



Cloud Computing



- **What is cloud computing?**
- **How does cloud computing work?**
- **Why is cloud computing significant?**
- **What are the downsides of cloud computing?**
- **Where is cloud computing going?**
- **What are the implications of cloud computing for higher education?**
- **Questions?**

• What is cloud computing?





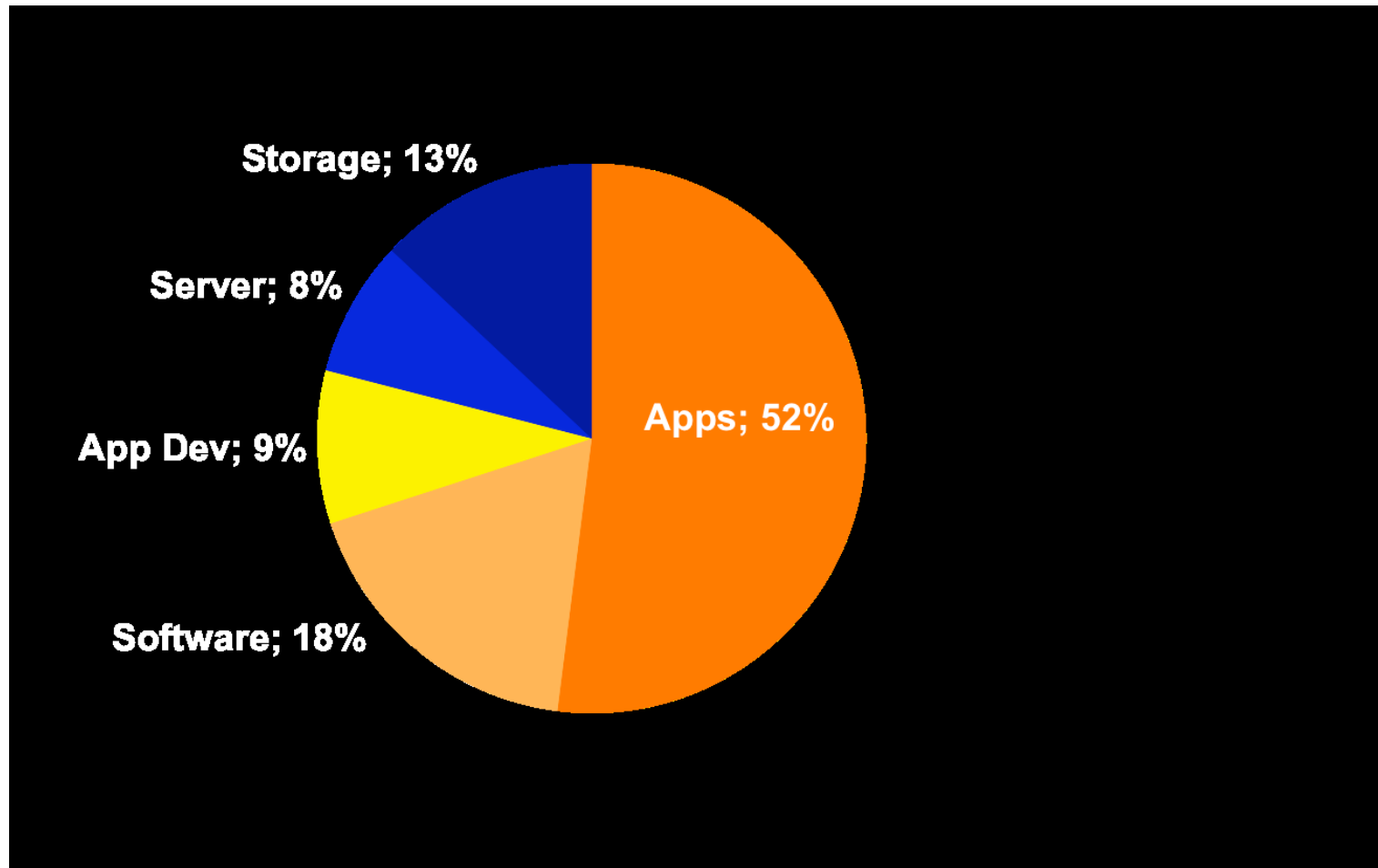
What is Cloud Computing ?

- the Fifth Generation of Computing**

**(after Mainframe, Personal Computer,
Client-Server Computing, and the web)**

- the biggest thing since the web?**

Worldwide IT Cloud Spending 2012



Source: IDC October 2008

Engr. Afzal Ahmed

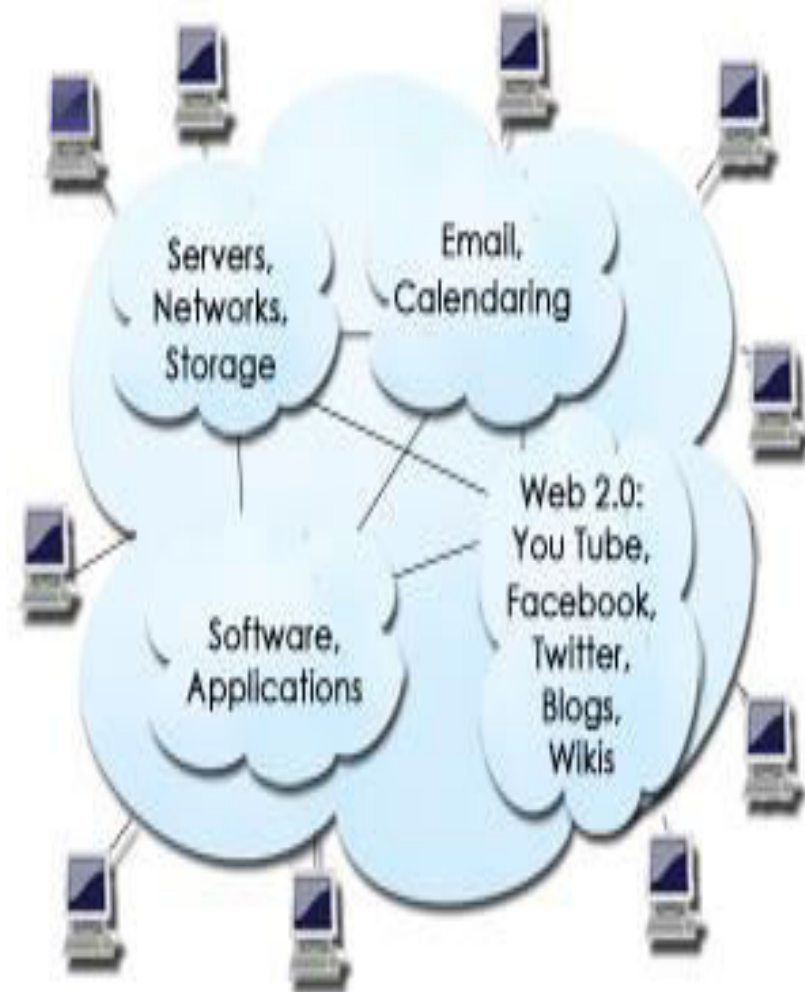
- Forrester Research, October 13, 2009 :

*“.....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.**”*

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.

Besides, databases in cloud are very dynamic and scalable.

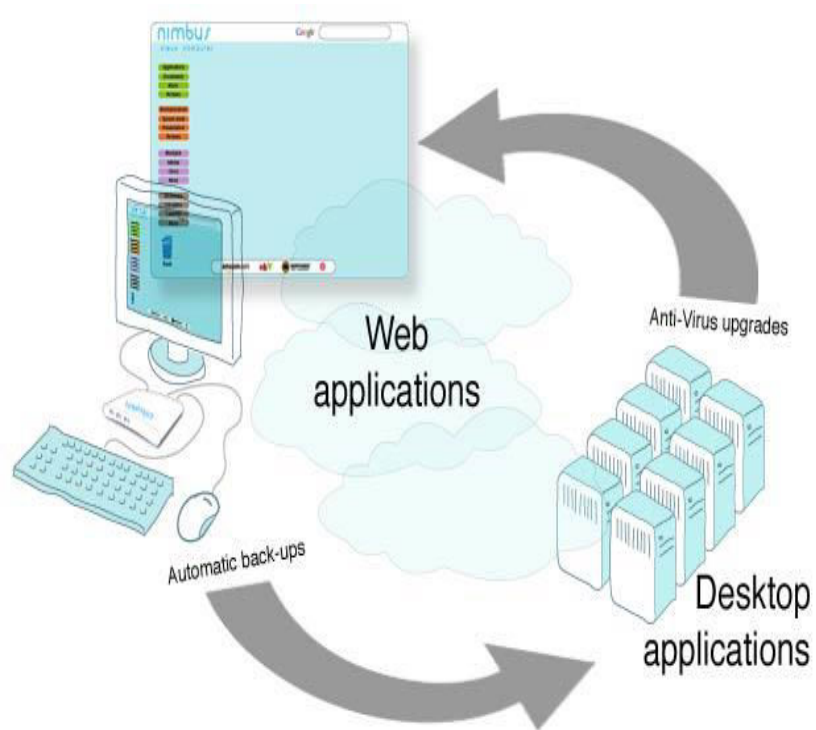
The best example of cloud computing is Google Apps where any application can be accessed using a browser and it can be deployed on thousands of computer through the Internet.

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

What is cloud computing?

--Some more serious definitions

“... means using **Web services** for our computing needs which could include using software applications, storing data, accessing computing power, or using a platform to build applications.”



What is cloud computing?

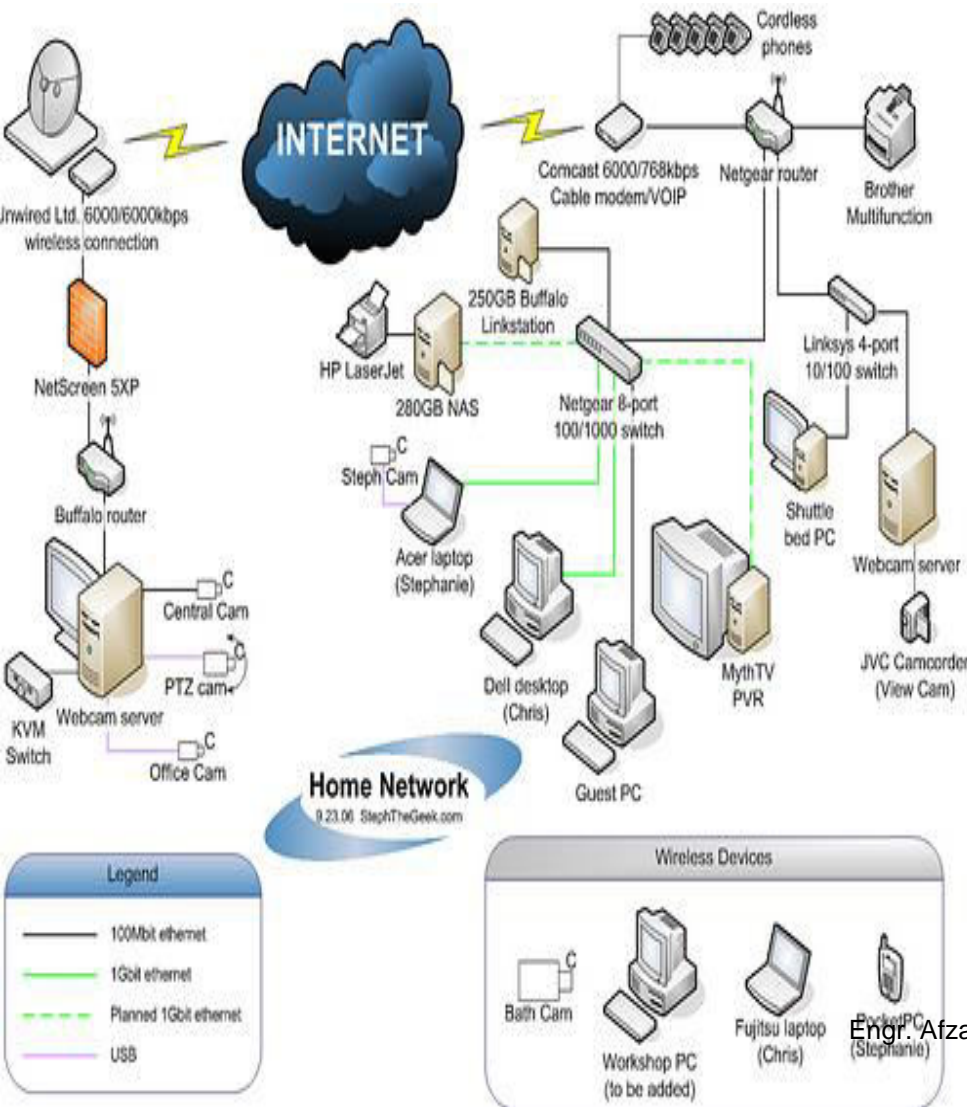
--Some more serious definitions

- **Cloud computing** is a general term for anything that involves delivering hosted services over the Internet.
- These services are broadly divided into three categories:
 - **Infrastructure-as-a-Service** ([IaaS](#)),
 - **Platform-as-a-Service** ([PaaS](#)) and
 - **Software-as-a-Service** ([SaaS](#)).



What is cloud computing?

--Some more serious definitions



McKinsey:

“Clouds are hardware-based services offering compute, network and storage capacity where:

Hardware management is highly *abstracted* from the buyer, Buyers incur infrastructure costs as variable OPEX (operational expenditure), and

Infrastructure capacity is highly *elastic*”

What is cloud computing?

--Some more serious definitions

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

Source: *National Institute of Standards and Technology*
(NIST)



What is cloud computing?

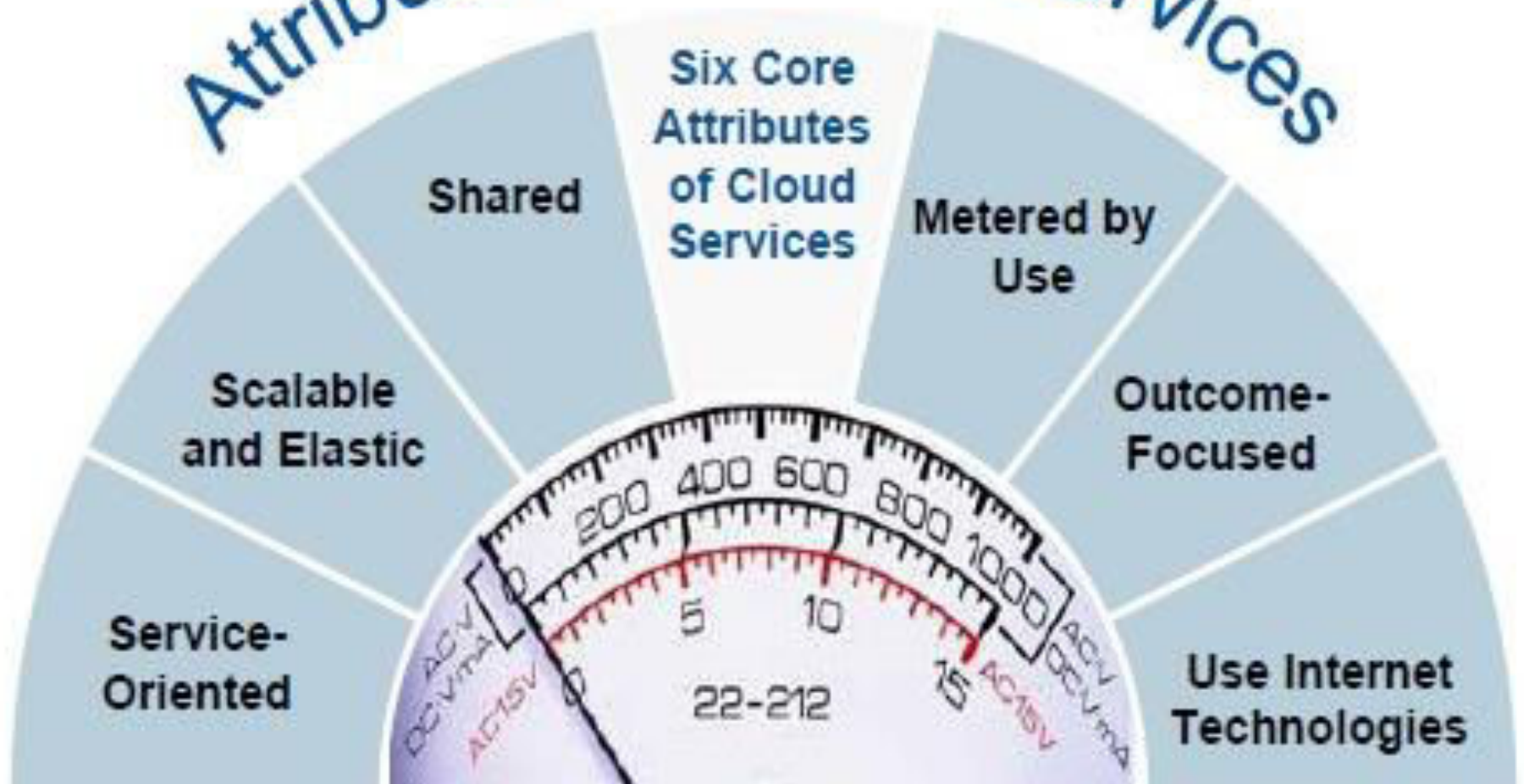
--Some more serious definitions

FZI (Jens Nimis):

”Building on compute and storage virtualization, cloud computing provides *scalable, network-centric, abstracted IT infrastructure, platforms, and applications* as *on-demand services that are billed by consumption.*”



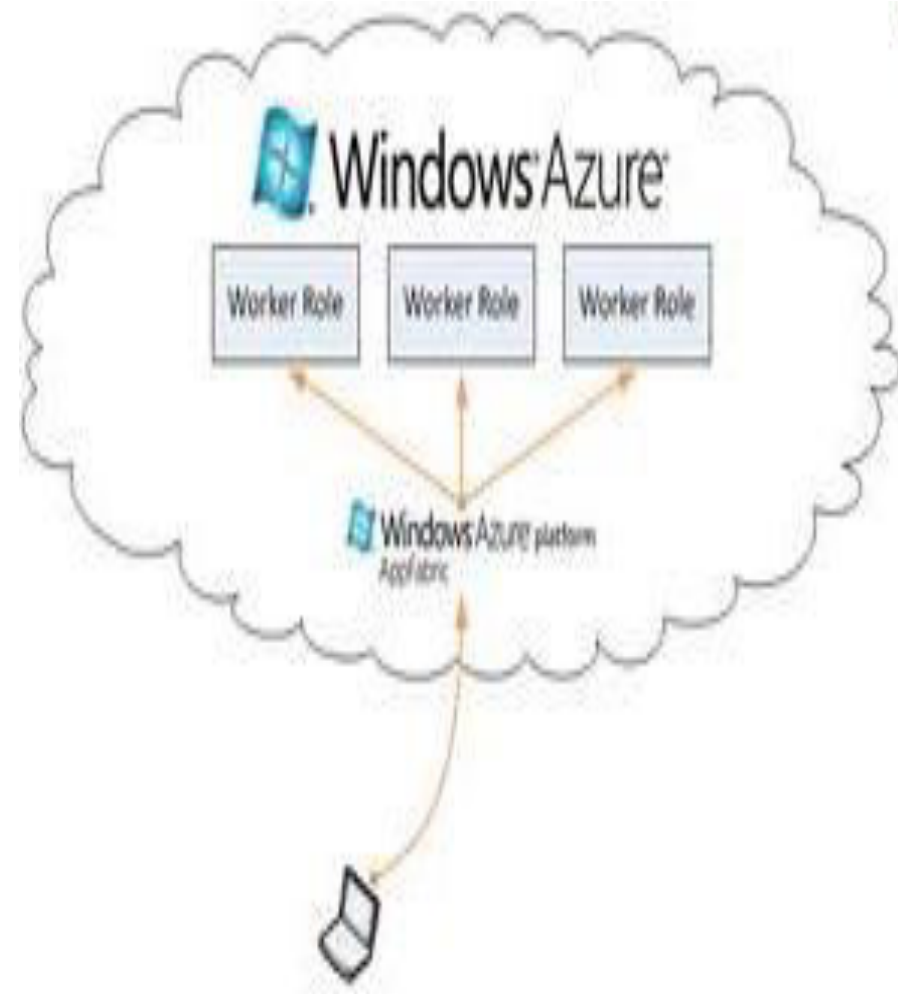
Attributes of Cloud Services



Gartner.

Cloud Computing Architecture

- is the systems architecture of the software systems involved in the delivery of *cloud computing*, typically involves multiple *cloud components* communicating with each other over application programming interfaces, usually web services.



Components of cloud computing architecture

- **the front end** - is the part seen by the client, i.e. the computer user. This includes the client's network (or computer) and the applications used to access the cloud via user interface such as a web browser.
- **the back end** - is the 'cloud' itself, comprising various computers, servers and data storage devices.

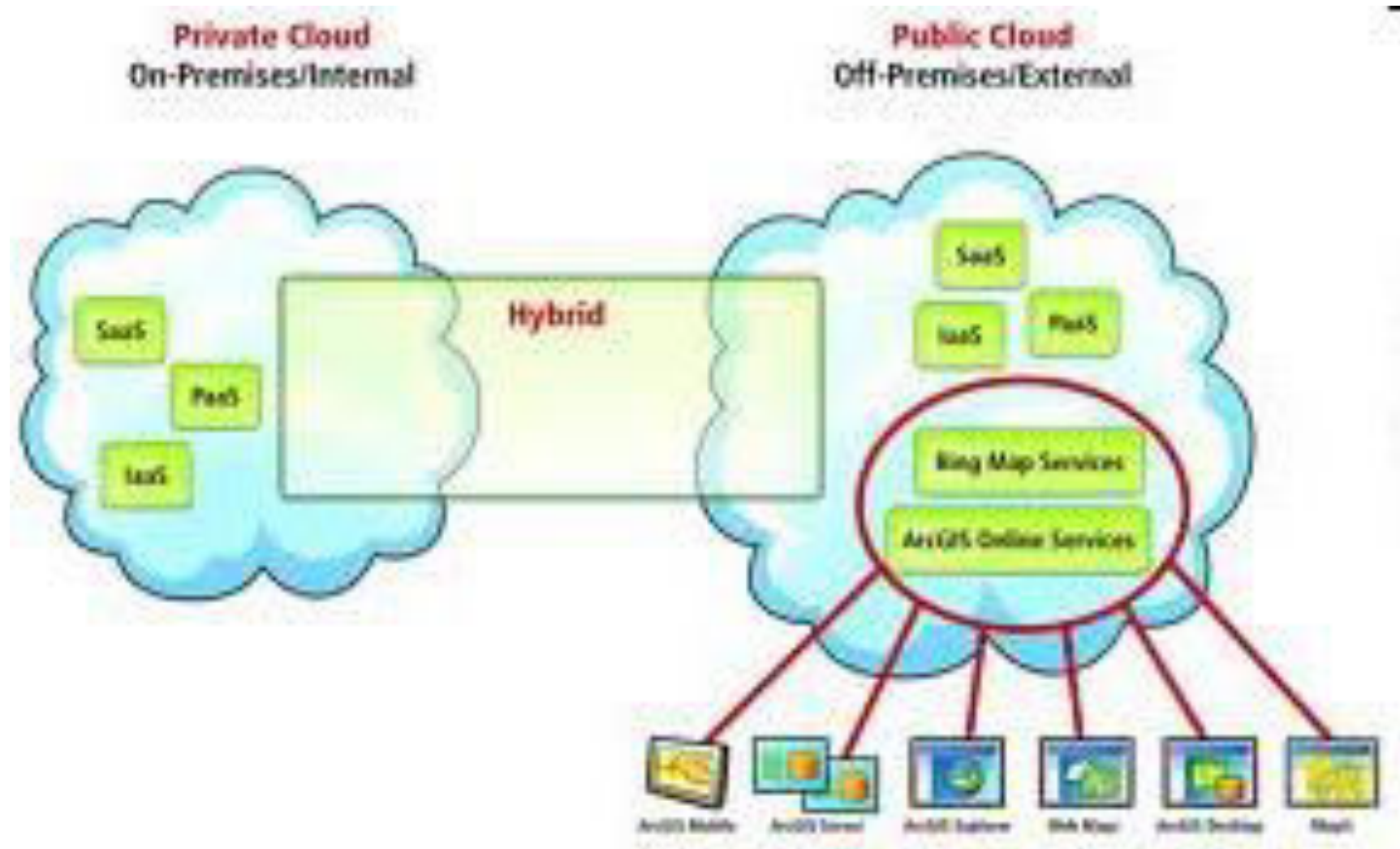
Components of cloud computing architecture

- It is usually assumed that cloud contains infinite storage capacity for any software available in market. Cloud has different applications that are hosted on their own dedicated server farms.
- Cloud has centralized server administration system. Centralized server administers the system, balances client supply, adjusts demands, monitors traffic and avoids congestion. This server follows protocols, commonly known as middleware. Middleware controls the communication of cloud network among them.
- Cloud Architecture runs on a very important assumption, which is mostly true. The assumption is that the demand for resources is not always consistent from client to cloud. Because of this reason the servers of cloud are unable to run at their full capacity. To avoid this scenario, server virtualization technique is applied. In server virtualization, all physical servers are virtualized and they run multiple servers with either same or different application. As one physical server acts as multiple physical servers, it curtails the need for more physical machines.
- As a matter of fact, data is the most important part of cloud computing; thus, data security is the top most priority in all the data operations of cloud. Here, all the data are backed up at multiple locations. This astoundingly increases the data storage to multiple times in cloud compared with a regular system. Redundancy of data is crucial, which is a must-have attribute of cloud computing.

Cloud computing types

- **Public clouds** computing environment are open for use to anyone who wants to sign up and use them. These are run by vendors and applications from different customers are likely to be mixed together on the cloud's servers, storage systems, and networks.
- Examples of a public cloud: **Amazon Web Services and Google's AppEngine**
- Source: Wikipedia
- A **private cloud** is basically an organization that needs more control over their data than they can get by using a vendor hosted service.

- A **hybrid cloud** combine both public and private cloud models.



Major Players' Cloud Computing Services

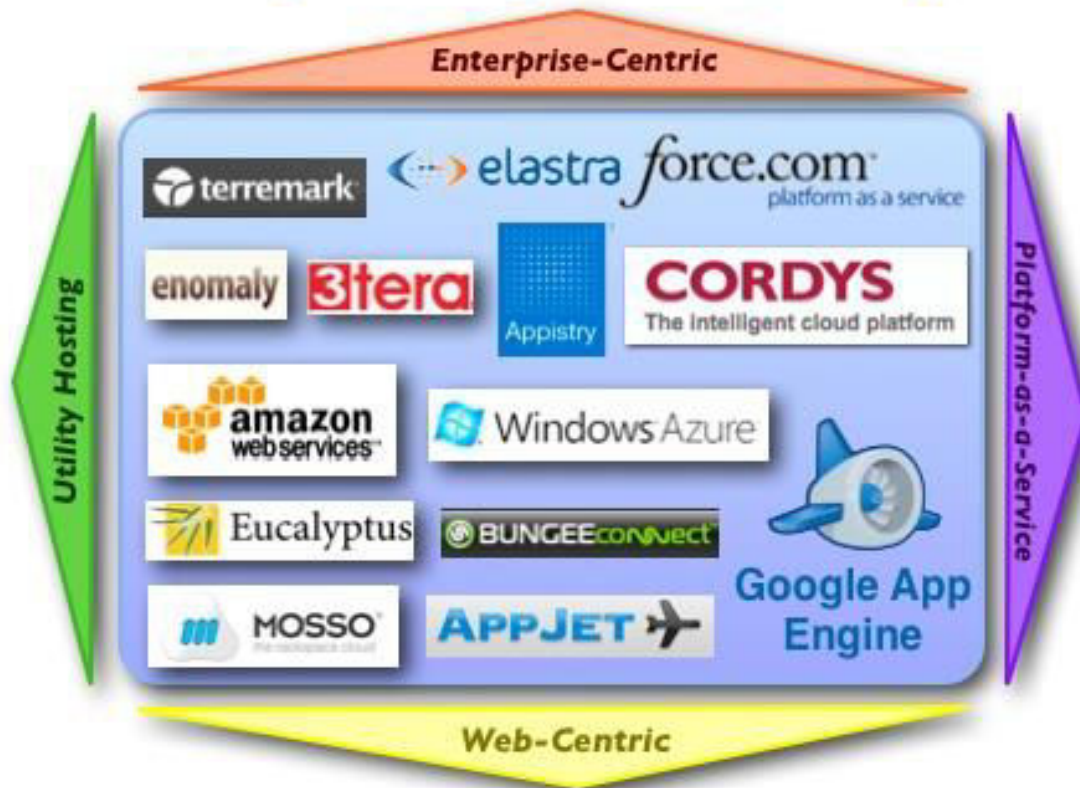
Highlights of the Cloud Computing Landscape

Google

Microsoft

Amazon

IBM



Cordys

Force.com

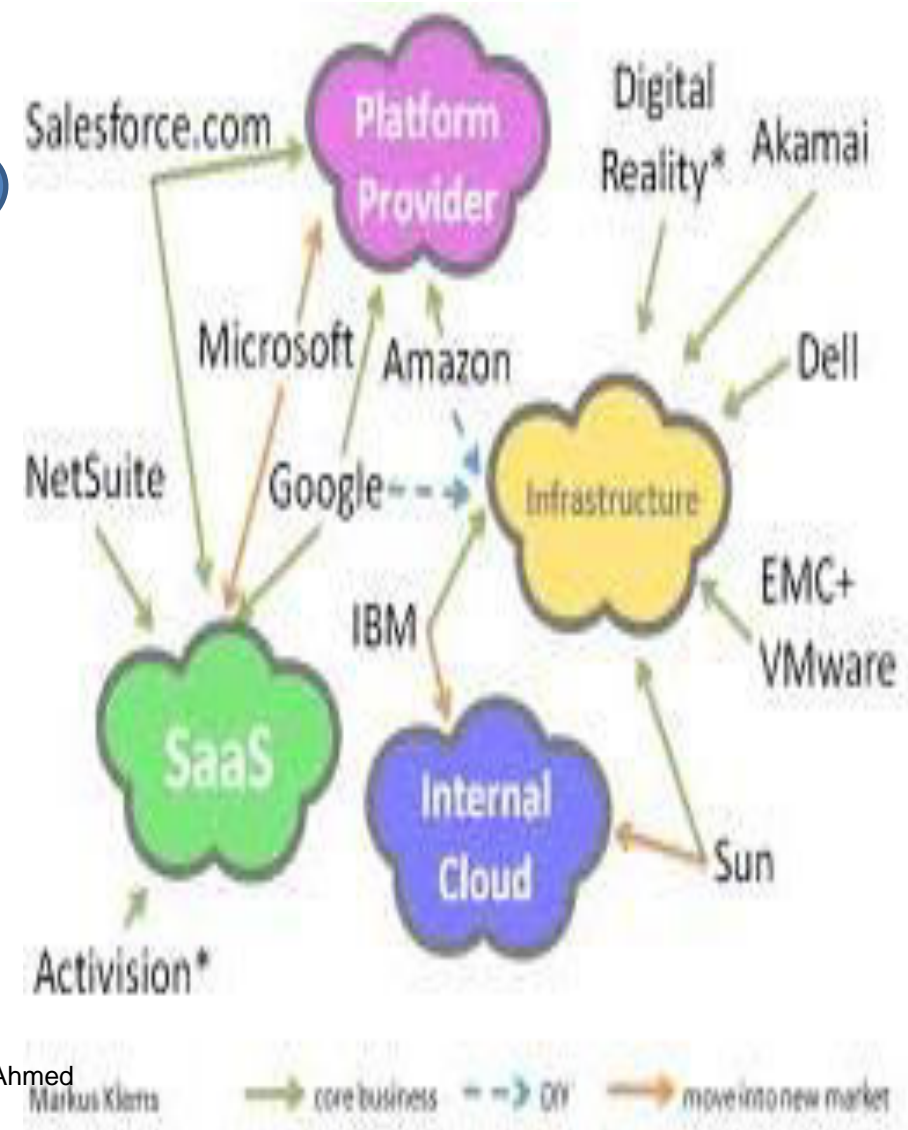
MOSSO

Cloud Providers

| Company | Category | Offering |
|-----------------------|--|------------------------|
| Rackspace | Hosting and Storage | Mosso |
| IBM | Hosting, Storage and Platform | Public & Private Cloud |
| Google | Hosting, Storage, Platform and some Application Services | Google AppEngine |
| Amazon | Hosting, Storage, Platform and some Application Services | Amazon Web Services |
| Microsoft | Hosting, Storage, Platform, Application Services, Tools | Azure Services |
| Salesforce.com | Hosting, Storage, Platform, Application Services, Tools | Force.com |

Types of Cloud Services

1. IaaS
2. PaaS
3. SaaS
4. Cloud web service web
5. MPS (Management Service Provider)
6. BSP (Business Service Platform)
7. Network Integration



Infrastructure as a Service (IaaS)

- sometimes referred as HaaS or Hardware as a Service and it involves both storage services and computing power.
- Provides user computing resources and storage comprised with many servers as an **on-demand and “pay per use”** service: Data Center, Bandwidth, Private Line Access, Servers and Server Room, Firewall, Storage space
- Examples:
 - Amazon: EC2 (ElasticComputeCloud)
 - Rackspace: cheaper than EC2 www.rackspace.com

Platform as-a-Service (*PaaS*)



- ❖ With PaaS, computing platform provides supplies tools and a development environment to help companies build, test, and deploy Web-based applications.
- ❖ Bundles all stack components (hardware, infrastructure, storage) together with database, security, workflow, user interface, and other tools that allow users to create and host powerful business applications, web sites, and mobile apps.

Examples

- Sales force <http://www.force.com>
- 800APP <http://www.800app.com>

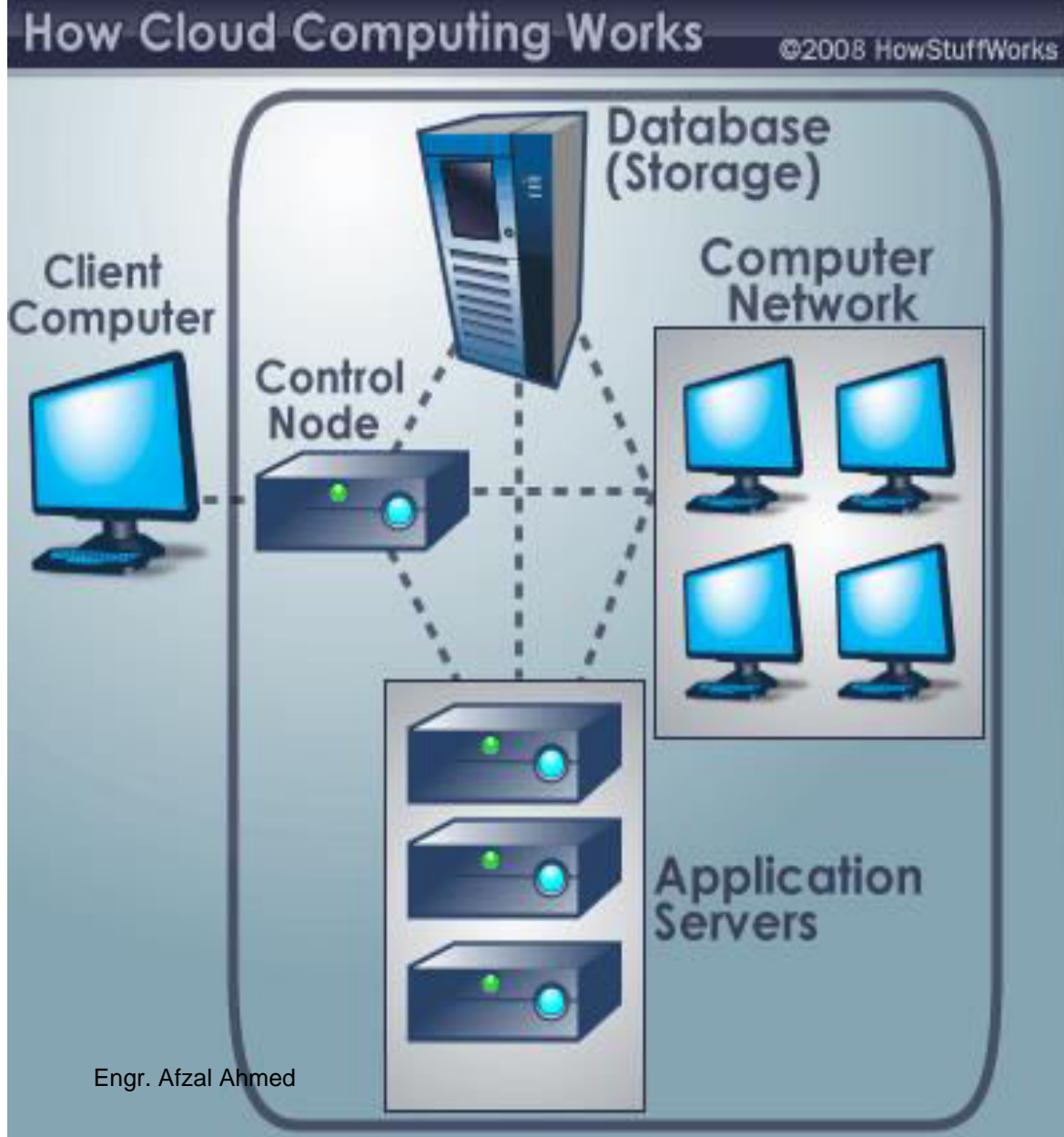
Software as a Service (SaaS)

- Applications or software is delivered as a service to the customer who can access the program from any online device, eliminating the need to install and run the application on the customer's own computers and simplifying maintenance and support.
- Some of these Web-based applications are free such as **Hotmail, Google Apps, Skype**, and many 2.0 applications, while most business-oriented SaaS, such as **Sales Force**, is leased on a subscription basis

SaaS can be defined through five key ideas:

- Services are fully managed and hosted;
- have regular recurring payments (Pay-As-They-Go and Pay-As-They-Grow);
- allow for anytime, anywhere access (usually 24/7 services) ;
- have multiple tenants on servers; and
- don't require installation of specialized software

How cloud computing works?





Cloud Computing Development @ Libraries

- **Google and IBM** have partnered to offer millions of dollars in resources to universities in order to promote cloud computing projects.
- The goal is to **improve students' knowledge of parallel computing practices and better prepare them for increasingly popular large-scale computing that takes place in the "real world,"** such as search engines, social networking sites, and scientific computational needs.



Cloud Computing Development @Libraries

- **YAHOO** has expanded its partnerships with top U.S. universities : The University of California at Berkeley, Cornell University, University of Massachusetts at Amherst and the Carnegie Mellon University **to advance cloud computing research through the used of Yahoo!'s cloud computing cluster large-scale systems software.**



Cloud Computing Development @ Libraries

IBM established a consortium with the European Union and universities to research new cloud-computing models to reduce the cost of hosting and maintaining Internet-based services.

- **The aim of the consortium is to undertake research that could lead to the development of new computer science models that bring together managed Internet-based services from diverse hardware and software environments in a flexible cloud environment.**



Cloud Computing @ Libraries

- The Qatar Cloud Computing Initiative led by Carnegie Mellon University, Qatar University and Texas A&M University **aimed to develop cloud computing technology and provide a platform for local organizations to test applications in the cloud.**
- The project, is to enable academic research projects that require a large amount of computing power. By sharing resources through a cloud model, **academic institutions can make better use of existing resources, and access more powerful resources for data intensive projects,** in a more cost effective manner than by deploying their own infrastructure or outsourcing processing.

Cloud Computing @ Libraries:

DaaS from Publishers & Aggregators



Cloud Computing @ Daily life

| Cloud Computing Activities by Different Age Cohorts | | | | |
|--|-------|-------|-------|-----|
| <i>Internet users in each age group who do the following online activities (%)</i> | | | | |
| | 18-29 | 30-49 | 50-64 | 65+ |
| Use webmail services such as Hotmail, Gmail, or Yahoo! mail | 77% | 58% | 44% | 27% |
| Store personal photos | 50 | 34 | 26 | 19 |
| Use online applications such as Google Documents or Adobe Photoshop Express | 39 | 28 | 25 | 19 |
| Store personal videos | 14 | 6 | 5 | 2 |
| Pay to store computer files online | 9 | 4 | 5 | 3 |
| Back up hard drive to an online site | 7 | 5 | 5 | 4 |
| | | | | |
| Have done at least <u>one</u> activity | 87% | 71% | 59% | 46% |
| Have done at least <u>two</u> activities | 59 | 39 | 31 | 21 |

Source: Pew Internet & American Life Project April-May 2008 Survey. N=1,553 Internet users. Margin of error is $\pm 3\%$.

Key Characteristics

- Cloud computing is cost-effective.
- Here, cost is greatly reduced as initial expense and recurring expenses are much lower than traditional computing.
- Maintenance cost is reduced as a third party maintains everything from running the cloud to storing data.
- Cloud is characterized by features such as platform, location and device independency, which make it easily adoptable for all sizes of businesses, in particular small and mid-sized.
- However, owing to redundancy of computer system networks and storage system cloud may not be reliable for data, but it scores well as far as security is concerned.
- In cloud computing, security is tremendously improved because of a superior technology security system, which is now easily available and affordable.
- Yet another important characteristic of cloud is scalability, which is achieved through server virtualization.
- In a nutshell, cloud computing means getting the best performing system with the best value for money.

Significance of Cloud Computing

Why cloud computing is significant?

- **Cloud computing reduce energy consumption significantly.** The 1000 plus US government data centers, for example, were consuming 6 billion kWh of energy in 2006, and if left unchecked, the consumption can be double by 2011.
- **Cloud computing involves centralizing the computing resources on the Internet (the cloud) and making these available to those who need it, when needed.** Because the resources are shared by many, capacity utilization goes up. And modern developments like virtualization can make the same resources available to multiple users "simultaneously," thus reducing the need for physical resources even further.

- **At the micro level, enterprises that used cloud computing services are freed of worrying about the technological issues related to IT installations.** They can replace their complex installations of servers, workstations, networking and numerous applications with simple workstation computers and fast Internet connectivity. The cloud service providers will attend to the infrastructure, platforms and even applications needed by the enterprises.
- **Cloud computing resources are available immediately as soon as the agreement with the service provider is executed.** Under the utility model of service provision, users are charged only for what they use, for the memory, CPU, data transfer, I/O requests, storage space and so on. As the business expands, the enterprises can seamlessly expand their computing capacities.

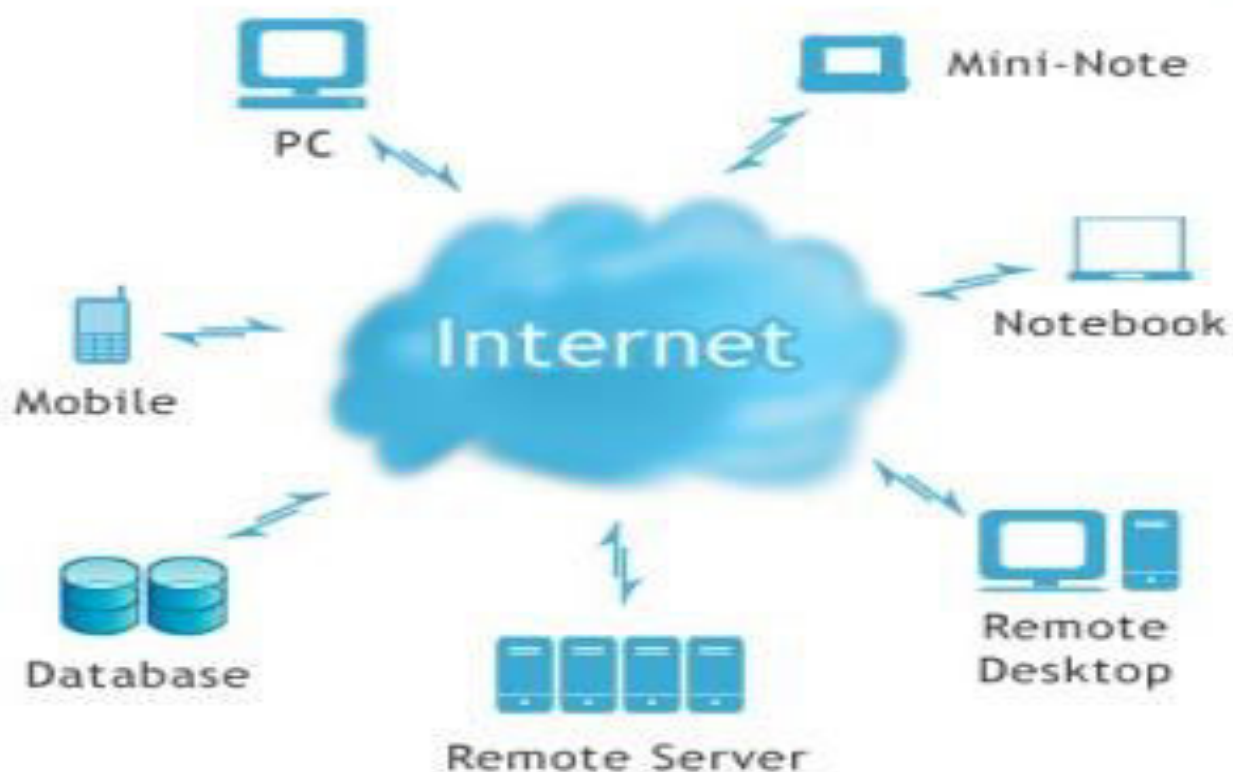
Benefits of Cloud Computing for educational institutions

- Universities can open their technology infrastructures to businesses and industries for research advancements;
- The efficiencies of cloud computing can help universities keep pace with ever-growing resource requirements and energy cost;
- The extended reach of cloud computing enables institutions to teach students in new, different ways and help them manage projects and massive workloads; and
- When students enter the global workforce they will better understand the value of new technologies.

The Cloud Computing Manifesto Principles

- User centric
- Openness
- Interoperability
- Discrimination
- Balance
- Philanthropic
- Transparency
- Representation
- Evolution
- Security

What are the downsides of cloud computing?



Cloud computing and IT issues:

- **Service level agreements** – What assurances do we have for uptime, legal protection, and security?
- **Uptime and reliability** – How does this provider compare to being able to locally host and manage our resources?
- **Cost and affordability** – What personnel and technology resources are involved with a hosted versus local solution? How does this cost model look over time?
- **Legal and organizational issues** – What organizational and legal issues do we need to consider? Are we dealing with patron data? Are we sure that the platform and our connection to it are secure?
- **Staff knowledge** – How would migrating to this platform impact staff knowledge and competency? Do we know everything that we need to know?

Cloud Computing Concerns

- Security of confidential data (e.g., SSN or Credit Card Numbers) is a very important area of concern as it can make way for very big problems if unauthorized users get access to it.
- Misuse of data can create big issues; hence, in cloud computing it is very important to be aware of data administrators and their extent of data access rights.
- Large organizations dealing with sensitive data often have well laid out regulatory compliance policies. However, these policies should be verified prior to engaging them in cloud computing.
- There is a possibility that in cloud computing network, sometimes the network utilizes resources from another country or they might not be fully protected; hence, the need arises for appropriate regulatory compliance policies.
- In cloud computing, it is very common to store data of multiple customers at one common location. Cloud computing should have proper techniques where data is segregated properly for data security and confidentiality. Care must be taken to ensure that one customer's data does not affect another customer's data.
- In addition, Cloud computing providers must be equipped with proper disaster recovery policies to deal with any unfortunate event.

Where is cloud computing going?

“Cloud computing” is emerging as a relevant computing paradigm aiming to be the technology that will mark the difference between **Web2.0** and **Web3.0**.



- **Clouds** are vast resource pools with on-demand resource allocation. The degree of on-demand can vary from phone calls to web forms to actual APIs that directly require servers.

The “cloud” may now be seen as a collection of networked features. New concept that will lead to a new implementation model called as **“cloud libraries”**.

Cloud Computing is the Wave of the Future (Perera, G. J., 2009)

- ❖ **Software as a Subscription**
- ❖ **Reduced Software Maintenance**
- ❖ **Increased Reliability**
- ❖ **Increased Scalability**



- ❖ **Cost Reduction**
- ❖ **Environmentally Friendly**
- ❖ **Matches Current
Computing Trends**
- ❖ **Portability/Accessibility**
- ❖ **Efficient Use of Computer
Resources**
- ❖ **Versionless Software**

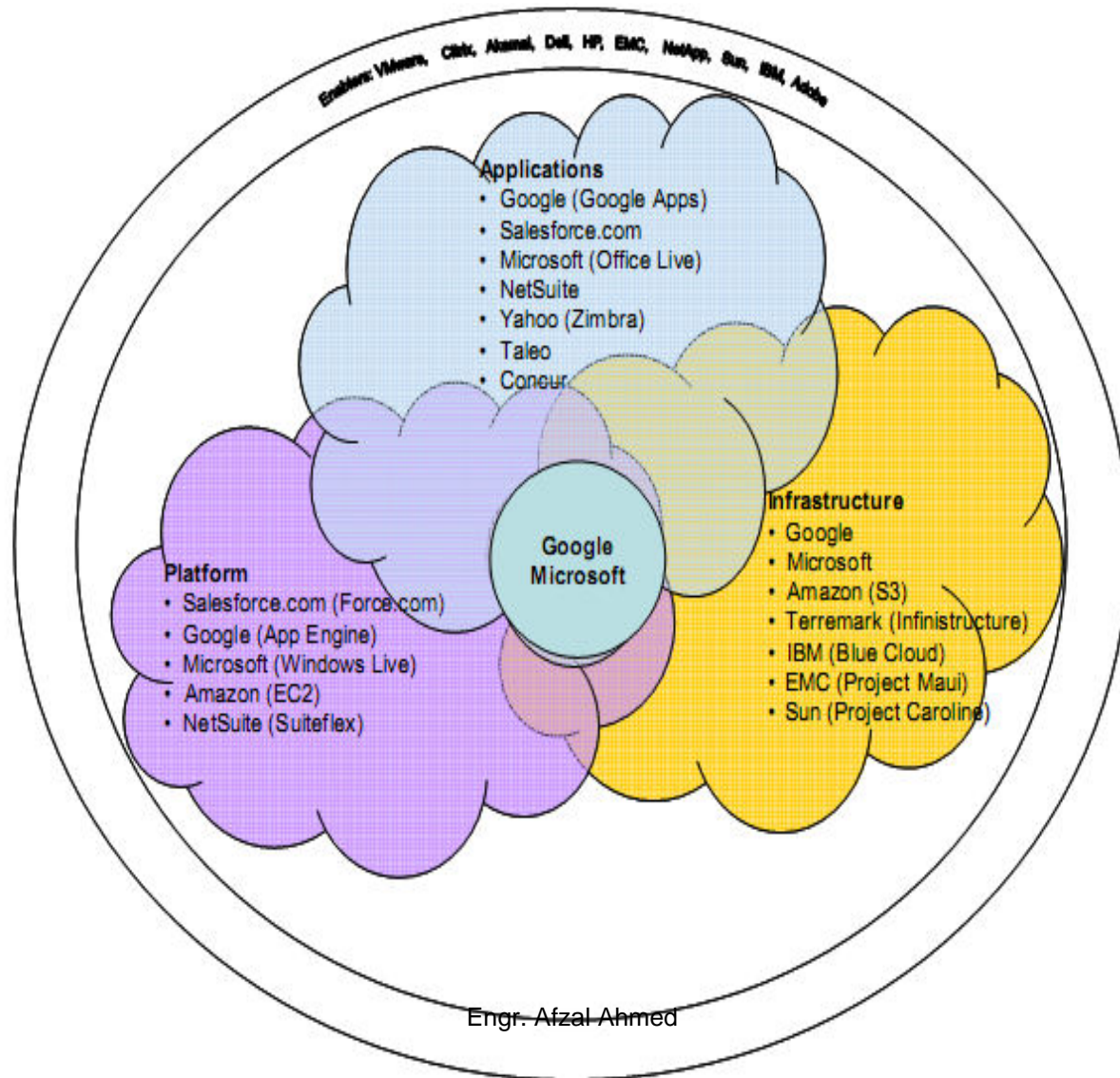


Conclusion



Cloud Computing – new IT buzzword

- is a concept like a flower in the glass. Every enterprise and person, want to explain this concept by their own benefits. But, if given a neutral definition to it, begin it here.



Abstract

Cloud computing has brought us a new perspective to look at the current resource-sharing problem, cloud computing can be applied to digital library resources to improve information sharing capabilities, improve resource utilization.