. Device Management in Linux (Ubuntu)**

Users can also view device information using system tools and terminal commands.

To list connected hardware devices:

```
$ lshw
```

To display information about USB devices:

```
$ lsusb
```

These commands help users view connected hardware and verify that devices are properly recognised by the system.

Figure 2.3 shows how the OS sits between your applications and the physical hardware.

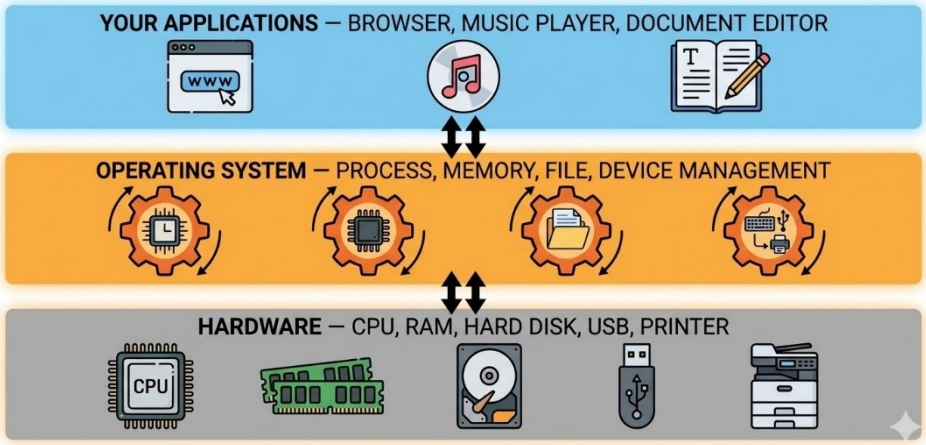



***Fig. 2.3: OS Layer Between Applications and Hardware***

Table 2.2 compares how Windows and Ubuntu handle common device management tasks.

***Table 2.2: Device Management in Windows vs Ubuntu***

| **Task** | **Windows** | **Ubuntu** |
|---|---|---|
| View all connected devices | Device Manager (Control Panel) | lsusb / lspci in terminal |
| Check for driver problems | Yellow triangle icon in Device Manager | dmesg command shows error logs |
| Update a driver | Right-click device > Update Driver | sudo apt update then apt upgrade |
| Remove a device safely | Right-click USB icon in taskbar > Eject | umount /dev/sdX in terminal |

**Practical Activity 2.1:** Exploring File Management and System Information

**Objective:** Perform basic file and folder operations and record system information on a device.

**Materials Required**

- A computer with Windows or Ubuntu installed
- Notebook and pen
- No internet connection required

**Theory (Brief):** File management and system information tools are built into every OS. Knowing how to use them directly - without installing anything extra - is a foundational skill for working with any computer.

**Procedure**

**Step 1.** Open the file manager (Windows: File Explorer / Ubuntu: Files app or terminal).

**Step 2.** On the Desktop, create a new folder named 'MySession2'.

**Step 3.** Inside that folder, create a text file named 'notes.txt'.

**Step 4.** Rename 'notes.txt' to 'session2_notes.txt'.

**Step 5.** View your system information and record it in the table below.

***Table 2.3: System Information Observation***

| Detail | Your Device's Value |
|---|---|
| Operating System Name and Version | |
| Total RAM | |
| Processor Name | |
| Total Disk Space | |
| Free Disk Space | |

**Result:** You have successfully created, renamed, and located files on your device, and recorded key system specifications. These two tasks - organising storage and knowing your system's capability - are skills you will use in every session that follows.

## Summary

Windows Server and Ubuntu are two widely used operating system environments, each offering tools for file management, system configuration, and device control. File and folder operations such as creating, renaming, moving, and deleting follow the same logic on both systems, though the methods differ. Configuring the working environment includes adjusting the

interface, managing storage, viewing system information, controlling services, and setting environment variables. Device management allows the OS to detect and communicate with connected hardware using drivers. Knowing how to navigate both environments gives you flexibility to work with a wide range of systems.

## Check Your Progress

### A. Multiple Choice Questions (MCQs)

1. A student creates a folder using “mkdir” command in Ubuntu. Which concept is being applied?
   (a) Memory management (b) File management (c) Device management (d) Service management
2. A school uses Windows Server to manage multiple users and resources. What type of OS is this?
   (a) Single-user OS (b) Server OS (c) Mobile OS (d) Embedded OS
3. A user changes the desktop background and theme of the system. Which process is this?
   (a) Disk management (b) Service management (c) User interface configuration (d) Device management
4. A user checks available disk space using “df -h” command. Which concept does this represent?
   (a) File management (b) Storage and disk management (c) Device control (d) Service control
5. A student uses “uname -a” command to view OS details. What is being accessed?
   (a) File system (b) System information (c) Environment variables (d) Services
6. A program runs in the background without user interaction. What is it called?
   (a) Process (b) Service (c) File (d) Driver
7. A system uses PATH variable to locate programs. What type of concept is this?
   (a) Disk partition (b) Environment variable (c) Device driver (d) User interface
8. A USB device is connected and detected by the OS using drivers. Which function is performed?
   (a) Memory management (b) Device management (c) File management (d) Process management

### B. Fill in the Blanks

1. A _____ operating system manages multiple users in a network.

2. The command _____ is used to create a new folder in Ubuntu.
3. The working environment includes interface, storage, and _____.
4. A disk can be divided into sections called _____.
5. The _____ command shows RAM usage in Linux.
6. Background programs that support system operations are called ____.

**C. True or False**

1. Windows Server is used for managing single users only.
2. File management helps organise data into folders.
3. Environment variables store system configuration information.
4. Services always require direct user interaction.
5. Device drivers help the OS communicate with hardware.
6. Disk partitions act as separate storage units.

**D. Short Answer Questions**

1. What is a server operating system? Give one example.
2. Explain file and folder management with one example.
3. What is meant by user interface configuration?
4. Define storage and disk management.
5. What is system information? Name any two components included in it.
6. What is a service in an operating system?
7. Explain the role of environment variables.
8. What is device management? Why are drivers important?

# Session 3. Computer Networks

In this session you will understand how computer networks connect devices, how data travels across networks, how network performance is measured, and how basic troubleshooting can be performed. Modern cloud computing depends completely on networking because users access cloud servers through networks. Understanding networks helps students identify problems, improve connectivity, and use digital resources effectively.

## 3.1 Computer Network

A computer network is a system in which two or more computing devices are connected so that they can communicate with each other and share resources. These devices may include computers, laptops, tablets, smartphones, printers, servers and storage devices. When devices are connected in a network, they can exchange files, share printers, access the Internet and communicate through applications such as email and video conferencing.

Networks can be small, such as a classroom network, or extremely large, such as the Internet which connects millions of devices across the world. Modern education, banking, business and entertainment all rely heavily on computer networks.

Cloud computing depends on networks because cloud services are located on remote servers. When a student opens Google Drive or attends an online class, the data travels through networks from the user's device to the cloud server and back.

Figure 3.1 shows a typical computer network with network devices

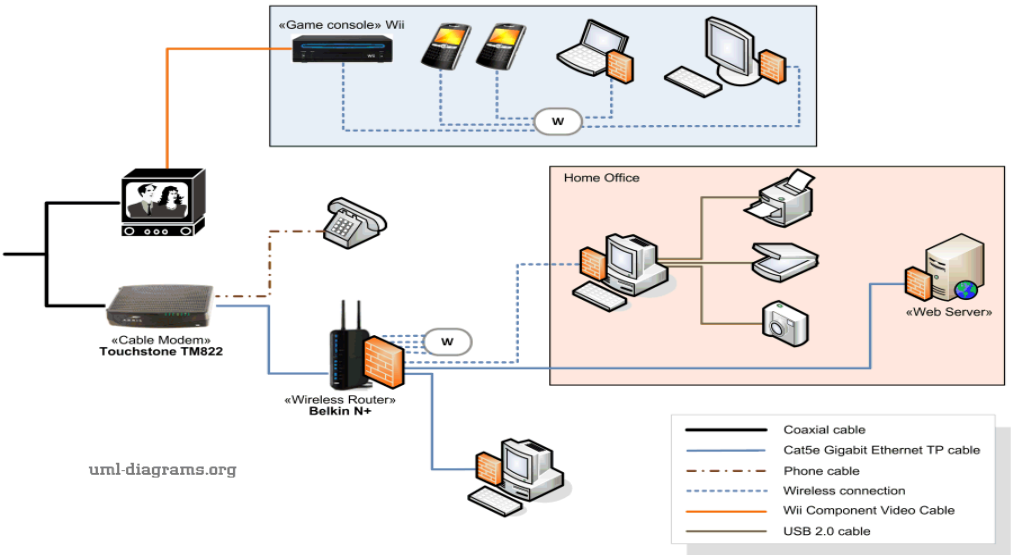



***Fig. 3.1: A Typical Computer Network***

## 3.2 Types of Computer Networks

### 3.2.1 Local Area Network (LAN)

A Local Area Network connects devices within a limited geographical area such as a classroom, school, office or home. LANs are usually high-speed and allow users to share files and printers easily. Figure 3.2 shows a Local Area Network used in a Class.

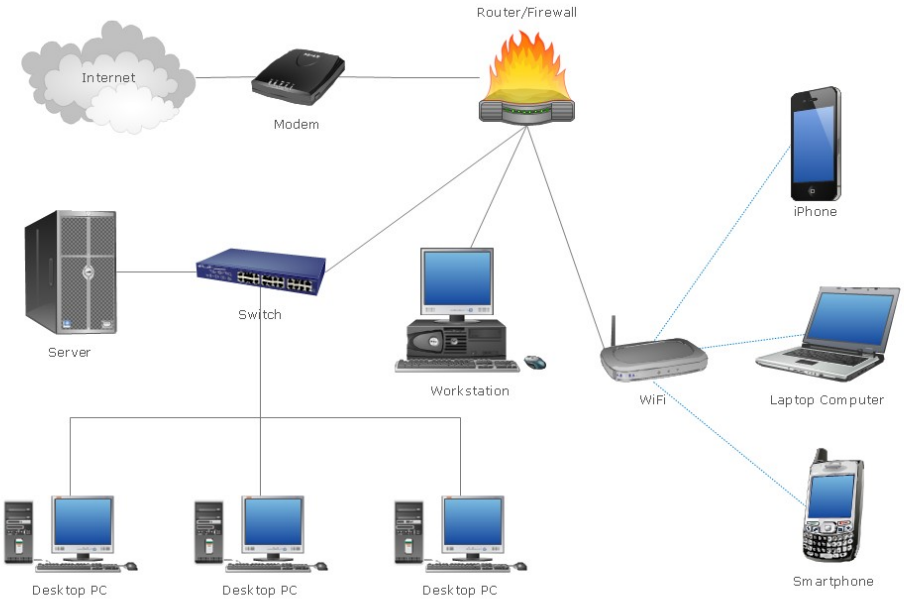



***Fig. 3.2 : Local Area Network in a classroom.***

***Characteristics:***

- Covers small area
- High speed
- Low delay (latency)
- Managed by one organization

***Devices used:***

- Switch
- Router
- Ethernet cables
- Wi-Fi access point

### 3.2.2 Wide Area Network (WAN)

A Wide Area Network connects multiple LANs over large distances such as cities or countries. The Internet is the largest WAN. WANs use fiber cables, satellites, and Internet Service Providers to connect distant networks. Figure 3.3 shows a Wide Area Network connecting different locations.

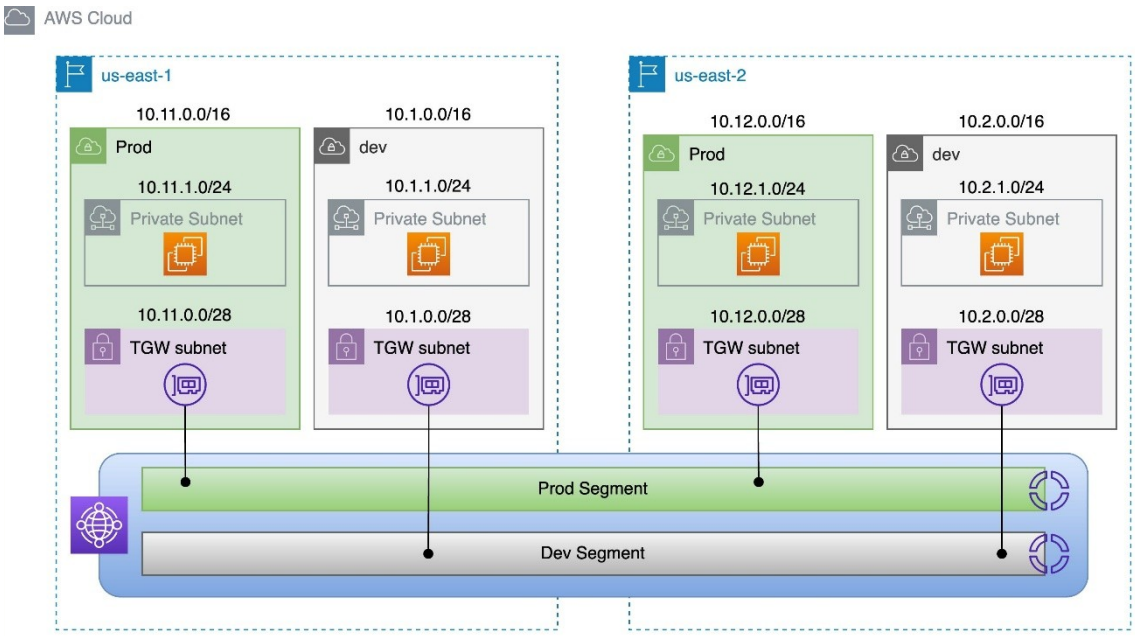



***Fig. 3.3 : WAN connecting different locations***

***Uses:***

- Connecting school branches
- Connecting banks
- Connecting cloud data centers

### 3.2.3 Virtual Private Network (VPN)

A Virtual Private Network creates a secure connection over the Internet. It forms an encrypted tunnel between the user and the organization's network. Figure 3.4 shows VPN tunnel connecting remote user securely.

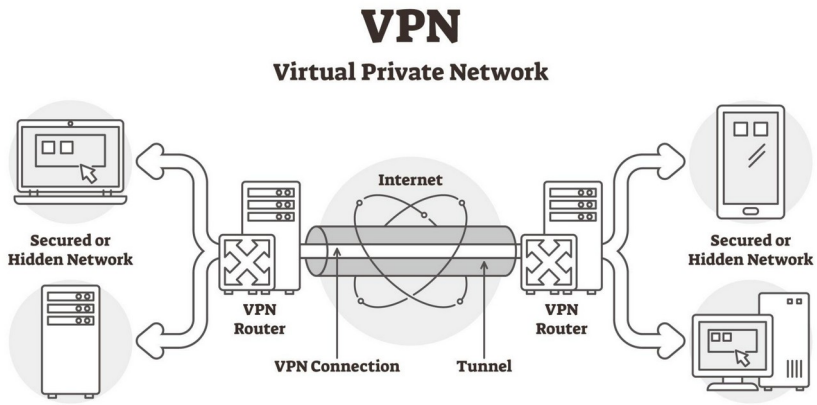



***Fig. 3.4 : VPN tunnel connecting remote user securely***

**Uses:**

- Work from home
- Secure school access
- Protect data privacy

### 3.3 Data Transmission in a Network

When we send a message or open a website, the data does not travel as one large file. Instead, it is divided into small units called **packets**.

Each packet contains, Header, that holds source and destination address and Payload, that contains actual data.

Packets travel through routers and reach the destination where they are reassembled to form a message.

### 3.4 IP Address

An IP address (Internet Protocol address) is a unique numerical label assigned to every device connected to a computer network that uses the Internet Protocol for communication.

Think of it like a physical home address; just as a mail carrier needs your street address to deliver a package, the internet needs an IP address to deliver data (like a website or an email) to the correct device.

**The Two Main Types (IPv4 vs. IPv6)**

As the number of devices globally has exploded, the system for creating these addresses had to evolve. Cloud providers are pushing hard for IPv6 adoption because the world has officially run out of new IPv4 addresses.

| **Feature** | **IPv4** | **IPv6** |
|---|---|---|
| Format | 32-bit (Numbers only) | 128-bit (Numbers and Letters) |
| Example | 192.168.1.1 | 2001:0db8:85a3:0000:0000:8a2e:0370:7334 |
| Capacity | ~4.3 Billion addresses | 340 Undecillion (effectively infinite) |
| Structure | 4 groups of numbers (0-255) | 8 groups of hexadecimal digits |

**Public vs. Private IP Addresses**

Your devices actually use two different types of addresses to stay organized:

***Public IP Address:*** This is the address assigned to your network by your Internet Service Provider (ISP). It is the face your entire home or office shows to the outside world.

***Private IP Address:*** This is the internal address assigned to your specific phone, laptop, or smart TV by your router. It allows the router to know which device requested which video or webpage within your local network.

**Static vs. Dynamic**

***Dynamic:*** Most IP addresses today are dynamic. Your ISP "leases" you an address, and it might change periodically (e.g., when you restart your router).

***Static:*** These never change. They are typically used by servers hosting websites, email services, or organizations that need a permanent, unchanging point of contact.

**IP addresses in Cloud Computing**

IP addresses are a fundamental concept in Cloud Computing. In the cloud, IP addresses are not just used for identifying computers; they are used to manage traffic, security, and connectivity between global services.

**Static vs. Reserved IPs**

In a standard home setup, your IP might change when you restart your router. In the cloud, this would be a disaster for a website or application.

***Elastic/Static IPs:*** Cloud providers (like AWS, Azure, or Google Cloud) allow you to "rent" a permanent IP address. Even if you shut down your virtual server and start a new one, you can point that same IP to the new machine so your users don't lose connection.

**3.5 Protocols**

A protocol is a set of rules that allows two devices to communicate. Without these rules, communication would be impossible.

Imagine if you tried to talk to a friend, but both of you spoke at the exact same time without stopping. You wouldn't understand a word! To solve this, humans have a "social protocol": one person speaks, while the other listens.

Computers are made by many different companies (Apple, Dell, Samsung). For an iPhone to send a message to a Windows laptop, they both must follow the exact same "digital rulebook."

When two computers first connect, they do a "Handshake", like this:

Computer A: "I want to send you a file. Are you ready?"

Computer B: "Yes, I am ready! Send it over."

Computer A: "Okay, here comes the first part."

**Communication Protocols (Sending Data)**

In networking, TCP and UDP are the two main "transport" protocols used to send data across the internet. These define how the data travels from one point to another. Think of them as two different types of delivery services: one that guarantees the package arrives perfectly, and one that just wants to deliver it as fast as possible.

**1. TCP (Transmission Control Protocol)**

TCP is known as a connection-oriented protocol. It is designed for reliability and accuracy. It checks if every piece of data arrived in the correct order. It is slower because of all the checking and double-checking.

Before sending data, TCP performs a "Three-Way Handshake" to make sure the receiver is ready. It numbers every packet of data. If a packet goes missing, TCP asks the sender to send it again.

It is commonly used for Web Browsing (HTTP/HTTPS), Email (SMTP) and File Downloads.

**2. UDP (User Datagram Protocol)**

UDP is a connectionless protocol. It is designed for speed and efficiency. It is incredibly fast because it sends data fast without checking for errors. UDP does not do a handshake or check if the data arrived. It just "fires" the data at the destination as fast as it can. If a packet is lost in transit, it is gone forever. It is commonly used in Video Streaming, Online Gaming and Live Calls (VoIP).

**Common Internet Protocols**

There are three protocols you use every day without even knowing it:

IP (Internet Protocol): Think of this as the address on an envelope. Every device has an "IP Address." This protocol ensures that when you send a message, it finds the right "house" on the internet.

HTTP (Hypertext Transfer Protocol): This is the language your web browser (like Chrome) uses to talk to a website. When you type google.com, your browser uses HTTP to ask Google's computer for its homepage.

TCP (Transmission Control Protocol): This protocol is the "checker." It breaks your data into small pieces called packets. It makes sure every single piece arrives safely and puts them back in the right order at the end.

**3.6 OSI Model**

The OSI (Open Systems Interconnection) model is a conceptual framework used to understand how data moves through a network. Data flows from the top (Application) down to the bottom (Physical) on the sending device, and then from the bottom back up to the top on the receiving device. It divides the complex process of computer-to-computer communication into seven logical layers. The 7 layers of OSI model are illustrated in Figure 3.5.

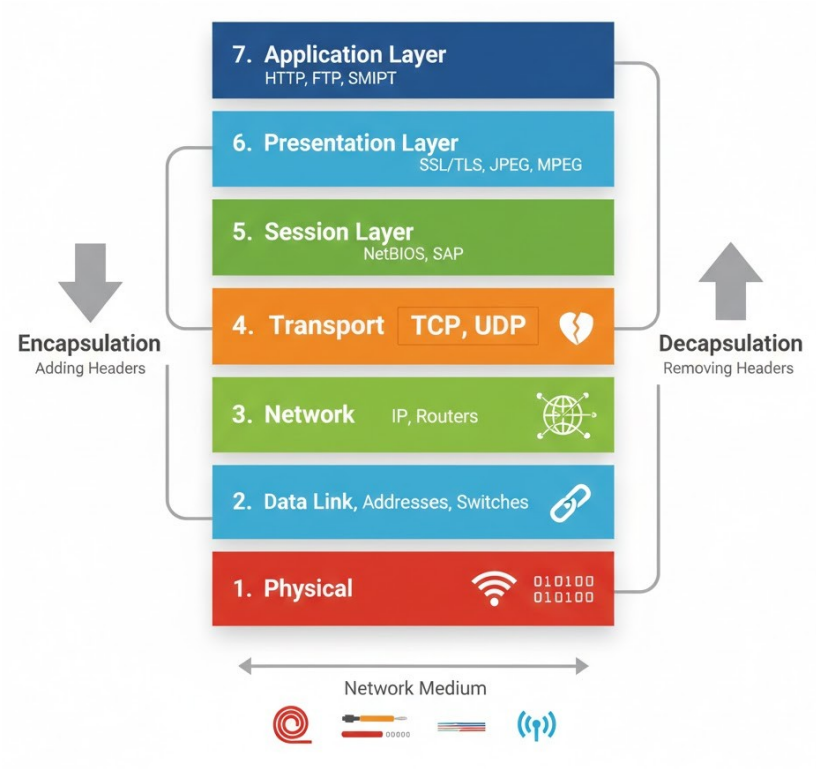



***Fig. 3.5: 7 Layers of OSI Model***

### *7. Application Layer*

This is the only layer that directly interacts with software applications (like a web browser or email client). It provides network services to the end-user's applications (like a browser or email client).

***Example:*** When you type a URL into Google Chrome, the HTTP or HTTPS protocol at this layer starts the request.

Protocols: HTTP (Web), SMTP (Email), FTP (File transfer).

### *6. Presentation Layer*

This layer acts as a translator. It ensures that data sent from the application layer of one system can be read by the application layer of another. It handles encryption, compression, and formatting.

***Examples:*** Converting a .jpeg image or encrypting a password using SSL/TLS.

### *5. Session Layer*

This layer manages the "conversation" between two devices. It opens, maintains, and terminates the connection (session) between applications.

***Example:*** If you are downloading a large file and the connection is lost, the session layer can resume the download from a checkpoint rather than starting over.

Protocols: NetBIOS, SAP.

### *4. Transport Layer*

This layer is responsible for end-to-end communication. It breaks data into segments and ensures they arrive reliably and in the correct order.

***Example:*** TCP (Transmission Control Protocol) provides a reliable connection by asking for an acknowledgment that data was received. UDP is used for faster, "best-effort" delivery like video streaming.

Protocols: TCP, UDP.

### *3. Network Layer*

The Network Layer handles the routing of data. It takes segments and breaks them into packets. It uses IP addresses to find the best physical path for the data to reach its destination.

***Examples:*** Routers and the Internet Protocol (IP). A Router operates at this layer, determining which path a packet should take to reach a server across the world.

Protocols: IP (IPv4/IPv6), ICMP.

### *2. Data Link Layer*

This layer provides node-to-node data transfer. It packages packets into "frames" and handles physical addressing using MAC addresses. It ensures data is error-free as it moves across a physical link.

***Examples:*** Switches and Ethernet. An Ethernet Switch uses MAC addresses to send data frames to the specific computer they are intended for on a local network.

Protocols: Ethernet, Wi-Fi (802.11), PPP.

### *1. Physical Layer*

This is the hardware level. It deals with the actual transmission of raw bitstreams (0s and 1s) over a physical medium (cables, radio waves, or light).

***Example:*** The physical cables (Fiber optic, CAT6), radio waves (Wi-Fi), and the voltages used to represent data.

Components: Hubs, Repeaters, Cables

These 7 layers are summarised in the Table below.

***Table 3.1: Network Layers***

| **Layer** | **Name** | **Data Unit** | **Focus** |
|---|---|---|---|
| 7 | Application | Data | User Interface |
| 6 | Presentation | Data | Format & Encryption |
| 5 | Session | Data | Dialogue Management |
| 4 | Transport | Segments | End-to-End Reliability |
| 3 | Network | Packets | Routing & IP Addresses |

| Layer | Name | Data Unit | Focus |
|---|---|---|---|
| 2 | Data Link | Frames | MAC Addresses |
| 1 | Physical | Bits | Cables & Signals |

**Data Encapsulation**

As data moves down the layers on the sender's side, each layer adds a "header" (and sometimes a "trailer") containing specific instructions. This process is called Encapsulation. When it reaches the receiver, the layers are stripped away one by one (Decapsulation) until only the original data remains, as shown in Figure 3.6.

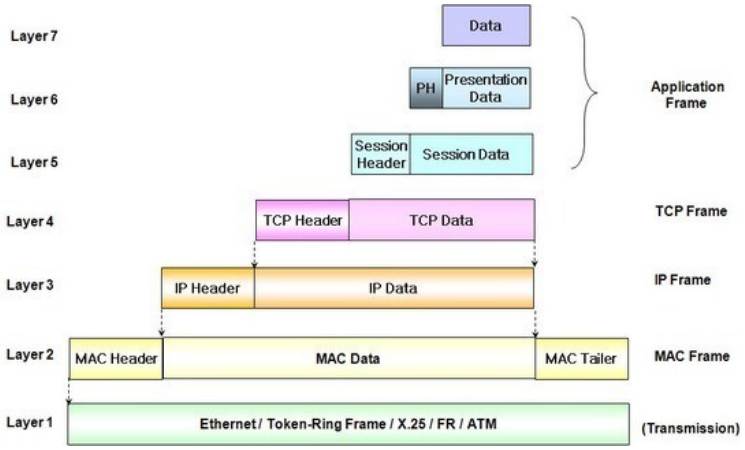



***Fig. 3.6 : Structure of a data packet and routing process***

**6.4 Network Performance Parameters**

Bandwidth: Bandwidth refers to the amount of data that can be transferred in one second. It is measured in Mbps.

***Latency:*** Latency is the time taken for data to travel from source to destination and back. It is measured in milliseconds.

***Jitter:*** Jitter is variation in delay. High jitter affects video and audio calls.

***Packet Loss:*** Packet loss occurs when data packets fail to reach the destination.

Table 3.2 shows the network requirements

**Table 3.2 : Network Requirements**

| Application | Bandwidth | Latency |
|---|---|---|
| Web browsing | 1 Mbps | <100 ms |
| HD video | 5 Mbps | <80 ms |
| Video call | 2 Mbps | <150 ms |
| Gaming | 3 Mbps | <50 ms |

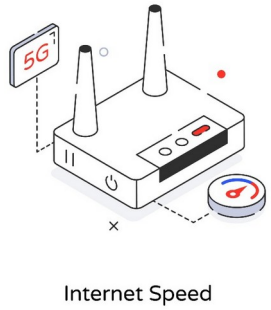



***Fig. 3.7 : Effect of bandwidth and latency on performance***

### 3.5 Importance of Networks in Cloud Computing

Cloud computing services are stored in remote servers. Networks connect users to those servers.

Good network provides:

- Fast file access
- Smooth video calls
- Reliable backups

Poor network causes:

- Slow loading
- Buffering
- Upload failure

Therefore, network quality directly affects cloud performance.

### 3.6 Network Devices

In computer networking, network devices (also known as networking hardware) are the physical tools used to connect computers, printers, and other electronic devices so they can share data and resources.

#### 3.6.1 Common Network Devices

***1. Modem:*** Short for Modulator-Demodulator, a modem is the bridge between your home and your Internet Service Provider (ISP). It translates the analog signals coming from your phone or cable line into the digital signals your computer understands. It's main function is Signal translation for internet access. It operates at Layer 2 (Data Link Layer) of OSI Layer.

***2. Router:*** A router is the most well-known network device. Its job is to connect different networks together (like connecting your home network to the Internet). It looks at the IP address of incoming data and directs it to the correct destination using the most efficient path. It's main function is Routing traffic between networks. It operates at Layer 3 (Network Layer) of OSI Layer.

***3. Hub:*** A hub is an older, "non-intelligent" version of a switch. When it receives data on one port, it broadcasts that data to every other port,

regardless of who it is meant for. This creates a lot of unnecessary traffic (collisions). It's main function is to simply connect the devices. It operates at Layer 1 (Physical Layer) of OSI Layer. This is been obsolete and switch is used in its place now.

***4. Switch:*** A switch connects multiple devices (computers, printers, servers) within a single Local Area Network (LAN). It has many "ports" as shown in Figure . It learns the MAC address of every connected device and sends data only to the specific port where the intended recipient is located. It's main function is directing data to specific devices on a local network. It operates at Layer 2 (Data Link Layer) of OSI Layer.

***5. Wireless Access Point (WAP):*** A Wireless Access Point allows Wi-Fi-enabled devices to connect to a wired network. They provide a Wi-Fi signal to a large area. Most "home routers" actually have a built-in Access Point. It's main function is Providing wireless connectivity to a wired network.

***6. Gateway:*** A gateway is a piece of networking hardware used to connect two different networks that use different protocols. It acts as a "converter" so that devices on different types of networks can communicate. It's main function is translation of protocol between different network types.

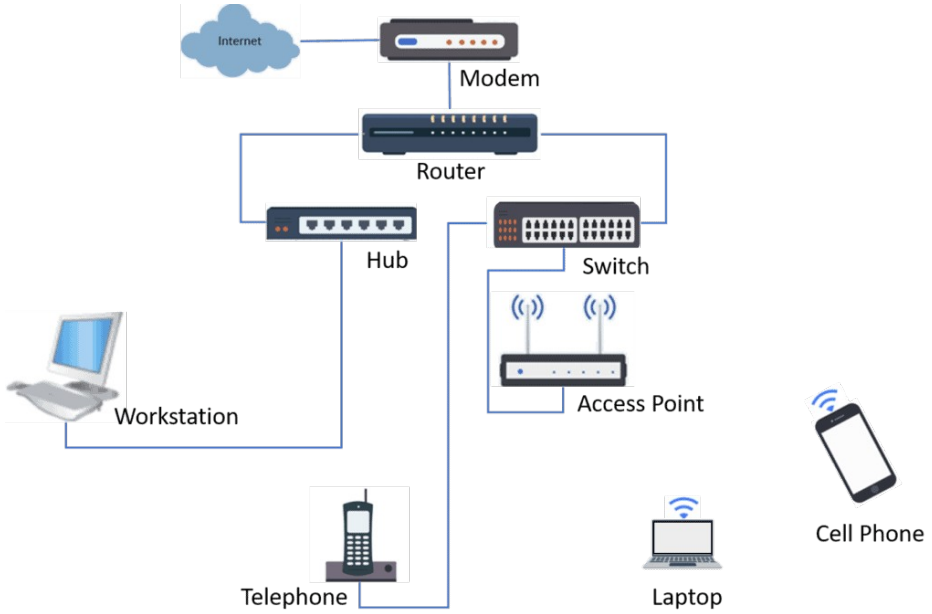



***Fig. 3.8: Network Devices in Computer Network***

The network devices are summarized in the Table 3.3.

***Table 3.3 : Network devices summarized***

| **Device** | **Scope** | **Smartness** | **Primary Address Used** |
|---|---|---|---|
| Hub | Local (LAN) | Low (Broadcasts to all) | None |
| Switch | Local (LAN) | Medium (Sends to specific device) | MAC Address |

| Device | Scope | Smartness | Primary Address Used |
|---|---|---|---|
| Router | Global (WAN) | High (Finds best path) | IP Address |
| Gateway | Cross-Network | Very High (Translates protocols) | Various |

**There are various network devices, some of these are given below.**

**Practical Activity 6.1.** Draw the Network Topology LAN, WAN and VPN diagrams and label devices.

**Materials Required**

A blank sheet of paper (Landscape orientation works best), Three different colored pens (e.g., Blue for LAN, Red for WAN, Green for Labels).

Modem, Router, Network Switch, Access Point (AP), End Devices: Laptops, smartphones, printers, and desktop computers.

**Part A. Drawing the LAN (Local Area Network)**

A LAN is restricted to a small geographic area, like your home or office.

**Step 1.** Draw a central Network Switch.

**Step 2.** Connect three lines to a Desktop PC, a Laptop, and a Network Printer.

**Step 3.** Label these as "Internal Wired Connections."

**Step 4.** Connect the Switch to a Router.

**Part B. Drawing the WAN (Wide Area Network)**

A WAN connects multiple LANs over a large distance, typically using the Internet.

**Step 1.** Draw a large cloud in the center labeled "The Internet".

**Step 2.** Draw two separate circles on either side representing "Office A (LAN)" and "Office B (LAN)".

**Step 3.** Draw a line from the Router of Office A to the Internet cloud, and another line from the Internet cloud to the Router of Office B.

**Step 4.** Label the entire structure as a WAN.

**Part C. Drawing the VPN (Virtual Private Network)**

A VPN creates a secure "tunnel" across a public WAN (the internet) so data stays private.

**Step 1.** Start with your WAN diagram from Part B.

**Step 2.** Draw a thick, shaded pipe (the tunnel) inside the internet cloud that connects Office A directly to Office B.

**Step 3.** Label this pipe as the "VPN Tunnel."

**Step 4.** Add a small lock icon on the tunnel to represent Encryption.

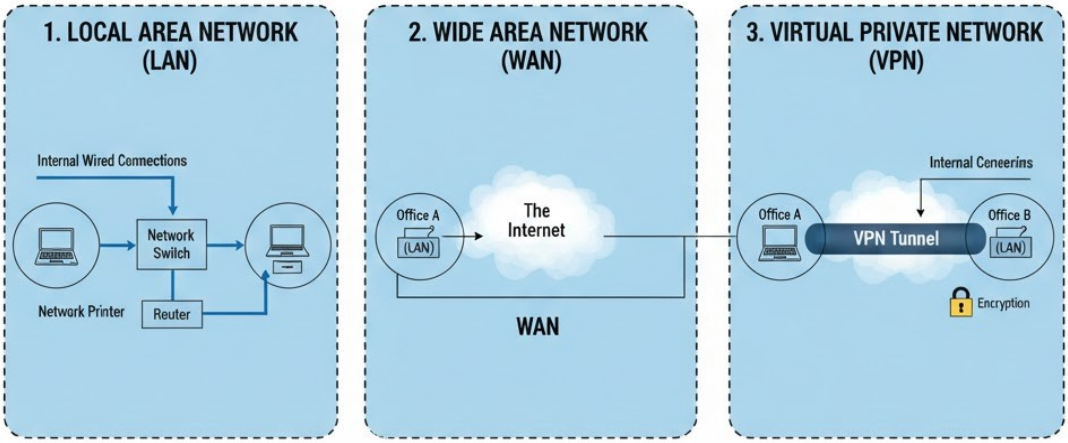



***Fig. Network Topology LAN, WAN,VPN***

**Practical Activity 6.2.** Demonstrate to test the Internet Speed

**Objectives**

To measure download speed, upload speed, and ping (latency), compare the performance of wired (Ethernet) and wireless (Wi-Fi) connections, and identify dead zones or interference in a physical space.

**Material Required**

- A laptop or smartphone,
- An Ethernet cable (optional, for comparison),
- A web-based speed test tool (e.g., Speedtest.net, Fast.com, or Google Speed Test).

**Procedure**

**Test 1:** The "Baseline" (Close to Router)

- Stand within 3 feet of your Wi-Fi router.
- Open your browser and run a speed test.
- Record the Download (Mbps), Upload (Mbps), and Ping (ms).

**Test 2:** The "Distance Test"

- Move to the furthest room in the building or behind a thick wall.
- Run the test again.
- Notice if the Ping increases or the Download speed drops.

**Test 3:** The "Wired vs. Wireless" (Optional)

- Plug your laptop directly into the router using an Ethernet cable.
- Turn off Wi-Fi on the laptop.

- Run the test. (Usually, this provides the most stable and highest speeds).

Enter your observation of Internet Speed Performance Log in the Table below to track your network's performance.

Internet Speed Performance Log

Device Used: _____

ISP (Provider): _____

| **Test Scenario** | **Download (Mbps)** | **Upload (Mbps)** | **Ping (ms)** | **Signal Strength (Bars)** |
|---|---|---|---|---|
| Baseline (Next to Router) | | | | Full |
| Distance (Far Room) | | | | |
| Obstruction (Behind Wall) | | | | |
| Peak Hours (e.g., 8 PM) | | | | |
| Wired (Ethernet Cable) | | | | N/A |

## Check your progress

### A. Multiple Choice Questions (MCQs)

1. Which device is responsible for directing data to specific devices within a single LAN using MAC addresses? (a) Hub (b) Router (c) Switch (d) Gateway
2. Which protocol is designed for speed and efficiency, making it ideal for live video calls and gaming? (a) TCP (b) UDP (c) HTTP (d) IP
3. At which OSI layer does a router operate? (a) Layer 1 (Physical) (b) Layer 2 (Data Link) (c) Layer 3 (Network) (d) Layer 4 (Transport)
4. What is the primary reason cloud providers are pushing for IPv6 adoption? (a) It is easier to remember (b) IPv4 addresses have officially run out (c) It is slower and more secure (d) It only uses numbers.
5. Which performance metric measures the variation in delay, affecting audio and video quality? (a) Bandwidth (b) Latency (c) Jitter (d) Packet Loss

### B. Fill in the Blanks

1. Data travels across a network not as one large file, but divided into small units called _____.

2. A _____ creates a secure, encrypted "tunnel" for data to travel over the public internet.
3. The _____ address is a unique numerical label assigned to every device for internet communication, similar to a physical home address.
4. The process of adding headers to data as it moves down the OSI layers is called _____.
5. _____ is the amount of data that can be transferred in one second, typically measured in Mbps.

**C. True or False**

1. A Hub is considered an "intelligent" device because it only sends data to the intended recipient.
2. TCP is a connection-oriented protocol that ensures every piece of data arrives accurately.
3. A LAN connects devices over large distances like cities or countries.
4. Private IP addresses are assigned to your network by your Internet Service Provider (ISP).
5. The Physical Layer (Layer 1) deals with the actual transmission of bits over cables or radio waves.

**D. Short Answer Questions**

1. Briefly explain the difference between a Static IP and a Dynamic IP.
2. Why is a high-quality network essential for Cloud Computing?
3. Name the 7 layers of the OSI Model in order from top to bottom.
4. In a speed test, what does Ping measure, and why is it important for online gaming?

## Session 4. Role of Internet in Cloud Computing

Aarav loves taking photos on his smartphone. One day, he notices that even after changing his phone, all his old photos are still available — how? Let's see what happens behind the scenes: Aarav's phone is connected to the Internet via mobile data or home Wi-Fi. His photos are automatically uploaded to Google Photos, a cloud storage service. These photos are saved on Google's remote servers, not just inside his phone memory. Whenever Aarav adds or deletes a photo, the change syncs instantly across all his devices through the Internet. Figure 4.1 illustrates this. In this session we will discuss about role of internet in communication and cloud computing.


***Fig. 4.1: Aarav's Photos Syncing with Google Photos***

**Internet**

The Internet is a global network of interconnected computers that communicate and share information using a common set of communication rules called protocols (mainly TCP/IP).

It connects millions of private, public, academic, business, and government networks worldwide, enabling users to access and exchange data, browse websites, send emails, and use cloud-based services.

**Working of the Internet**

5. ***Data Transmission through Packets:*** Information sent over the Internet is divided into small units called data packets. Each packet travels independently through the network and is reassembled at the destination.
6. ***IP Addressing:*** Every device connected to the Internet has a unique identifier called an IP address. For example, 192.168.1.1 or IPv6 address. This helps locate the sender and receiver of data.
7. ***DNS (Domain Name System):*** The Internet uses DNS to convert human-readable domain names like www.google.com into machine-readable IP addresses.
8. ***Routing and Switching:***Data packets are sent via routers and switches, which determine the best path across multiple networks to reach the destination quickly and reliably.
9. ***Protocols:*** Communication is governed by TCP/IP (Transmission Control Protocol/Internet Protocol), ensuring data is delivered correctly and securely.
10. ***Client–Server Model:*** The Internet operates on this model. The client (like a user's browser) sends a request, and the server (like Google's web server) processes it and sends back a response. Figure 4.2 illustrates working of internet.

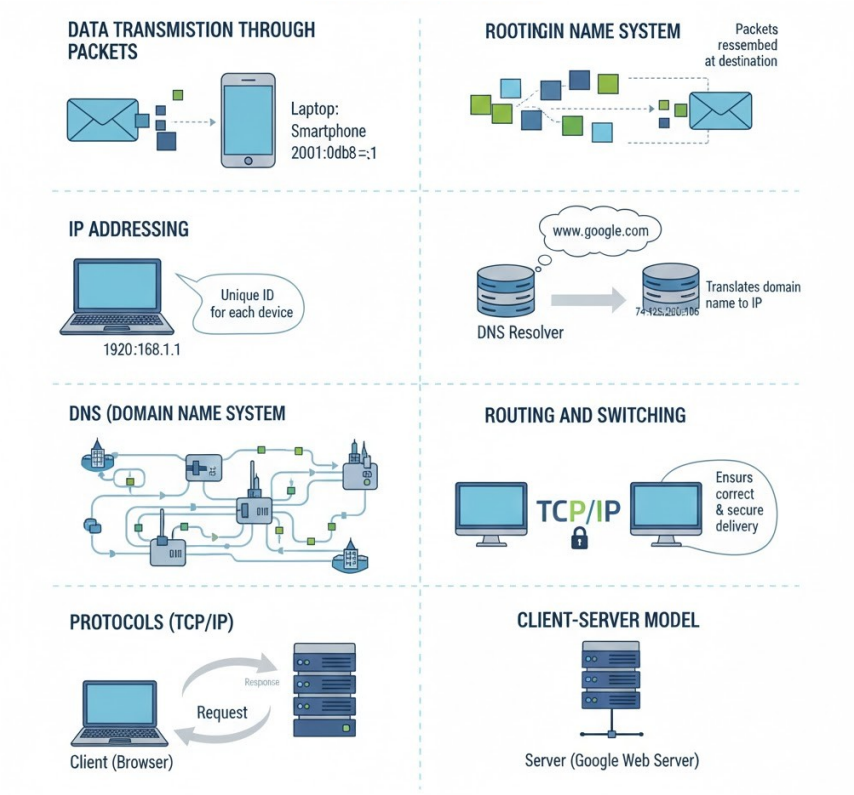



***Fig. 4.2: Working of the Internet***

**Relationship between Internet and Cloud Computing**

The Internet and Cloud Computing are deeply interconnected. The Internet acts as the foundation and transport layer, while Cloud Computing is the service layer built on top of it as shown in the Figure 4.3.

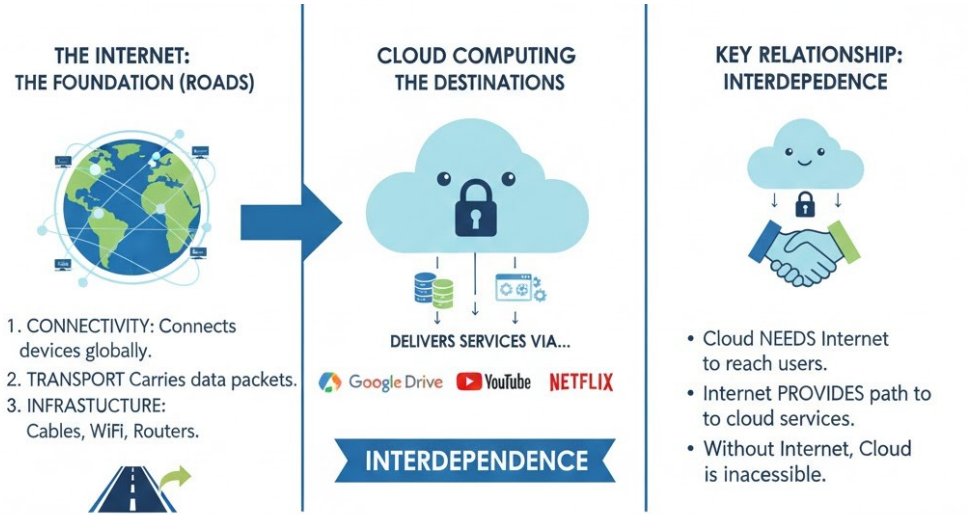



***Fig. 4.3 : Relationship between Internet and cloud Computing***

**Key Relationships**

- Cloud computing depends on the Internet to deliver computing resources like data storage, software, and processing power remotely.
- Without the Internet, users could not connect to cloud servers, access cloud-based applications, or share resources globally.
- The Internet provides global reach, scalability, and connectivity, which make cloud computing practical and cost-effective.

***Example:*** When you upload photos to Google Drive, the Internet connects your device to Google's cloud servers, enabling storage and access from anywhere as shown in Figure 4.4.

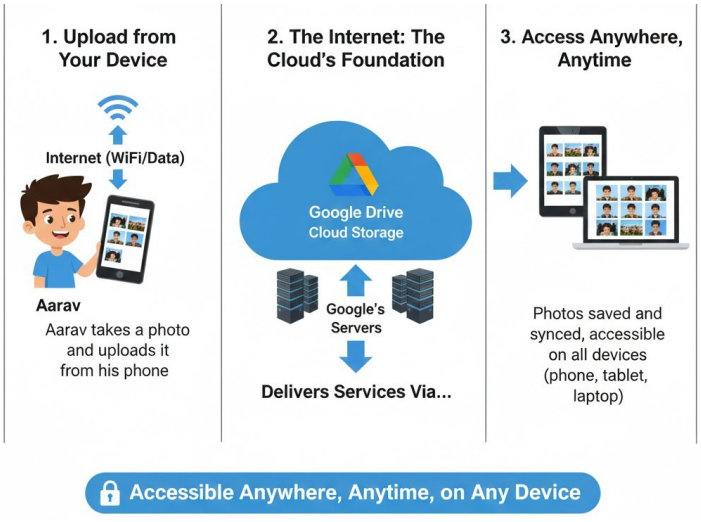



***Fig. 4.4 : How the Internet Connects the Device to Google Drive***

**Role of Internet in Enabling Cloud Services**

The Internet plays a central role in making cloud services functional and accessible as illustrated in Figure 4.4.

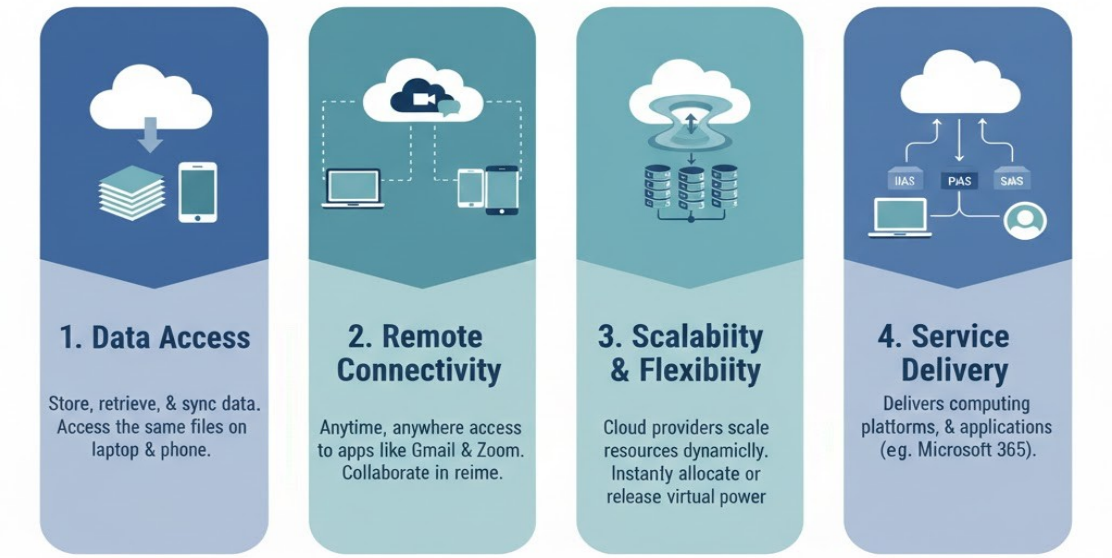



***Fig. 4.5: How the Internet Makes Cloud Services Possible***

**1. Data Access**

Users can store, retrieve, and modify data stored on remote cloud servers using Internet connectivity. Data synchronization between devices, like accessing the same document from laptop and phone, is possible only through the Internet.

**2. Remote Connectivity**

The Internet enables anytime, anywhere access to cloud applications like Gmail, Zoom, or Microsoft 365. Remote users can collaborate in real time, share files, and communicate without being physically present in one place.

**3. Scalability and Flexibility**

The Internet allows cloud providers to scale services dynamically based on user demand. Virtual resources can be allocated or released instantly over the Internet.

**4. Service Delivery**

Cloud service models — IaaS (Infrastructure as a Service), PaaS (Platform as a Service), and SaaS (Software as a Service) — all rely on the Internet to deliver computing power, development platforms, and applications to end users.

**Components Required for Internet Access**

To connect to and use the Internet, several hardware and service components are essential as shown in Figure 4.6 and explained below that.

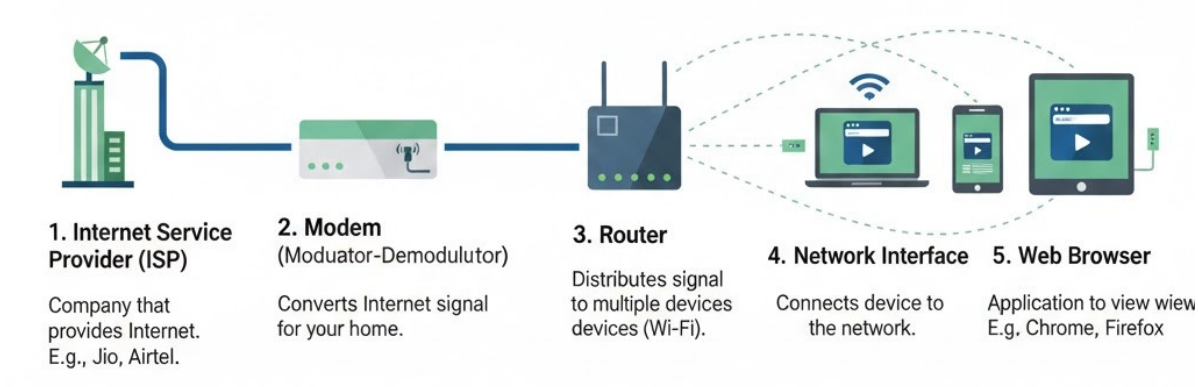



***Fig. 5.6: Essential Components to Access Internet***

### *1. Internet Service Provider (ISP)*

An ISP is a company that provides Internet connectivity to users. BSNL, Airtel, Jio, ACT, Hathway. The ISP connects the user's device to the global Internet through broadband, fiber, mobile data, or Wi-Fi.

### *2. Modem (Modulator–Demodulator)*

A modem converts digital signals from a computer into analog signals that can travel through telephone or cable lines — and vice versa. It enables communication between the computer and the ISP.

### *3. Router*

A router distributes Internet signals from the modem to multiple devices within a local network (LAN or Wi-Fi). It routes data packets between the local devices and the Internet.

### *4. Network Interface (LAN Card or Wi-Fi Adapter)*

This hardware connects your computer or smartphone to the network wired or wireless.

### *5. Web Browser*

A browser is an application that allows users to access and interact with information on the World Wide Web. Examples: Google Chrome, Mozilla Firefox, Microsoft Edge, Safari. It sends user requests to web servers via the Internet and displays the received web pages.

***Table 4.1 : Various aspects to access the Internet***

| **Aspect** | **Description** |
|---|---|
| Internet | Global network connecting computers and devices worldwide. |
| Cloud Computing | Delivery of computing services (storage, apps, and servers) via the Internet. |
| Internet's Role in | Enables data transfer, remote access, and |

| Aspect | Description |
|---|---|
| Cloud | communication between users and cloud servers. |
| Key Components for Access | ISP, Modem, Router, Browser, Network Interface. |

**Practical Activity 4.2.** Demonstrate How to Connect to the Internet (Wired / Wireless)

**Materials Required**

- Computer / Laptop / Smartphone
- Wi-Fi Router with Internet connection
- Ethernet (LAN) Cable
- Active Internet Service
- Web Browser (Chrome, Firefox, etc.)

**(A) Wired Connection**

A wired connection uses physical cables (Ethernet or LAN) to connect your computer directly to the Internet through a modem or router.

**Procedure**

**Step 1.** Locate the **Ethernet port** on the computer/laptop. Take an **Ethernet cable (LAN cable)**.

**Step 2.** Plug one end of the Ethernet cable into your computer's LAN port.

**Step 3.** Plug the other end into the router or modem.

**Step 4.** Ensure the router/modem is connected to the ISP line (broadband or fiber).

**Step 5.** Look for the **network icon** on the screen to show connected status.

**Step 6.** Once connected, your computer automatically detects the network and provides Internet access.

**Step 7.** Open a web browser and type **www.google.com** to test connectivity.

**Observation**

The network shows a connected wired connection, the webpage loads successfully, and it provides high speed, stability, and minimal interference or data loss.

**(B) Wireless Connection (Wi-Fi)**

A wireless connection uses radio signals to connect to the Internet without cables.

**Step 1.** Ensure your device (laptop, tablet, or phone) has Wi-Fi enabled.

**Step 2.** Turn ON the Wi-Fi on your device.

- On Laptop: Click the Wi-Fi icon in the taskbar.
- On Mobile: Go to Settings → Wi-Fi.

**Step 3.** A list of available networks will appear.

**Step 4.** Select your Wi-Fi network name (SSID).

**Step 5.** Enter the Wi-Fi password (if secured).

**Step 6.** Click Connect.

**Step 7.** Wait until the status shows Connected.

**Step 8.** Open a browser and visit a website to confirm Internet access.

**Observation**

The Wi-Fi icon shows a connected signal with strength, and the website opens successfully.

**Advantages of wi-fi connection:**

- Mobility and convenience.
- Multiple devices can connect simultaneously.

**Example Demonstration in Class:**

Teacher connects a laptop to the Internet using both a LAN cable and Wi-Fi and shows how both methods enable online access (e.g., opening Google Classroom or YouTube).

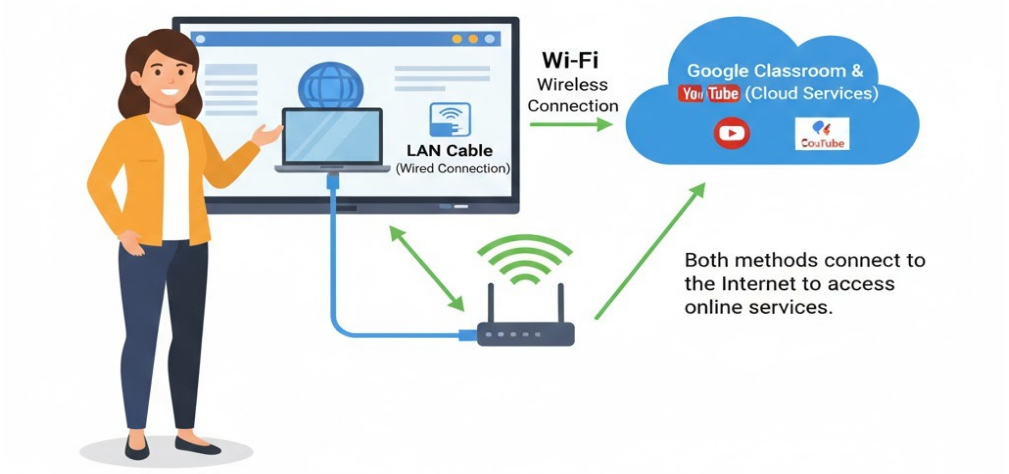



***Fig. 4.7 : Connecting the device through wired and wireless media***

**2. Identify Internet-Based Applications that Use Cloud**

Many everyday apps rely on cloud computing — they store data and run applications over the Internet rather than your local device. How these applications uses cloud computing is given in the Table

***Table 4.2: Applications using the type of cloud computing***

| Application | Type | How it Uses Cloud Computing |
|---|---|---|
| Google Drive | Cloud Storage | Saves and syncs files online; accessible from any device. |
| Zoom / Google Meet | Communication Tool | Hosts video conferences and stores recordings on cloud servers. |
| YouTube | Media Streaming | Stores videos on cloud servers and streams them to users worldwide. |
| Gmail / Outlook | Email Service | Stores emails and attachments securely in cloud-based mail servers. |
| Google Docs / Microsoft 365 | Online Office Apps | Allows users to create, edit, and share documents in real time. |
| Spotify / Netflix | Entertainment Service | Streams music or movies directly from cloud servers. |

All these applications require the Internet to connect users to their cloud-based data and services.

**Practical Activity 4.3.** Group Discussion on – "Can Cloud Exist Without the Internet?"

**Objectives**

To understand the concept of cloud computing, analyze the role of the Internet in cloud services, develop critical thinking and reasoning skills, and enhance communication and group discussion skills.

**Material Required**

- Notebook/worksheet
- Pen/pencil
- Blackboard/whiteboard
- Chart paper (optional)

**Procedure**

**Step 1.** The teacher introduces the concept of cloud computing with simple examples (e.g., online storage, email services).

**Step 2.** The topic ***"Can Cloud Exist Without the Internet?"*** is written on the board.

**Step 3.** Students are divided into small groups (3–5 students each).

**Step 4.** Each group discusses the topic and lists points for and against the statement.

**Step 5.** Groups present their viewpoints one by one.

**Step 6.** The teacher moderates the discussion and encourages

participation from all students.

**Step 7.** Key points from all groups are summarized on the board.

**Step 8.** The teacher provides the final explanation and clarifies misconceptions.

**4. Observation/Result**

Students observed that cloud computing relies on internet connectivity to access data and services, while limited offline access through cached or previously saved data is possible but does not represent true cloud usage.

***Conclusion:*** Cloud computing cannot effectively exist without the internet, as it relies on online servers and connectivity for its functioning.

## Summary

This session explains that the Internet is the backbone of cloud computing. It describes how devices connect using IP addresses, DNS, routers, and ISPs. Students understand how data travels in packets and how cloud services depend on Internet connectivity to function. Without the Internet, cloud services cannot be accessed.

## Check Your Progress

### A. Multiple Choice Questions (MCQs)

1. The Internet is best described as a (a) Single computer (b) Global network of interconnected computers (c) Type of software (d) Local storage device
2. Information sent over the Internet is broken into small units called (a) Signals (b) Data packets (c) Files (d) Domains
3. Every device connected to the Internet has a unique identifier called (a) URL (b) IP Address (c) DNS (d) Protocol
4. DNS is used to (a) Store files online (b) Convert domain names into IP addresses (c) Speed up Wi-Fi (d) Block viruses
5. Cloud computing depends on the Internet to (a) Print documents (b) Deliver services like storage and applications (c) Replace hardware completely (d) Create cables
6. Which of the following distributes Internet signals to multiple devices? (a) Modem (b) Router (c) Browser (d) Server
7. Which service provider gives Internet connectivity to users? (a) DNS (b) ISP (c) TCP (d) HTTP
8. Gmail, Google Drive, and Zoom are examples of (a) Offline software (b) Internet cables (c) Cloud-based applications (d) Operating systems

### B. Fill in the Blanks

1. The Internet works using communication rules called _____.
2. The _____ model is used where the client sends a request and the server responds.
3. A _____ converts digital signals into analog signals and vice versa.
4. The Internet enables users to access cloud services from _____.
5. _____ allows users to store and access data from remote servers.
6. A _____ is used to access websites like Google Chrome or Firefox.
7. Cloud services such as SaaS, PaaS, and IaaS are delivered through the _____.
8. A wireless Internet connection is commonly called _____.

**C. True or False**

1. Cloud computing can function without the Internet for general users.
2. Data packets travel independently across networks.
3. A router connects multiple devices to the Internet.
4. Google Photos stores images only on the phone memory.
5. The Internet provides connectivity, while the cloud provides services.
6. An ISP is responsible for providing Internet access.
7. A web browser is hardware used to connect to networks.
8. Wi-Fi allows devices to connect without physical cables.

**D. Short Answer Questions**

1. Define the Internet.
2. What is an IP address and why is it important?
3. Explain the relationship between the Internet and cloud computing.
4. What is the role of DNS in Internet communication?
5. Name any two components required for Internet access.
6. How does the Internet enable cloud-based collaboration?
7. Differentiate between modem and router.
8. Give two examples of applications that use cloud computing through the Internet.

# Module 4. Cloud Storage, Collaboration & Applications

This module on ***Cloud Storage, Collaboration & Applications*** introduces students to the effective use of cloud technologies for managing digital information and working collaboratively. In **Session 1**, students learn the concept of cloud storage, its importance in daily life, and the process through which data is uploaded, stored, and accessed via the internet. The session also familiarizes them with popular cloud storage services and develops essential file management skills such as organizing files, creating folders, and sharing resources efficiently. **Session 2** focuses on cloud file sharing, highlighting how it differs from traditional methods and enables users to work on a single file without creating multiple copies. Students understand different sharing methods and permission levels, along with the role of version history and access control in maintaining security. Safe sharing practices are also emphasized to ensure responsible use of cloud platforms. In **Session 3**, students explore real-time collaboration, where multiple users can simultaneously work on the same document using cloud tools. The session highlights the benefits of collaborative work, introduces appropriate tools for different tasks, and reinforces collaboration etiquette to ensure effective teamwork. Overall, the module equips students with the knowledge and skills required to store, manage, share, and collaboratively create digital content in a secure and efficient manner.

# Session 1. Using Cloud Storage Tools for File Management

Riya, a Class 9 student from Pune, has just finished creating beautiful digital illustrations and a short video for her science project on her home desktop. The next morning at school, her heart sinks—she forgot her pen drive! The final presentation is in ten minutes.

But then, she smiles. She remembers saving her heavy 182 video files and artwork on Google Drive the previous night. She simply opens the school lab computer, logs into her account, and finds her complete project sitting safely online, ready to present. Figure 1.1 illustrates how Riya's files traveled securely through the Internet instead of on a physical pen drive.

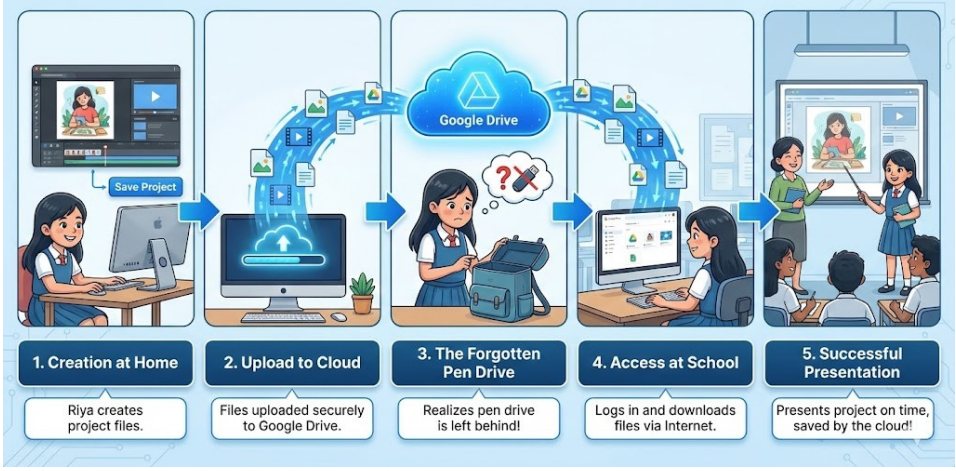



***Fig. 1.1: Riya accessing her digital project via the cloud***

This is the power of cloud storage. It allows us to store our files on the internet and access them from anywhere, at any time, using any device.

In this Session, we will learn what cloud storage is, how it works, and how we can use it smartly for managing our files.

## 1.1 Use of Cloud Storage in Daily Life

Every day, we use our phones, computers, or tablets to click photos, write notes, watch videos, and create documents. All this data needs to be stored somewhere. Earlier, people stored all their files on the computer's hard disk or on a pen drive. But what if the hard disk gets damaged? What if you lose your pen drive?

Cloud storage solves this problem. Instead of keeping files only on your device, you save them on secure servers on the internet. These servers are managed by large companies and are available 24 hours a day, 7 days a week. You do not need to worry about carrying a device or losing your data.

As shown in Figure 1.2, cloud storage is used in many situations of our daily life:

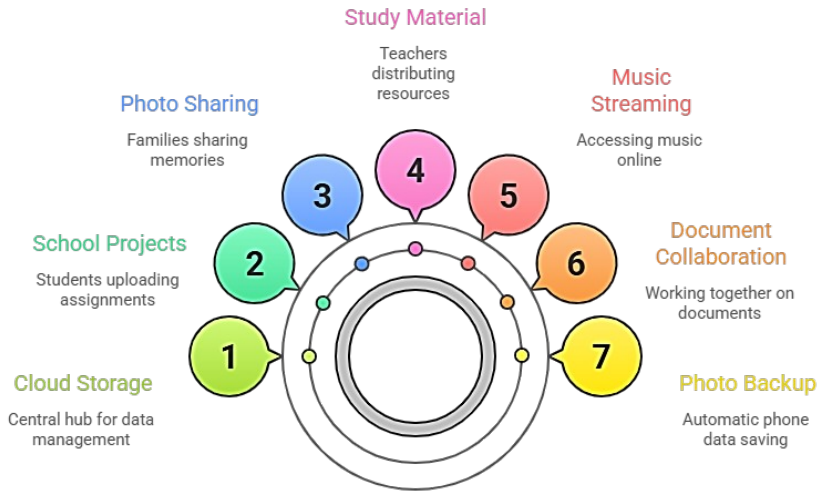



***Fig. 1.2: Cloud Storage in Daily Life***

## 1.2 Working of Cloud Storage

When you save a file on cloud storage, it does not just disappear into thin air. There is a clear process behind it. Let us understand how cloud storage works, step by step.

**Step-wise Explanation**

**Step 1.** You create or save a file on your device (computer, phone, or tablet).

**Step 2.** You connect to the internet (mobile data or Wi-Fi).

**Step 3.** You upload the file to the cloud storage service (e.g., Google Drive).

**Step 4.** The cloud service stores the file securely on its servers in a data centre.

**Step 5.** The service also creates backup copies on multiple servers for safety and reliability.

**Step 6.** Whenever you need the file, you log in to the cloud service from any device and download or open it.

**Step 7.** If you edit the file and save it, the updated version is automatically synced across all your devices.

## 1.3 Advantages and Limitations of Cloud Storage

Like all technology, cloud storage has both benefits and limitations. It is important to know both so that we can use it wisely and safely.

Table 1.1 presents the advantages and limitations of cloud storage side by side.

***Table 1.1: Advantages and Limitations of Cloud Storage***

| **Advantages** | **Limitations** |
|---|---|
| Access files from anywhere using any | Requires a working internet |

| | |
|---|---|
| device with internet. | connection at all times. |
| No need to carry pen drives or hard disks. | Slow internet can make uploading or downloading difficult. |
| Free storage available (e.g., 15 GB on Google Drive). | Free storage is limited; extra space needs a paid plan. |
| Files are automatically backed up — no risk of data loss. | Privacy concerns — files are stored on third-party servers. |
| Easy to share files with friends, classmates, or teachers. | Some services may limit file size for single uploads. |
| Files sync automatically across all your devices. | Account may be at risk if password is weak or stolen. |

### 1.4 Popular Cloud Storage Services

Many companies provide cloud storage services. Some are free (up to a certain storage limit) and some require payment for extra storage. Let us look at some widely used cloud storage services available in India. As shown in Figure 1.3, the popular cloud storage services can be compared across key features

***Fig. 1.3: Popular Cloud Storage Services***

***a) Google Drive:*** Google Drive is one of the most widely used cloud storage services in India. It provides 15 GB of free storage. Students can create, edit, and store documents, presentations, and spreadsheets directly using Google Docs, Sheets, and Slides. It is accessible from all devices using a Gmail account.

***b) Microsoft OneDrive:*** OneDrive is Microsoft's cloud storage service. It works well with Windows computers and Microsoft Office applications. Schools using Windows devices often use OneDrive to store student assignments and teacher resources.

***c) Apple iCloud:*** iCloud is designed for Apple device users — iPhone, iPad, and Mac computers. It automatically backs up photos, contacts, and files from Apple devices. It is not commonly used on non-Apple devices.

***d) Dropbox:*** Dropbox was one of the first popular cloud storage services. It is well known for easy file sharing. However, its free storage of only 2 GB is lower than other services, which can be a limitation for students.

***e) MEGA:*** MEGA offers 20 GB of free storage — the highest among common free services. It is known for strong encryption, meaning your files are well protected. It is suitable for users who want to store large files securely.

### 1.5 File Management in Cloud Storage

Just like you organize your notebooks, textbooks, and files in your school bag and cupboard, you also need to organize digital files in cloud storage. This is called File Management.

Good file management makes it easier to find, share, and use your files. It also helps you avoid duplication and keeps your storage space clean. Let us learn the basic file management operations that you can perform in cloud storage.

As shown in Figure 1.4, the complete file management process in cloud storage includes the following operations:

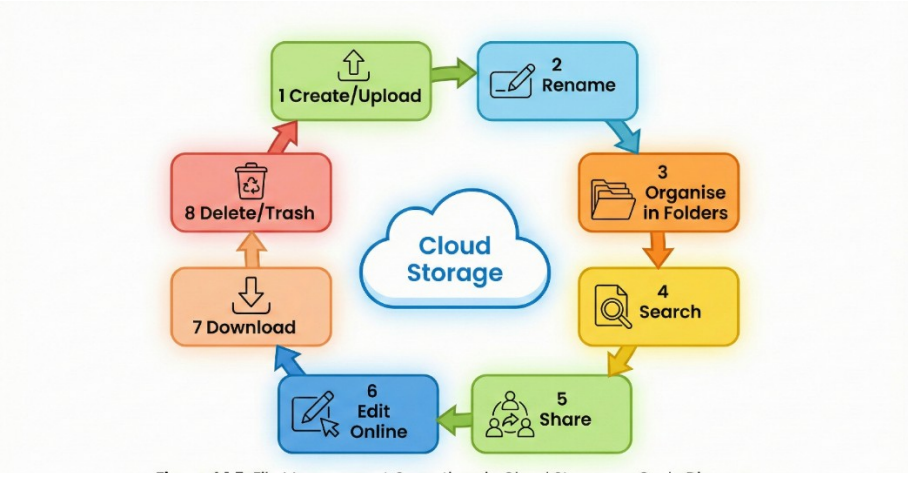



***Fig. 1.4: File Management Operations in Cloud Storage***

**Practical Activity 1.1.** Organising a Digital Classroom Library

**Objective:** To understand file management concepts by creating a virtual folder structure on paper.

**Material Required**

- Computer / Laptop / Tablet
- Internet connection
- Cloud storage platform (e.g., Google Drive / Microsoft OneDrive)
- Sample files (documents, PDFs, images, videos)

**Procedure**

**Step 1.** Login to Google Drive / OneDrive using your account

**Step 2.** Create a folder named: ***"Class IX Digital Classroom Library"***

**Step 3.** Create subject-wise folders: English, Mathematics, Science, Social Science, ICT

**Step 4.** Upload sample files into respective folders. Use proper naming (e.g., ***Maths_Chapter1_Notes.pdf***)

**Step 5.** Rename, move, or delete files as required. Sort files using date/name.

**Step 6.** Share the main folder with classmates or teacher. Set permissions (view/edit)

**Step 7.** Search and open a specific file from the library

**Learning Outcome**

Students will be able to efficiently manage files using cloud storage tools and organize digital learning resources for collaborative use.

## Summary

Cloud storage enables users to store files on internet-based servers and access them anytime from any device, ensuring convenience, backup, and easy sharing. Files are uploaded through the internet, securely stored on remote servers, and automatically synchronized across devices. Popular services such as Google Drive and Microsoft OneDrive provide limited free storage with options for expansion. While cloud storage offers advantages like accessibility, collaboration, and data safety, it also depends on internet connectivity and may involve privacy concerns. Effective file management—through proper folder organization, naming conventions, and sharing practices—helps in efficient storage, retrieval, and use of digital resources.

## Check Your Progress

### A. Multiple Choice Questions (MCQs)

- A student wants to access files from both home and school computers. Which method is most suitable? (a) Saving on hard disk (b) Using cloud storage (c) Using a CD (d) Printing files
- Which of the following is an example of a cloud storage service? (a) Notepad (b) Paint (c) Google Drive (d) Calculator
- A student uploads files to an online platform to keep them safe. This process is called: (a) Downloading (b) Uploading (c) Deleting (d) Printing
- Organizing files into folders like “Science” and “Maths” helps in: (a) Deleting files (b) Easy retrieval (c) Reducing internet use (d) Slowing down system
- Which of the following is a limitation of cloud storage? (a) Easy sharing (b) Requires internet connection (c) Automatic backup (d) Access from anywhere

**B. Fill in the Blanks**

- Cloud storage stores files on _____ servers.
- Files can be accessed from anywhere using an _____ connection.
- The process of arranging files into folders is called _____.
- _____ allows users to give access to others for their files.
- Cloud storage services provide limited free _____.

**C. True or False**

- Cloud storage allows access to files from multiple devices.
- Files stored in cloud storage cannot be shared.
- Internet connection is required to use cloud storage.
- File naming is not important in cloud storage.
- Cloud storage provides automatic backup of files.

**D. Short Answer Questions**

- What is cloud storage?
- How does cloud storage help in accessing files anywhere?
- Why is file management important in cloud storage?
- Mention two advantages of cloud storage.
- Give two examples of cloud storage services.

## Session 2. File Sharing with Permissions

Ananya and her classmates were preparing a report on the "Clean India Campaign." Initially, they shared the file through email, which created multiple versions and confusion. Some edits were repeated, and important points were accidentally deleted.

To fix this, their teacher created one shared file in Google Drive (see Figure 2.1, shared Cloud File with Controlled Permissions) and assigned Edit, Comment, and View access to different students. Everyone then worked on the same document, changes were tracked with time details, and the project was completed smoothly without losing any work.

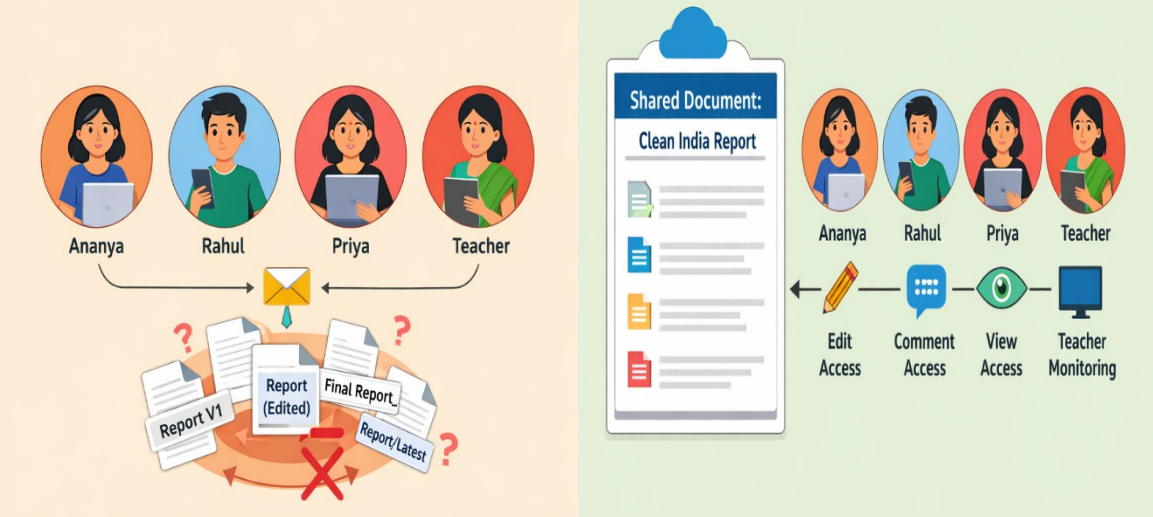



***Fig. 2.1 Shared cloud file with controlled permissions***

### 2.1 Cloud File Sharing

Cloud file sharing is the practice of storing a single authoritative copy of a file on a cloud server and granting specific users-controlled access to that file over the Internet — so everyone always works on the same version.

***Example:*** Think of it like a school library's single reference book. Only one copy exists. Anyone with a library card (account) can read it. Only the librarian (owner) can update it. No one takes it home and creates a personal copy — the original stays in the library.

Traditional file sharing — copying to pen drives, burning CDs, or emailing attachments — creates multiple independent copies of the same file. The moment two people start editing their own copies, the versions diverge and someone must spend hours merging them back. Cloud file sharing solves this by design: there is only one file, stored on the provider's server. Every collaborator access that same file, sees every change in near real time, and works without creating personal copies.

Table 2.1 compares traditional and cloud-based file sharing across dimensions that matter most in a classroom.

***Table 2.1: Traditional File Sharing vs Cloud File Sharing***

| **Dimension** | **Traditional (email / pen drive)** | **Cloud File Sharing** |
|---|---|---|
| Number of copies | One per person — all diverge over time | One canonical copy — everyone sees the same version |
| Collaboration | Merge multiple files manually; error-prone | Real-time co-editing; changes visible to all instantly |
| Version tracking | No automatic history; old files lost | Version history: every save recorded with author and timestamp |
| Access control | No control after sending — anyone can forward | Granular permissions; revocable at any time |
| Recovery | Deleted file is gone unless locally backed up | Restore any earlier version from history |
| Audit trail | No record of who read or edited | Activity logs show who accessed, edited, or commented |
| Submission evidence | Timestamp = when email arrived — can be disputed | Provider records exact upload and edit time — verifiable |

## 2.2 Cloud File Sharing Work

Sharing a file using Google Drive, Microsoft OneDrive, or Dropbox follows the same core steps regardless of provider: the owner uploads or creates a file, then chooses who can access it and what they can do. Figure 2.2 shows the two main sharing methods before each is explained.

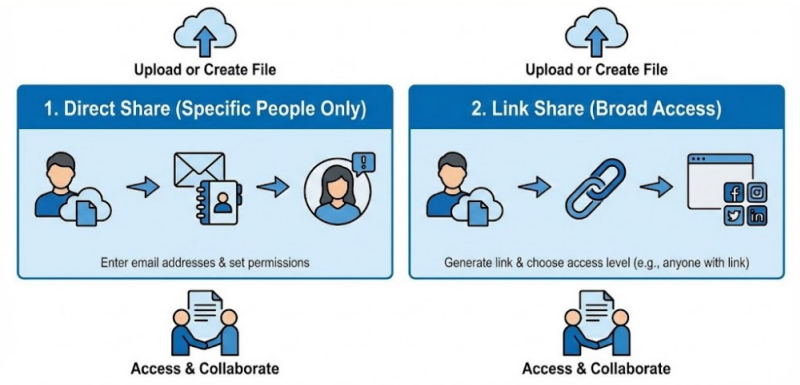



***Fig. 2.2: Two methods of sharing a cloud file***

***Method 1 — Authenticated invite:*** You type the recipient's email address directly into the share dialog. Access is tied to that person's account — only they can open the file when signed in. This is the safest method because you can remove one person's access later without affecting others. Use this for group project members, assignment submissions, and any sensitive material.

***Method 2 — Shareable link:*** The platform generates a URL. Anyone who receives this URL can open the file — no sign-in required (unless you choose 'domain-restricted'). Links are convenient for distributing reading materials to a whole class, but a leaked link is as good as public access. Always set the minimum permission needed and add an expiry date for important links.

## 2.3 Types of Sharing Permissions

Sharing permission is the level of access granted to a user for a specific cloud file or folder, determining whether they can only read it, add comments, make edits, or fully manage the file including its sharing settings.

***Example:*** Like the different keys given to people in a school building. The cleaning staff gets a key that opens corridors only. Teachers get a key for classrooms. The principal gets a master key for everything. Each key grants exactly what is needed — no more.

Figure 2.3 shows the four permission levels as a hierarchy.

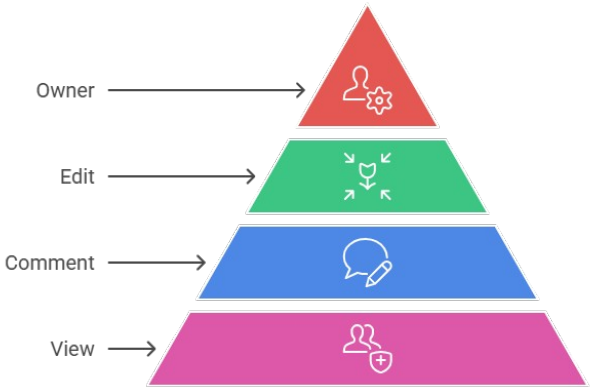



***Fig. 2.3: Permission hierarchy***

The principle of least privilege: Always assign the minimum permission level that allows the person to do their job. If Priya only needs to read the project rubric, give her View — not Edit. If Kabir needs to review a draft, give him Comment — not Edit. Grant Edit only when someone actively needs to write or modify content. This single habit prevents most accidental data loss and unauthorised changes in shared cloud files.

### 2.4 Version History and Access Control

Two features protect your shared work even after permissions are correctly set: version history and access control. Together they act as your safety net and your security layer.

Version history is an automatic record maintained by the cloud platform of every saved change to a file, including who made the change, what was changed, and when — allowing any earlier version to be restored at any time.

***Example:*** Like the undo button — but for weeks or months, not just the last few minutes. If Kabir accidentally deletes three paragraphs on Monday and nobody notices until Friday, version history lets you restore the file exactly as it was on Sunday evening.

Access control is the combination of technical settings and human processes that determines who can see or modify a file, when they can do so, and what record is kept of their actions.

***Example:*** Like a school gate with a register. Only people with a valid ID badge enter (technical setting). The guard records who came and left (audit log). Badges expire at the end of the year (access revocation). All three parts together make the system secure.

Table 2.2 shows the desired security outcomes and the specific actions that achieve them — a practical checklist for any teacher or project lead setting up a shared folder.

***Table 2.2: Access Control***

| Desired Outcome | Action to Take | When to Do It |
|---|---|---|
| Prevent unauthorised access | Use authenticated email invites; restrict links to school domain | At setup, before sharing |
| Limit accidental edits | Grant View or Comment access until active collaboration is needed | Default for all new shares |
| Maintain audit trail | Enable and periodically review activity logs and version history | Throughout the project |

| | | |
|---|---|---|
| Minimise exposure | Set link expiry dates; disable public indexing of sensitive files | Before distributing any link |
| Ensure recoverability | Keep teacher or admin as Owner; verify retention policy with school IT | At project creation |
| Close access after task ends | Revoke Edit rights; change to View-only or remove collaborators entirely | At submission deadline or project end |

### 2.5 Security and Safe-Sharing

Technical permissions are only as strong as the habits of the people using them. The five practices below as you can see Table 2.3, when followed consistently, make cloud file sharing both efficient and safe for any school environment.

***Table 2.3: Security Best Practices for Cloud File Sharing***

| **Practice** | **Why It Matters** | **How to Apply** |
|---|---|---|
| Give limited access | Reduces mistakes or misuse | Start with View, give Edit only if needed |
| Share with emails | More secure access | Enter email, avoid public links |
| Set link expiry | Stops long-term access | Set expiry for shared links |
| Use 2-step verification | Protects account | Enable 2FA |
| Log out on shared devices | Keeps account safe | Always sign out |
| Check permissions later | Removes extra access | Review sharing after work |
| Use comments for feedback | Keeps original safe | Use Comment, not Edit |

**Practical Activity 4.1. Share, Collaborate, and Manage a Google Drive Document**

**Material Required**

- Computer / Laptop / Tablet

- Internet connection
- Google Drive
- Student email accounts

**Procedure**

**Step 1.** Open Google Drive and create a new Google Docs document.

**Step 2.** Name the document as ***"Group Project – Class IX"*** and add some content.

**Step 3.** Click on the "Share" button and enter email IDs of classmates.

**Step 4.** Assign permissions such as Viewer, Commenter, and Editor.

**Step 5.** Allow classmates to access and make changes or comments.

**Step 6.** Modify permissions or remove access as required.

**Step 7.** Check "Version History" to track changes made by different users.

**Observation / Result**

The document is successfully shared with multiple users with appropriate permission levels (view, comment, edit), enabling real-time collaboration and effective tracking and management of changes.

## Summary

In this session, students learned how cloud file sharing allows multiple users to work on a single document stored online, avoiding confusion caused by multiple copies. They understood different sharing methods such as email-based access and shareable links, and learned to assign appropriate permissions like view, comment, and edit based on the task. The session also highlighted the importance of version history for tracking changes and restoring previous work, along with access control for maintaining security. Additionally, students learned safe sharing practices such as giving limited access, using strong passwords, and managing permissions carefully for effective and secure collaboration.

## Check Your Progress

### A. Multiple Choice Questions (MCQs)

1. A group of students want to work on the same document without creating multiple copies. Which method should they use? (a) Email attachments (b) Pen drive sharing (c) Cloud file sharing (d) Printing copies
2. Which permission allows a user to make changes in a document? (a) Viewer (b) Commenter (c) Editor (d) Reader
3. Sharing a file using email IDs is considered: (a) Public sharing (b) Authenticated sharing (c) Offline sharing (d) Manual sharing

4. Which feature helps to restore an earlier version of a file? (a) File upload (b) Version history (c) Download (d) Delete
5. What is the safest practice while sharing files? (a) Give full access to everyone (b) Share with unknown users (c) Assign minimum required permission (d) Disable password

**B. Fill in the Blanks**

1. Cloud file sharing keeps only one _____ copy of a file.
2. Access given to users is called _____.
3. The _____ permission allows only viewing of a file.
4. _____ history records all changes made in a document.
5. Sharing files using links may become risky if the link is _____.

**C. True or False**

1. Cloud sharing creates multiple independent copies of a file.
2. Editor permission allows users to modify the document.
3. Version history cannot be used to restore files.
4. Permissions can be changed or removed anytime.
5. Strong passwords help in securing cloud files.

**D. Short Answer Questions**

1. What is cloud file sharing?
2. Why is permission important while sharing files?
3. What is the difference between Viewer and Editor?
4. How does version history help users?
5. Mention two safe practices for file sharing.

## Session 3. Real-Time Collaboration Using Cloud Tools

On Thursday afternoon in a Bengaluru school, Aarav, Priya, Riya, and Kabir had 45 minutes to finish their Science report. Though sitting in different locations, they worked on one shared file in Google Docs titled “Group 4 — Water Conservation Report.”

All four edited the document at the same time, seeing each other’s coloured cursors move in real time. When Priya accidentally deleted a sentence, she quickly restored it using Undo. Within 40 minutes, the complete report was ready — no emails, no version confusion.

Dr. Meena reviewed the same document and could clearly see each student’s contribution. Figure 3.1 shows this example of real-time cloud collaboration.

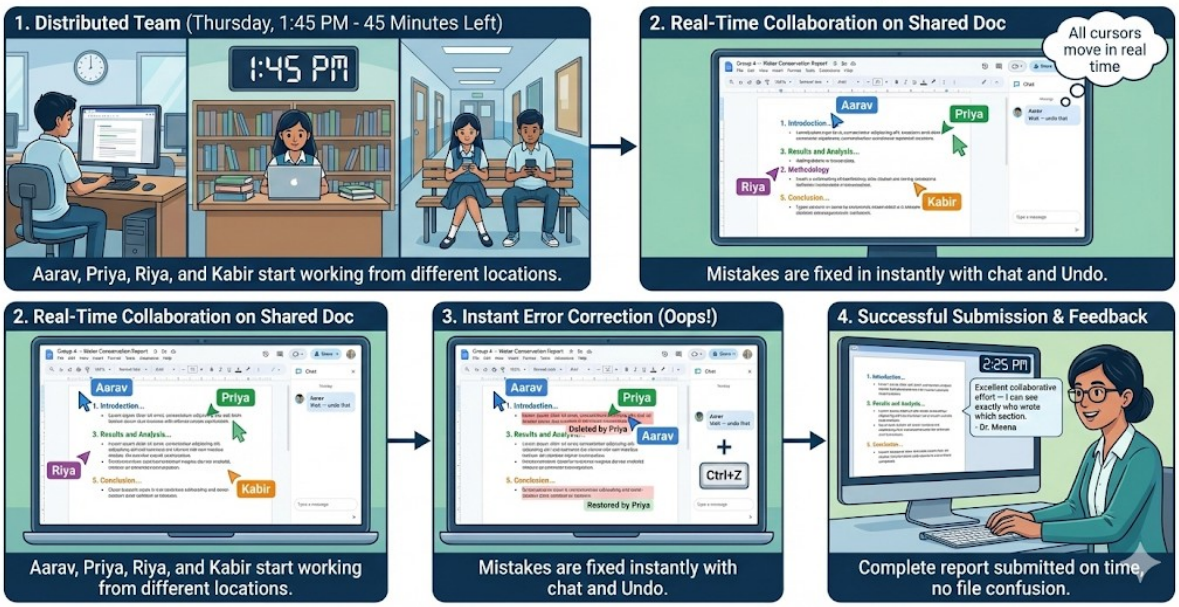



***Fig. 3.1: Real-time collaboration***

### 3.1 Real-Time Collaboration

Real-time collaboration is a way of working in which two or more people access, view, and edit the same digital file simultaneously, with every participant's changes appearing on all other participants' screens within seconds — always keeping one single authoritative copy in the cloud.

***Example:*** Imagine a group of students sharing one physical whiteboard in a classroom — anyone can walk up and write, everyone sees every addition immediately, and there is only ever one whiteboard, not one copy per student. Cloud real-time collaboration does exactly this, but digitally, across any distance.

Table 3.1 compares both approaches across the dimensions that matter most in a school project.

***Table 3.1: Pass-the-File vs. Real-Time Cloud Collaboration***

| Dimension | Pass-the-File (Email/Pen Drive) | Real-Time Cloud Collaboration |
|---|---|---|
| Number of copies | One per person — all diverge immediately | One canonical file — everyone works on the same version |
| Visibility of others | No visibility — you cannot see what teammates wrote | Live coloured cursors show who is working where, in real time |
| Conflict resolution | Manual merge — tedious and error-prone | System handles simultaneous edits automatically |
| Feedback speed | Must send file back; wait for reply | Teacher or peer comments appear instantly in the same document |
| Version tracking | No automatic history; old versions lost | Every change recorded with author, timestamp, and restorability |
| Coordination | Email or WhatsApp out-of-band | In-document chat and comments keep discussion in context |
| Submission evidence | Difficult to prove individual contributions | Version history shows every participant's exact edits |

### 3.2 Cloud Tools for Real-Time Collaboration

Cloud tools allow students to work together on the same file at the same time. When one person edits the file, the change appears instantly for others and the document saves automatically in the cloud. This makes group work faster and keeps everyone on the same version.

Different tools should be chosen based on the task. For writing reports or notes, document tools like Google Docs are suitable. For numbers, calculations, or data tables, spreadsheet tools such as Google Sheets work best. For presentations, Google Slides helps organize content into slides. For brainstorming ideas or drawing plans, whiteboard tools like Google Jamboard can be used.

Students may face problems like accidental edits or confusing file names. These issues can be reduced by assigning roles in the group, using clear file

names, and giving suggestions through comments instead of deleting others' work.

### 3.4 Benefits and Classroom Considerations

Real-time collaboration delivers genuine educational advantages — but only when structured properly. Table 3.2 pairs each key benefit with its classroom implication and a practical strategy to maximise it.

***Table 3.2: Benefits of Real-Time Collaboration***

| **Benefit** | **Why It Helps** | **What to Do** |
|---|---|---|
| One shared file | No confusion of multiple copies | Share only one document link |
| Quick teacher feedback | Students get instant suggestions | Use comments or suggestion mode |
| Track contributions | Easy to see who did what | Check version history |
| Faster work | Work is done together | Divide work into parts |
| Better teamwork | Improves communication | Discuss using comments |

### 3.5 Collaboration Etiquette and Precautions

The ability to edit a document together in real time is a powerful feature of cloud-based tools. However, effective collaboration depends not only on technology but also on proper behavior and discipline. Following clear collaboration etiquette ensures respect, fairness, and productivity during group work.

Table 3.3 explains each rule, why it is important, and what may happen if it is not followed.

***Table 3.3: Collaboration Etiquette Rules and Reasons***

| **Rule** | **Why It Matters** | **If Not Followed** |
|---|---|---|
| Don't delete others' work | Respects team effort | Work is lost, conflicts happen |
| Use comments for changes | Keeps original content safe | Ideas get overwritten |
| Mention your name | Shows your work clearly | Hard to give marks |
| Log out on shared devices | Protects your account | Others may misuse it |
| Inform internet | Helps team adjust | Causes delay and confusion |

| Rule | Why It Matters | If Not Followed |
|---|---|---|
| issues | work | |
| Discuss inside document | Keeps record of decisions | No proof of discussion |

**Practical Activity 3.1.** Live Co-Authoring — Group Report in Google Docs

**Objective**

To understand real-time collaboration using cloud tools, create and edit a document collaboratively, and observe live co-authoring along with tracking changes.

**Material Required**

- Computer / Laptop / Tablet
- Internet connection
- Google Drive and Google Docs
- Student email accounts

**Procedure**

**Step 1.** Open Google Drive and create a new Google Docs document.

**Step 2.** Name the document as ***"Group Report – Environment Protection".***

**Step 3.** Add 3–4 group members by clicking the "Share" button and entering their email IDs.

**Step 4.** Assign all members Editor permission for collaboration.

**Step 5.** Divide the report into sections (Introduction, Causes, Effects, Solutions).

**Step 6.** Each student writes content in their assigned section simultaneously.

**Step 7.** Use the comment feature to give suggestions and feedback.

**Step 8.** Observe real-time typing and edits made by different users.

**Step 9.** Use Version History to view changes and contributions of each member.

**Observation / Result**

Multiple users successfully edit the same document simultaneously with real-time updates, while comments and suggestions enhance the report quality and individual contributions are effectively tracked.

## Summary

In this session, students learned about real-time collaboration using cloud tools, where multiple users can work on the same document simultaneously while viewing each other's changes instantly. They understood how cloud tools like Google Docs enable faster teamwork by maintaining a single shared file, avoiding duplication and confusion. Students also learned to use features such as comments, version history, and live editing to improve collaboration and track contributions. Additionally, the session emphasized proper collaboration etiquette, such as respecting others' work, using comments for suggestions, and working responsibly to ensure effective and smooth group work.

## Check Your Progress

### A. Multiple Choice Questions (MCQs)

1. A group of students are editing the same document at the same time from different locations. This is called: (a) File sharing (b) Real-time collaboration (c) File downloading (d) Offline editing
2. Which tool is best suited for writing a group report online? (a) Calculator (b) Paint (c) Google Docs (d) Media Player
3. What helps in tracking who made changes in a document? (a) File name (b) Version history (c) Folder name (d) Download option
4. Which feature allows giving suggestions without changing the original content? (a) Delete (b) Comment (c) Print (d) Rename
5. What is the best way to avoid confusion while working in a group document? (a) Create multiple copies (b) Work offline (c) Use one shared file (d) Avoid collaboration

### B. Fill in the Blanks

1. Real-time collaboration allows multiple users to work on a _____ file.
2. Changes made by one user appear _____ to others.
3. _____ history helps track changes in a document.
4. _____ are used to give feedback without editing the content.
5. Cloud tools automatically _____ the document.

### C. True or False

1. Real-time collaboration creates multiple copies of a file.
2. All users can see changes made by others instantly.
3. Comments help in improving the document without deleting content.
4. Version history cannot show previous changes.
5. Collaboration improves teamwork among students.

**D. Short Answer Questions**

1. What is real-time collaboration?
2. How does it help in group work?
3. Why is version history important?
4. What is the role of comments in collaboration?
5. Mention two benefits of real-time collaboration.

## Answer Key

## Module 1. Basics of Cloud Computing

### Session 1. Evolution of Cloud Computing

**A. Multiple Choice Questions (MCQs)**

1. (b), 2. (c), 3. (c), 4. (b), 5. (c), 6. (b), 7. (c)

**B. Fill in the Blanks**

1. Internet, 2. Remote, 3. Cloud, 4. Backbone, 5. Online, 6. Hardware, 7. Cost

**C. True or False**

False, 2. True, 3. False, 4. True, 5. False, 6. True, 7. True

### Session 2. Features and Advantages of Cloud Computing

**A. Multiple Choice Questions**

1. (c), 2. (b), 3. (b), 4. (c), 5. (b)

**B. Fill in the Blanks**

1. Pay-as-you-go, 2. Broad, 3. Backup, 4. Collaboration, 5. Green

**C. True or False**

1. True, 2. False, 3. True, 4. False, 5. False

### Session 3. Cloud Deployment Models

**A. Multiple Choice Questions (MCQs)**

1. (b), 2. (c), 3. (b), 4. (c), 5. (b), 6. (c), 7. (b), 8. (b)

**B. Fill in the Blanks**

1. Private, 2. Internet, 3. scalability, 4. vendor, 5. goals, 6. public, 7. initial, 8. migration

**C. True or False**

1. False, 2. True, 3. False, 4. True, 5. False, 6. True, 7. False, 8. True

### Session 4. Cloud Tools for Communication and Storage

**A. Multiple Choice Questions (MCQs)**

1. (b), 2. (b), 3. (b), 4. (a), 5. (a), 6. (b), 7. (c), 8. (b)

**B. Fill in the Blanks**

1. Internet, 2. Google Drive, 3. uploading, 4. Zoom, 5. collaboration, 6. strong, 7. Docs, 8. log out

**C. True/False**

1. False, 2. True, 3. False, 4. True, 5. True, 6. True, 7. False, 8. True

## Module 2. Cloud Service Models & Architecture

### Session 1. Introduction to Cloud Service Models

**A. Multiple Choice Questions**

1. (c), 2. (b), 3. (c), 4. (b), 5. (c)

**B. Fill in the Blanks**

1. computing, 2. application code, 3. browser, 4. pay, 5. all

**C. True or False**

1. False, 2. True, 3. True, 4. False, 5. False

### Session 2. Infrastructure as a Service (IaaS)

**A. Multiple Choice Questions (MCQs)**

1.(b), 2.(b), 3.(b), 4.(b), 5.(c), 6.(b), 7.(b), 8.(b)

**B. Fill in the Blanks**

1.Internet, 2.Virtual Machine (VM), 3.Hypervisor, 4.Use/Consume, 5.Load Balancer, 6.Firewall/Security Group, 7.Internet, 8.Virtual Private Cloud (VPC)

**C. True or False**

1.False, 2.True, 3.True, 4.False, 5.True, 6.True, 7.True, 8.False

### Session 3. Platform as a Service (PaaS)

**A. Multiple Choice Questions**

1. (b) 2. (b) 3. (b) 4. (c) 5. (b)

**B. Fill in the Blanks**

1. application development 2. code 3. servers 4. CI/CD 5. vendor lock-in

**C. True or False**

1. False 2. True 3. True 4. False 5. True

### Session 4. Software as a Service (SaaS)

**A. Multiple Choice Questions (MCQ)**

1. (a) 2. (b) 3. (a) 4. (a) 5. (b)

**B. Fill in the Blanks**

1. Software 2. browser 3. cloud 4. real-time 5. account

**C. True or False**

1. False 2. True 3. True 4. False 5.True

## Module 3. Basics of Operating System and Computer Network

### Session 1. Digital Devices and Operating System

**A. Multiple Choice Questions (MCQs)**

1. (c) 2. (b) 3. (b) 4. (b) 5. (b) 6. (c) 7. (b) 8. (b)

**B. Fill in the Blanks**

1. digital 2. BIOS/UEFI 3. bridge 4. Process 5. Android 6.memory

**C. True or False**

1. False 2. True 3. False 4. True 5. False 6. True

### Session 2. Operating System Environment

**A. Multiple Choice Questions (MCQs)**

1. (b) 2. (b) 3. (c) 4. (b) 5. (b) 6. (b) 7. (b) 8. (b)

**B. Fill in the Blanks**

1. server 2. mkdir 3. services 4. partitions 5. free -h 6. services

**C. True or False**

1. False 2. True 3. True 4. False 5. True 6. True

### Session 3. Computer Networks

**A. Multiple Choice Questions (MCQs)**

1. (c), 2. (b), 3. (c), 4. (b), 5. (c)

**B. Fill in the Blanks**

1. packets, 2. VPN, 3. IP address, 4. encapsulation, 5. Bandwidth

**C. True or False**

1. False, 2. True, 3. False, 4. False, 5. True

### Session 4. Role of Internet in Cloud Computing

**A. Multiple Choice Questions (MCQs)**

1. (b), 2. (b), 3. (b), 4. (b), 5. (b), 6. (b), 7. (b), 8. (c)

**B. Fill in the Blanks**

1. protocols, 2. client-server, 3. modem, 4. anywhere, 5. cloud computing, 6. web browser, 7. Internet, 8. Wi-Fi

**C. True or False**

1. False, 2. True, 3. True, 4. False, 5. True, 6. True, 7. False, 8. True

## Module 4. Cloud Storage, Collaboration & Applications

### Session 1. Using Cloud Storage Tools for File Management

**A. Multiple Choice Questions (MCQs)**

**1.** (b) 2. (c) Google Drive 3. (b) 4. (b) 5. (b)

**B. Fill in the Blanks:**

**1.** Remote 2. Internet 3. File management 4. Sharing 5. Storage space

**C. True or False:**

**1.** True 2. False 3. True 4. False 5. True

### Session 2. File Sharing with Permissions

**A. Multiple Choice Questions (MCQs)**

**1.** (c), 2. (c), 3. (b), 4. (b), 5. (c)

**B. Fill in the Blanks**

**1.** Single, 2. Permission, 3. Viewer, 4. Version, 5. Shared

**C. True or False**

**1.** False, 2. True, 3. False, 4. True, 5. True

### Session 3. Real-Time Collaboration Using Cloud Tools

**A. Multiple Choice Questions (MCQs)**

**1.** (b), 2. (c), 3. (b), 4. (b), 5. (c)

**Fill in the Blanks**

1. Single, 2. Instantly, 3. Version, 4. Comments, 5. Save

**True or False**

1. False, 2. True, 3. True, 4. False, 5. True