ECAP470: Cloud Computing

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Learning Outcomes

After this lecture, you will be able to

- ✓ explore cloud computing fundamentals,

- ✓ know about the history of cloud computing,

- ✓ analyse the evolution of cloud computing,

- ✓ learn about the different cloud components.

What is Cloud?

- Cloud refers to a Network or Internet.

- Cloud is something, which is present at a remote location.

- Cloud can provide services over the network, that is, on public networks or on private networks, that is, Wide Area Networks (WANs), Local Area Networks (LANs), or Virtual Private Networks (VPNs).

- Applications such as e-mail, web conferencing, customer relationship management (CRM), all run in the cloud.

Do You Use Cloud?
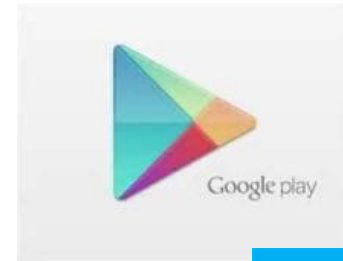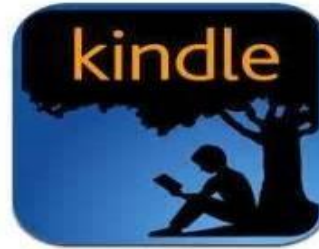
What is Cloud Computing?

- Embarked a revolution in accessing, provisioning and consumption of the information and computing in the ICT industry.

- Novel paradigm of high-performance and large scale computing that actuates relocation of computing and data from desktops and personal computers to big data centers.
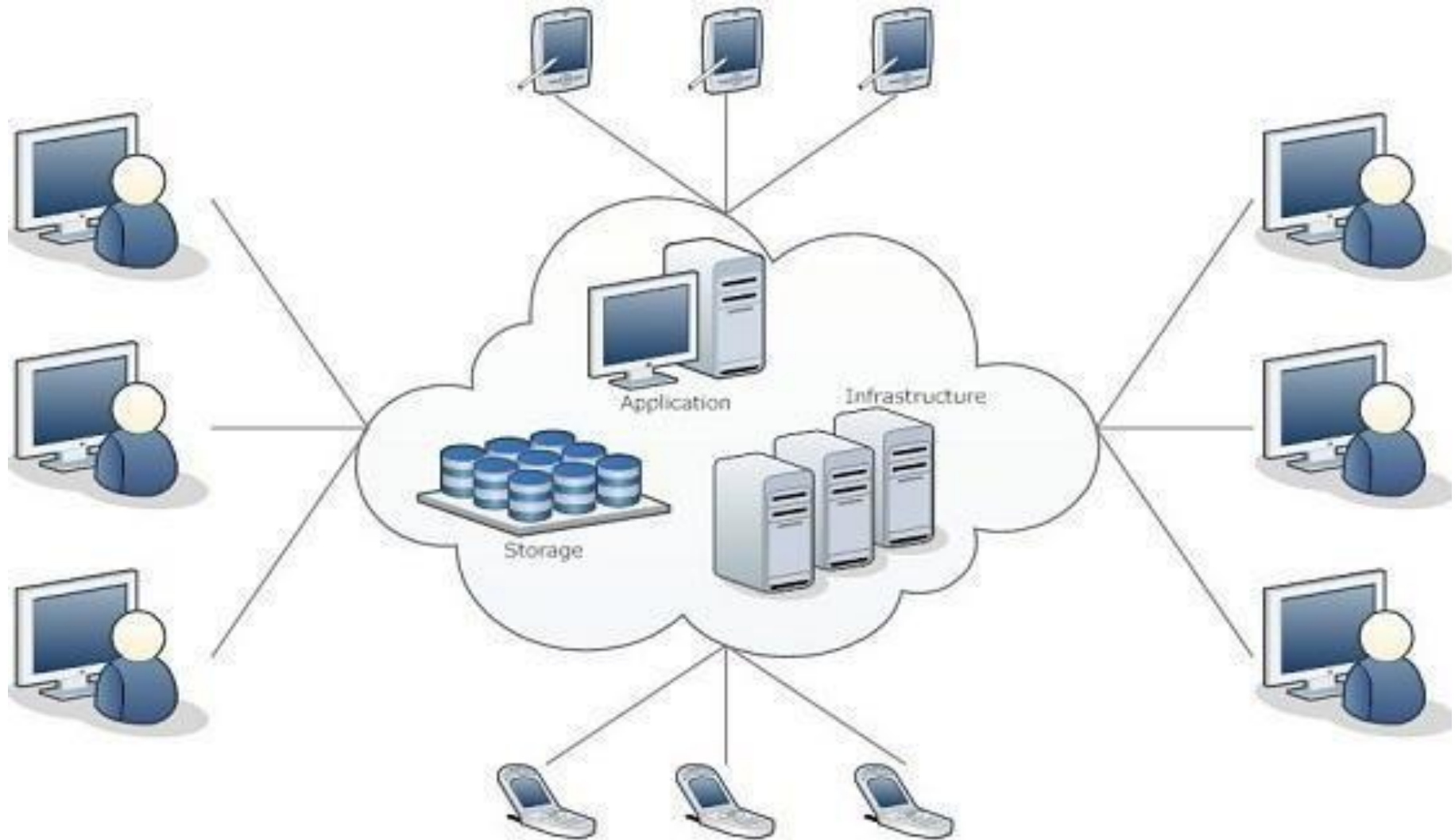
What is Cloud Computing?

- Construct (or an infrastructure that allows to access application that actually resides at a remote location).

- An abstraction (pooling physical resources and presenting them as a virtual resource).

- New model for provisioning resources.

Cloud Computing: Definition as per NIST

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

Cloud Computing Scenario

Detailed Cloud Computing Scenario

SERVICES

APPLICATIONS

COMPUTER NETWORK

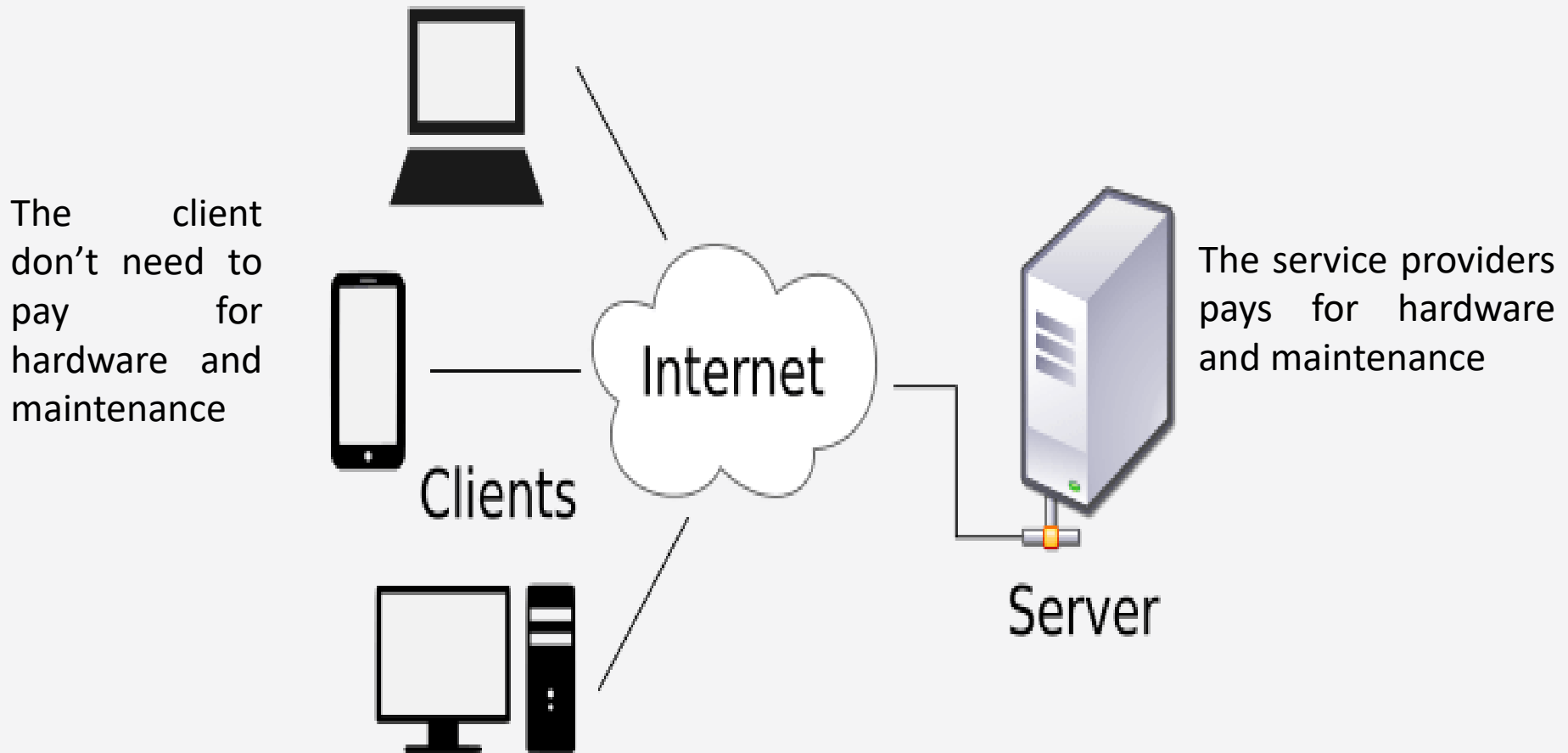STORAGE (DATABASE)

SERVERS
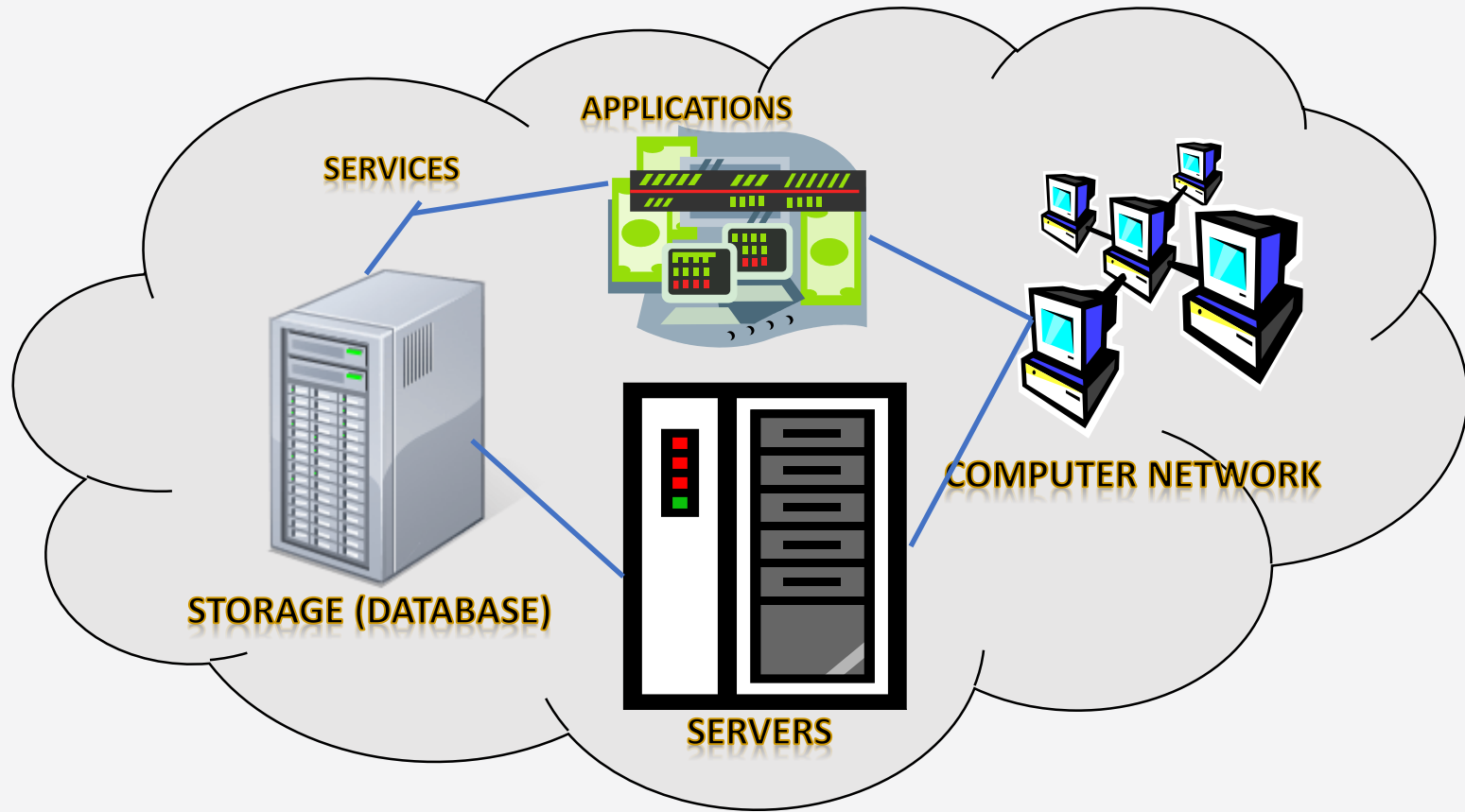
What is Cloud Computing?

- Refers to manipulating, configuring, and accessing the applications online.

- Offers online data storage, infrastructure and application.

- Combination of software and hardware-based computing resources delivered as a network service.

- Example:-

Cloud Scenario

- If some other company hosts your application, that is, they handle the cost of servers, manage the software update.

- Charge the customer as per their utilization, that is, as per the usage you will pay them.

- Reduce the cost of using this software.

- Reduce the cost of installation of heavy servers.

- Reduce the cost of electricity bills.

Cloud Scenario

The client don't need to pay for hardware and maintenance

Clients

Internet

Server

The service providers pays for hardware and maintenance

Cloud Computing Collaboration

- With the growth of the Internet, there was no need to limit group collaboration to a single enterprise's network environment.

- Users from multiple locations within a corporation, and from multiple organizations, desired to collaborate on projects that crossed company and geographic boundaries.

Cloud Computing Collaboration

- Projects have to be housed in the "cloud" of the Internet and accessed from any Internet-enabled location.

- The concept of cloud-based documents and services took wing with the development of large server farms, such as those run by Google and other search companies.

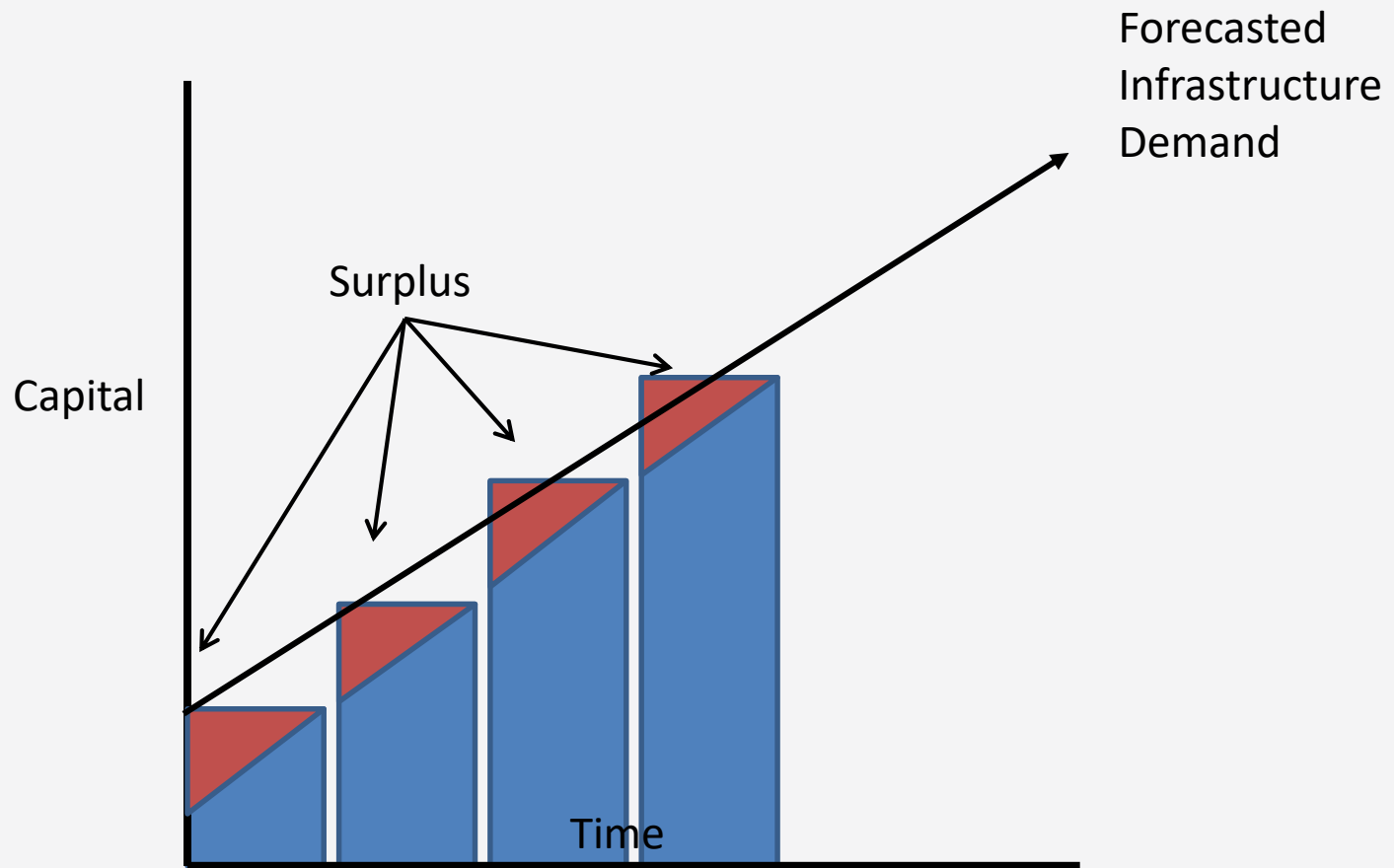- Internet-based group collaboration.

Cloud Properties: Google's Perspective

- Cloud computing is User-centric

- Cloud computing is Task-centric

- Cloud computing is Powerful

- Cloud computing is Accessible

- Cloud computing is Intelligent
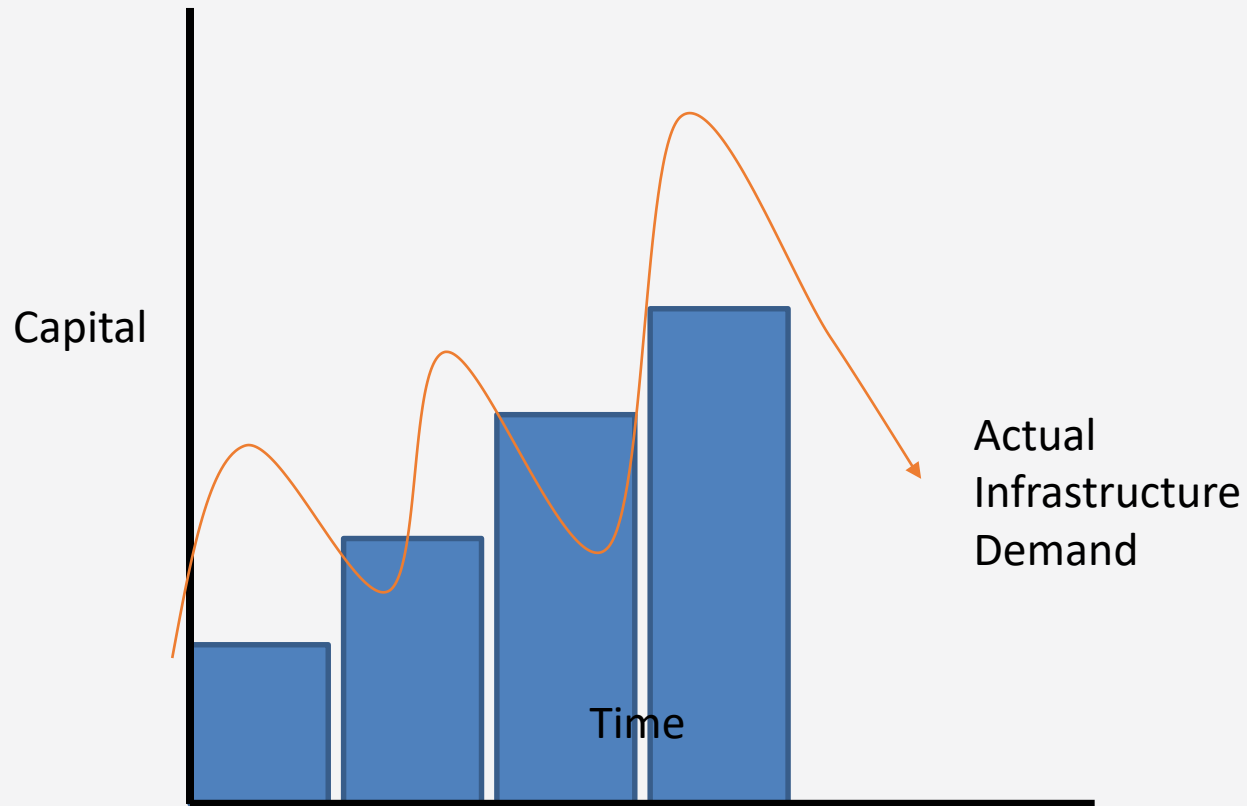
- Cloud computing is Programmable

Traditional Infrastructure Model
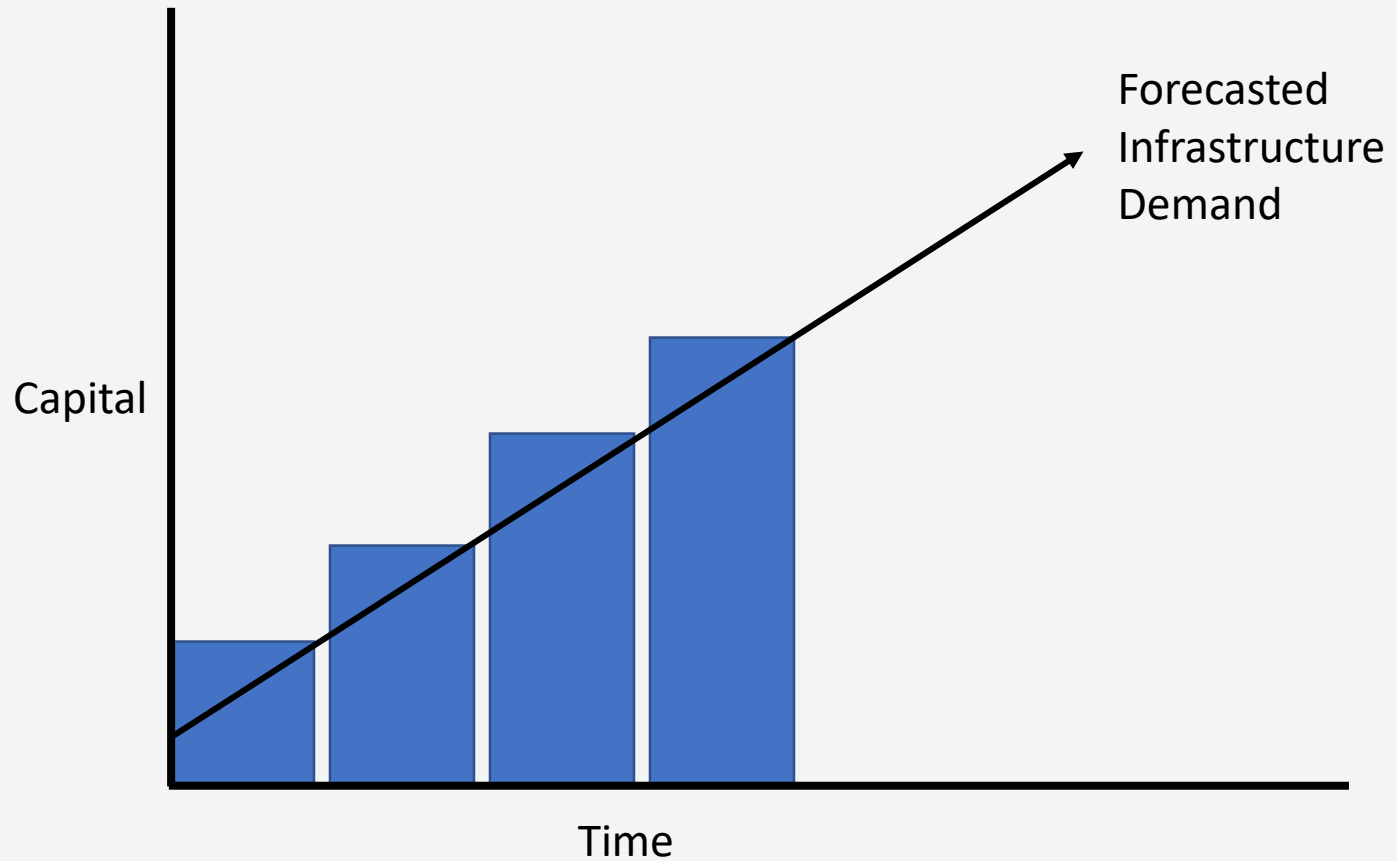
Acceptable Surplus

Actual Demand

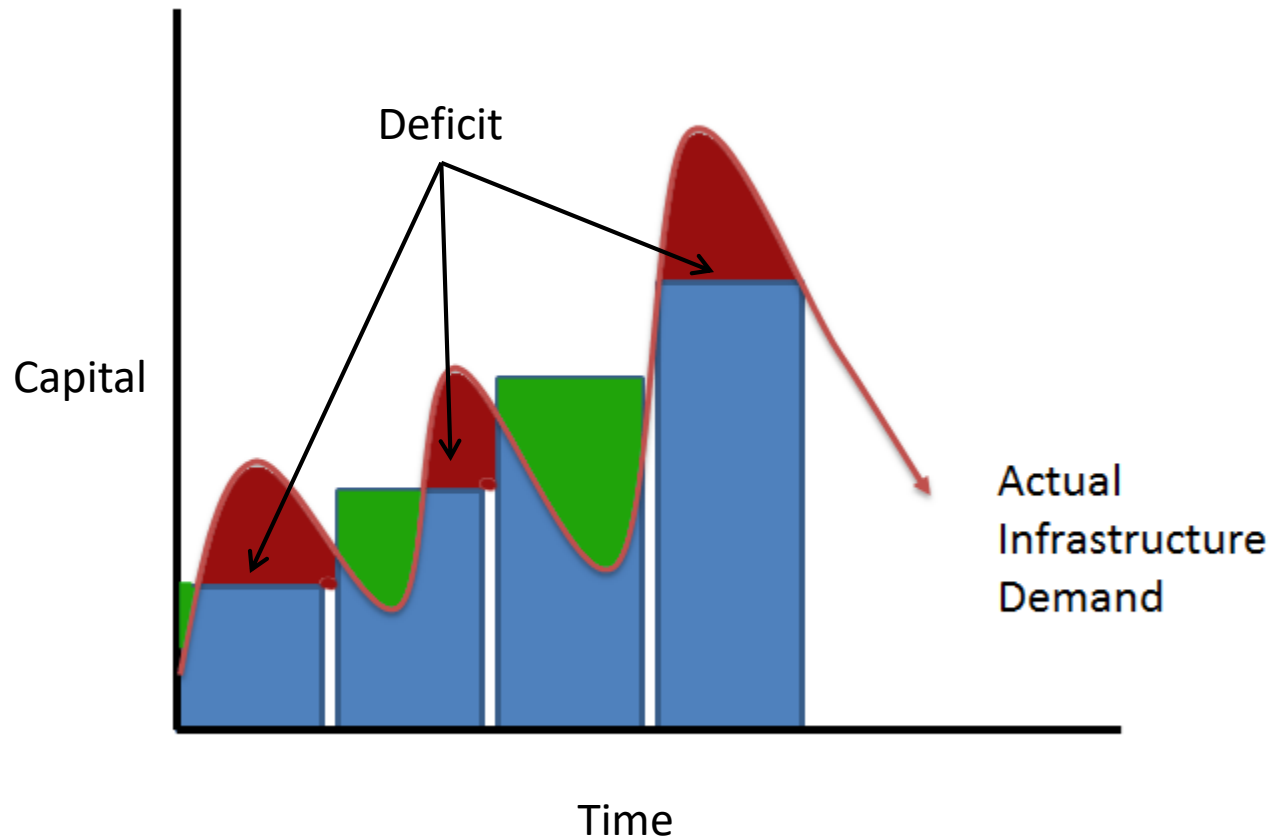# Unacceptable Surplus
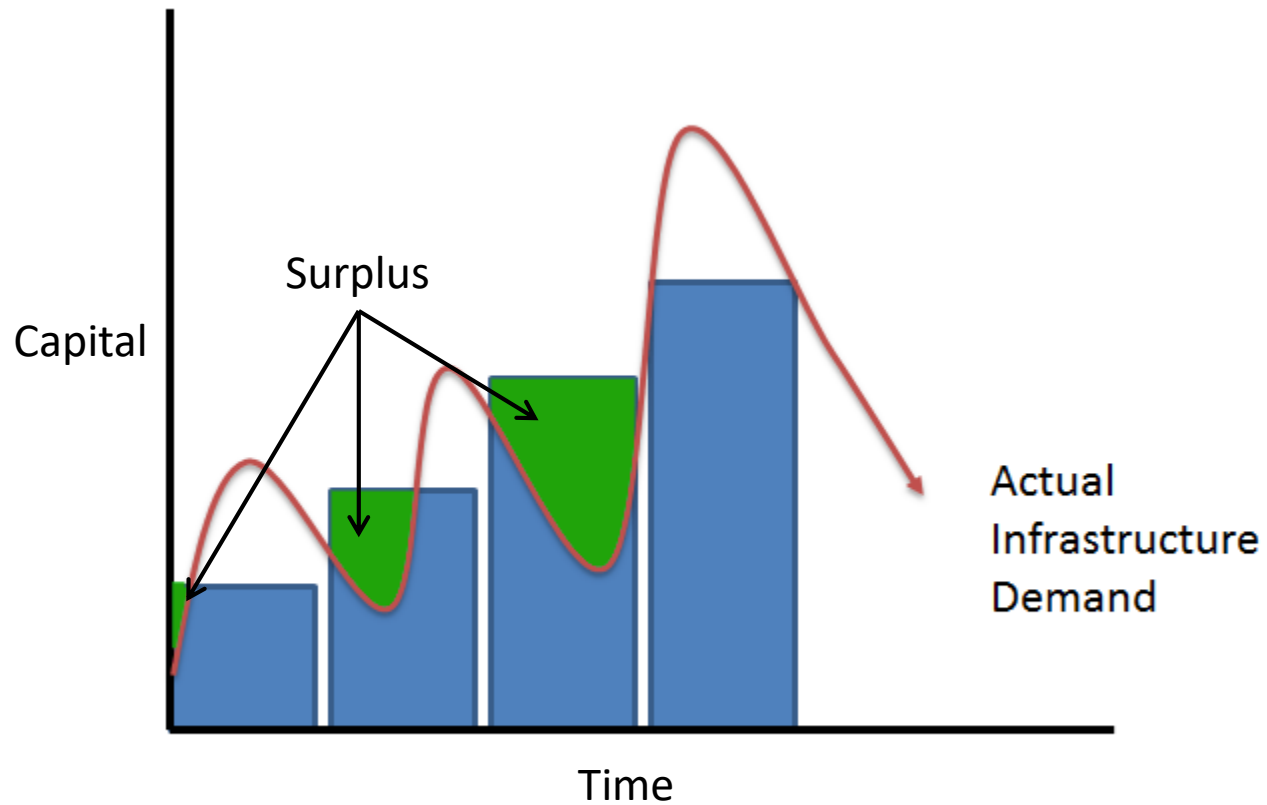
Unacceptable Deficit

History of Cloud Computing

Client-Server Computing

Centralized storage in which all the software applications, all the data and all the controls are resided on the server side.

Distributed Computing

All the computers are networked together and share their resources when needed.

Cloud Computing

Emergence of the concept of cloud computing

History of Cloud Computing

- Cloud Computing was invented in the early 1960s by J.C.R Licklider (Joseph Carl Robnett Licklider).

- During his network research work on ARPANet (Advanced Research Project Agency Network).

- His interest in Information Technology made him appointed as Head of IPTO at ARPA (US Department of Defense Advanced Research Project Agency) in 1962.

History of Cloud Computing

- At around 1961, John MacCharty suggested in a speech at MIT that computing can be sold like a utility, just like water or electricity.

- In 1999, Salesforce.com

- The beauty of the cloud computing phase went on running throughout the era of the 21st Century.

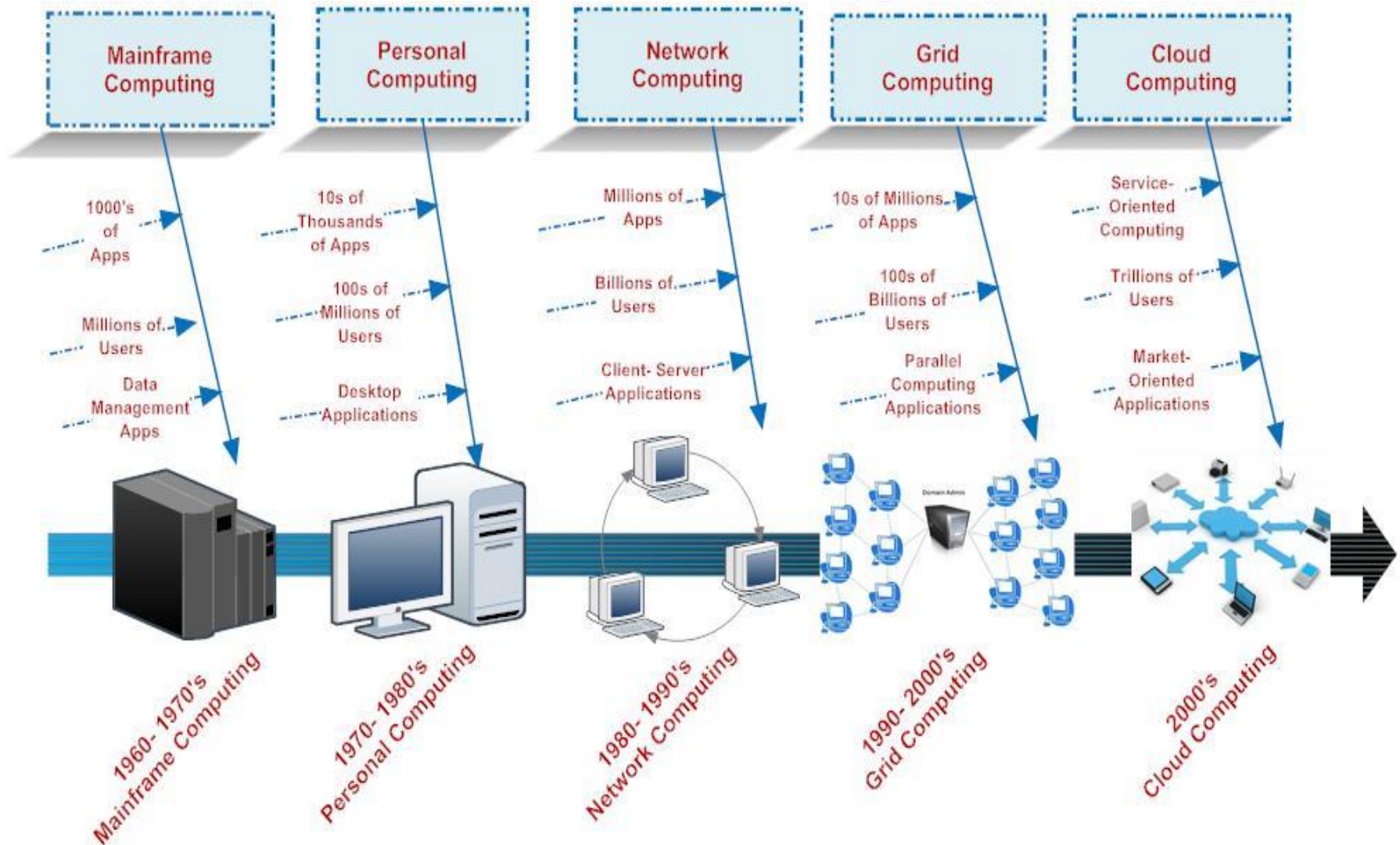# History of Cloud Computing

- In 2002, Amazon started Amazon Web Services.

- By 2008, Google too introduced its beta version of the search engine.

- In 2009, Google Apps

- In the year 2008, Microsoft Azure

- In the year 2012, Google Compute Engine

- By the end of 2013, Oracle Cloud

- Currently, as per the record, Linux and Microsoft Azure share most of their work in parallel.

Evolution of Cloud Computing

- Five intermediary stages, from **mainframe computing** to **personal computing** to the influx of **network computing**.

- Network computing results in **autonomic computing** or follows client-server architectures, resulting in **client-server computing**.

- Development of **grid computing**, followed by the rise of **cloud computing**.

Evolution of Cloud Computing

Mainframe Computing	Personal Computing	Network Computing	Grid Computing	Cloud Computing
1000's of Apps	10s of Thousands of Apps	Millions of Apps	10s of Millions of Apps	Service-Oriented Computing
Millions of Users	100s of Millions of Users	Billions of Users	100s of Billions of Users	Trillions of Users
Data Management Apps	Desktop Applications	Client-Server Applications	Parallel Computing Applications	Market-Oriented Applications

1960-1970's Mainframe Computing

1970-1980's Personal Computing

1980-1990's Network Computing

1990-2000's Grid Computing

2000's Cloud Computing

Evolution of Cloud Computing

Client/Server Computing

A system comprised of a centralized (hub) computer that is connected to less powerful computers or workstations (clients). The clients can access data, content and programs via the hub. As a security model, it ensures policy compliance.

Grid Computing

A network, or grid, of connected computing devices that share resources to create a supercomputer enabling large tasks, such as analysis of big data sets, to be divided among the networked computers and processed in parallel to reduce computation time.

Evolution of Cloud Computing

Peer-to-Peer Computing

Enables two computer systems to communicate directly with their counterpart (peer) without having to connect to a central server. Peer environments, in contrast to client/server approaches, share resources and are consumers and suppliers.

Utility Computing

Introduced the pay-as-you-use concept of computing services. Users pay for the services they use rather than a flat access rate. Computing resources are provided as users need them, making this approach more cost effective and efficient.

Essential Cloud Computing Concepts

"Cloud" makes reference to the two essential concepts:

1. Abstraction

2. Virtualization

Who Benefits from Cloud Computing?

- Collaborators

- Road Warriors

- Cost-Conscious Users

- Cost-Conscious IT Departments

- Users with Increasing Needs

Advantages of Cloud Computing

1. Cost Efficiency

2. High Speed

3. Excellent Accessibility

4. Back-up and Restore data

5. Manageability
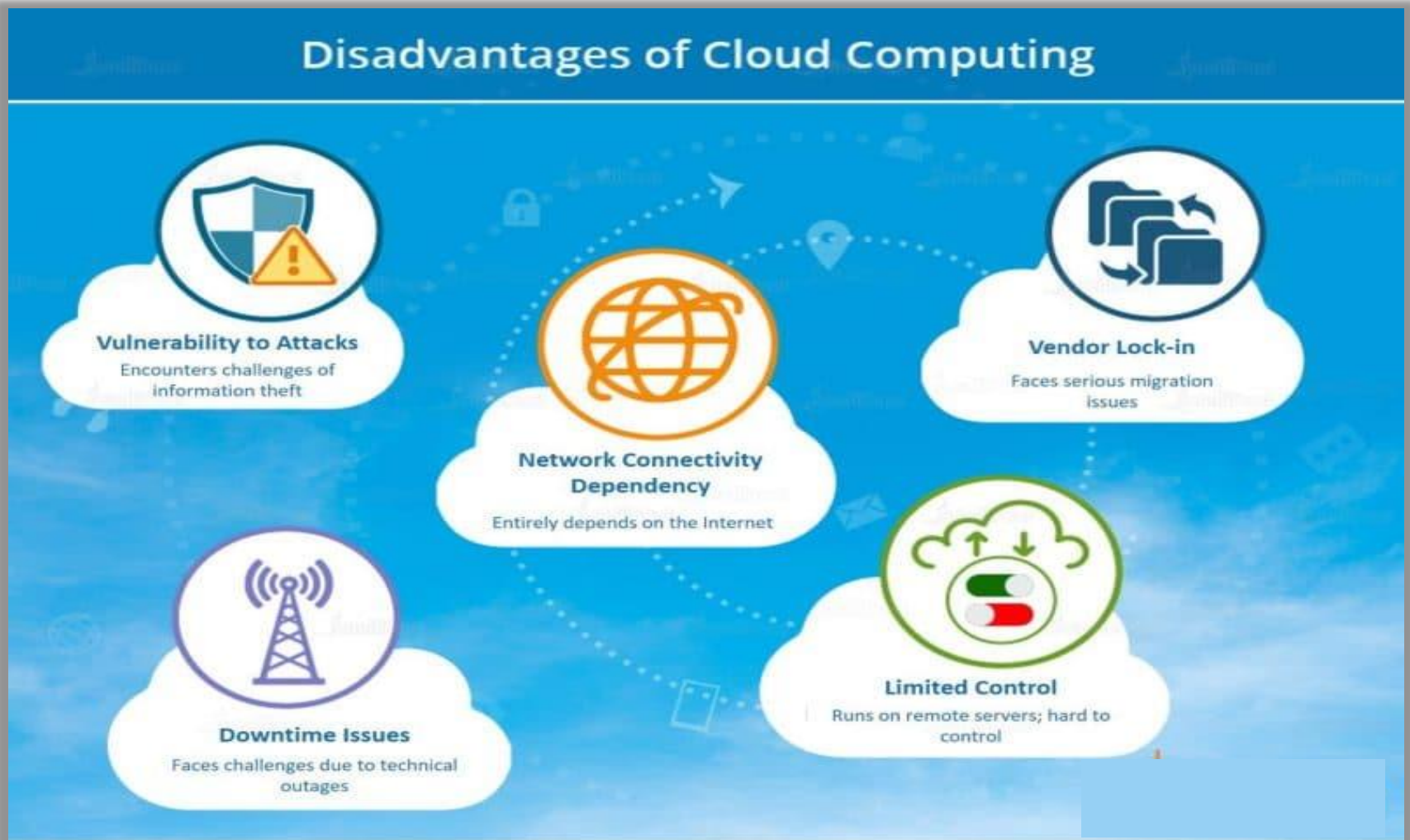
6. Sporadic Batch Processing

7. Strategic Edge

Summarization of Cloud Computing Advantages
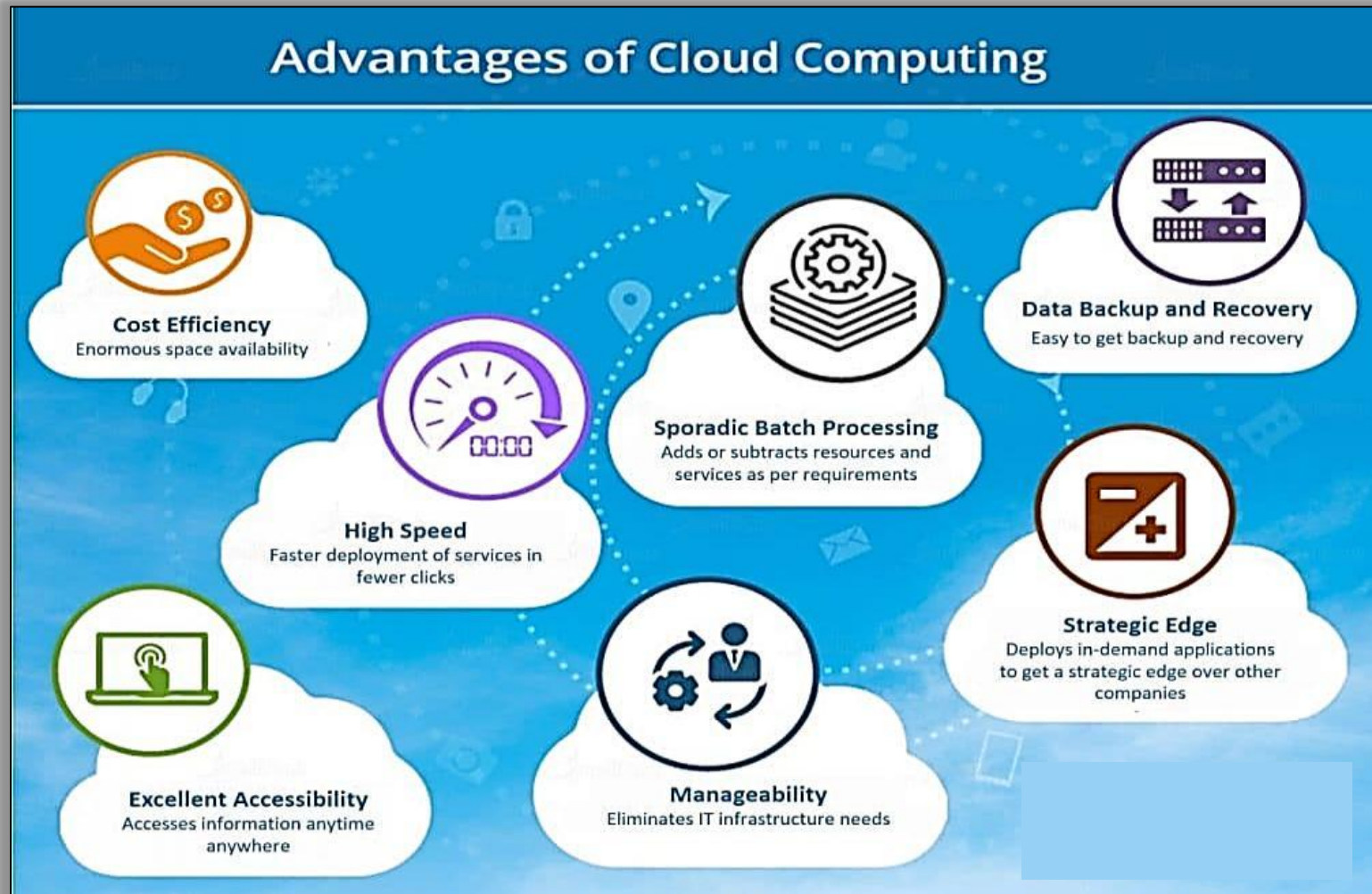
Disadvantages of Cloud Computing

1. Vulnerability to Attacks

2. Network Connectivity Dependency

3. Downtime

4. Vendor Lock-In

5. Limited Control

Summarization of Cloud Computing Disadvantages

Disadvantages of Cloud Computing

Vulnerability to Attacks
Encounters challenges of information theft

Network Connectivity Dependency
Entirely depends on the Internet

Vendor Lock-in
Faces serious migration issues

Downtime Issues
Faces challenges due to technical outages

Limited Control
Runs on remote servers; hard to control

Components of Cloud Computing

Cloud computing solution is made up of several elements and these elements make up the three components of a cloud computing solution.

- clients

- the data center, and

- distributed servers
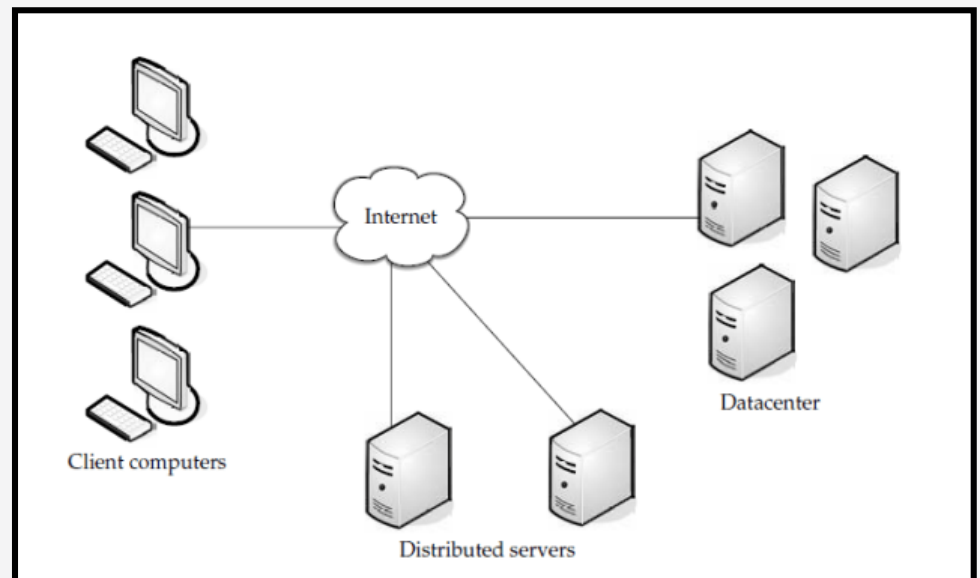
Clients

1. Devices that end users interact with to manage their information on cloud.

    - Mobile Clients

    - Thin Clients

    - Thick Clients

2. Thin Clients vs Thick Clients

3. Advantages of Thin Clients

Datacenter

- **Collection of servers** where the application to which you subscribe is housed.

- **A large room in the basement** of your building or a room full of servers on the other side of the world that you can access via the Internet.

- A growing trend in the IT world is **virtualizing servers.**

Distributed Servers

Servers are in **Geographically Disparate Locations.**

Other Components of Cloud Computing

Cloud Services

- Example:

    - Identity – OpenID, OAuth, etc

    - Integration – Amazon Simple Queue Service

    - Payments – PayPal, Google Checkout

    - Mapping – Google Maps, Yahoo! Maps

Other Components of Cloud Computing

Cloud Applications

- Example:

  - Peer-to-peer – BitTorrent, SETI, and others

  - Web Application – Facebook

  - SaaS – Google Apps, SalesForce.com, and others

Other Components of Cloud Computing

Cloud Platform

- Example:

  - Web Application Frameworks – Python Django, Rubyon Rails, .NET

  - Web Hosting

  - Propietary– Force.com

Other Components of Cloud Computing

Cloud Storage

- Example:

    - Database – Google Big Table, Amazon SimpleDB.

    - Network Attached Storage – Nirvanix CloudNAS, MobileMe iDisk.

Other Components of Cloud Computing

Cloud Infrastructure

- Example:

  - Grid Computing – Sun Grid.

  - Full Virtualization – GoGrid, Skytap.

  - Compute – Amazon Elastic Compute Cloud