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Unit I
Introduction to Cloud Computing

Distributed Computing Taxonomy

- **What is Computing?**

- The utilization of computers to complete a task.

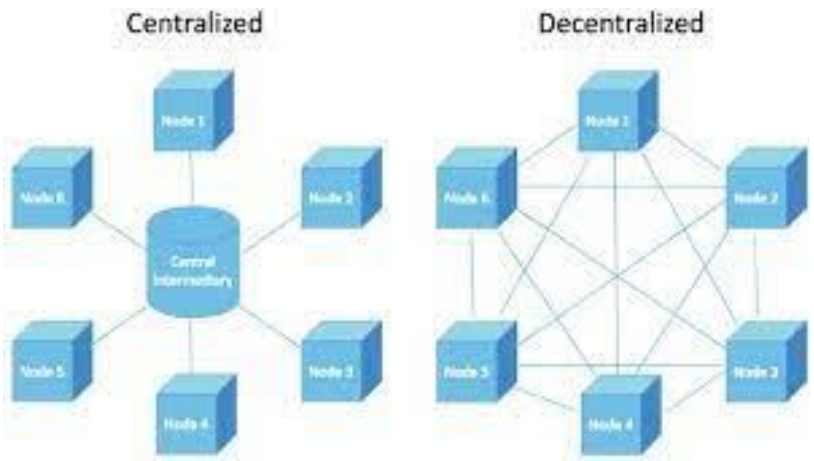
- It involves both hardware & software functions performing some sort of task with a computer.

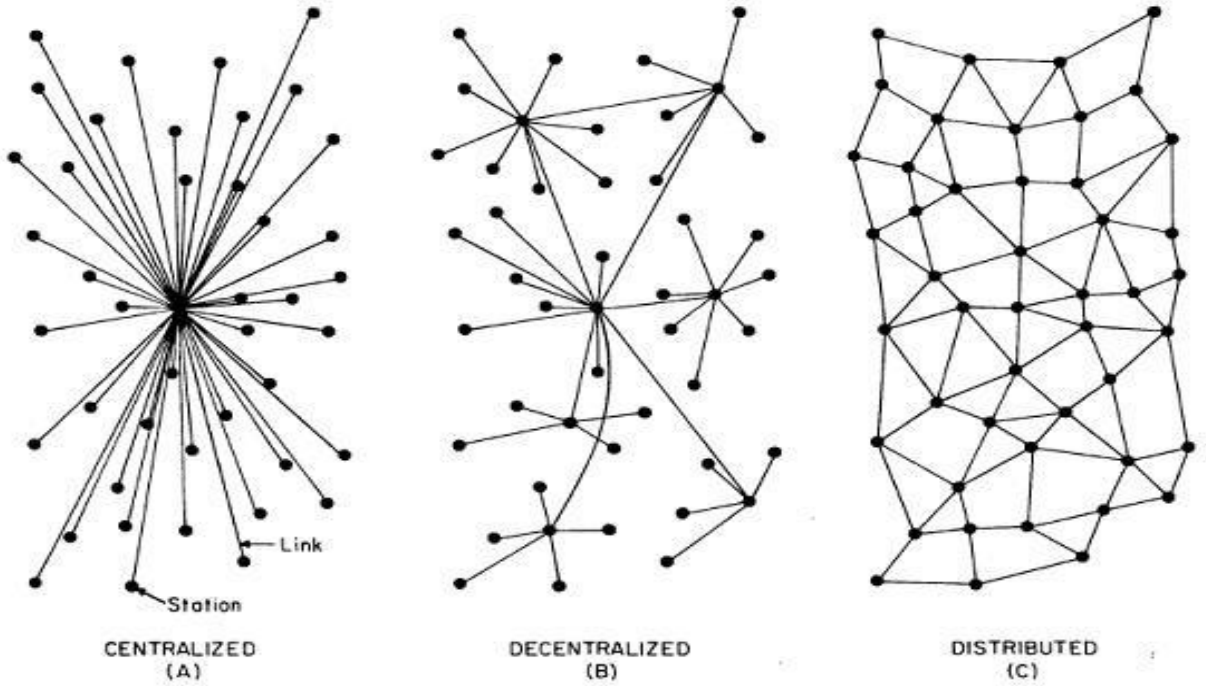
- Examples of computing being used in everyday life:

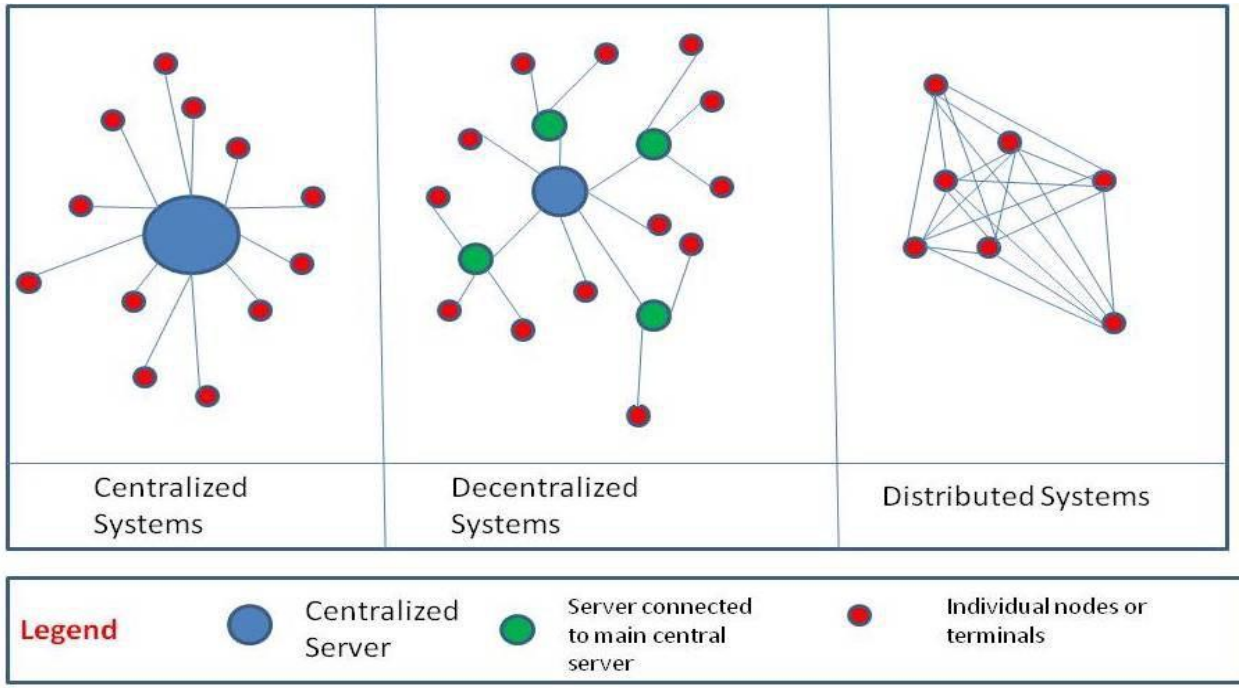
  sending an email, swiping credit/debit cards etc.

- Computing is any activity that uses computers from designing and building software and hardware to analyse data, process data, communicate and solving complex problems to help push humanity.

Paradigm shift ?



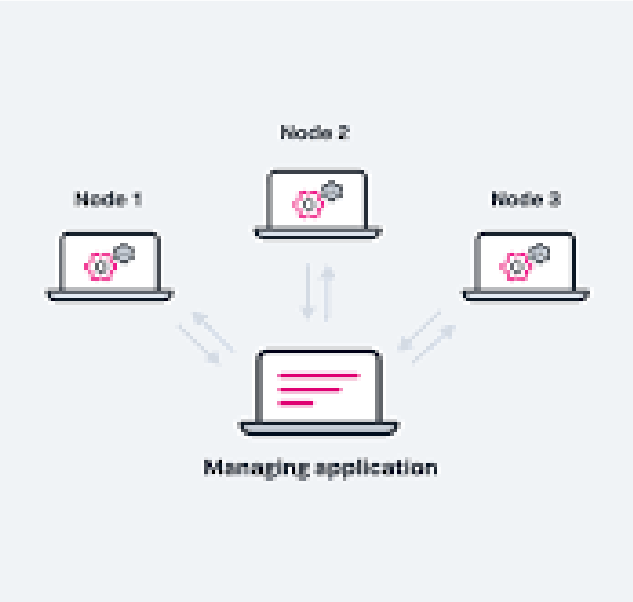


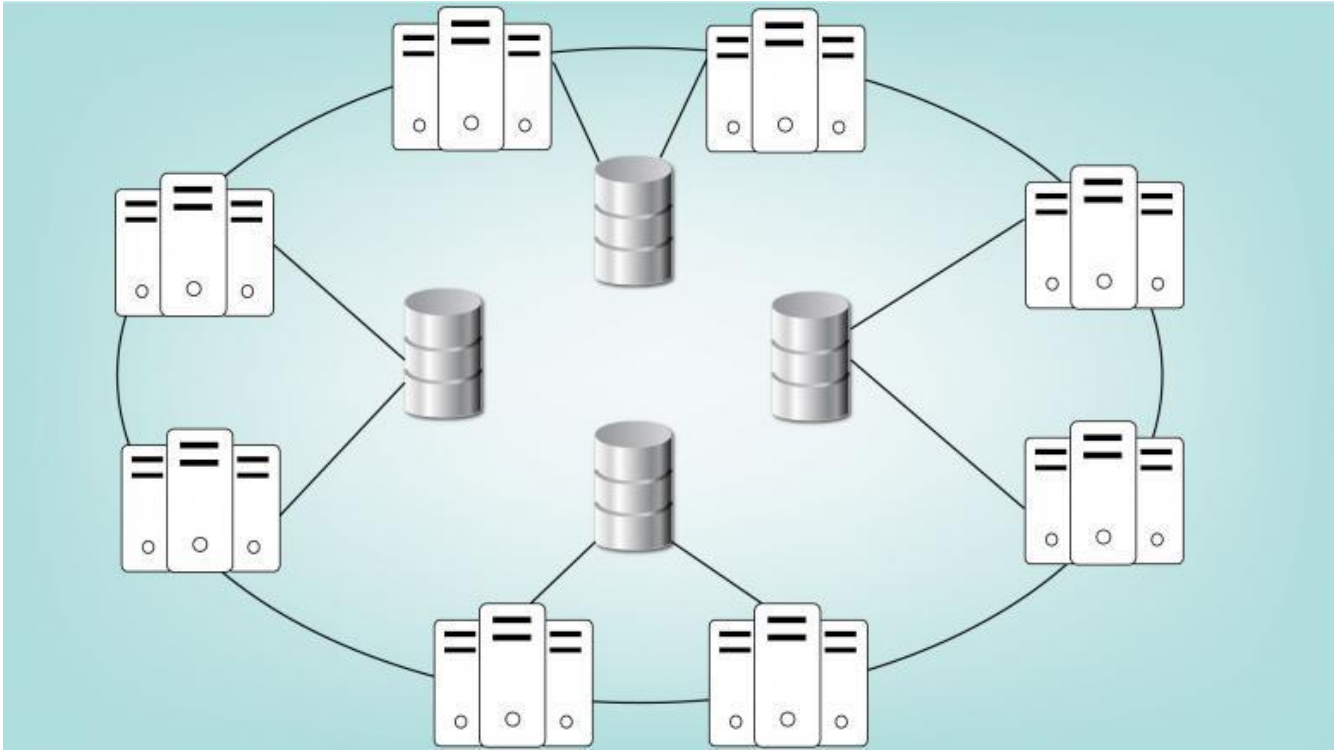


Distributed Computing

- “A distributed computing is a collection of independent computers that appears to its users as a single coherent system”.
- solve a single large problem by breaking it down into several tasks where each task is computed in the individual computers of the distributed system.
- A distributed computing system consists of more than one self directed computer that communicates through a network.
- All the computers connected in a network communicate with each other to attain a common goal by making use of their own local memory.
- Supports Fault Tolerance mechanism.

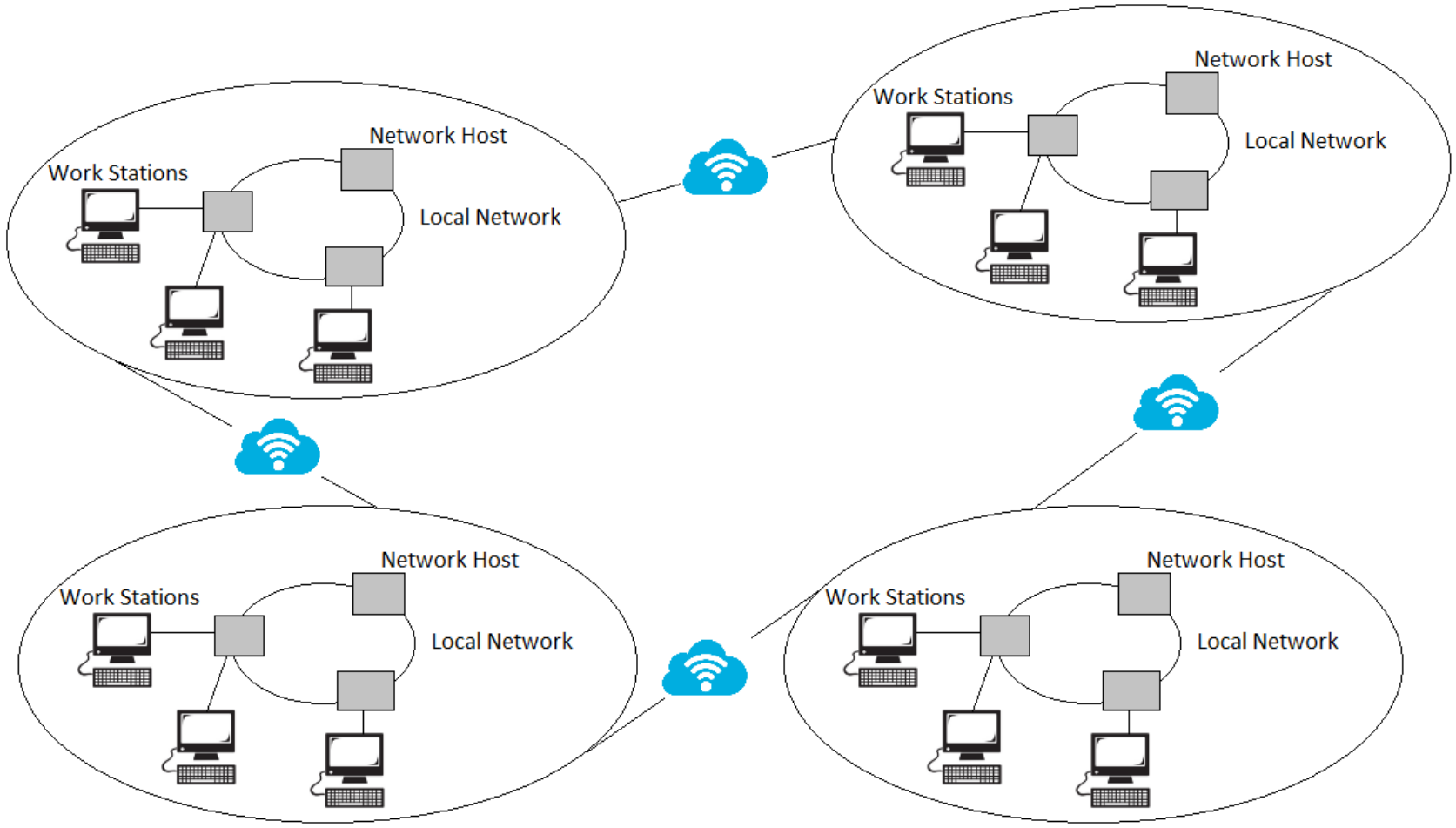
Distributed Computing…





- Composed of multiple independent components and are perceived as a single entity by users
- **The primary purpose of distributed systems is to share resources and utilize them better**.
- **The goal of distributed computing is to distribute a single task among multiple computers and to solve it quickly by maintaining coordination between them**

Distributed Computing



Distributed Computing System - Examples

1. World Wide Web
2. Social Media Giant Facebook
3. Hadoop's Distributed File System (HDFS)
4. ATM
5. Cloud Network Systems(Specialized form of Distributed Computing Systems)
6. Google Bots, Google Web Server, Indexing Server
7. Netflix, Amazon Prime….

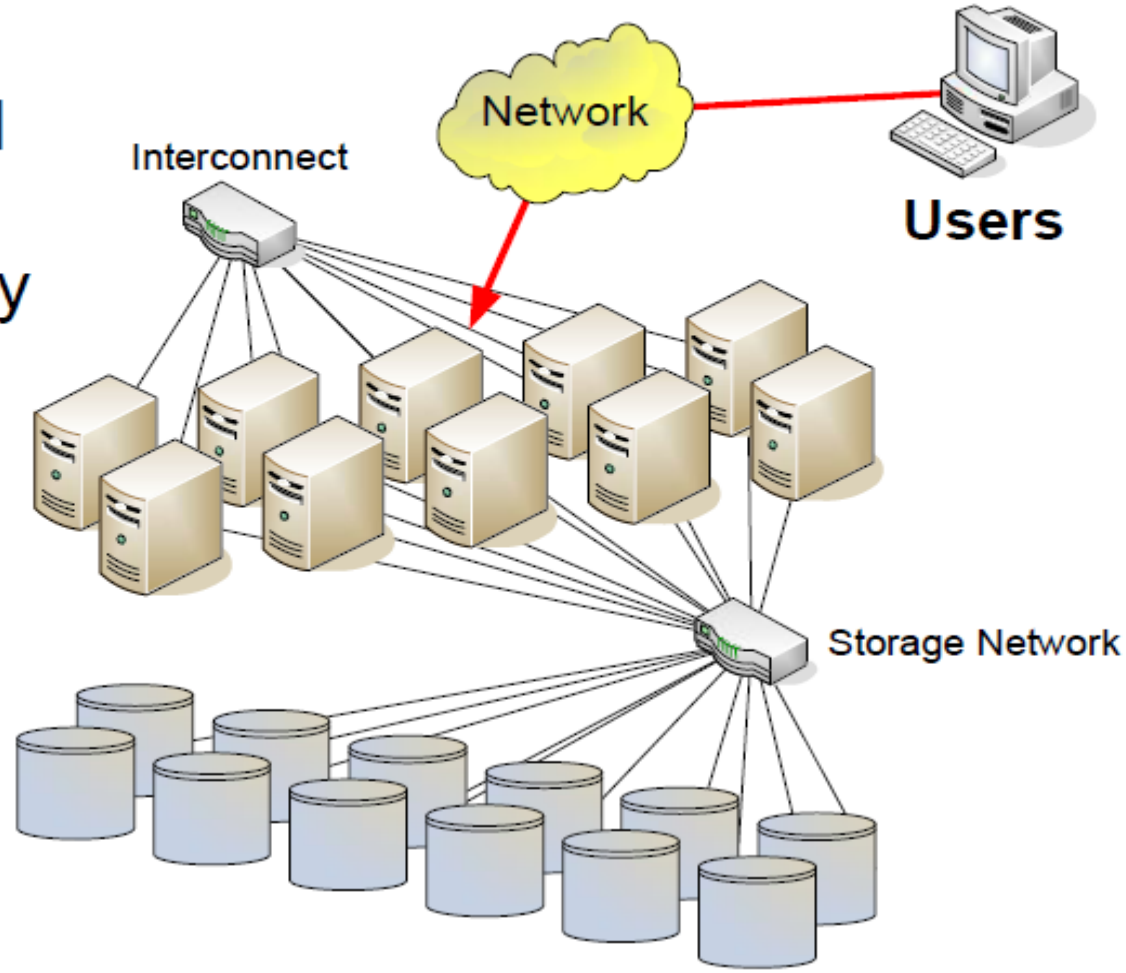
Advantages of Distributed Computing

Distributed computing makes all computers in the cluster work together as if they were one computer.

1. **Scalability.** The system can easily be expanded by adding more machines as needed. Higher loads can be handled by simply adding new hardware (versus replacing existing hardware).
2. **Performance.** Through parallelism in which each computer in the cluster simultaneously handles a subset of an overall task, the cluster can achieve high levels of performance through a divide-and-conquer approach.
3. **Redundancy**. Duplication of critical resources to improve system reliability. Several machines can provide the same services, so if one is unavailable, work does not stop
4. **Resilience.** How well a system recovers from failure. Distributed computing clusters typically copy or "replicate" data across all computer servers to ensure there is no single point of failure.
5. **Cost-effectiveness.** Distributed computing typically leverages low-cost, commodity hardware, making initial deployments as well as cluster expansions very economical.
6. **High availability**
7. **Reliability -** The probability that a system will function as expected
8. **Transparency**
9. **Fault tolerance:** Able to continue providing a service in the event of a failure

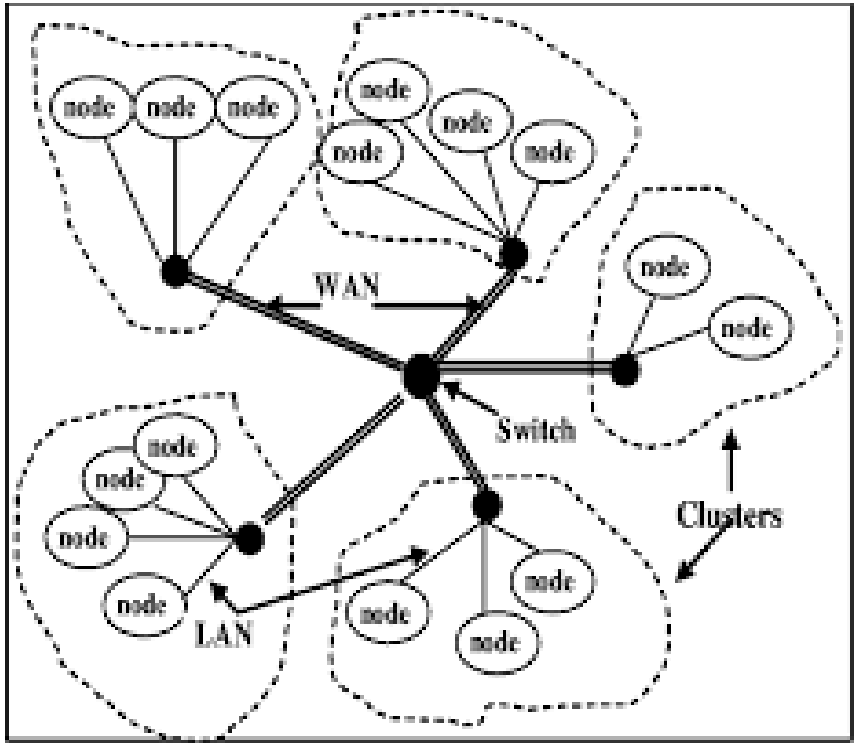
1. Clusters

- A group of independent, but interconnected, computers that act as a single system
- Usually deployed to increase availability and performance or to balance a dynamically changing workload

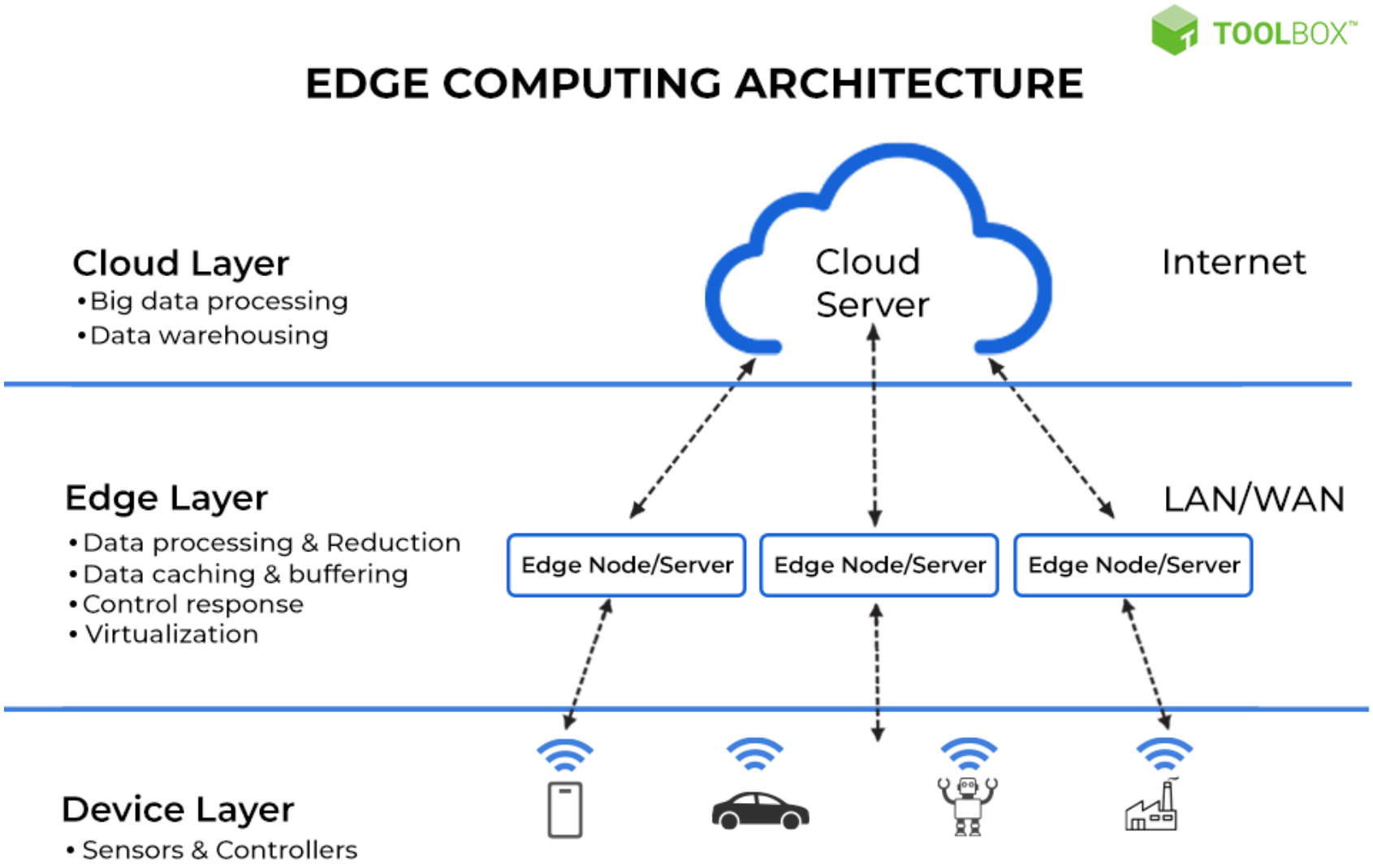


2. Grid Computing

- A computer network consisting of a number of computer systems connected in a grid topology
- Access large computational power, huge storage facilities, and a variety of services.
- Users can “consume” resources in the same way as they use other utilities such as power, gas, and water.
- Geographically dispersed clusters by means of Internet connections. These clusters belonged to different organizations, and arrangements were made among them to share the computational power.



3. Edge Computing



Edge Computing

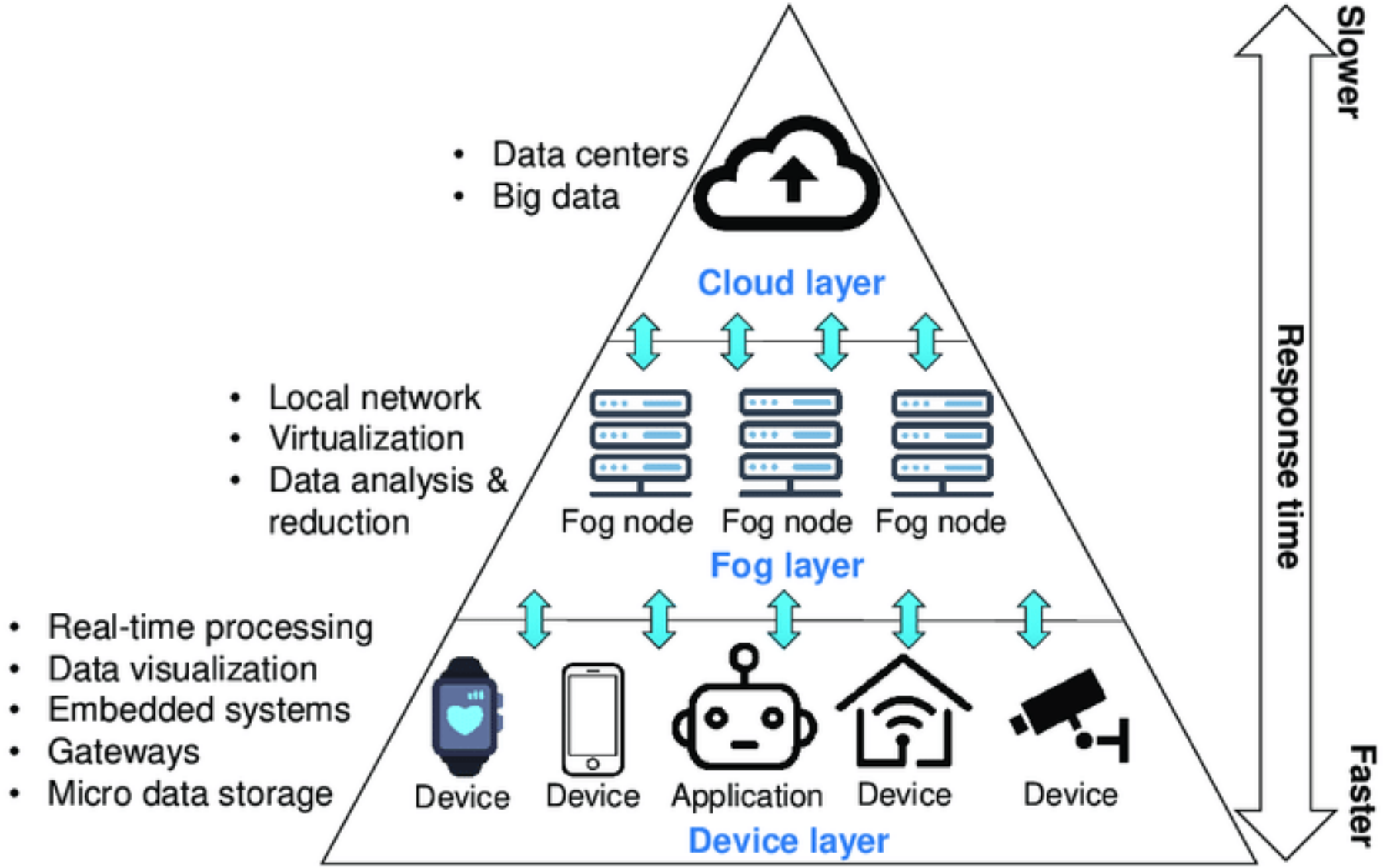
- **Edge computing is the processing and computing of client data closer to the data source rather than a centralized server or a cloud-based location. At its simplest, edge computing brings computing resources, data storage, and enterprise applications closer to where the people actually consume the information.**

- Edge computing is a distributed information technology (IT) architecture in which client data is processed at the periphery of the network, as close to the originating source as possible.

- Edge computing is the computational processing of sensor data away from the centralized nodes and close to the logical edge of the network, toward individual sources of data.

- **Edge computing is the practice of capturing, storing, processing and analyzing data near the client, where the data is generated, instead of in a centralized data-processing warehouse.**

4. Fog Computing



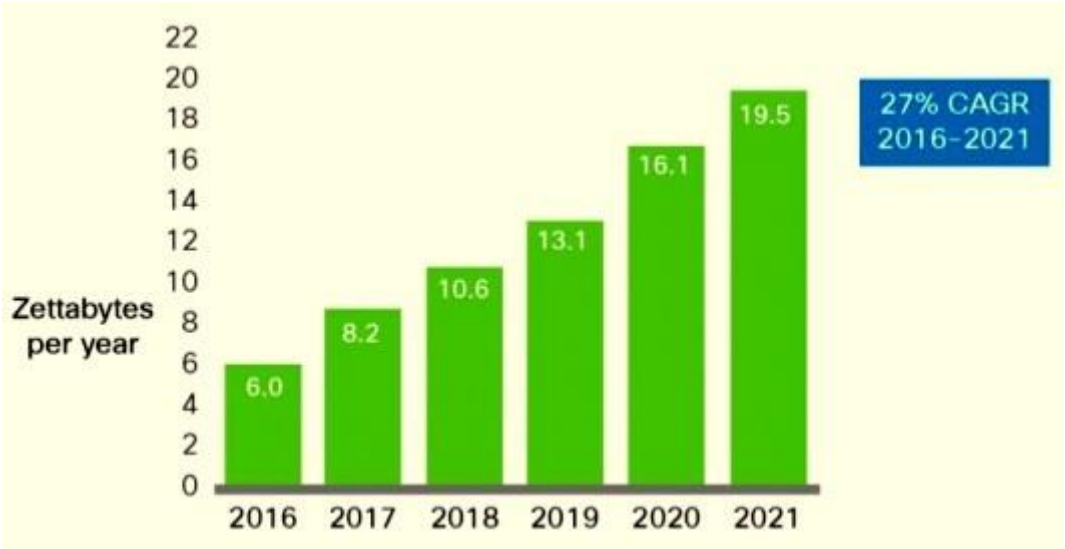
Introduction to Cloud Computing

- Many organizations are shifting from desktop application to cloud application to provide the effective services.
- Cloud computing refers to the provision of software, storage and computational power to users from remote datacenters through the internet.
- Resource provisioning dynamically to the application, it is the key feature of the cloud computing technology.

CISCO Survey Report

By 2021, hyper scale datacenters' will support:		Nov, 2018
53%	of all data centers **servers**	**27%**
69%	of all data centers **processing power**	**41%**
65%	of all **data stored** in data centers	**51%**
55%	of all data centers **traffic**	**39%**

Source: CISCO Global Cloud Index (Nov 2018)



Global data center workloads and compute instances in millions

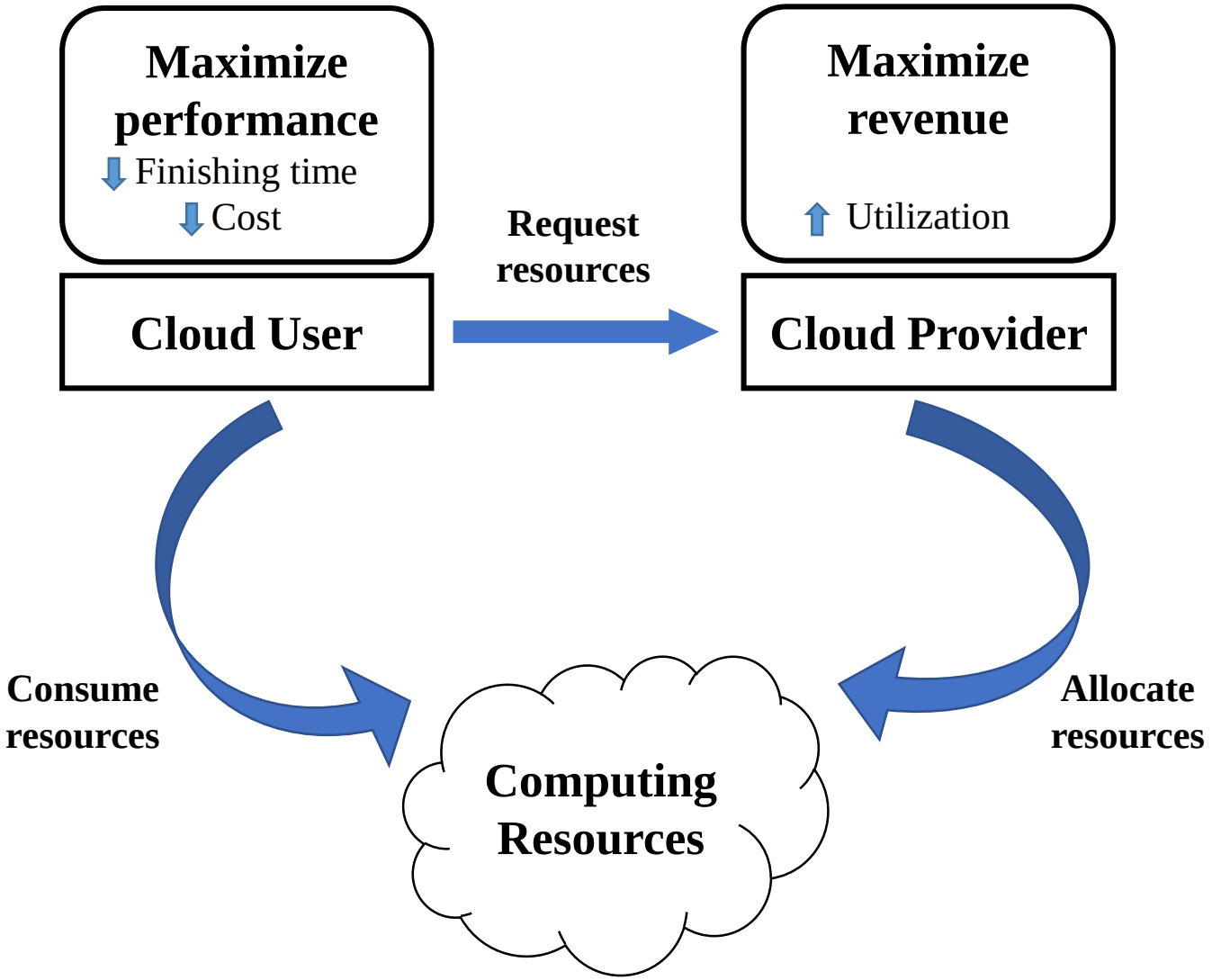
	2016	2017	2018	2019	2020	2021	CAGR 2016-2021
Traditional data center workloads and compute instances	42.1	41.4	40.8	39.1	36.2	32.9	-5%
Cloud data center workloads and compute instances	199.4	262.4	331.0	393.3	459.2	533.7	22%
Total data center workloads and compute instances	241.5	303.8	371.8	432.4	495.4	566.7	19%
Cloud workloads and compute instances as a percentage of total data center workloads and compute instances	83%	86%	89%	91%	93%	94%	-
Traditional workloads and compute instances as a percentage of total data center workloads and compute instances	17%	14%	11%	9%	7%	6%	-

Source: CISCO Global Cloud Index (Nov 2018)

Introduction to Cloud Computing

- **Cloud computing is a delivery model for computing resources that allow users to access those resources through the Internet.**
- **Cloud computing is the delivery of computing services—servers, storage, databases, networking, software, analytics and more—over the Internet (“the cloud”).**
- This model contrasts with the traditional client-server model, in which a computer is dedicated to a single user and is accessed through a network. In cloud computing, resources are shared among many users, who access them through a web browser or application.
- Cloud computing is the ability to access electronic data and applications over the internet.

Introduction to Cloud Computing



Cloud Service Models

Infrastructure as a Service (IaaS): Infrastructure as a Service (IaaS) refers to providing infrastructure services such as **physical computing resources, scaling, security, storage, and networking to its users.**

Platform as a Service (PaaS): Platform as a Service (PaaS) refers to **offering a development environment (typically like an operating system, database, Integrated Development Environment, etc.).**

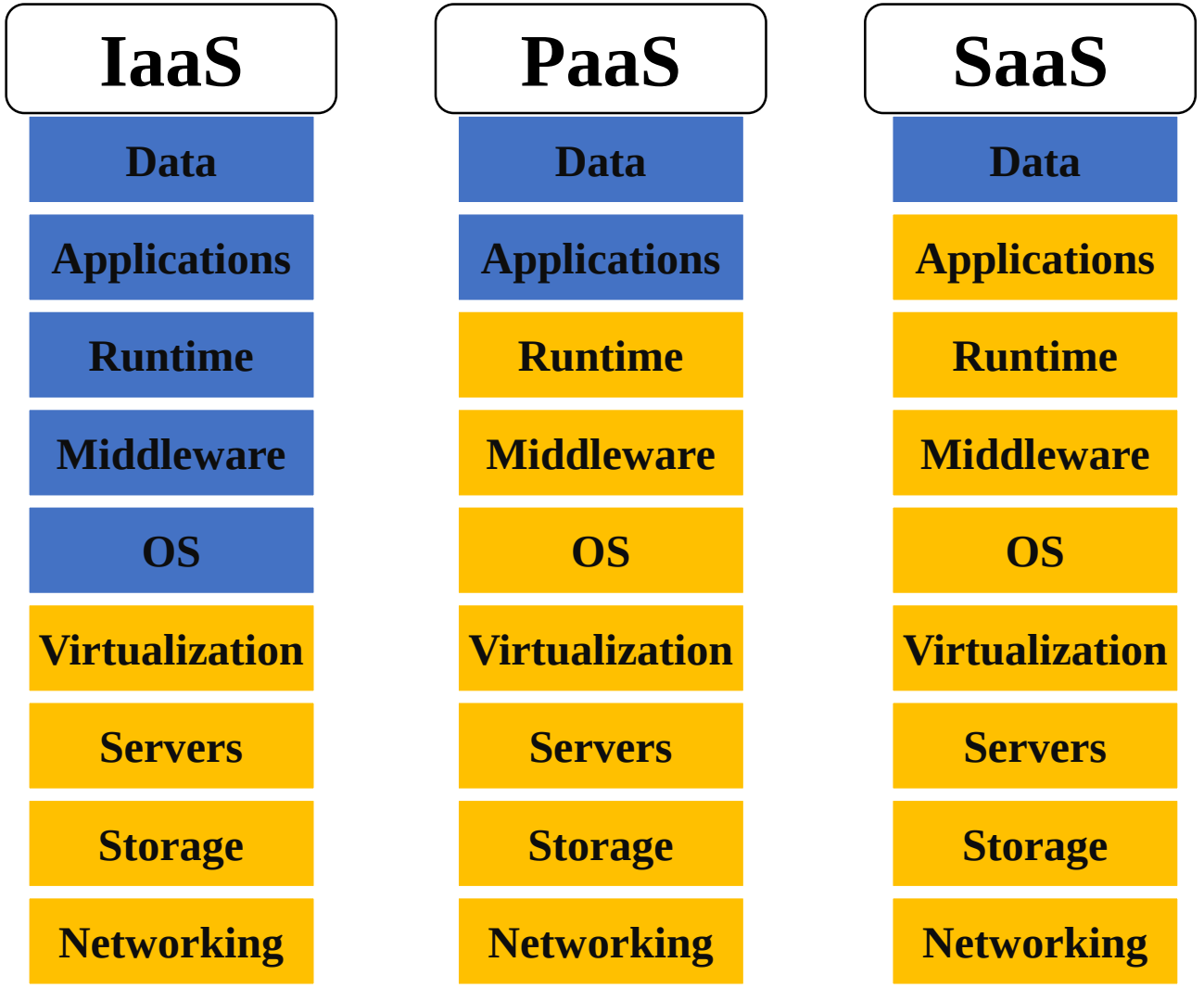
***Software as a service (SaaS)*:** In the Software as a Service (SaaS) model, **users can gain access to applications and software from anywhere in the world.**

Cloud Service Models

- Software-as-a-Service
- Platform-as-a-Service
- Infrastructure-as-a-Service

Manage by users

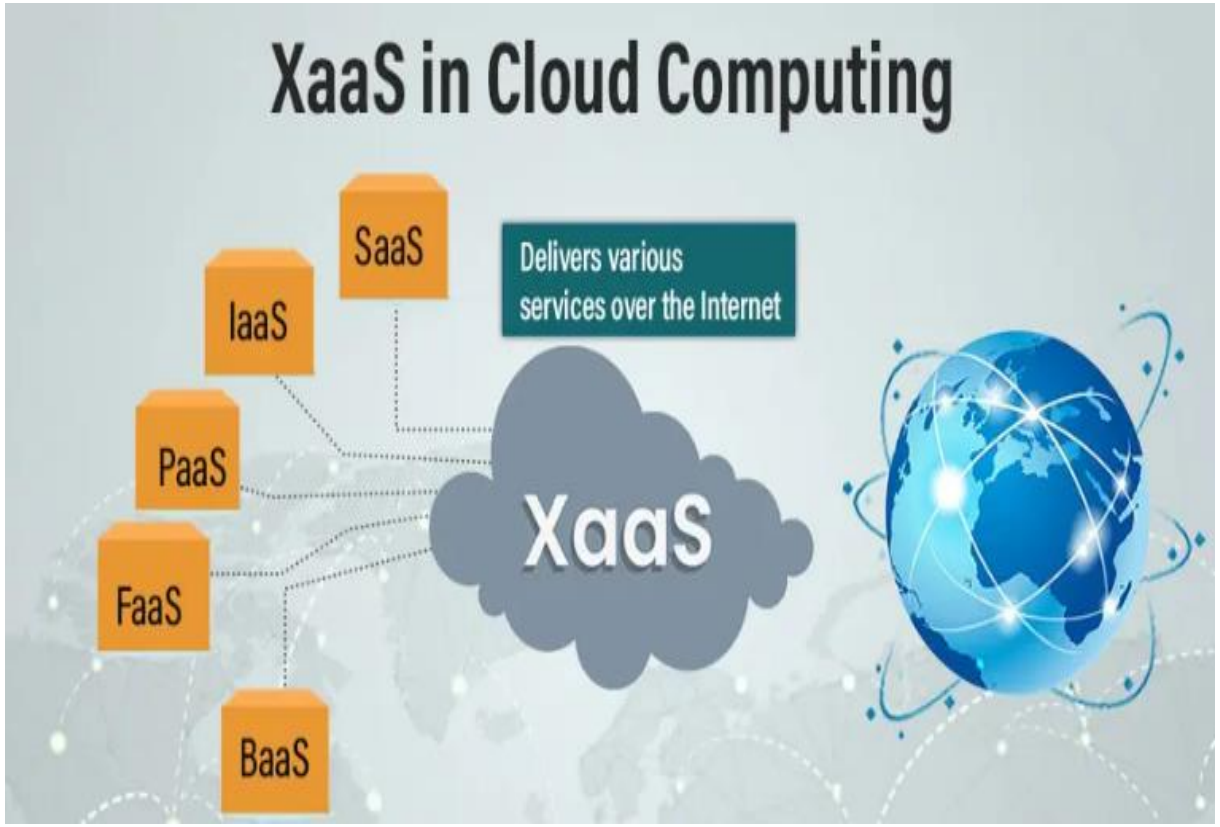
Manage by providers



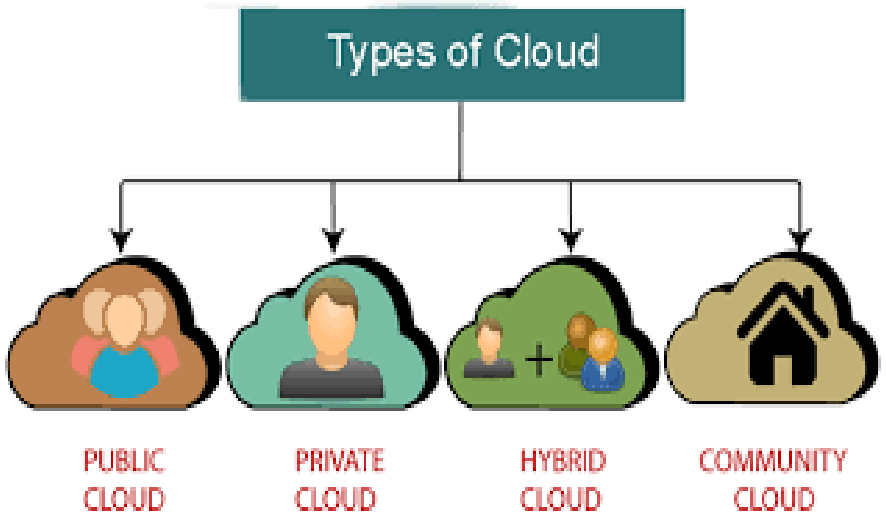
Cloud Delivery Models (XaaS)

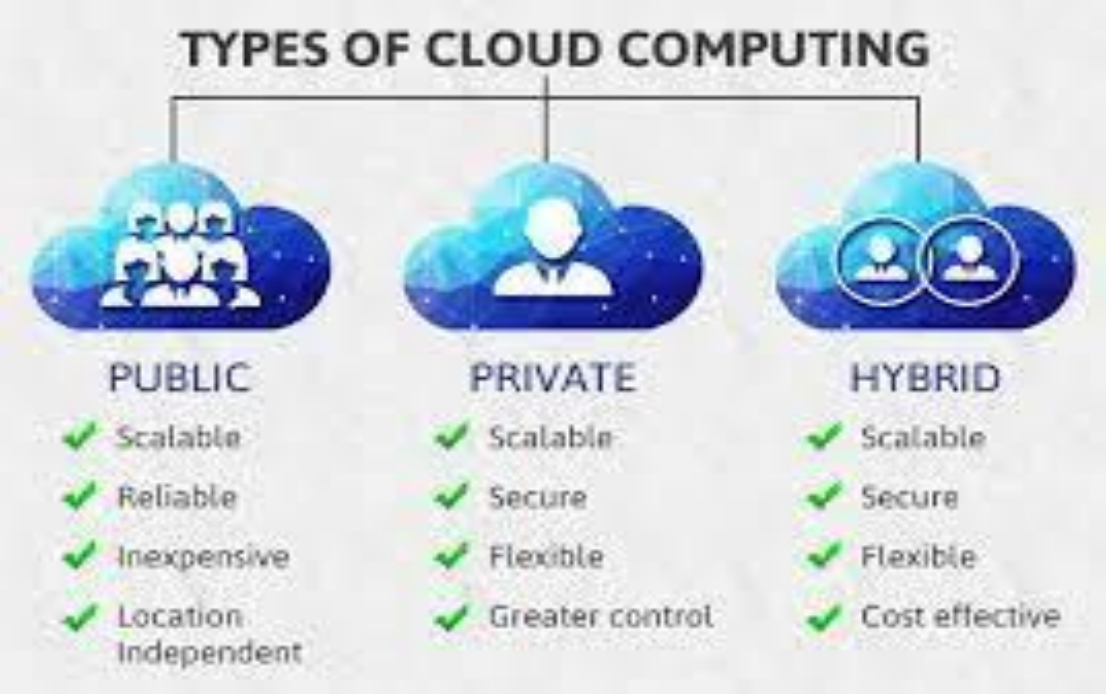
- There are numerous types of XaaS:

- Software as a service
- Platform as a service
- Infrastructure as a service
- Storage as a service
- Mobility as a service
- Database as a service
- Communications as a service
- Network as a service
- Other



Cloud Computing Deployment Models





Types of cloud deployment

Public cloud: Public clouds are cloud environments typically created from IT infrastructure not owned by the end user.

Alibaba Cloud, Amazon Web Services (AWS), Google Cloud, IBM Cloud, and Microsoft Azure.

Private clouds: Private clouds are dedicated to a single end user or group, where the environment usually runs behind that user or group's firewall. All clouds become private clouds when the underlying IT infrastructure is dedicated to a single customer with completely isolated access

Hybrid clouds = Public + Private

Characteristics of Cloud

- **On-demand self-services:** The Cloud computing services does not require any human administrators, user themselves are able to provision, monitor and manage computing resources as needed.
- **Broad network access:** The Computing services are generally provided over standard networks and heterogeneous devices.
- **Rapid elasticity:** The Computing services should have IT resources that are able to scale out and in quickly and on a need basis. Whenever the user require services it is provided to him and it is scale out as soon as its requirement gets over.
- **Resource pooling:** The IT resource (e.g., networks, servers, storage, applications, and services) present are shared across multiple applications and occupant in an uncommitted manner. Multiple clients are provided service from a same physical resource.
- **Measured service:** The resource utilization is tracked for each application and occupant, it will provide both the user and the resource provider with an account of what has been used. This is done for various reasons like monitoring billing and effective use of resource.
- **Multi-tenancy:** Cloud computing providers can support multiple tenants (users or organizations) on a single set of shared resources.

Characteristics of Cloud

- **Virtualization:** Cloud computing providers use virtualization technology to abstract underlying hardware resources and present them as logical resources to users.
- **Flexible pricing models:** Cloud providers offer a variety of pricing models, including pay-per-use, subscription-based, and spot pricing, allowing users to choose the option that best suits their needs.
- **Security:** Cloud providers invest heavily in security measures to protect their users' data and ensure the privacy of sensitive information.
- **Automation:** Cloud computing services are often highly automated, allowing users to deploy and manage resources with minimal manual intervention.
- **Sustainability:** Cloud providers are increasingly focused on sustainable practices, such as energy-efficient data centers and the use of renewable energy sources, to reduce their environmental impact.

Major use cases of Cloud

- To summarize, these **characteristics of cloud computing** offer the following benefits:
- Cloud computing allows for the storage of information on remote servers instead of on your personal computer. This means **you can access your files and data from anywhere at any time.**
- The main advantage of using cloud computing is that you don’t have to worry about having enough storage space or dealing with **hardware failures**. In addition, there’s no need to worry about **backing up your data** because it will always be available.
- Cloud storage is **much cheaper than traditional hard drives** because there’s no need for high-quality hardware or physical space, which is one of the best cloud computing features.

Major use cases of Cloud

- Storage
- Test and Development
- Serverless Computing
- High Performing Applications
- SaaS, PaaS, and IaaS.
- AI as a service (AIaaS)
- Disaster Recovery Plan
- Security
- Others

Disadvantages of Cloud Computing

- **Downtime:** Downtime is often cited as one of the biggest cloud computing disadvantages. Since cloud computing systems are internet-based, service outages are always an unfortunate possibility and can occur for any reason.

- **Security and privacy:** Cloud service providers implement the best security standards and industry certifications, storing data and important files on external service providers always opens up risks.

- **Vulnerability to attack:** every component is online, which exposes potential vulnerabilities. Even the best teams suffer severe attacks and security breaches from time to time.

Disadvantages of Cloud Computing

- **Limited control and flexibility:** cloud infrastructure is entirely owned, managed, and monitored by the cloud service provider, it transfers minimal control over to the customer.

- **Vendor lock-in:** Easy switching between cloud services is a service that hasn't yet completely evolved, and organizations may find it difficult to migrate their services from one vendor to another.

- **Cost Concern:** Adopting cloud solutions on a small scale and for short-term projects can be perceived as being expensive.

Best practices of cloud computing

- Automating Deployment Processes
- Ensuring Data Security and Compliance
- Optimizing Resource Allocation
- Implementing Cost Management Strategies
- Implementing Scalability Practices
- Implementing DevOps Principles
- Monitoring Performance Metrics
- Implementing Disaster Recovery Plans
- Implementing High Availability Architectures
- Implementing Microservices Architecture

Major public cloud players in the market

#	Cloud Service Provider	Regions	Availability Zones
1	Amazon Web Services (AWS)	33	105
2	Microsoft Azure	64	126
3	Google Cloud Platform (GCP)	40	121
4	Alibaba Cloud	30	89
5	Oracle Cloud	48	58
6	IBM Cloud	10	30
7	Tencent Cloud	21	65
8	OVHcloud	17	37
9	DigitalOcean	9	15
10	Linode (Akamai)	20	20

#2024

Security Issues and Challenges

- **Data Loss:** This is also known as Data Leakage. As we know that our sensitive data is in the hands of Somebody else, and we don't have full control over our database.
- **Interference of Hackers and Insecure API's**
- **User Account Hijacking**
- **Human Error & Misconfiguration**
- **Insider threats:** An insider threat is a cybersecurity threat that comes from within the organization — usually by a current or former employee or other person who has direct access to the company network, sensitive data and intellectual property (IP), as well as knowledge of business processes, company policies or other information that would help carry out such an attack.

Security Issues and Challenges

- **Lack of cloud security strategy and skills**
- **Data Encryption:** While data in transit is often encrypted, data at rest can be susceptible to breaches. It's crucial to ensure that data stored in the cloud is properly encrypted to prevent unauthorized access.
- **Loss of Control:** When using a cloud service, you are entrusting a third party with your data and applications. This loss of direct control can lead to concerns about data ownership, access, and availability.
- **IoT Devices and Edge Computing:** The proliferation of IoT devices and edge computing can increase the attack surface. These devices often have limited security controls and can be targeted to gain access to cloud resources.

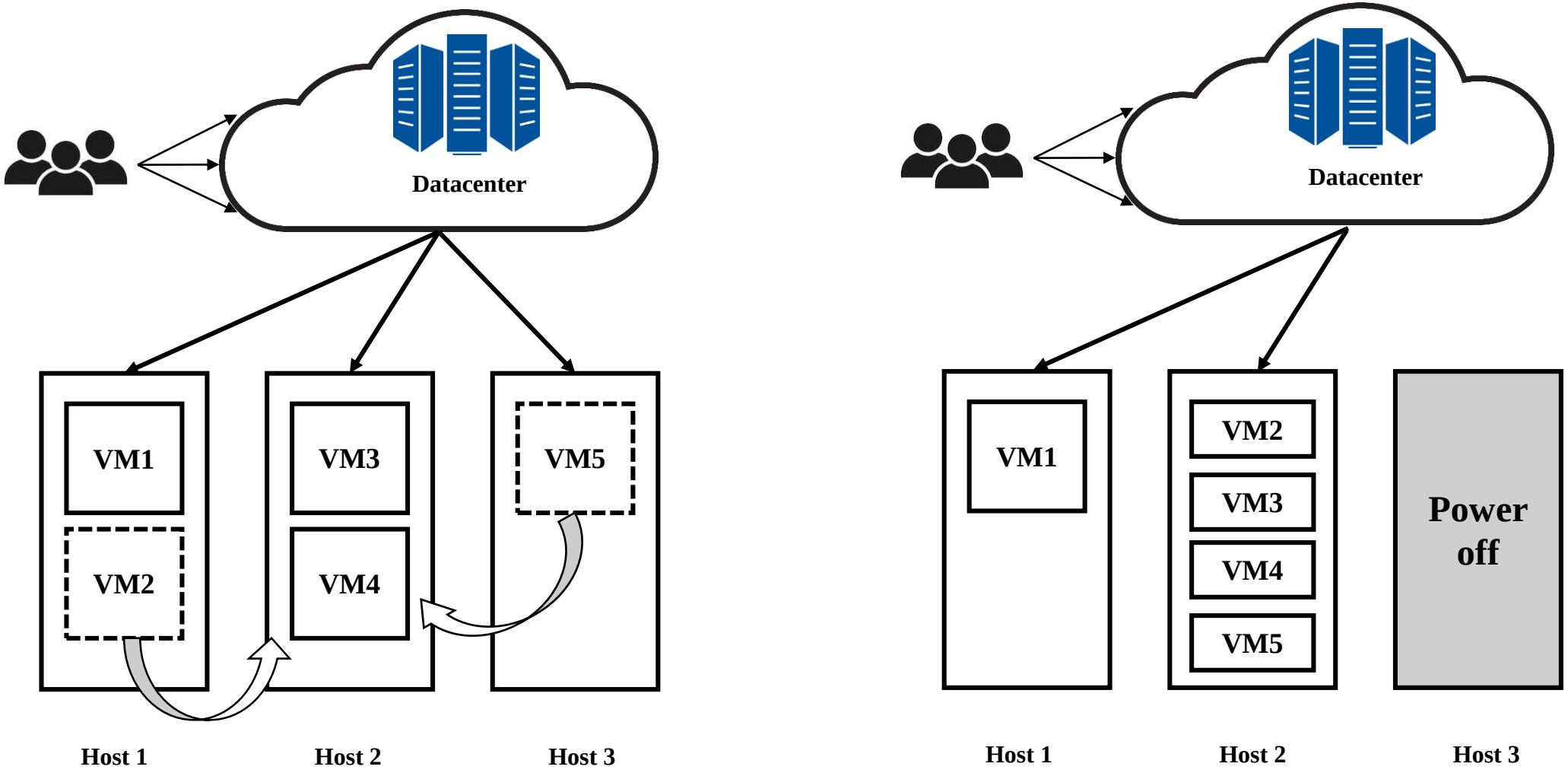
Security Issues and Challenges

- **Monitoring and Logging:** Monitoring and logging services are frequently offered by cloud providers. These services can assist organizations in identifying and addressing security concerns.
- **Compliance:** Using cloud services may be subject to legal compliance regulations, depending on the industry. Organizations must make sure their cloud provider complies with these specifications and has access to the required paperwork.

Resource Management in Cloud

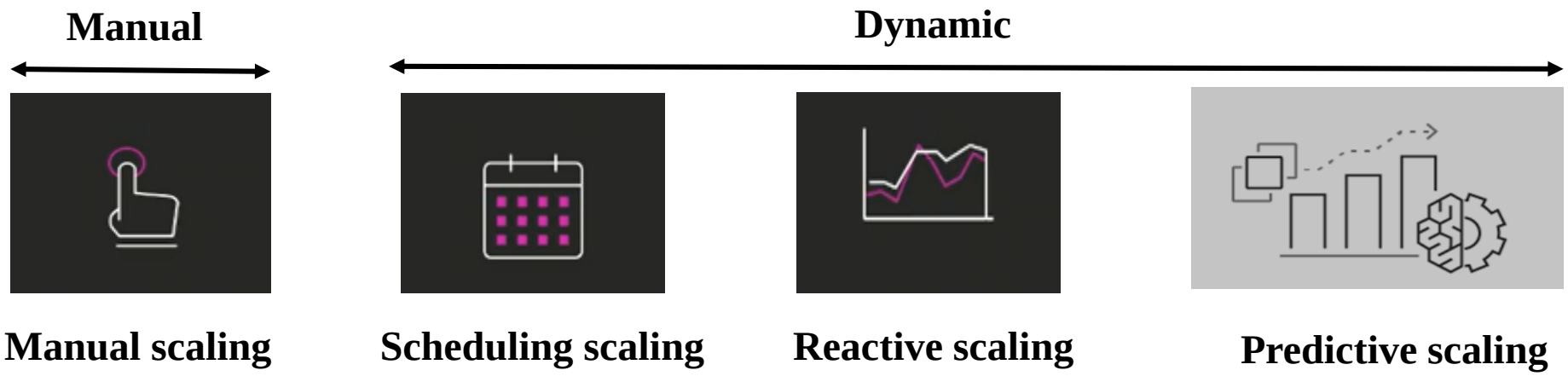
- Based on the workload demand of the objects, we can categorize the resource management mechanism (RMM) into three types:
  - Virtual Machine (VM) based RMM
  - Physical Machine (PM) or Host based RMM
  - Cloud Service (Application) workload based RMM

Load Balancing



Auto Scaling

- Auto scaling advantages
  - Smart scaling decisions in sudden increase/decrease in traffic
  - Automatically maintain performance
  - Pay only for what you need
- Scaling operation types



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