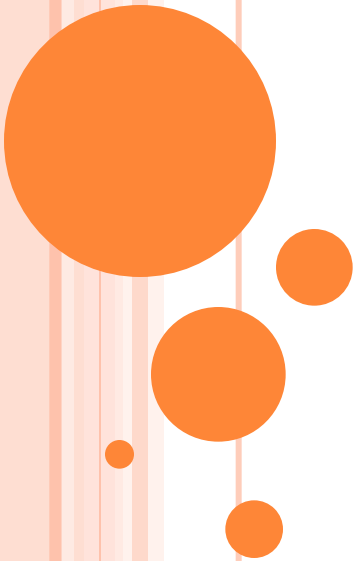
Module – I

Introduction to Cloud Computing



Session outline

- Trends in Computing
- Platform Evolution
- Necessity of Cloud Computing
- NIST Definition of Cloud Computing
- Key Characteristics of Cloud Computing
- Common Characteristics of Cloud Computing
- Advantages of Cloud Computing
- Disadvantages of Cloud Computing
- Benefits of cloud computing for end users and organizations

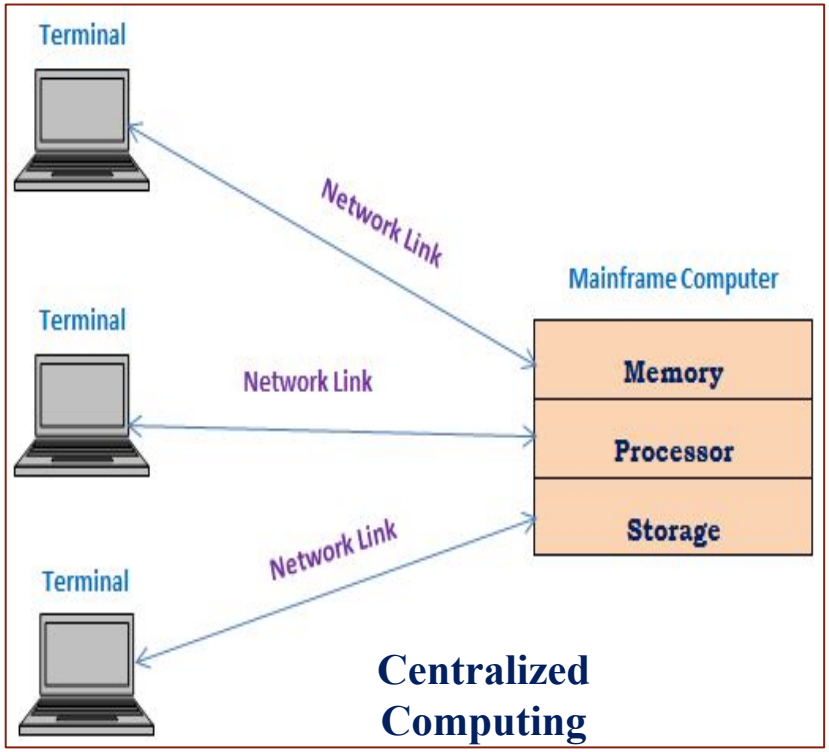
Trends in Computing

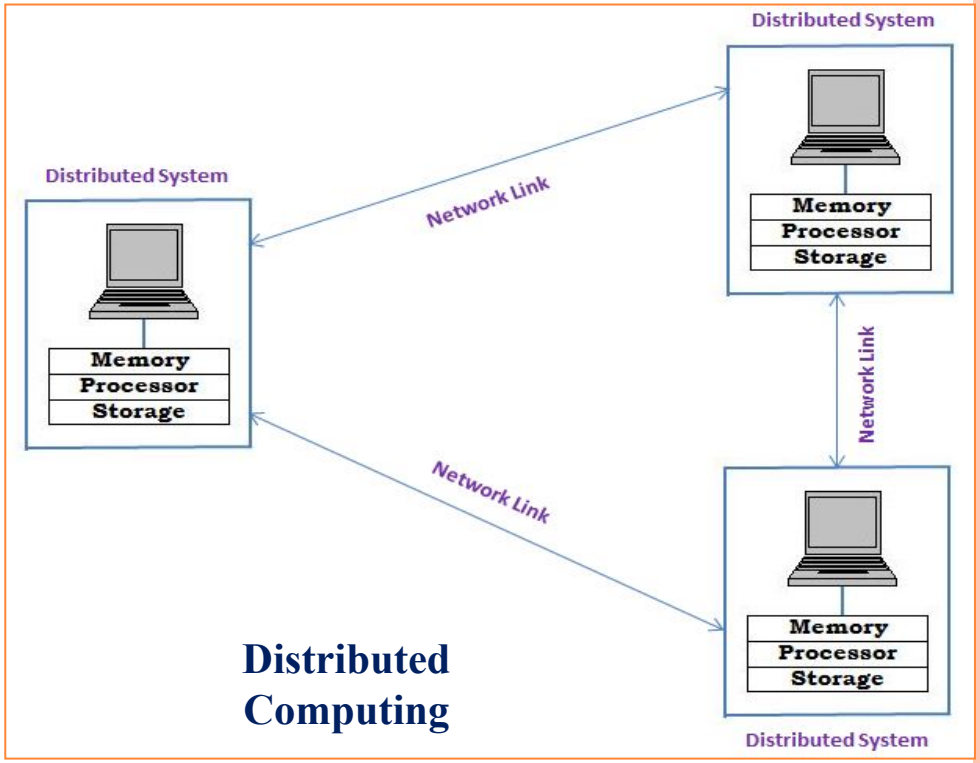
- Distributed Computing
- Grid Computing
- Cluster Computing
- Utility Computing
- Cloud Computing

Distributed Computing

- Distributed computing is a field of computing science that uses distributed systems to **solve computational problems**.

- Distributed systems are autonomous computational entities, each of which having its **own memory, processor and storage capacity**. These distributed systems are connected with each other through network links and communicates by performing message passing.

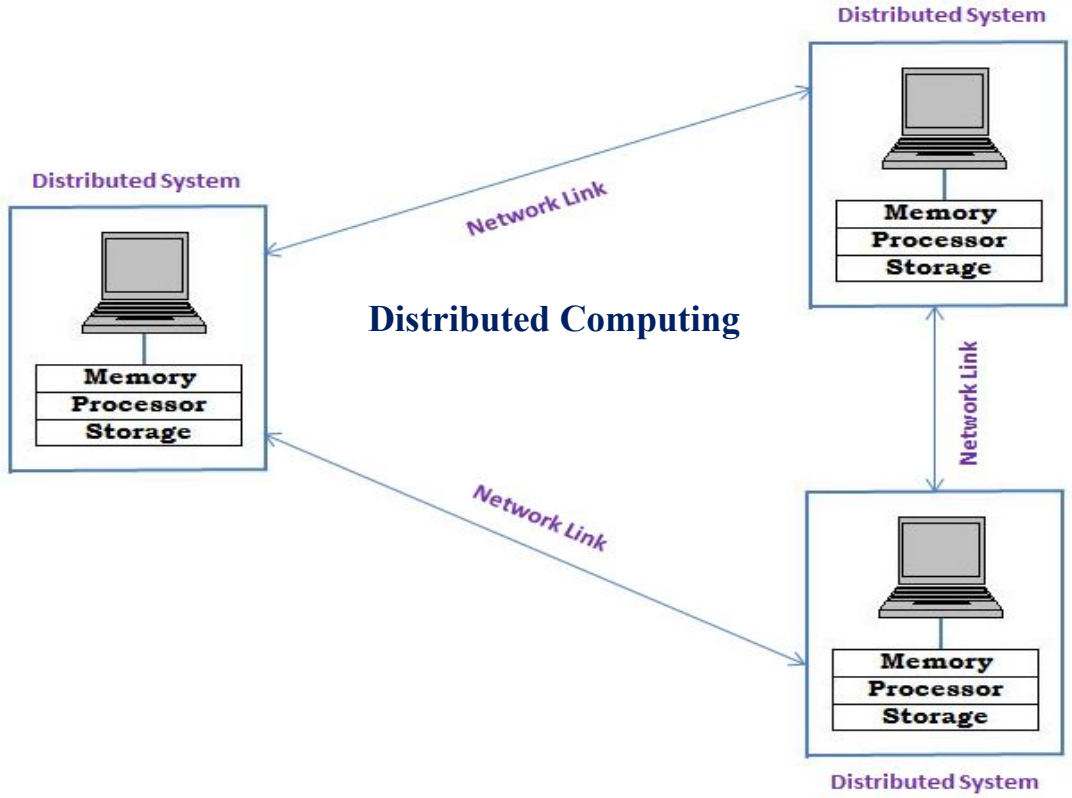




Distributed Computing Cont….

Properties of Distributed Computing:

- Fault tolerance
- Resource sharing
- Load Sharing
- Easy to expand
- Performance
- Robustness



Examples of Distributed Computing:

- Internet
- ATM machines

Distributed Computing Cont….

Properties of Distributed Computing:

- **Fault tolerance :** Enables an operating system to respond to a failure in hardware or software. System's ability to continue operating despite failures or malfunctions.
- **Resource sharing :** Resources such as printers, files, web pages or database records are managed by servers of the appropriate type. For example, web servers manage web pages and other web resources
- **Load Sharing :** includes sending a portion of the traffic to one server and the rest to another. Example For example**, suppose there are two connections of servers of different bandwidths of 500Mbps and another 250Mbps.** Let, **there are 2 packets.** Instead of sending the 2 packets to the same connection i.e. 500Mbps, 1 packet will be forwarded to the 500Mbps and another to the 250Mbps connection
- **Easy to expand**
- **Performance**
- **Robustness**

Distributed Computing Cont….

Properties of Distributed Computing:

- **Easy to expand :** expansion of the system in terms of **adding more data, increasing database sizes or adding more processor is easier**

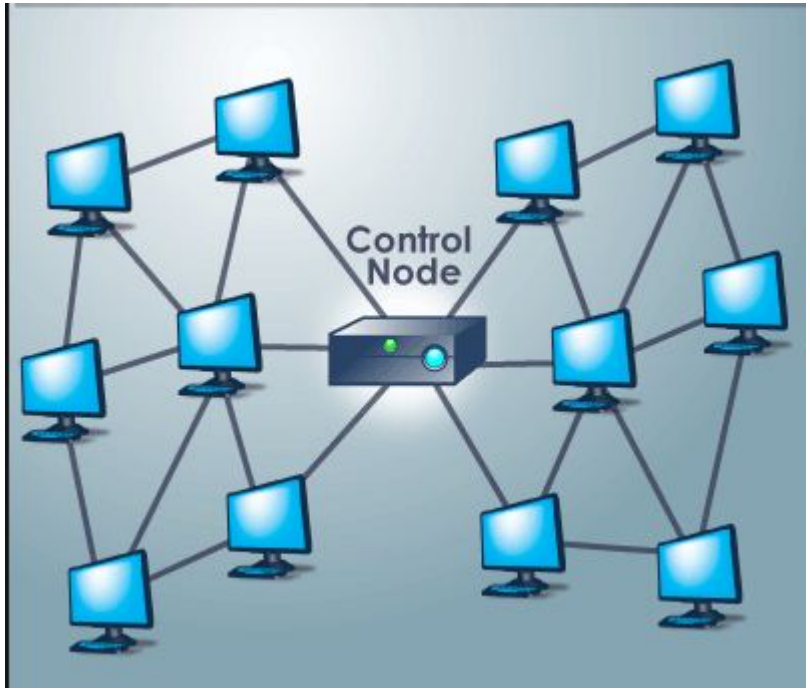
- **Performance :** High performance can be achieved by distributing the task over different machines, using a better algorithm, using faster computers or by using an MPSoC (Multiple Processor System on Chip)

- **Robustness :** A distributed system may suffer from various types of **hardware failure**. The failure of a link, the failure of a site, and the loss of a message are the most common types. To ensure that the system is robust, we must detect any of these failures, reconfigure the system so that computation can continue, and recover when a site or a link is repaired

Grid Computing

- Grid Computing is a subset of distributed computing, where widely distributed computer resources are used to reach a common goal.

- In grid computing, the computers on the network can work on a task together, thus functioning as a supercomputer.



The Grid

Grid Computing Cont….

- Grid Computing consists of network of computers working together to perform a task that would rather be difficult for a single machine. All machines on that sub network work under the same protocol to act like a virtual supercomputer. The task that they work on may include analyzing huge datasets or simulating situations which require high computing power.
- Grid Computing links together computing resources (PCs, workstations, servers, storage elements) and provides the mechanism needed to access them.

Types of Grids:

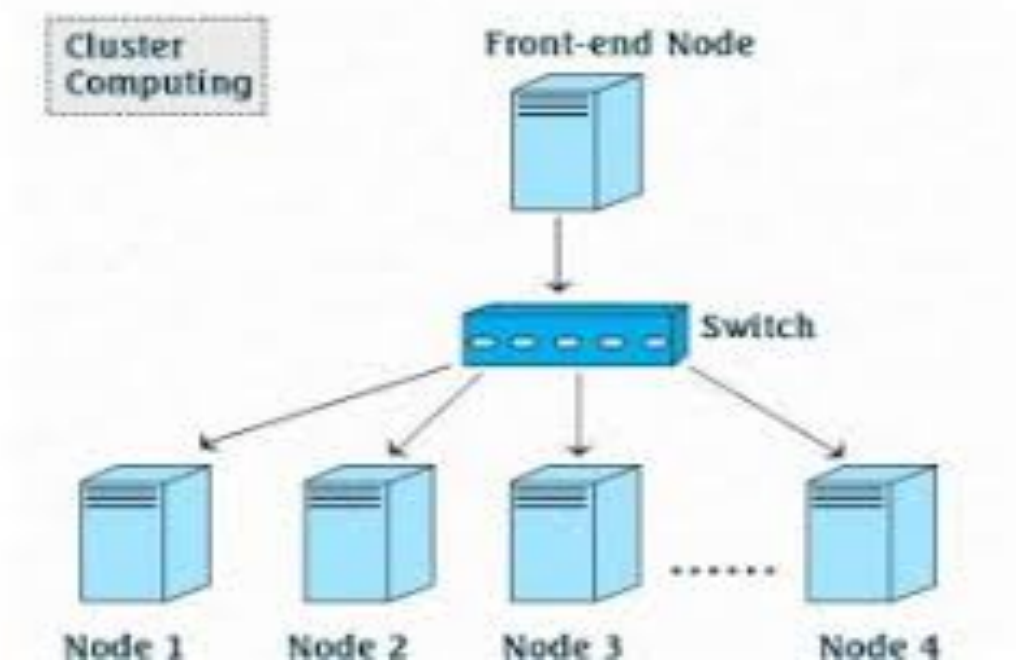
1. **Computational Grid**
2. **Data Grid**
3. **Collaboration Grid**
4. **Network Grid**

Applications of Grid Computing:

1. **Weather Forecast**
2. **Detection and Modeling of Natural Disasters**
3. **Scientific and Engineering problems require more accurate, precise solutions to their problems in shortest possible time.**

Cluster Computing

- Cluster computing or High-Performance computing is a form of computing in which collection of inter-connected stand-alone computers (often called nodes) that are connected through a LAN (local area network) so that, they behave like a single integrated computing resource.
- The nodes of a cluster are usually connected to each other through fast local area networks, with each node has same hardware and same operating system.



Cluster Computing Cont….

- A cluster help to solve complex operations more efficiently with much faster processing speed, better data integrity than a single computer and they only used for mission-critical applications.

- In case of Cluster, the whole system (all nodes) behave like a single system and resources are managed by centralized resource manager. In case of Grid, every node is autonomous i.e. it has its own resource manager and behaves like an independent entity.

Types of Clusters:

1. **High Availability or Failover Clusters**
2. **Load Balancing Cluster**
3. **Parallel/Distributed Processing Clusters**

Benefits of Cluster Computing:

1. **System availability**
2. **Hardware fault tolerance**
3. **OS and application reliability**
4. **Scalability**
5. **High performance**

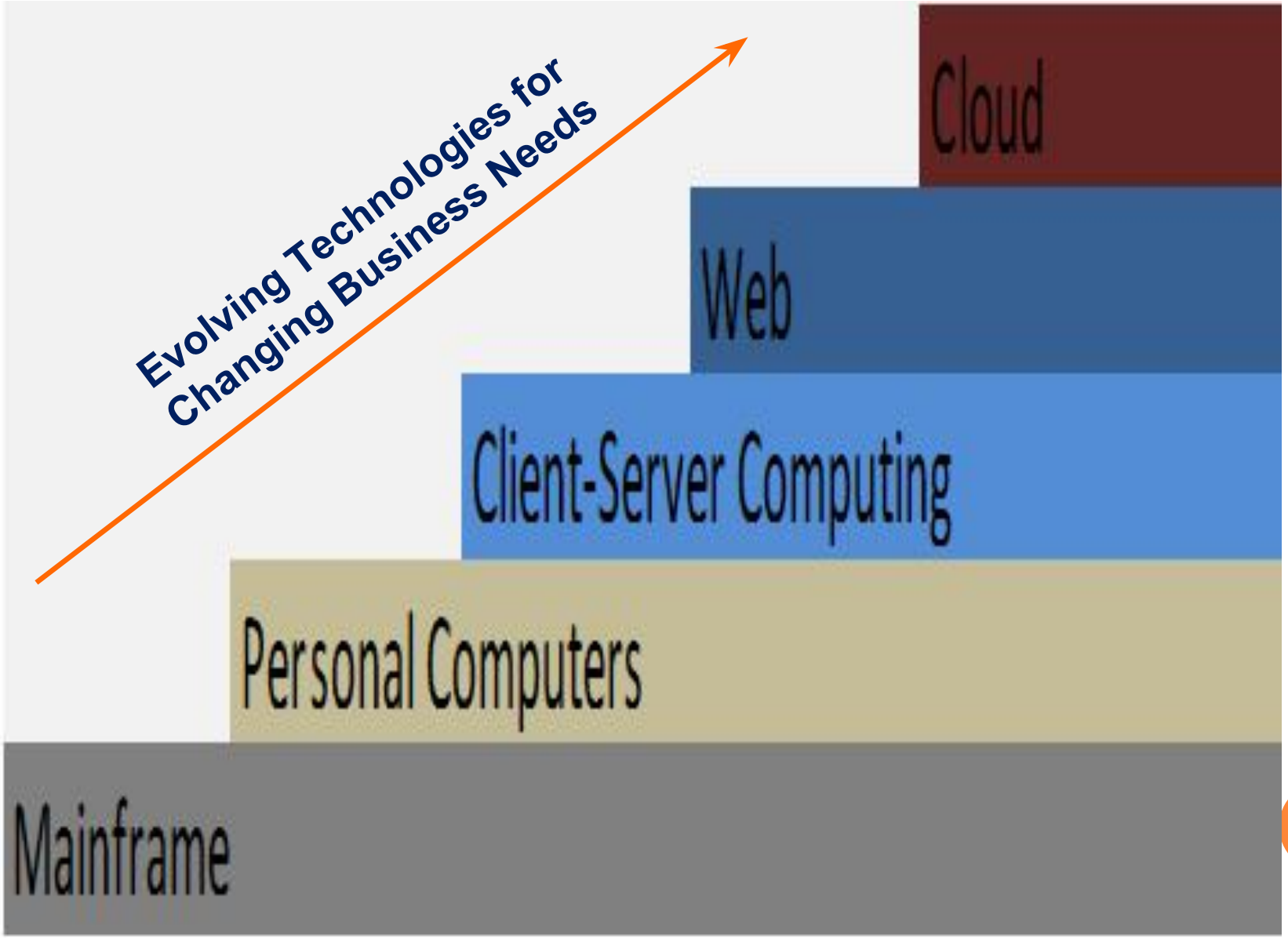
Utility Computing

- Utility computing is a service provisioning model in which a service provider makes computing resources and infrastructure management available to the customer as needed, and charges them for specific usage rather than a flat rate.
- This model has the advantage of a low or no initial cost to acquire computer resources; instead, computational resources are essentially rented.
- Utility Computing is purely a concept which cloud computing practically implements.
- The word utility is used to make an analogy to other services, such as electrical power, that seek to meet fluctuating customer needs, and charge for the resources based on usage rather than on a flat-rate basis.
- This approach known as pay-per-use or metered-services.

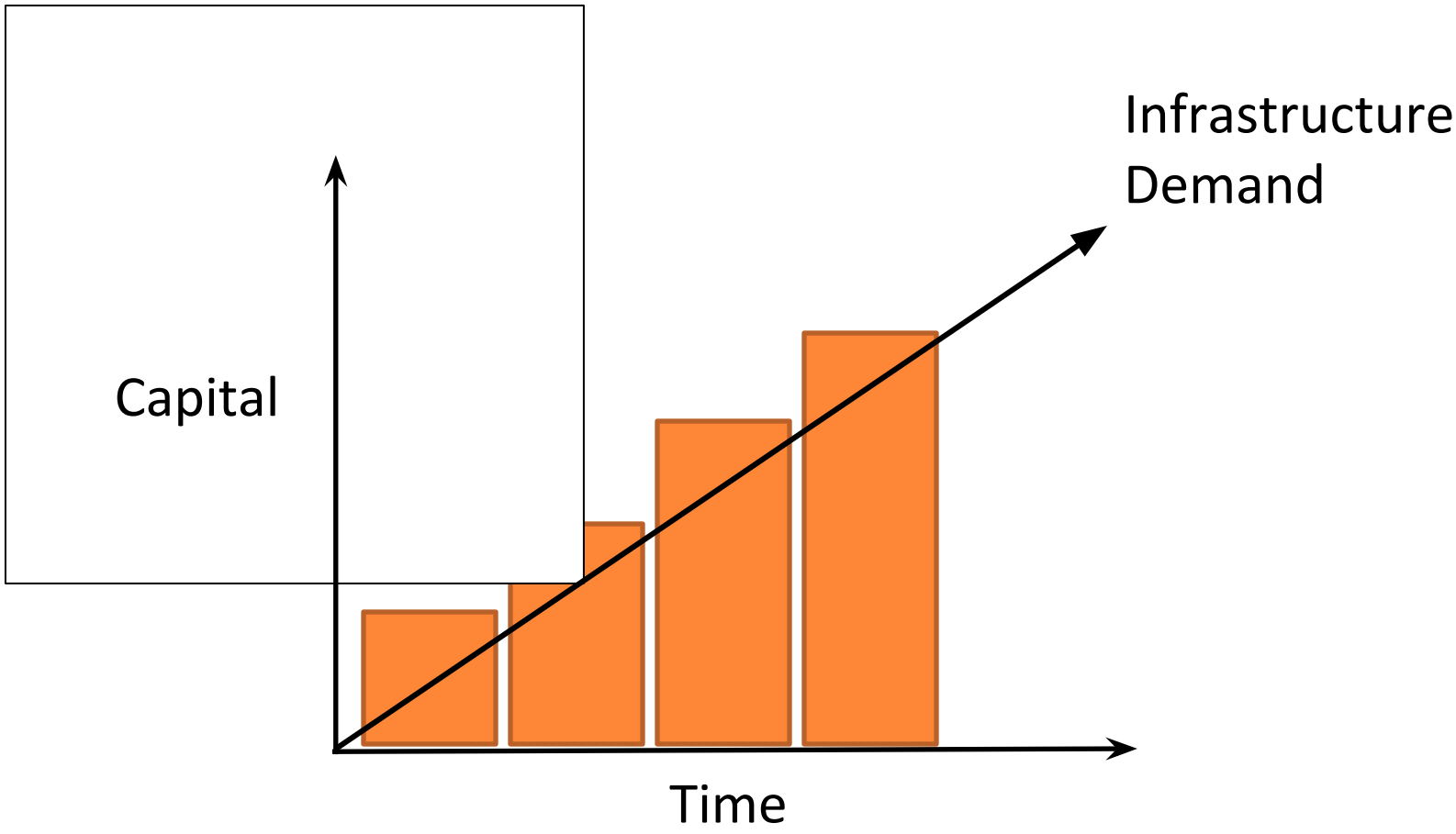
The Platform Evolution:

1950-1970	**Mainframe Computers:** To satisfy the demands of large businesses and government organizations for critical applications and bulk data processing. Very expensive.
1960-1980	**Personal Computers:** For individuals, small businesses, universities and college campuses.
1970-1990	**Client-Server Model:** A distributed model that partitions tasks or workloads between the providers of a service (servers) and service requesters(clients).
1990-2010	**Web Technology:** Personal computers appeared in both wired and wireless applications. Allow services and information to be accessed via the Internet.

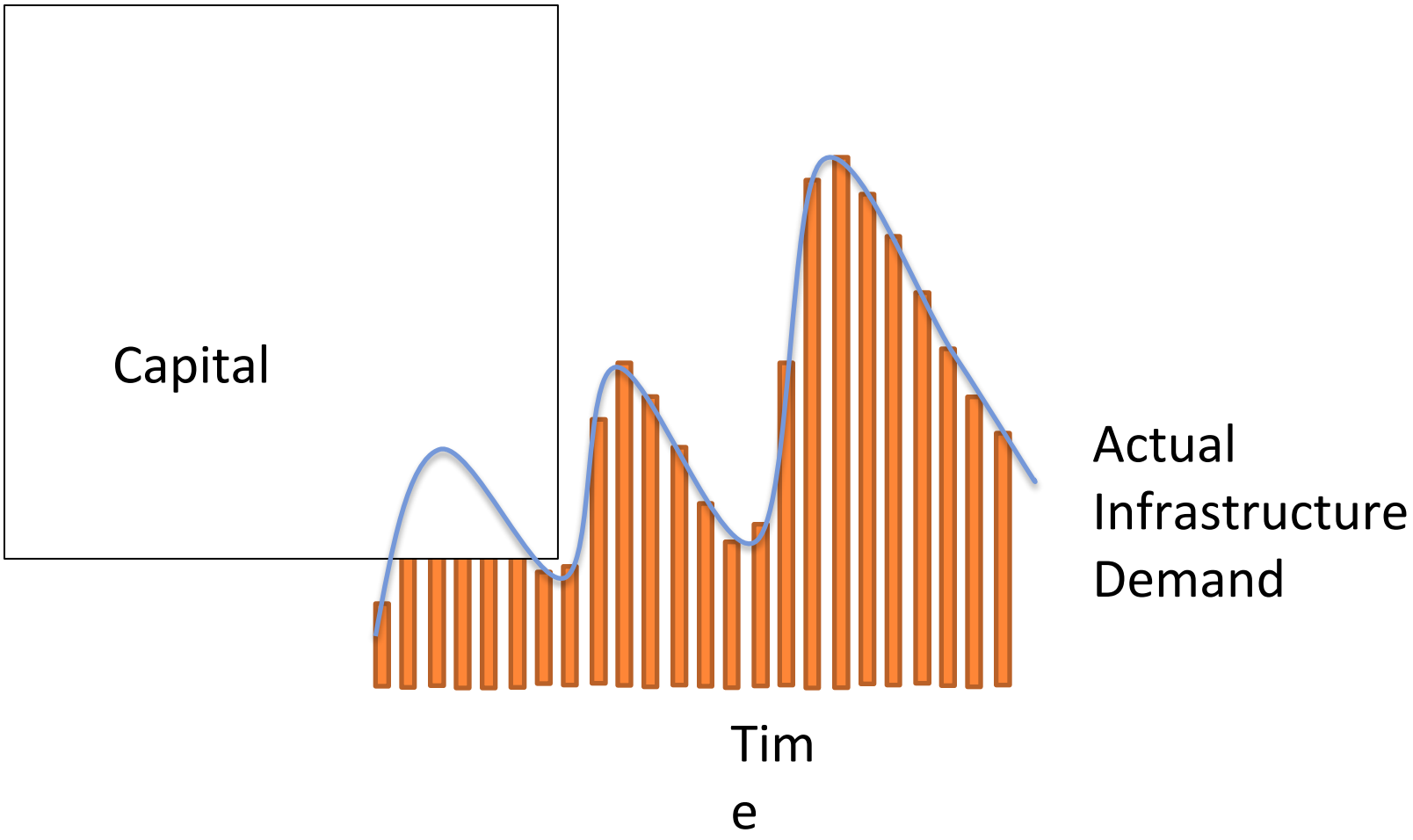
The Platform Evolution Cont….



Necessity of Cloud Computing:

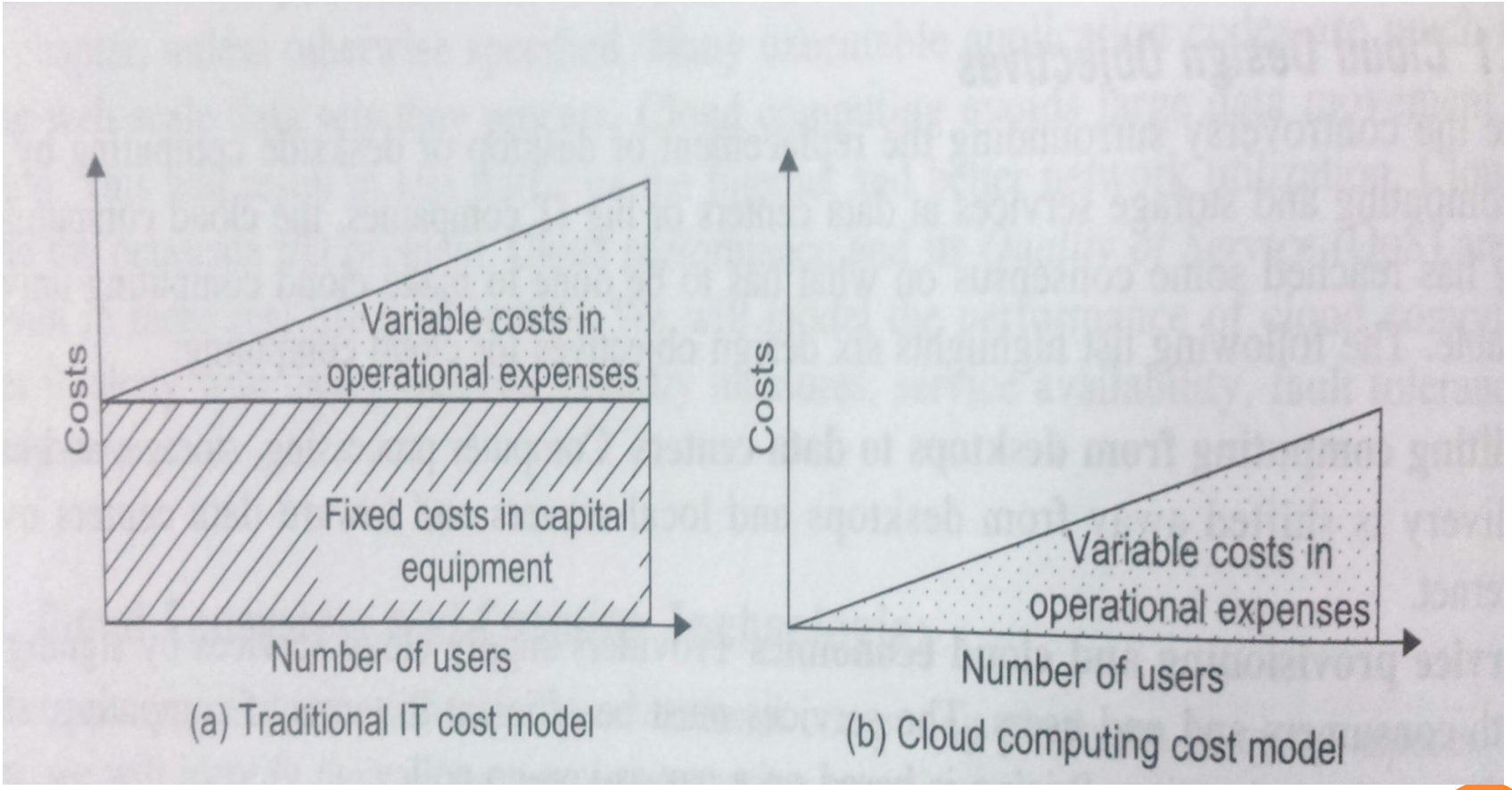


Traditional Infrastructure model(Continue) :



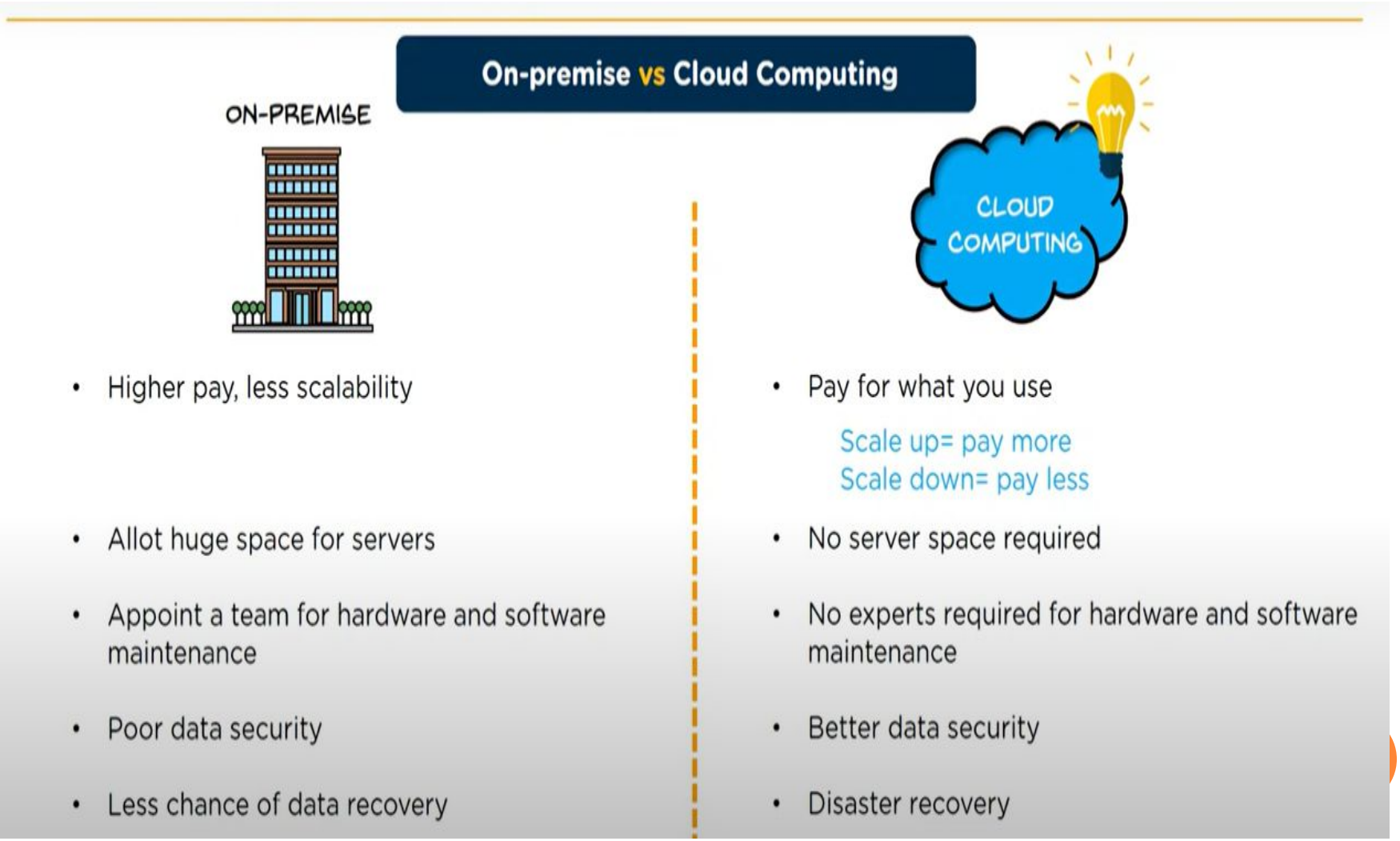
Necessity of Cloud Computing Cont….

Cost Model : Traditional V/S Cloud



Why Cloud Computing

Cost Model : Traditional V/S Cloud



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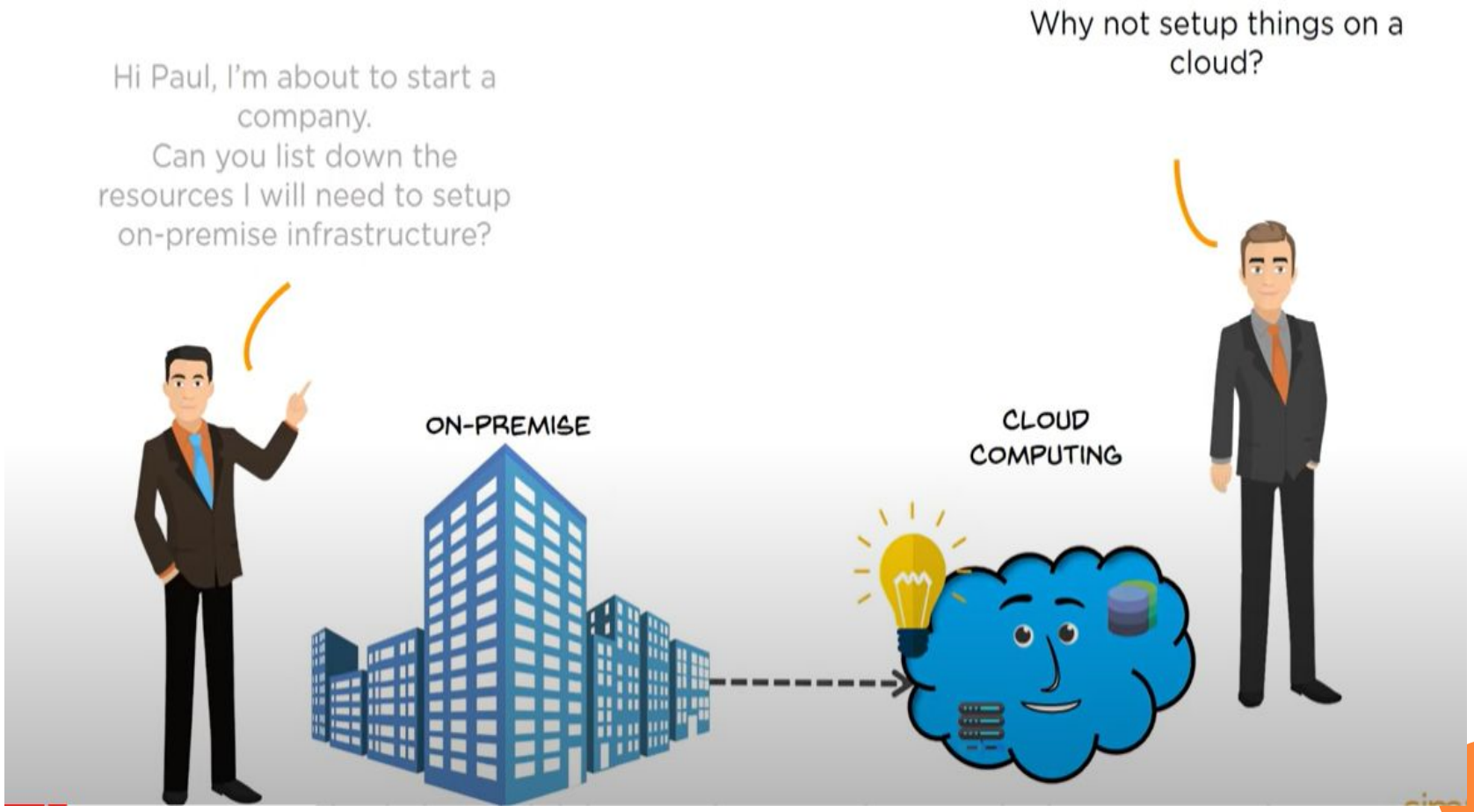
Cost Model : Traditional V/S Cloud



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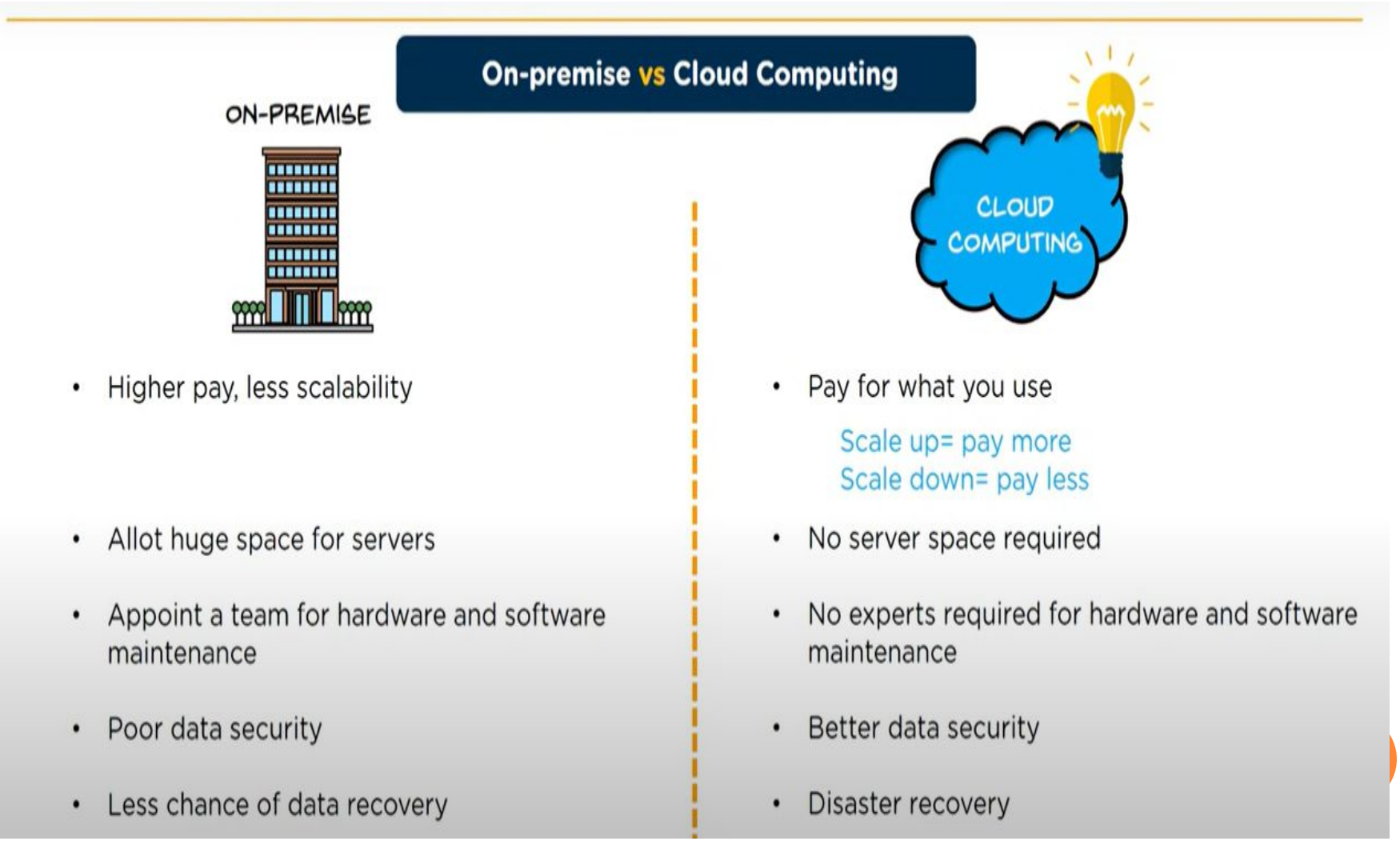
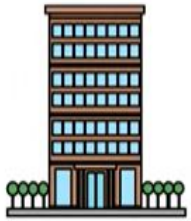


Why Cloud Computing

Cost Model : Traditional V/S Cloud

On-premise vs Cloud Computing

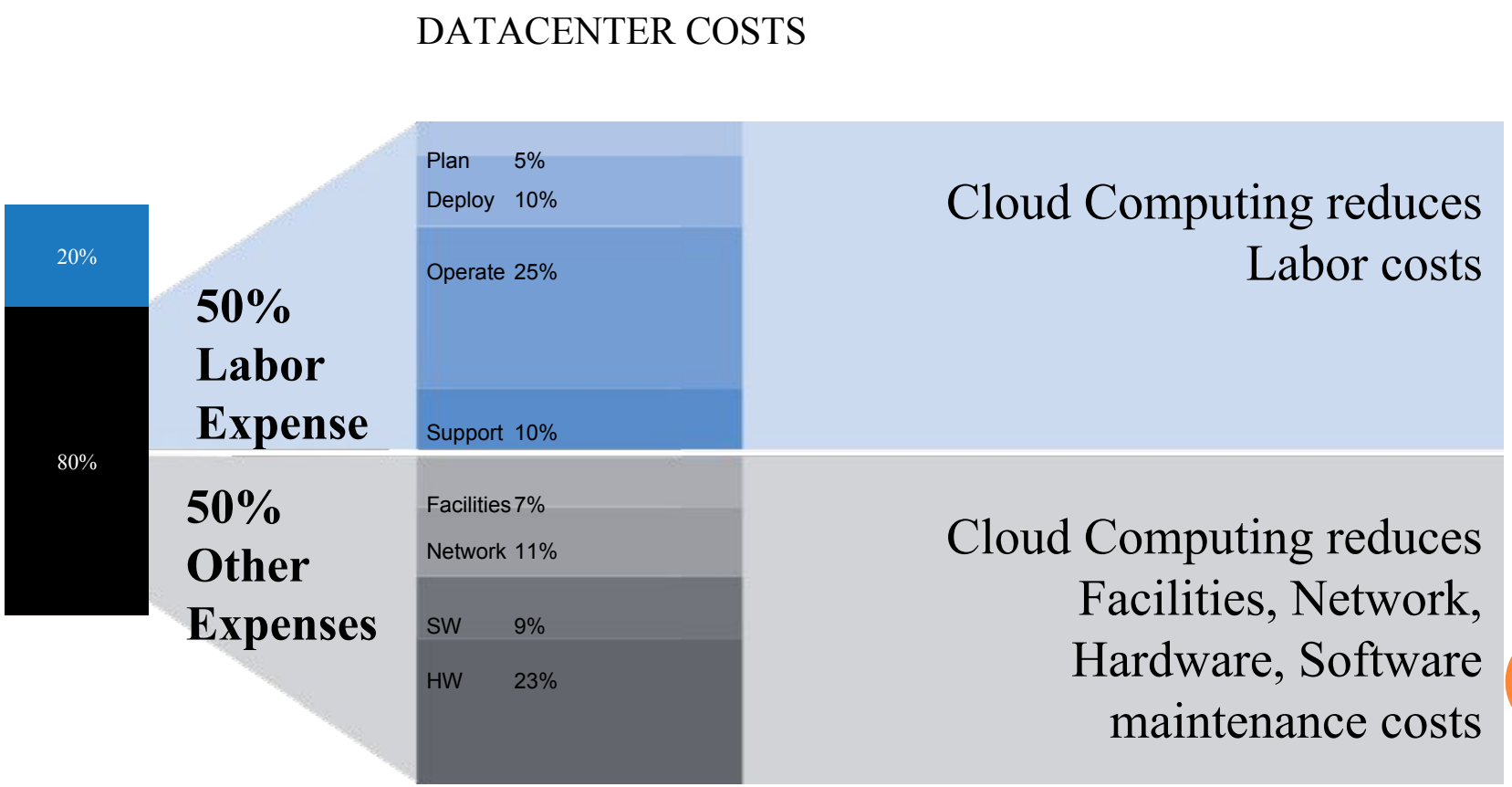


- Lack of flexibility
- No automatic updates
- Less collaboration
- Data cannot be accessed remotely
- Takes longer implementation time

- High Flexibility
- Automatic software updates
- Teams can collaborate from widespread locations
- Data can be accessed and shared anywhere over the internet
- Rapid implementation

Re-allocate IT expenditures

- Most companies today spend roughly 80% of their IT budget on operations and maintenance.



What is Cloud Computing:

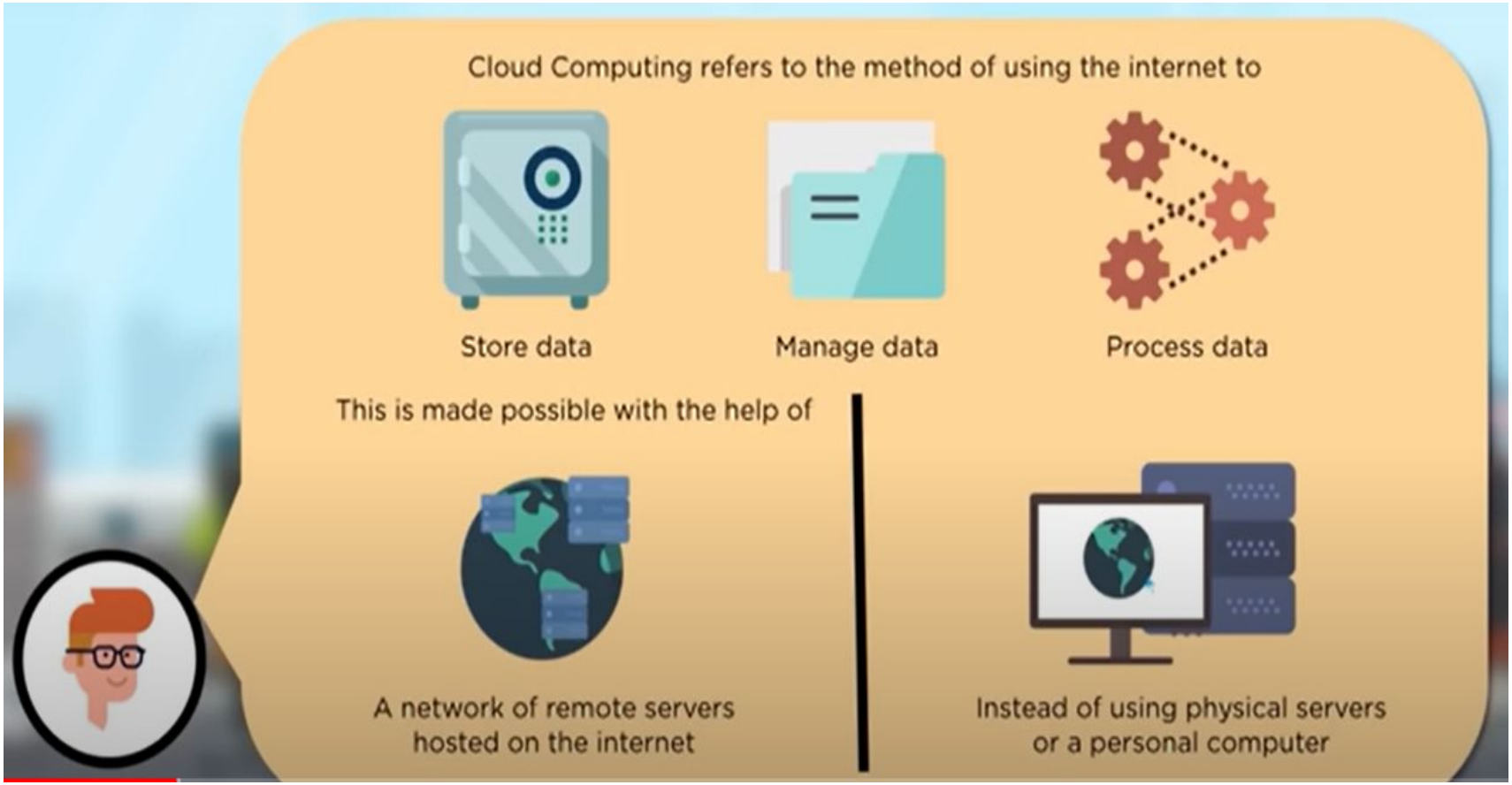
The NIST (National Institute of Standards and Technology) definition of Cloud Computing:

"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

What is Cloud Computing Cont….

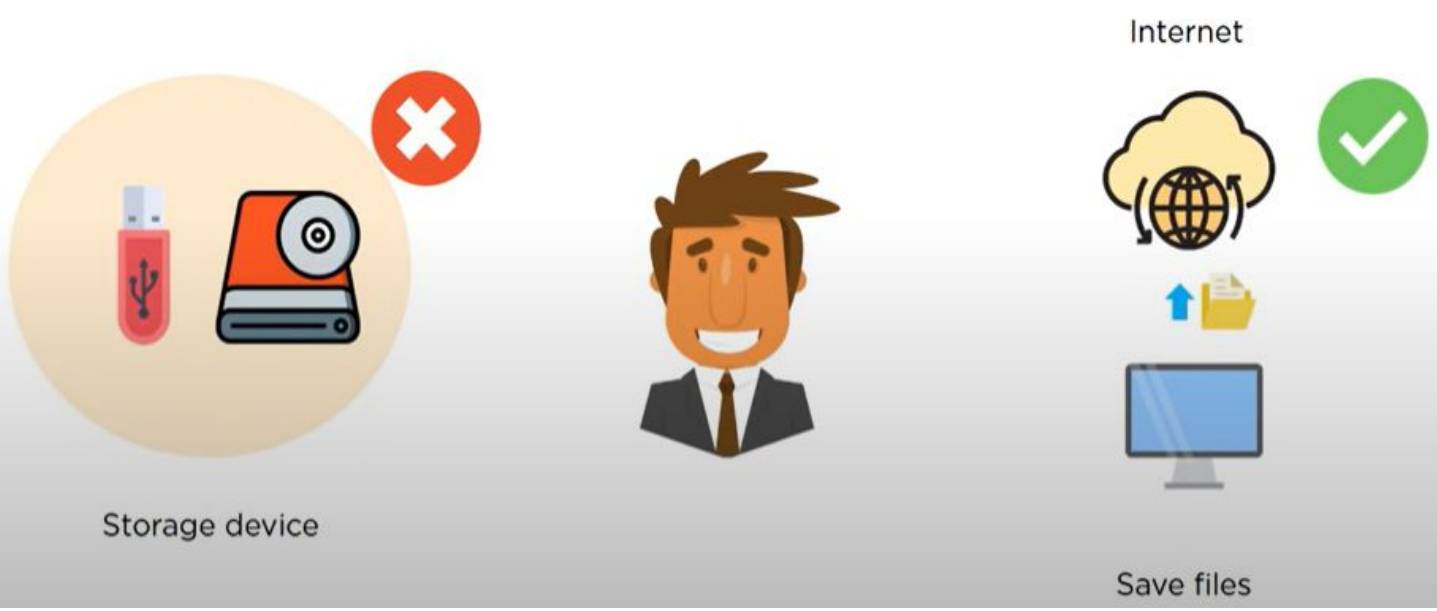
Cloud computing is the delivery of on-demand computing services over the internet on a pay-as-you-go basis

What is Cloud Computing Cont….

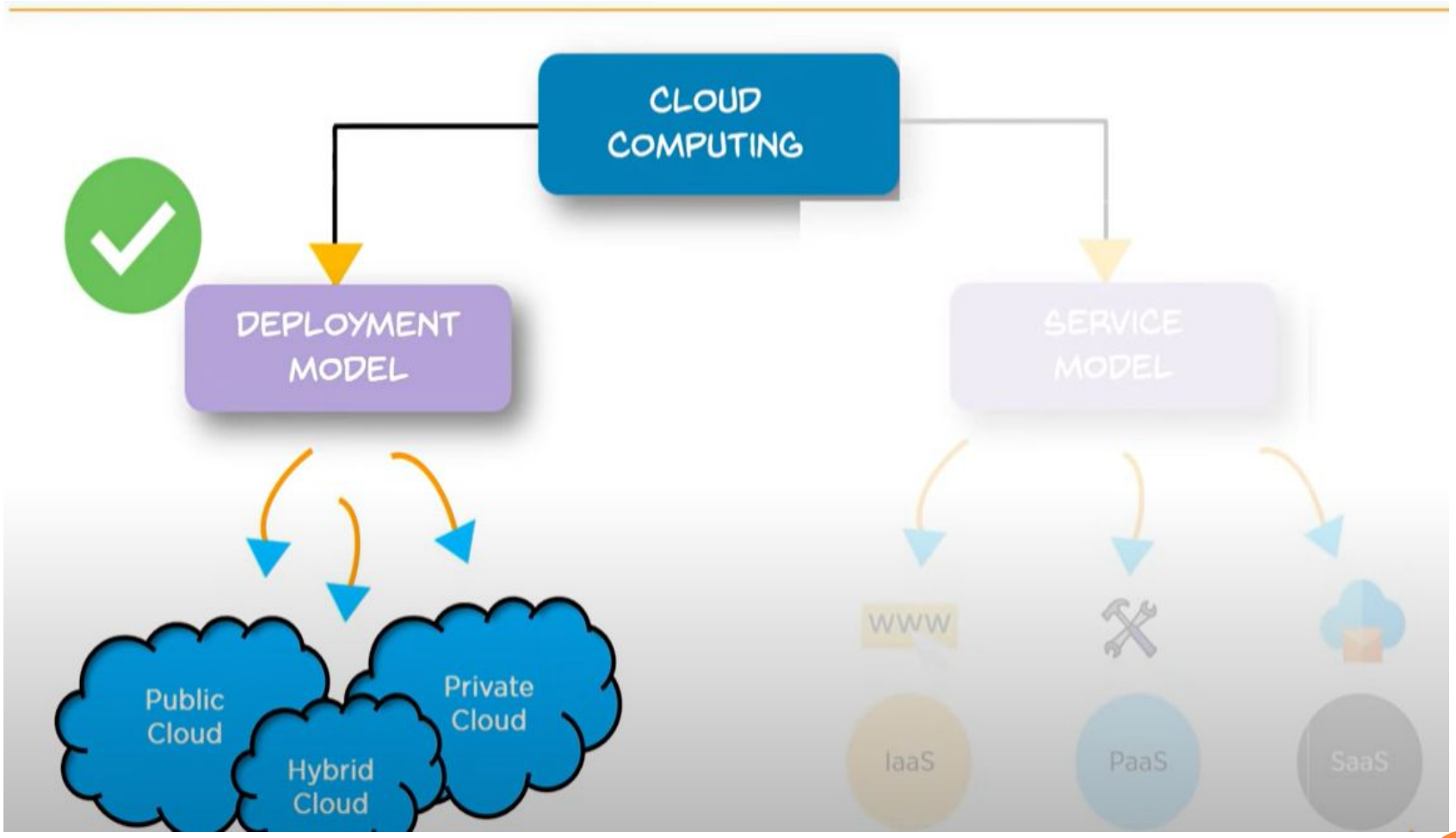


What is Cloud Computing Cont….

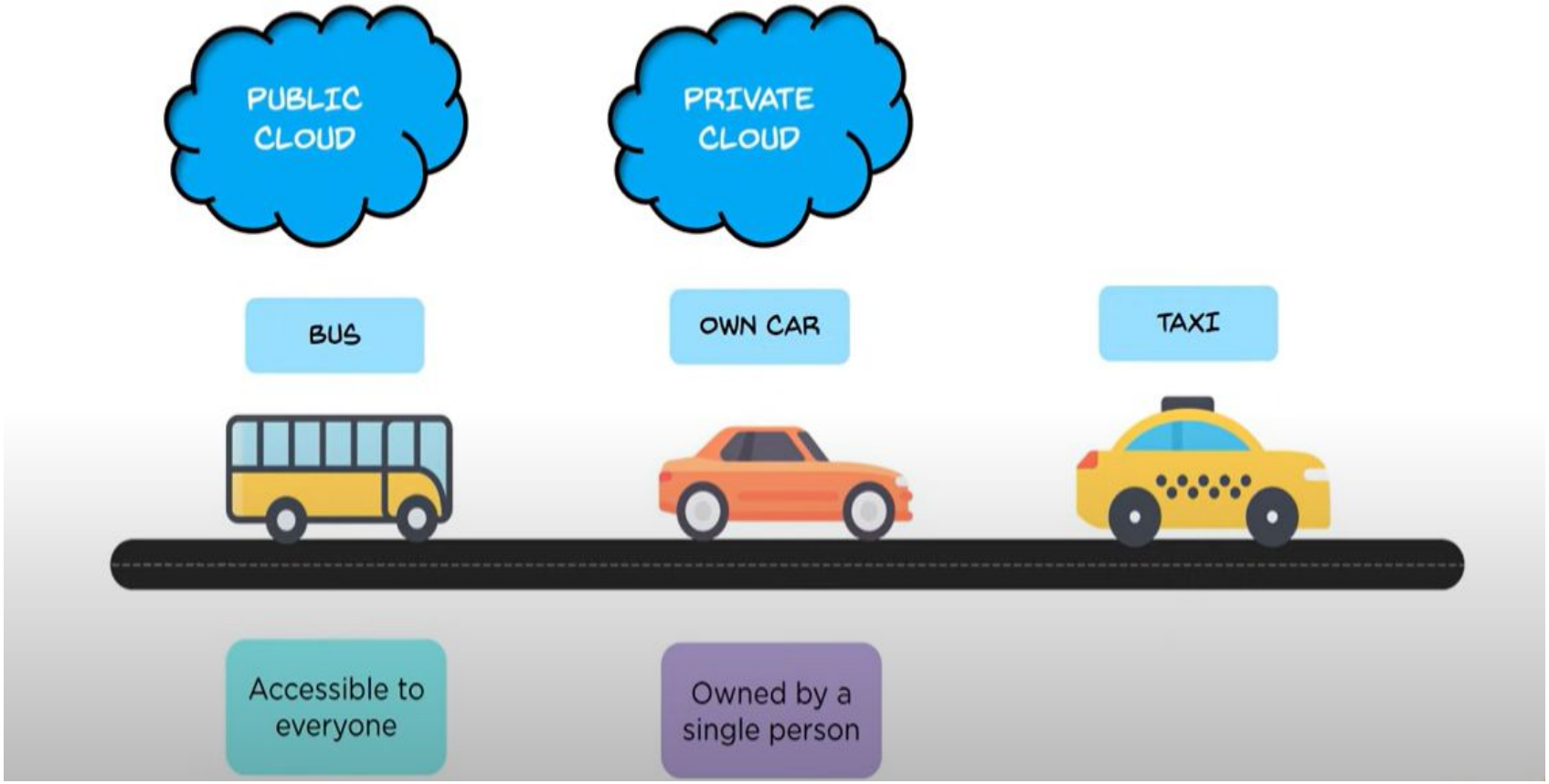
Rather than managing files on a local storage device, cloud computing makes it possible to save them over internet



Deployment Model



Types of Deployment Model



What is Cloud Computing Cont….

- Cloud computing is an innovative Internet-based computing paradigm that enables software and data to be delivered as services over the Internet.

- Application and service are thus able to move out their data and software to a remote cloud to deploy cost-effective service on demand without having to provision a data center.

Key Characteristics of Cloud Computing:

1. **Rapid Elasticity** – Cloud computing resources can be elastically provisioned and released. Cloud computing has the ability of scaling the resources both ways as per the need of consumers. Cloud is infinite and one can buy the computing power or storage resources as per the need.
2. **Measured service** – Cloud services are monitored as well as controlled by the service provider. This helps in billing, resource optimization, access control and capacity planning. This characteristic provides transparency for both the service provider and consumer about all statistics regarding utilized services.
3. **On demand self service** – A consumer can individually provision and release cloud computing resources such as server time, storage space, networking resources, applications etc. as and when needed without requiring any interaction with cloud service provider.

Key Characteristics of Cloud Computing Cont….

4. **Everywhere network access** – Cloud services provided by service provider are available over the Internet. These services are accessed by any particular client through diverse set of platforms e.g. mobile phones, tablets, laptops, and desktop PCs.

5. **Resource pooling** – The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

Common Characteristics of Cloud Computing:

- Massive Scale
- Resilient Computing
- Geographic Distribution
- Virtualization
- Service Orientation
- Low Cost Software
- Advanced Security

Advantages of Cloud Computing:

1. Lower Computer Cost:

- No need of a high-powered and high-priced computer systems to run cloud computing's web-based applications.
- Since applications run in the cloud, not on the desktop PC, your desktop PC does not need the processing power or hard disk space demanded by traditional desktop software.
- When you are using web-based applications, your PC can be less expensive, with a smaller hard disk, less memory and less efficient processor.

2. Improved Performance:

- Desktop PC or mobile with limited memory & limited processing power can efficiently run large software applications hosted on cloud.

Advantages of Cloud Computing Cont….

3. Reduced Software Cost:

- Instead of purchasing expensive software applications, you can use them by paying less amount of money. Most of the software applications such as Google Docs, Google Sheets are available for free.

4. Instant Software Updates:

- For cloud based software applications, updates are automatically available whenever you logged in to cloud.
- When you access a cloud applications, you get the latest version without needing to pay for or downloading an upgrade.

5. Improved Document Format Compatibility:

- Since users sharing documents and applications in the cloud, particular user do not have to worry about the compatibility of documents created on one machine and being accessed on other machine with different OS.

Advantages of Cloud Computing Cont….

6. Unlimited Storage Capacity:

- Cloud computing offers virtually limitless storage.
- Your computer's current 1 Tera Bytes hard drive is small compared to the hundreds of Peta Bytes available in the cloud.

7. Increased Data Reliability:

- In case of desktop computing, if a hard disk crashes and user didn't backed up data, it will destroy all valuable information.
- This does not happen in case of cloud. If your personal computer crashes, all your data is still out there in the cloud. Hence you can still access your valuable information.

8. Universal Information Access:

- Since applications and documents are stored on cloud, you do not need to carry them with you wherever you go. You can easily access them whenever you have computer and Internet connection.

Advantages of Cloud Computing Cont….

9. Easier Group Collaboration:

- Multiple cloud users can easily share documents and other collaborative work with each other for better productivity.
- Cloud Computing allows multiple users to work collaboratively on shared documents and shared projects.

10. Device Independence:

- Cloud computing ensures device portability. It means, with cloud computing, you need not to be depend on a specific type of device.
- Your applications and documents can be accessed on any type of device which are having any type of CPU architecture.

Disadvantages of Cloud Computing:

1. Constant Internet Connection Requirement:

- Cloud computing is impossible if you cannot connect to the Internet.
- Since you use the Internet to connect to both your cloud applications and documents, if you do not have an Internet connection you cannot access anything, even your own documents.

2. High-Speed Internet Connection Requirement:

- Cloud applications requires high network bandwidth.
- Users may experience bad service availability while accessing cloud computing resources through low-speed Internet connection.

3. Limited Features:

- Many cloud-based applications are not as fully-featured as compared to their corresponding desktop-based applications.

Disadvantages of Cloud Computing Cont….

4. Slower Accessibility:

- Even with a fast network connection, cloud applications can sometimes be slower than accessing a similar software program on desktop PC.

5. Security of a stored data:

- With cloud computing, all data is stored on the cloud, at third-party location.
- This raise a question about how secure your data is.....
- An unauthorized user can attack on a network and can gain access to your confidential data.

6. Interoperability:

- Each cloud systems uses different protocols and different APIs.

Benefits of Cloud Computing:

For End Users:

- High utilization
- High scalability
- No separate hardware procurement
- No separate power cost
- No separate IT infrastructure administration/ maintenance required
- Public clouds offer user friendly Service Level Agreement (SLA) by offering high availability (~99%) and also provide compensation in case of SLA miss.
- Users can rent the cloud to develop and test prototypes before making major investments in technology.
- In order to enhance portability from one public cloud to another, several organizations such as Cloud Computing Interoperability Forum and Open Cloud Consortium are coming up with standards for portability. For e.g. Amazon EC2 and Eucalyptus share the same API interface.

Benefits of Cloud Computing Cont….

For End Users Cont….

- Software startups benefit tremendously by renting computing and storage infrastructure on the cloud instead of buying them as they are uncertain about their own future.
- Public clouds can provide all necessary services with significantly reduced costs.
- From end user perspective cloud computing gives the illusion of potentially infinite capacity with ability to scale rapidly and pay only for the consumed resources.

Benefits of Cloud Computing Cont….

For Organizations:

- Reduced cost of infrastructure.
- Flexibility of growing and reducing resources.
- Confidentiality of data is preserved.
- Fast and easy provisioning of cloud resources.
- Business continuity and disaster recovery.
- Speed of implementation with ease of doing business.
- Deploying the applications on cloud costs nothing. Depending upon the usage, costs are incurred.
- Cloud scales automatically to successfully handle increased requests to the web applications. No need for the organization to handle scaling and load balancing of requests.
- Employees can use collaboration tools to carry out collaborative work on projects. Hence improves overall employee productivity.

Benefits of Cloud Computing Cont….

For Organizations:

- Cloud computing also provide web based Integrated Development Environment for development and deployment of application on the cloud. Hence developers can directly write applications on the cloud and don't have to buy separate licenses of IDE.
- Organizations can use cloud based CRM, ERP, or supply chain management applications, instead of buying servers and installing these software's and associate databases on them.
- Organizations can use cloud computing for developing and testing software, storing and archiving large files, analyzing customer or operational data, analyzing data for research and development and for many other business processes.