Parul® University
Vadodara, Gujarat

NAAC GRADE A++

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INTRODUCTION TO CLOUD

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DIGITAL LEARNING CONTENT

CHAPTER-1

INTRODUCTION TO CLOUD

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Topics to be Covered

- Introduction to Cloud Computing
- Layers of Cloud Computing
- Cloud Infrastructure Management
- Types of Clouds
- Challenges in Cloud Computing
- Applications of Cloud Computing

POPULAR CLOUD PROVIDERS

Adobe Creative Cloud

Microsoft Azure

KAMATERA

amazon web services

IBM Cloud

Google Cloud Platform

Cloud vs. On-premise Comparison Chart

Aspect	Cloud solutions	On-premise solutions
Upfront costs	Lower upfront costs	Higher upfront costs
Maintenance	Managed by cloud provider	Self-managed by organization
Scalability	Easily scalable based on demand	Limited scalability, may require hardware upgrades
Flexibility	Offers flexibility to adjust resources as needed	Requires additional investments for flexibility
Total cost of ownership	Predictable subscription fees, potential cost savings	Higher total cost of ownership due to maintenance costs
Security	Data security managed by cloud provider	Organization has control over data security measures
Accessibility	Remote access from anywhere with internet connectivity	Access limited to on-premise network
Customization	Limited customization options	Full control for customization and tailored solutions


CLOUD
COMPUTING
Provides mobile access to files from everywhere

Cloud computing is about how you do computing, not where you do computing.

Paul Maritz, CEO of VMware

- **Cloud computing is often far more secure than traditional computing, because companies like Google and Amazon can attract and retain cyber-security personnel of a higher quality than many governmental agencies.**

Vivek Kundra, Former U.S. Chief Information Officer

BRIEF HISTORY

- **1960s – Foundational Concepts of Cloud Computing:**
- **1961: John McCarthy proposed the idea of computing as a public utility, similar to water or electricity.**
- **1966: Douglas Parkhill published "The Challenge of the Computer Utility", where he envisioned the core concepts of modern cloud computing**
- **1970s IBM introduced the CP/CMS operating system, laying groundwork for virtualization by enabling multiple users to operate on one system.**
- **1990s :Virtualization technologies, like VMware (founded in 1998), allowed better use of server infrastructure.**
- **2000: Amazon launched AWS with Elastic Compute Cloud (EC2), marking the start of modern cloud services. Google and Microsoft introduced their cloud platforms.**
- **2010s SaaS solutions like Google Workspace, Salesforce, and Dropbox gained popularity.**
- **Cloud computing expanded into hybrid and multi-cloud models for flexibility and cost-effectiveness.**
- **2020s – Next-Generation Cloud Technologies:**
- **Integration with AI, edge computing, and IoT enabled advanced use cases like autonomous vehicles, smart cities, and large-scale machine learning models.**

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DEFINATION

Cloud Computing is the delivery of computing services over the internet ("the cloud"), including storage, processing power, and applications, without the need for users to manage the underlying hardware and software.

Cloud computing is the on-demand delivery of compute power, database storage, applications, and other IT resources through a cloud services platform via the internet with pay-as-you-go pricing."

- **Source: AWS**

Key Features:

- **On-demand self-service**
- **Broad network access**
- **Resource pooling**
- **Scalability and elasticity**
- **Measured service**
- **Pay-as-You Go Pricing**
- **Disaster Recovery**

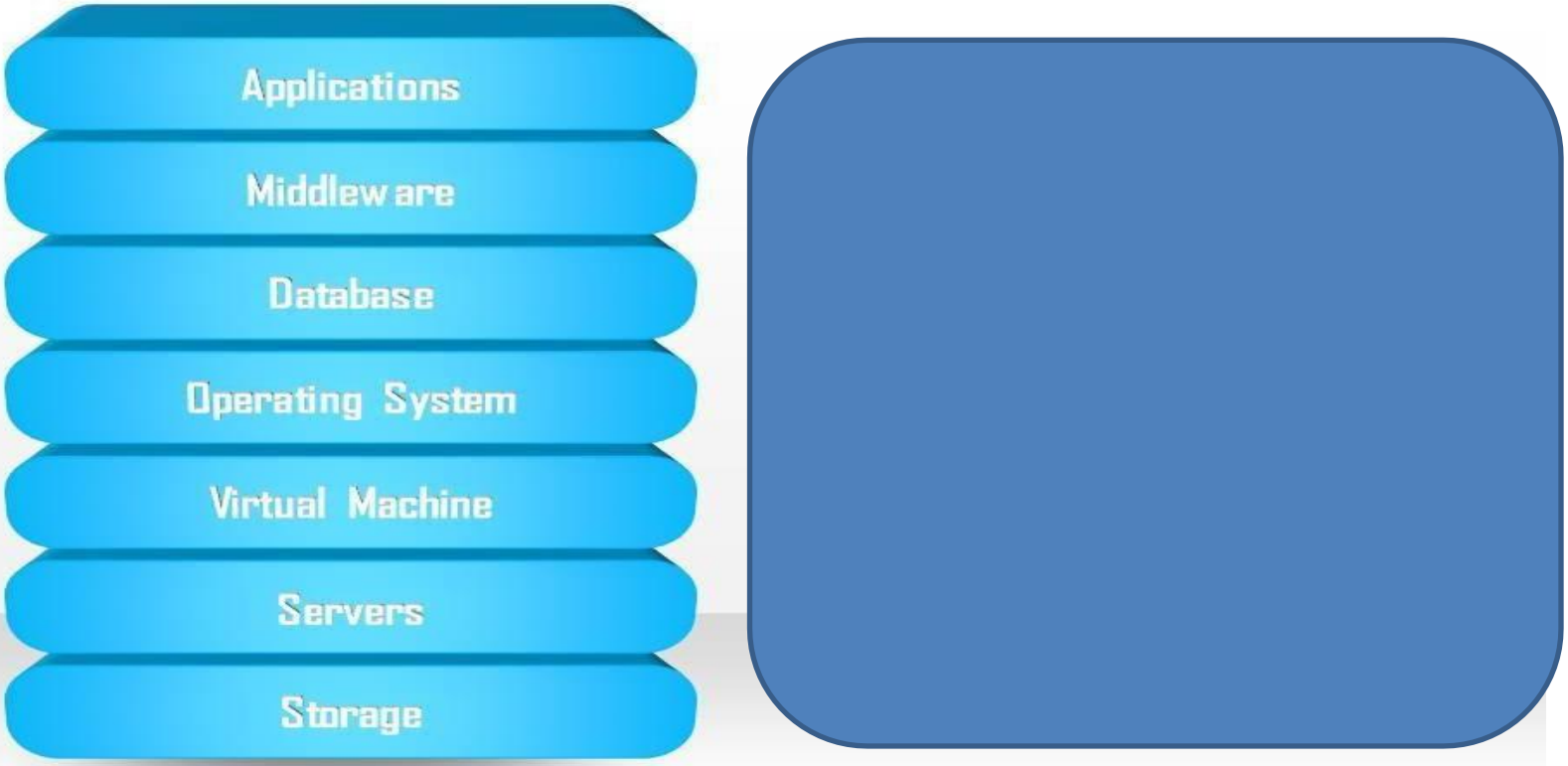
Where do the clouds reside?

- **Where do the clouds reside?**
- Globally cloud computing facilities are provided by major computing vendors. They generally develophuge infrastructure for cloud at different locations around the globe. Such arrangements are knownas cloud data centers or CDCs. Apart from computing facilities, these centers have other essential amenities like uninterrupted power supply system, fire control system and cooling system. CDCs are highly protected areas where vendors set up networks of large number of computing devices like servers, storages etc. and create cloud computing utility service out of those.

Will cloud computing replace traditional computing devices with high configured desktops or laptops?

- In cloud computing approach, all load of computing shifts into the highly configured computing facilities provided by the cloud. People just need an interfacing device through which they can connect to the cloud using Internet. This interfacing device can be any desktop, laptop, tablet or even a mobile interface which can run the cloud interfacing application. Hence, these interfacing devices do not need to be highly configured any more. So, cloud computing is going to replace highly-configured traditional desktops or laptops with minimally-configured ones, as they will only have to act as interfacing devices to cloud.
- **Is cloud computing beneficial only for larger organizations?**
- Individual users who work in their PCs at home can avail cloud facility sitting at home itself. They can store files, install software, or run programs just like they did it in PCs. Apart from individual users, small offices that need a networked environment with a small number of terminals can easily move into the cloud. In short, cloud computing is for all those who need computing facilities in any form as well as volume.

Cloud computing stack showing layers from storage to application



Your Logo

Layers of Clouds

Cloud Computing Layers

User	SaaS	Application Layer (Business Application, Web Services, Multimedia)	Gmail, Facebook, Sales Force, Youtube	
Software Developer	PaaS	Platform Layer (Social Framework)	Amazon Simple, Google App Engine	
System Admin	IaaS	Infrastructure Layer (Storage, Virtual Machine)	Amazon Web Service, Flexiscale, Rack Space	
		Datacenter Layer (CPU, Bandwidth, Disk, Memory)	Data Centers	

Service Class	Main Access & Management Tool	Service content
 SaaS	Web Browser	**Cloud Applications** Social networks, Office suites, CRM, Video processing
 PaaS	Cloud Development Environment	**Cloud Platform** Programming languages, Frameworks, Mashups editors, Structured data
 IaaS	Virtual Infrastructure Manager	**Cloud Infrastructure** Compute Servers, Data Storage, Firewall, Load Balancer

IAAS

Infrastructure as a Service (IaaS)

Definition:

IaaS provides virtualized computing resources like servers, storage, and networks over the internet.

It acts as the foundational layer where users control and manage the infrastructure themselves.

Scalability: Resources can be scaled up or down based on demand.

Cost Efficiency: Pay-as-you-go model eliminates upfront hardware costs.

Flexibility: Complete control over the operating system, applications, and middleware.

Where It Is Used:

Disaster Recovery: Storing and retrieving critical data during emergencies.

Big Data Analysis: Companies like Netflix use IaaS to process and analyze massive datasets.

Web Hosting: Hosting applications and websites with high traffic demands.

Examples:

Amazon EC2, Microsoft Azure Virtual Machines, Google Compute Engine.

MANAGES

YOU MANAGE	IAAS	PAAS
• APPLICATION • DATA • RUNTIME • MIDDLEWARE • OS • VIRTUALIZATION • SERVERS • STORAGE	• APPLICATION • DATA • RUNTIME • MIDDLEWARE • OS • VIRTUALIZATION • SERVERS • STORAGE	• APPLICATION • DATA • RUNTIME • MIDDLEWARE • OS • VIRTUALIZATION • SERVERS • STORAGE

PAAS

Platform as a Service (PaaS)

Definition:

PaaS provides a development platform and environment to build, test, and deploy applications without managing the underlying infrastructure. It focuses on software development.

Developer-Friendly: Offers pre-built tools, APIs, and libraries for faster development.

Automatic Scaling: Automatically adjusts resources based on app demand.

Collaboration: Ideal for team projects with shared development tools.

Where It Is Used:

App Development: Building mobile or web applications quickly.

IoT Development: Smart city solutions, like real-time traffic apps.

Data Integration: Developing and testing APIs for seamless data flow between apps.

Examples:

Google App Engine, Microsoft Azure App Service, Heroku.

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SAAS

Software as a Service (SaaS)

Definition:

SaaS delivers fully functional software applications over the internet, eliminating the need for installation or maintenance. It is the most user-friendly layer of the cloud.

Accessibility: Access software from any device with an internet connection.

No Maintenance: Updates and maintenance are handled by the provider.

Subscription Model: Users typically pay a subscription fee (monthly or annually).

Where It Is Used:

Collaboration Tools: Google Workspace (Docs, Sheets) for team productivity.

Customer Relationship Management (CRM): Salesforce helps businesses track customer interactions.

E-Governance Tools: Applications like e-municipal portals for citizens.

Examples:

Google Workspace, Salesforce, Dropbox, Zoom.

IaaS: Think of renting an empty plot of land (virtual servers). You build everything—foundation, structure, and interiors—according to your needs.

PaaS: Rent a pre-built mall structure (platform) where you can add your shop's interiors and designs, focusing only on what you want to sell.

SaaS: Lease a fully operational shop in the mall (application) that's ready to use, where you just display your products and serve customers.

- Cloud compose of primary outcome of cloud computing.
- They are a type of parallel and distributed system,physical and virtual computers
- Types of clouds depends on nature and services offered by cloud.
- Types also identifies the boundaries within which cloud computing services are implemented

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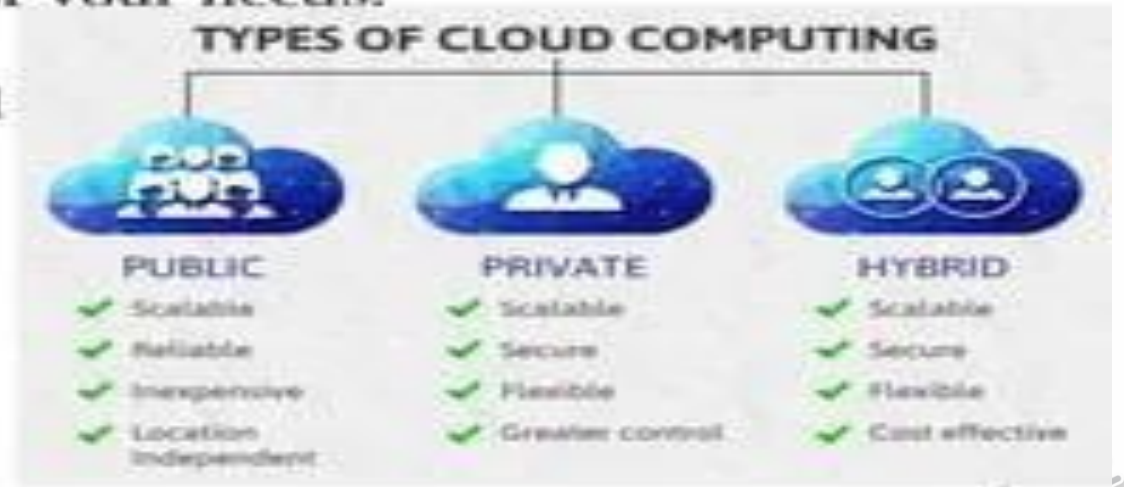
TYPES OF CLOUDS

Types of cloud deployment

Not all clouds are the same and not one type of cloud computing is right for everyone. Several different models, types and services have evolved to help offer the right solution for your needs.

- Public cloud
- Community cloud
- Private cloud
- Hybrid cloud



- Cloud computing offers a variety of deployment models and service models to cater to diverse needs and preferences.

1. Public Cloud: A public cloud refers to cloud services offered by third-party providers over the internet, accessible to anyone who wishes to use or purchase them.

Third-Party Ownership: Managed and maintained by external providers like AWS, Google Cloud, or Microsoft Azure.

Multi-Tenant Environment: Resources are shared among multiple users or organizations.

On-Demand Access: Offers services such as computing, storage, and networking on a pay-as-you-go model.

Global Accessibility: Accessible from anywhere with ar internet connection.

Elastic Resources: Automatically scales up or down based on workload needs.
No Upfront Investment: Users do not need to invest in physical hardware or infrastructure.
Service Models: Includes SaaS (e.g., Gmail), PaaS (e.g., Heroku), and IaaS (e.g., EC2).
Reliability: Supported by large data centers with high uptime.
Standardized Services: Offers predefined configurations that fit general use cases.
Publicly Available: Suitable for both individuals and businesses.

Private cloud

A private cloud is a dedicated cloud environment tailored specifically for one organization, ensuring exclusive access and control.

Single-Tenant Architecture: Used exclusively by one organization.
High Customization: Configured to meet specific business requirements.
Ownership Models: Can be hosted on-premises or by a third-party provider.
Enhanced Security: Dedicated infrastructure reduces exposure to external threats.
Regulatory Compliance: Tailored to meet industry-specific legal and regulatory requirements.
Resource Optimization: Utilizes the organization's existing hardware efficiently.
Full Control: Provides organizations with direct oversight of data and resources.
High Availability: Designed for minimal downtime and disruption.
Internal Hosting: Often located within the organization's premises.
Predictable Costs: Cost structure based on fixed investments and maintenance.
Data Sovereignty: Ensures data remains within specific geographical locations.
Restricted Access: Accessible only by authorized users within the organization.

Hybrid cloud

A hybrid cloud combines public and private clouds, allowing organizations to utilize both environments for different purposes.

Dual Deployment: Incorporates both private and public cloud infrastructures.
Seamless Integration: Enables data and applications to move between environments.
Flexibility: Optimizes workloads by placing sensitive data in private clouds and scalable tasks in public clouds.
Cost Efficiency: Balances cost between private infrastructure and public scalability.
Dynamic Workloads: Suited for fluctuating demand, such as seasonal spikes.
Custom Solutions: Combines the best features of public and private clouds.
Data Partitioning: Segregates sensitive and non-sensitive data effectively.
Shared Resources: Public resources complement the limitations of private infrastructure.
High Scalability: Accommodates growth while maintaining data security.
Strategic Use: Allows businesses to leverage advanced technologies without full migration.

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Community cloud

A community cloud is a shared cloud infrastructure designed for use by multiple organizations with common goals or regulatory needs.

Collaborative Use: Shared by organizations within a specific community.

Common Objectives: Serves groups with similar goals, such as education or healthcare.

Shared Costs: Infrastructure and maintenance costs are divided among participants.

Data Privacy: Offers more security than public clouds while being cost-effective.

Industry-Specific: Tailored to meet the needs of specific sectors like government or finance.

Access Control: Restricted access to authorized members of the community.

Joint Ownership: Managed collectively or by a third-party provider.

Regulatory Compliance: Adheres to specific regulations relevant to the community.

Resource Sharing: Enables sharing of computing power and storage among participants.

Secure Collaboration: Facilitates data sharing and joint projects securely.

Limited Scope: Typically smaller scale compared to public clouds.

-

Feature	Public Cloud	Private Cloud	Hybrid Cloud	Community Cloud
Cost	Low	High	Medium	Medium
Security	Medium	High	High	Medium
Scalability	High	Medium	High	Medium
Control	Low	High	Medium	Medium
Flexibility	High	Low	High	Medium

- A cloud architecture describes how the components of a cloud environment work together, whereas cloud infrastructure specifies the features and capabilities of particular components.
- While the cloud architecture describes how a cloud environment is supposed to function, cloud infrastructure comprises the components that make it work.

CLOUD INFRASTRUCTURE MANAGEMENT

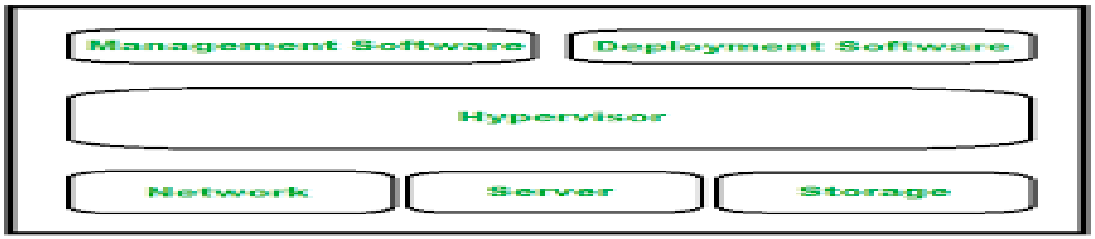
- Cloud infrastructure is the collection of hardware and software that enables cloud computing services.
- Cloud infrastructure is the layer of software and hardware between your internal systems and the cloud.
- It includes: servers, storage, networking equipment, and virtualization components
- Cloud infrastructure also include a user interface (UI) for managing these virtual resources.
- Cloud infrastructure is a set of hardware and software components that enable organizations to create, process, and store workloads remotely over the Internet. This practice is called cloud computing, and cloud infrastructure refers to all the components that power it.
- Hardware components include servers, power supplies, memory and storage, processing

The components of cloud infrastructure are typically broken down into three main categories: compute, networking, and storage:

Compute: Performs the basic computing for the cloud systems. This is almost always virtualized so the instance can be moved around.

Networking: Usually commodity hardware running some kind of software-defined networking (SDN) software to manage cloud connections

Storage: Usually a combination hard disks and flash storage designed to move data back and forth between the public and private clouds.



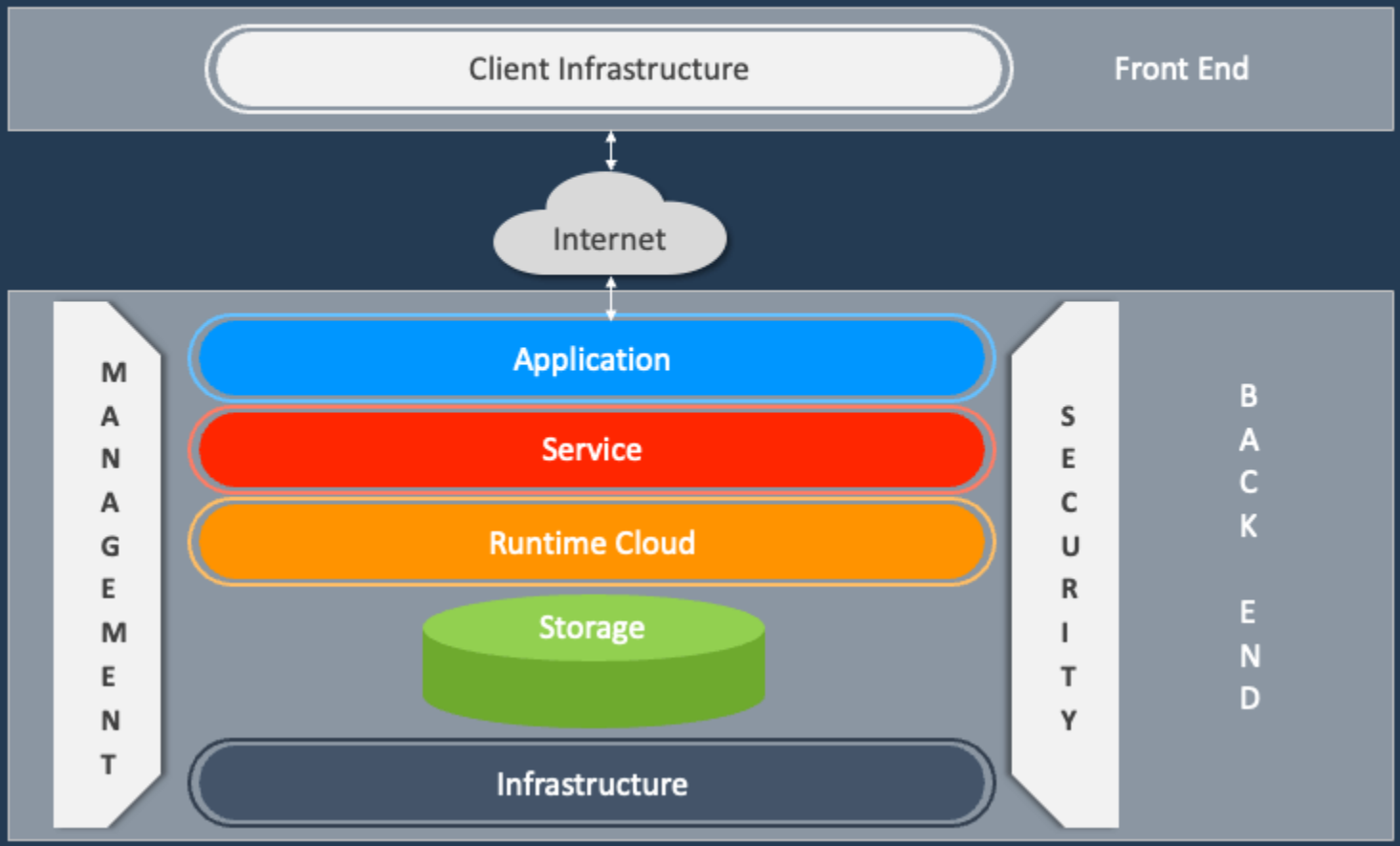
- **Virtualization**: It is used to create an abstracted machine layer that allows multiple virtual machines to run on a single physical machine.
- **Cloud Storage**:-. It is more secure, accessible from anywhere with an internet connection, and cheaper than traditional data storage methods.
- Cloud storage comes in three main forms.
- Block Storage - Block storage is used for storing data that is accessed randomly, such as operating system files, database files, and application files.
- File Storage – Most commonly linked to the file manager storage system on a regular PC.
- Object Storage – Suitable data storage architecture for unstructured data.

A network in cloud computing is a cluster of interconnected computers and devices that are used to share resources and data. Cloud networks can be private, public, or hybrid.

- Private networks are owned and operated by a single organization and are not accessible to the public.
- Public networks are owned and operated by a third-party provider and are accessible to anyone with an internet connection.
- Hybrid networks combine elements of both private and public networks.

CLOUD ARCHITECTURE

Architecture of Cloud Computing



Cloud Infrastructure Management

- Research the different cloud solutions and options, and select the infrastructure that best supports your requirements — both in the delivery models explored above and the potential of different cloud networks for different business operations.
- Consider how you can use modern technology to your advantage, for example, Artificial Intelligence. Cloud servers are designed to support the use of these tools, and it is worth exploring whether they can help with automating your services or supporting a global expansion plan.
- Tier optimization to make the most commonly accessed data easier to find on a higher level than that which is rarely searched for and opened. This is a simple hack that can streamline internal and external access within the network and works in much the same way as a multi-tiered file manager.
- Governance is key to ensuring that your data is always safely secured and up to date. It’s worth having a plan in place in case of disaster

CLOUD ARCHITECTURE

Cloud Reference Architecture

Cloud Consumer

Cloud Auditor

- Security Audit
- Privacy Impact Audit
- Performance Audit

Cloud Provider

Service Layer

- SaaS
- PaaS
- IaaS
- Resource Abstraction & Control Layer

Physical Resource Layer

- Hardware
- Facility

Cloud Service Management

- Business Support
- Provisioning/ Configuration
- Portability/ Interoperability

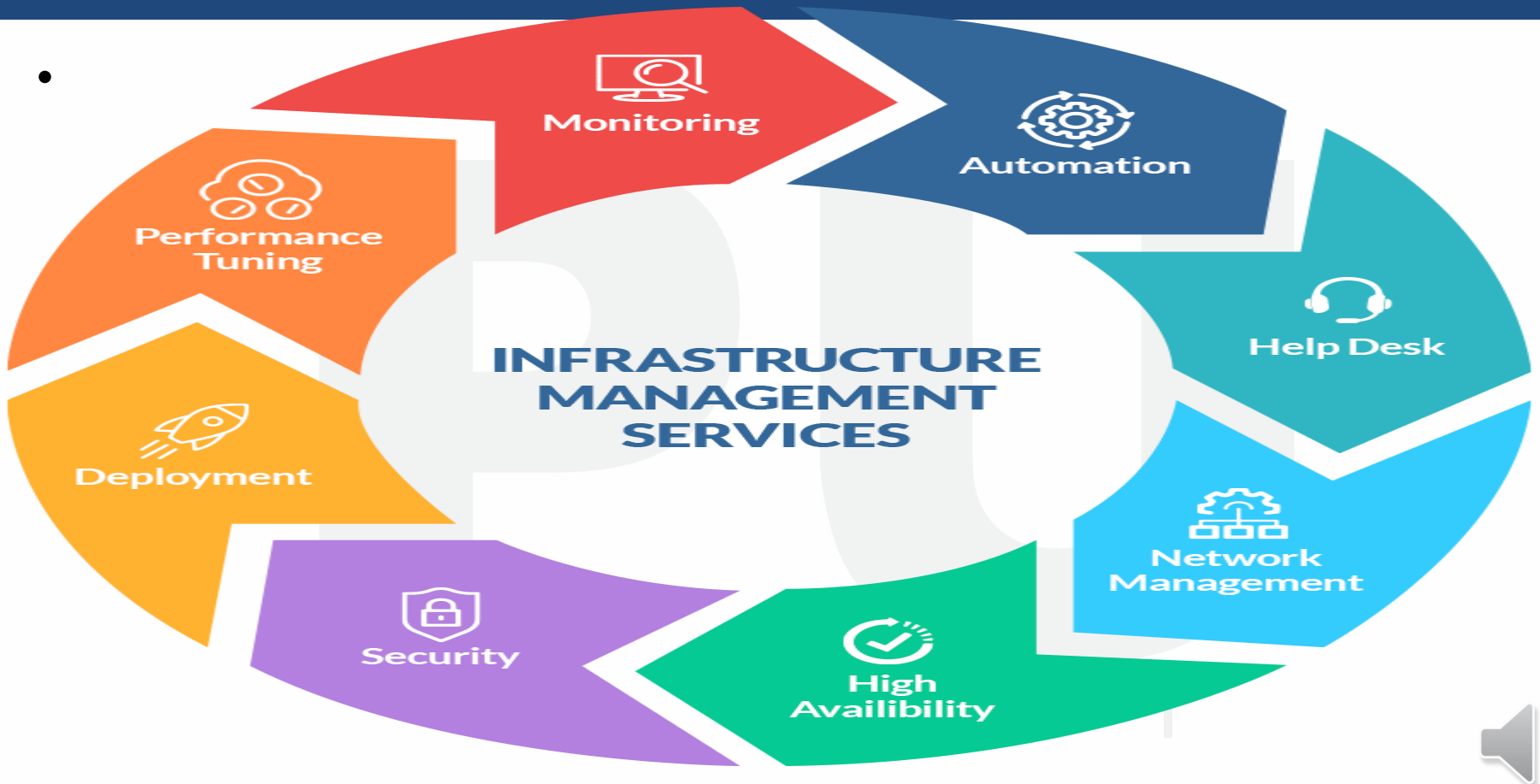
SECURITY

PRIVACY

Cloud Broker

- Service Intermediation
- Service Aggregation
- Service Arbitrage

Cloud Carrier


Monitoring
Automation
Help Desk
Network Management
High Availibility
Security
Deployment
Performance Tuning
INFRASTRUCTURE MANAGEMENT SERVICES

1. Monitoring

- This segment emphasizes the continuous observation and analysis of cloud infrastructure components.
- In cloud environments, monitoring tools track metrics like server CPU usage, disk space, network bandwidth, application response times, and more.
- This data helps identify potential issues, optimize performance, and ensure smooth operations.

2. Automation

- Automation involves streamlining repetitive tasks through scripts and tools.
- In cloud infrastructure, automation can be applied to tasks like server provisioning, software deployment, backup, and configuration management.
- This reduces manual effort, minimizes errors, and improves efficiency.

3. Performance Tuning
•This segment focuses on optimizing the performance of cloud resources.
•It involves identifying and addressing performance bottlenecks, such as slow database queries or inefficient application code.
•Performance tuning ensures that cloud infrastructure can handle the workload efficiently and deliver optimal performance.
4. Deployment
•This segment deals with deploying new applications, infrastructure components, or updates to existing systems.
•Cloud infrastructure enables rapid deployment of applications and services through automated deployment tools and processes.
5. Security
•Security is paramount in cloud environments.
•This segment encompasses measures to protect cloud infrastructure from threats like cyberattacks, data breaches, and unauthorized access.
•Security practices include firewalls, intrusion detection systems, encryption, access

6. High Availability
•High availability ensures that cloud infrastructure remains accessible and operational even in the face of failures or disruptions.
•It involves techniques like redundancy, load balancing, and automatic failover mechanisms.
7. Help Desk
•The help desk provides technical support to users, troubleshooting issues, and resolving problems.
•In cloud environments, help desks may be integrated with cloud management tools to provide efficient support.
8. Network Management
•This segment focuses on managing and maintaining the network infrastructure, including routers, switches, and firewalls.
•In cloud environments, network management includes configuring virtual networks, load balancers, and security groups.

9 Benefits of Cloud Infrastructure Management Services

- Cost Optimization
- Enhanced Security
- Business Continuity & Disaster Recovery
- Scalability & Flexibility
- Improved Collaboration
- Agility & Time-to-Market
- Environmental Sustainability
- Global Reach
- Automation & Efficiency

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Data Flair

Challenges of Cloud Computing

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