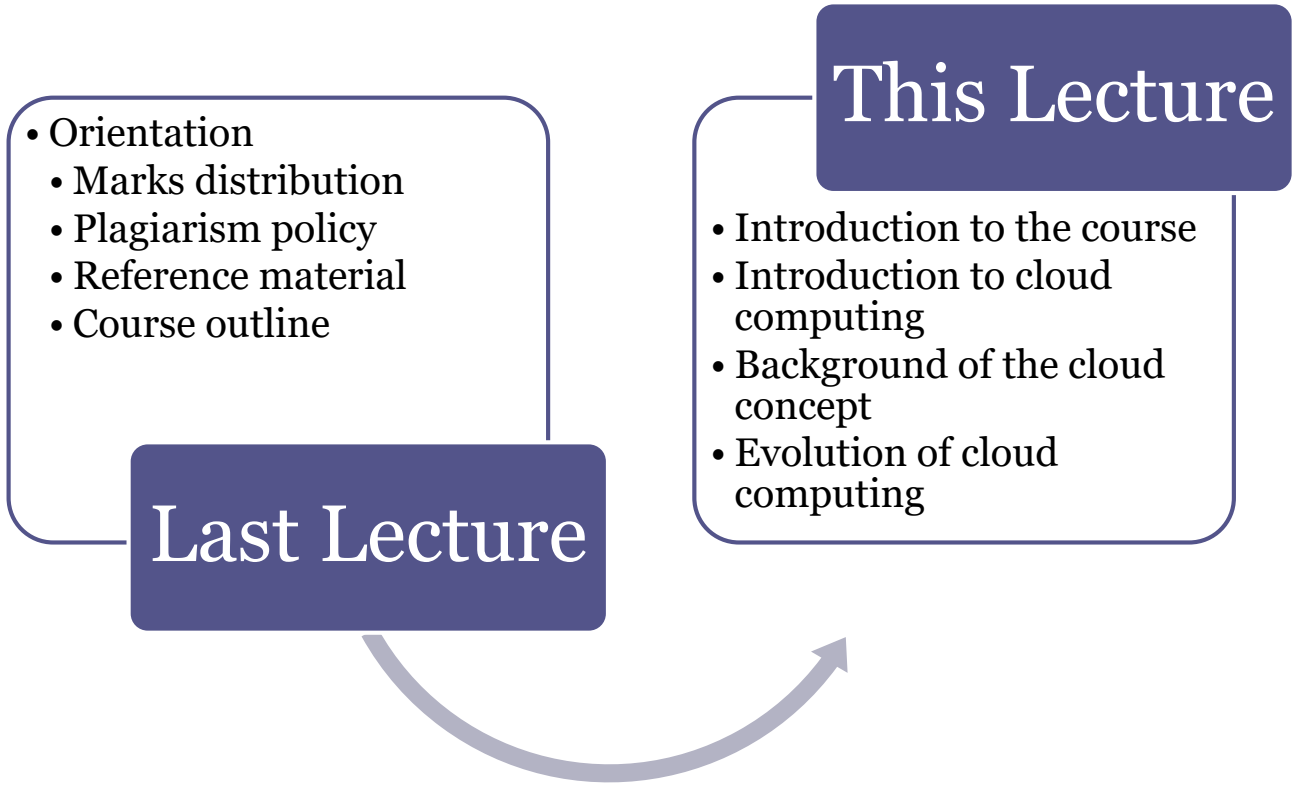
BSE-3502
Cloud Computing
Lecture 01

Department of Software Engineering
Mirpur University of Science and Technology (MUST)

Lecture 01
Introduction: What, Why, How, Where



FAQs about Cloud Computing

- **What is cloud computing?**
- **Why is cloud computing significant?**
- **How does cloud computing work?**
- **What are the advantages of Cloud Computing?**
- **What are the downsides of cloud computing?**

WHAT

What is cloud computing?

- Storing information on the cloud has significant advantages.
- Content previously confined to personal devices such as workstations, laptops, tablets, and smart phones need no longer be stored locally. Data stored on computer clouds can be shared among all these devices and it is accessible whenever a device is connected to the Internet.
- For example, in 2011 Apple announced the iCloud, a network-centric alternative for content including music, videos, movies, and personal information. In February 2017 iCloud had 782 million subscribers according to http://appleinsider.com/.

What is cloud computing?

- The Fifth Generation of Computing (after Mainframe, Personal Computer, Client-Server Computing, and the web)
- Conceptually, computing can be viewed as another utility, like electricity, water, or gas, and computer clouds are the utilities providing computing services.
- In utility computing the hardware and the software resources are concentrated in large data centers. The users of computing services pay as they consume computing, storage, and communication resources.
- The cloud computing movement is motivated by the idea that data processing and storage can be done more efficiently on large farms of computing and storage systems accessible via the Internet.
- Computer clouds support a paradigm shift from local to network-centric computing and network-centric content where distant data centers provide the computing and storage resources.
- In this new paradigm users hand over control of their data and code to Cloud Service Providers.

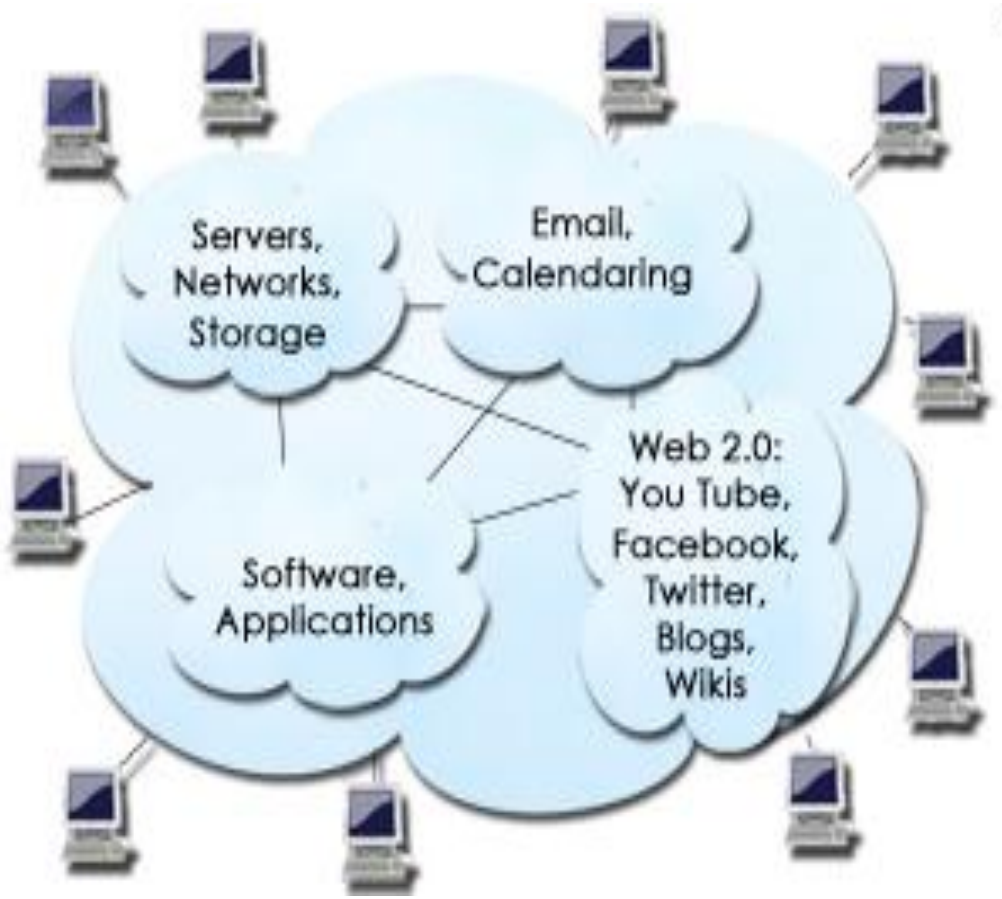
What is cloud computing?

- In 2011, NIST, the US National Institute of Standards and Technology, defined cloud computing as
  - **"a model for enabling ubiquitous, 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?

--Wikipedia Definition

"**Cloud computing** is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand through the Internet"



What is cloud computing?

"**Cloud Computing**," to put it simply, means "Internet Computing".
The Internet is commonly visualized as clouds; hence the term "cloud computing" for computation done through the Internet.

- With Cloud Computing users can access database resources
  - via the Internet from anywhere,
  - for as long as they need,
  - without worrying about any maintenance or management of actual resources.

http://dotnetslackers.com/articles/sql/Introduction-to-Cloud-Computing.aspx

What is cloud computing?

Cloud computing is characterized by five attributes:

- on-demand self-service,
- broad network access,
- resource pooling,
- rapid elasticity, and
- measured service.

WHY

Why is cloud computing significant?

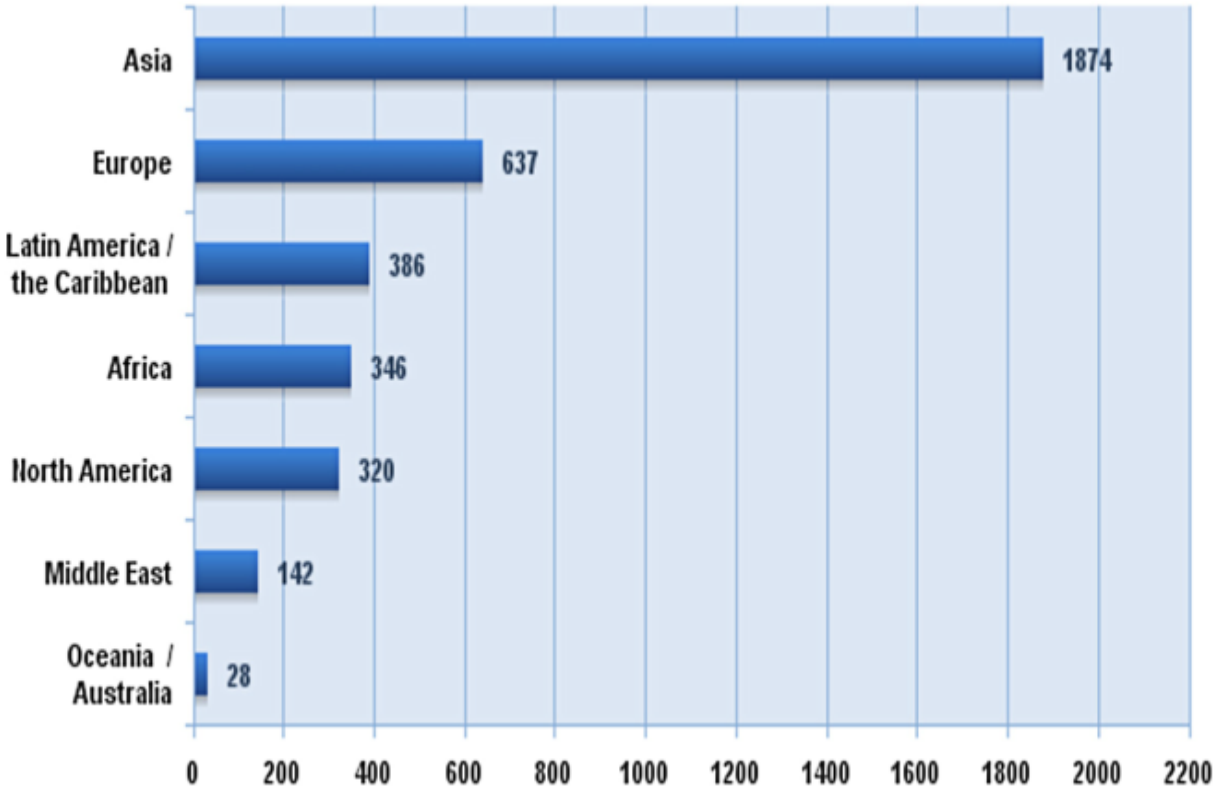
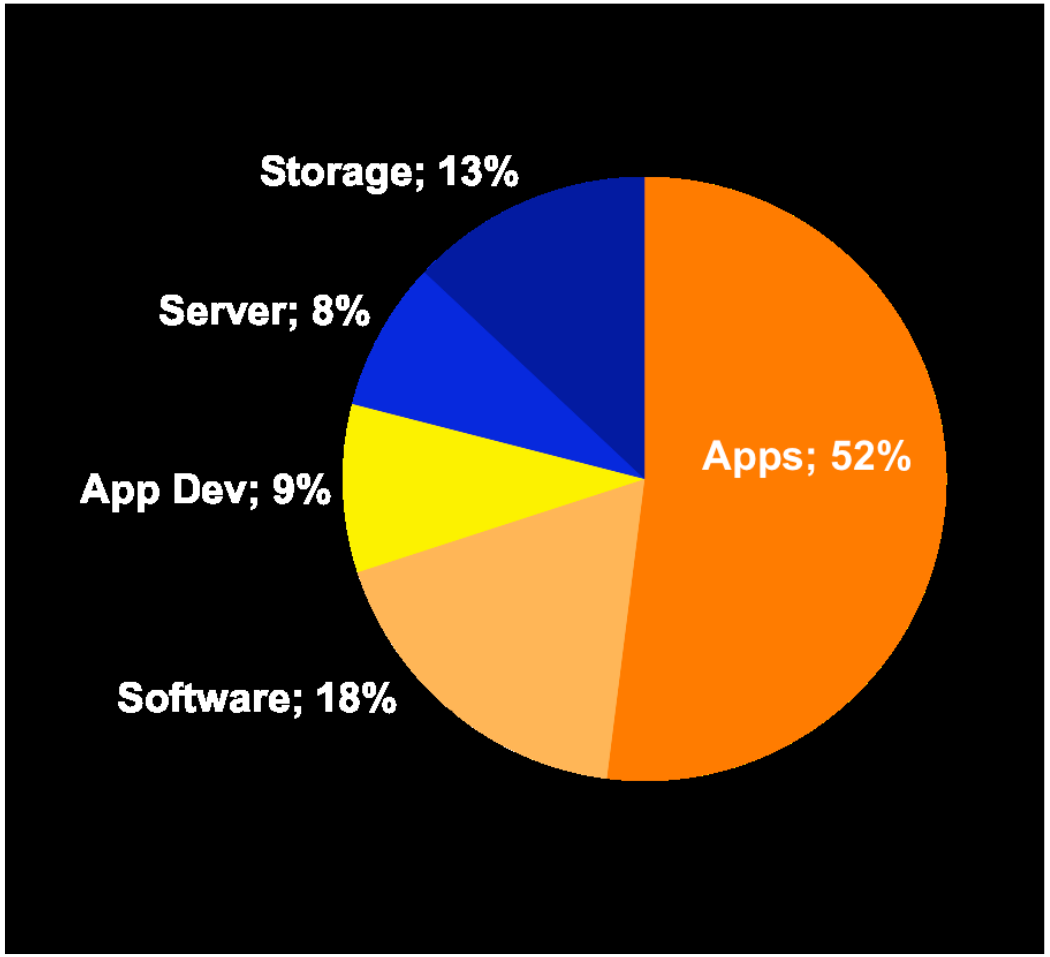


FIGURE 1.1

The number of Internet users in different regions of the world as of March 25, 2017 (in millions), according to http://www.internetworldstats.com/stats.htm.

- The number of Internet users has increased tenfold from 1999 to 2013; the first billion was reached in 2005, the second in 2010, and the third in 2014. This number is even larger now, see Figure 1.1.
- Many Internet users have discovered the appeal of cloud computing either directly or indirectly through a variety of services, without knowing the role the clouds play in their life.
- In the years to come the vast computational resources provided by the cloud infrastructure will be used for the design and engineering of complex systems, scientific discovery, education, business, analytics, art, and virtually all other aspects of human endeavor.
- Exabytes of data stored in the clouds are streamed, downloaded, and accessed by millions of cloud users.

Why is cloud computing significant?



Source: IDC October 2008

Worldwide IT Cloud Spending 2012

Forrester Research, October 13, 2009 :

"……that cloud computing is one of the Top 15 Technology Trends and that it warrants investment now so you can gain the experience necessary to take advantage of it in its many forms to transform your organization into a more efficient and responsive service provider to the business."

Cloud Computing is considered the **fifth generation of computing**
(after Mainframe, Personal Computer, Client-Server, and Web Computing).

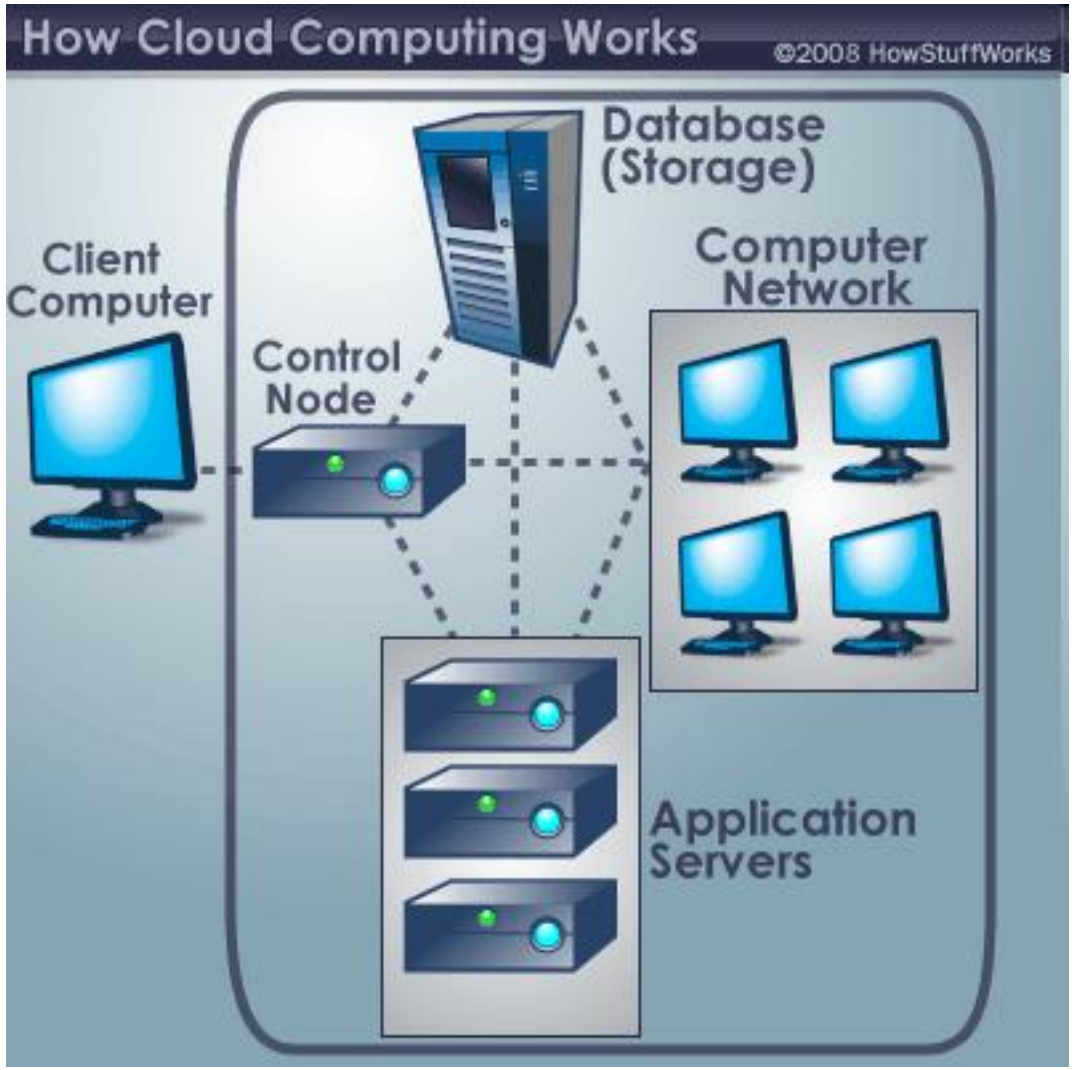
HOW

The Evolution of Cloud Computing

- Cloud computing era started in 2006 when Amazon offered the Elastic Cloud Computing (EC2) and the Simple Storage Service (S3), the first services provided by Amazon Web Services (AWS).
- Five years later, in 2012, EC2 was used by businesses in 200 countries.
- S3 has surpassed two trillion objects and routinely runs more than 1.1 million peak requests per second.
- The Elastic MapReduce has launched 5.5 million clusters since the start of the service in May 2010 (ZDNet 2013).
- The range of services offered by Cloud Service Providers (CSPs), and the number of cloud users have increased dramatically during the last few years.

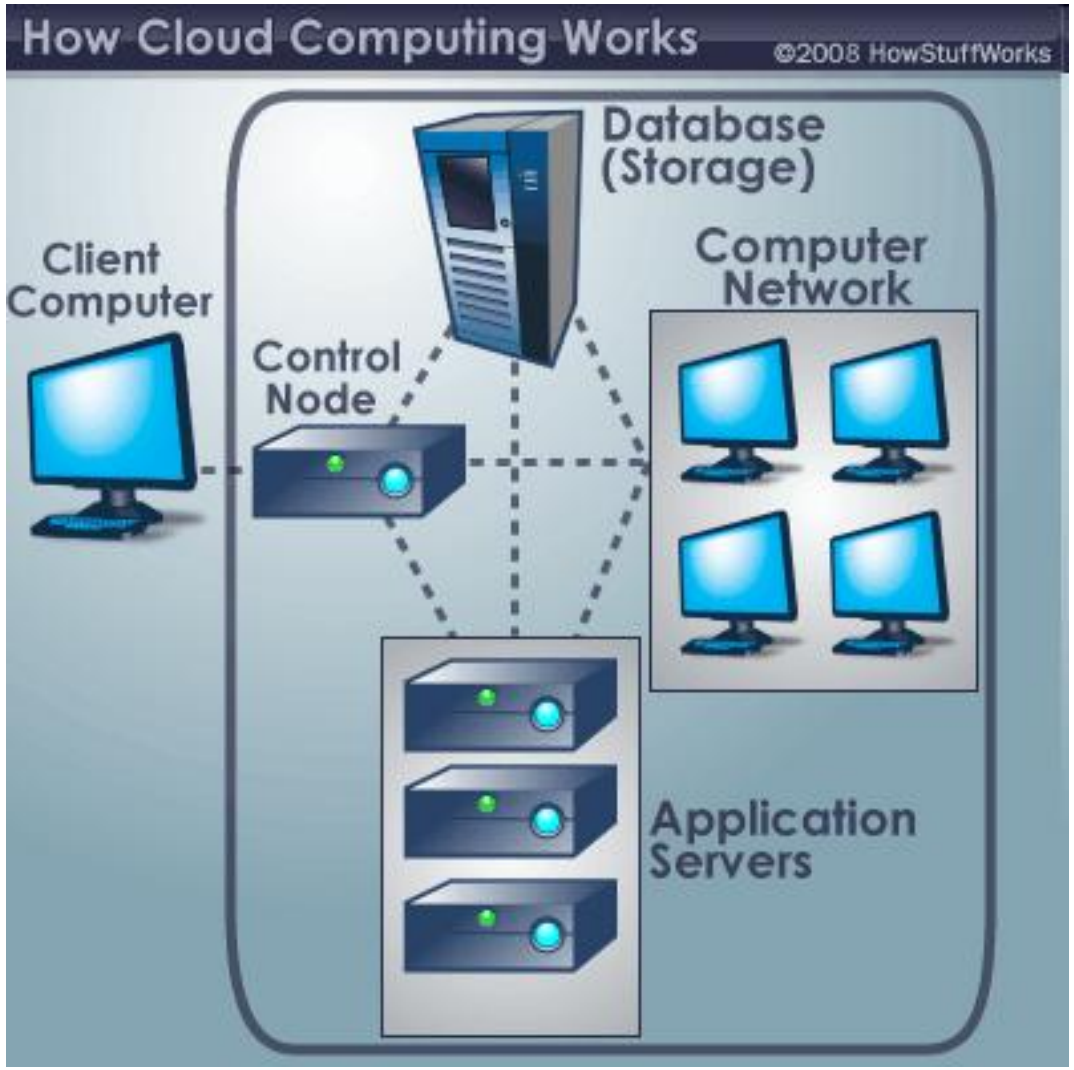
How cloud computing works?

- **Cloud computing** is a **disruptive paradigm** in the field of computing, which has brought **major transformations** in several areas of **computer science** and **computer engineering**.
- These areas include:
- **Data storage**
- **Computer architecture**
- **Networking**
- **Resource management**
- **Scheduling**
- And most importantly, **computer security**



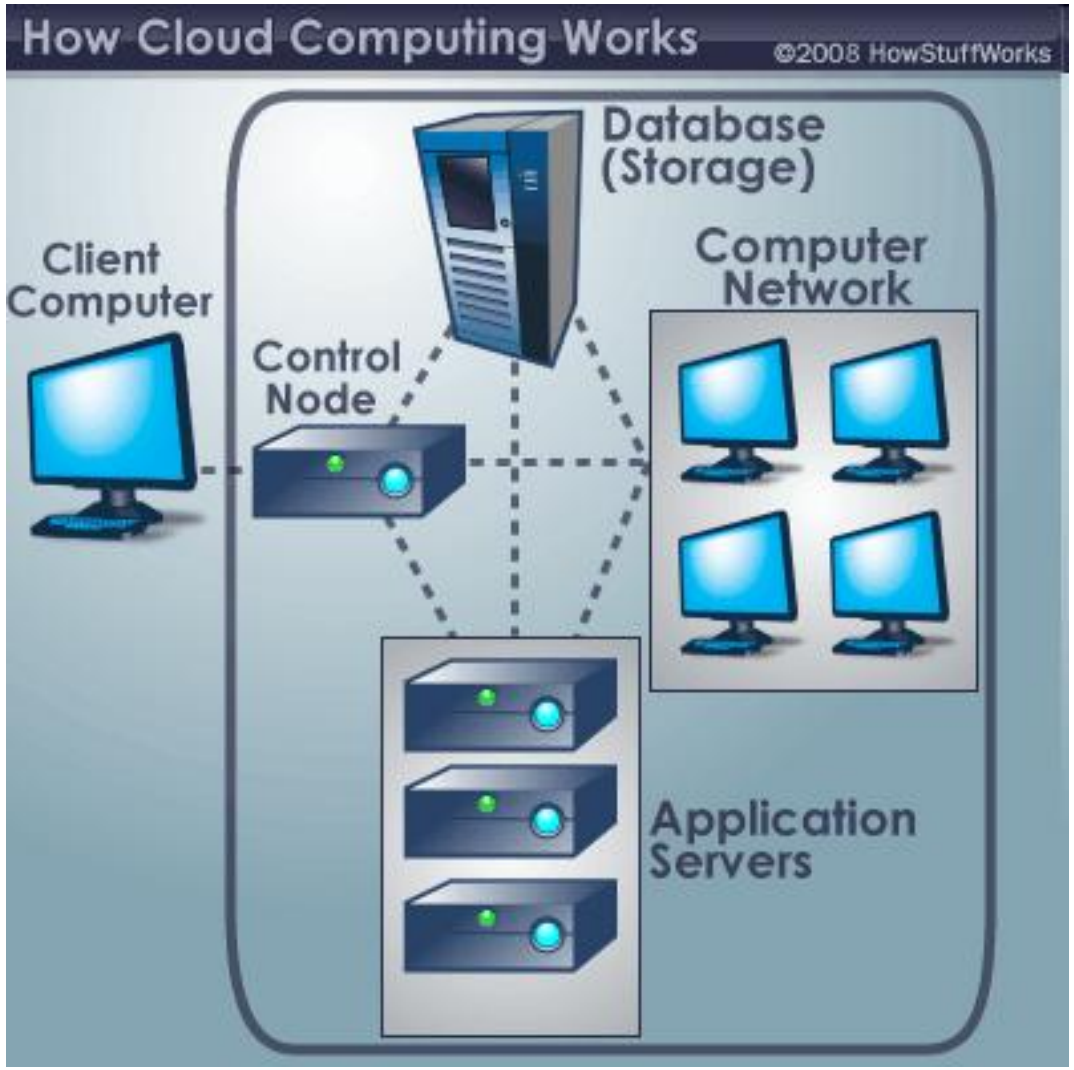
How cloud computing works?

- **Role of the Internet**
- The **Internet** made cloud computing possible.
  Without **high-speed communication networks**, we could never have imagined using computing and storage resources from distant **data centers**.
- Therefore, the **evolution of cloud computing** is deeply connected to the **future of the Internet**.

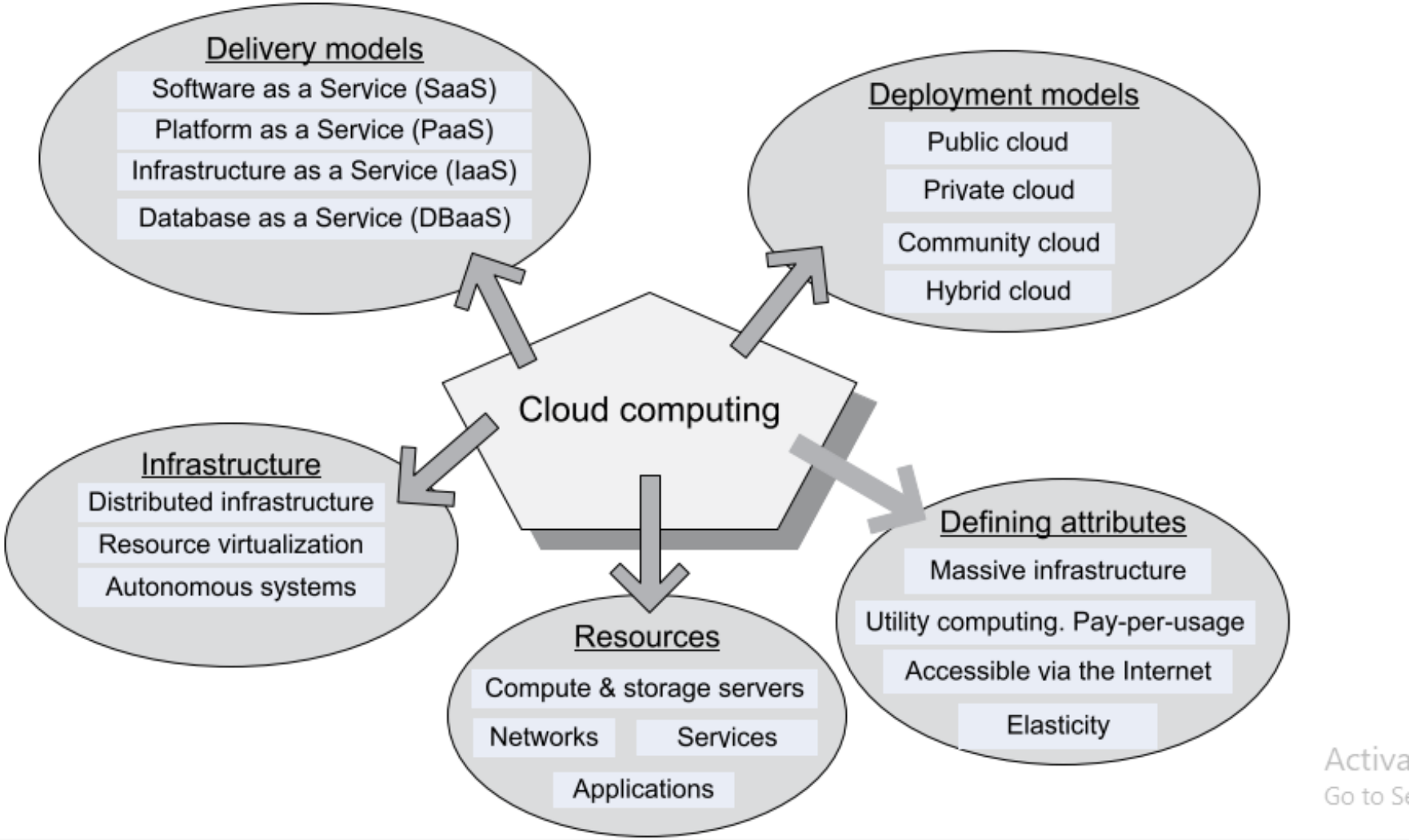


How cloud computing works?

- he **Internet of Things (IoT)** has already started integrating with **cloud computing**.
  For example, **Amazon** offers services such as **AWS Lambda** and **Amazon Kinesis**,
  which enable **real-time data processing** and **event-driven computing**..



Cloud delivery models and defining attributes



Cloud delivery models and defining attributes

The cloud delivery models, SaaS, PaaS, IaaS, and DBaaS can be deployed as public, private, community, and hybrid clouds:

- **Private Cloud** – the infrastructure is operated solely for an organization; It may be managed by the organization or a third party and may exist on or off the premises of the organization.
- **Community Cloud** – the infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premises or off premises.
- **Public Cloud** – the infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
- **Hybrid Cloud** – the infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

Cloud delivery models and defining attributes

The defining attributes of the new philosophy for delivering computing services are:

- Cloud computing uses Internet technologies to offer elastic services. The term "elastic computing" refers to the ability of dynamically acquiring computing resources and supporting a variable workload. A cloud service provider maintains a massive infrastructure to support elastic services.
- The resources used for these services can be metered and the users can be charged only for the resources they used.
- The maintenance and security are ensured by service providers.
- Economy of scale allows service providers to operate more efficiently due to specialization and centralization.
- Cloud computing is cost-effective due to resource multiplexing; lower costs for the service provider are passed on to the cloud users.
- The application data is stored closer to the site where it is used in a device and location-independent manner; potentially, this data storage strategy increases reliability and security and, at the same time, it lowers communication costs.

What are the advantages of Cloud Computing?

A non-exhaustive list of reasons for the success of cloud computing includes:

- Organizations using computer clouds are relieved of supporting large IT teams, acquiring and maintaining costly hardware and software, and paying large electricity bills.
- Cloud computing is focused on enterprise computing, its adoption by industrial organizations, financial institutions, healthcare organizations and so on, has a potentially huge impact on the economy.
- A cloud provides the illusion of infinite computing resources; its elasticity frees the applications designers from the confinement of a single system.
- A cloud eliminates the need for up-front financial commitment, and it is based on a pay-as-you-go approach; this has the potential to attract new applications and new users for existing applications generating a new era of industry-wide technological advancements.

Ethical Issues In Cloud Computing

Cloud computing is based on a paradigm shift with profound implications on computing ethics. The main elements of this shift are:

1. The control is relinquished to third party services.
2. The data is stored on multiple sites administered by several organizations.
3. Multiple services interoperate across the network.

Unauthorized access, data corruption, infrastructure failure, and service unavailability are some of the risks related to relinquishing the control to third party services; moreover, whenever a problem occurs it is difficult to identify the source and the entity causing it. Systems can span the boundaries of multiple organizations and cross the security borders, a process called de-perimeterisation.

Class Activity

- **Write down a few examples of each type of cloud (**public, private, community, and hybrid**).**