Cloud Computation over the Internet

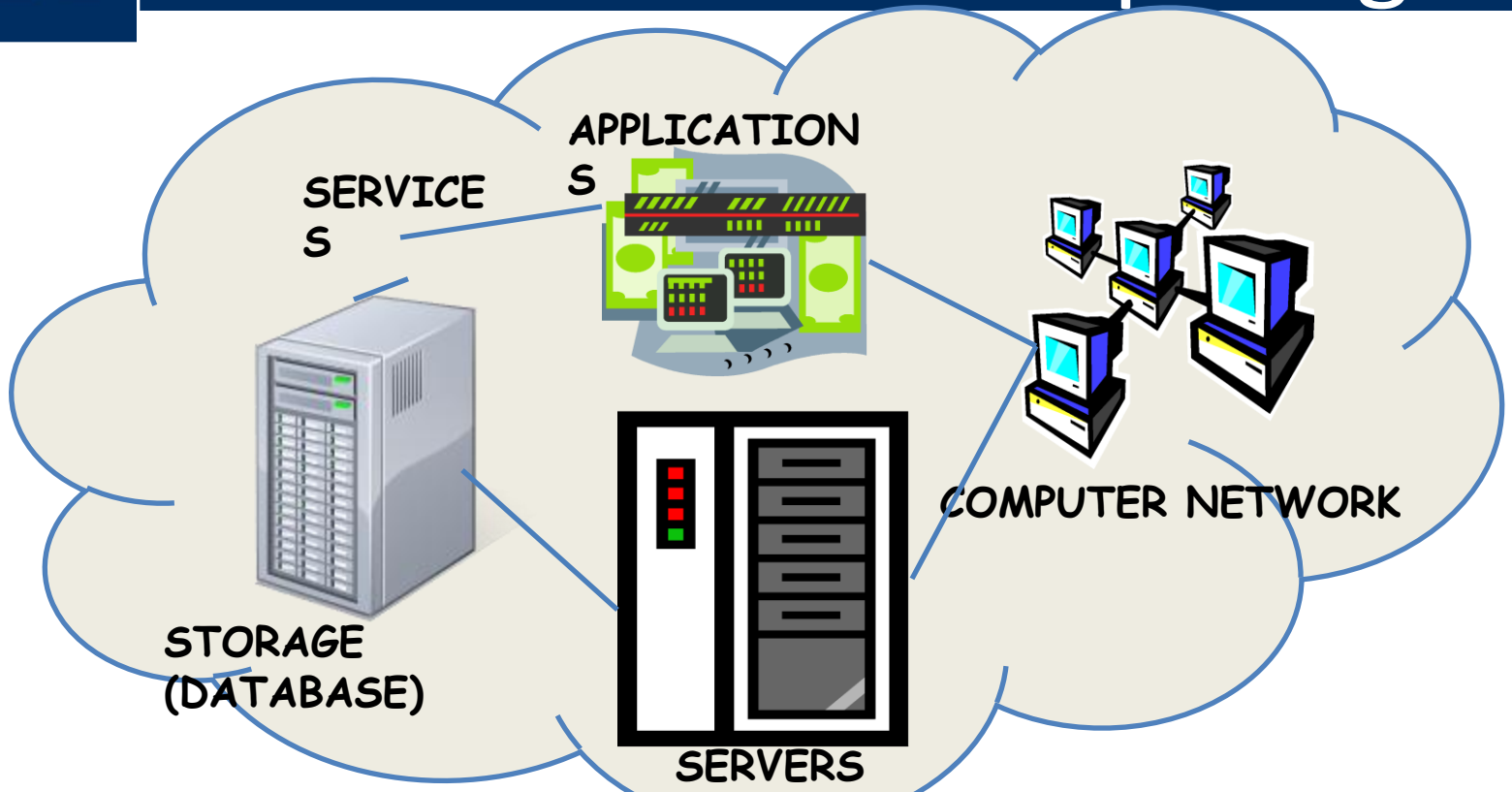
What is Cloud Computing?

- **Cloud Computing** is a general term used to describe a new class of network based computing that takes place over the Internet,
  - basically a step on from Utility Computing
  - a collection/group of integrated and networked hardware, software and Internet infrastructure (called a platform).
  - Using the Internet for communication and transport provides hardware, software and networking services to clients
- These platforms hide the complexity and details of the underlying infrastructure from users and applications by providing very simple graphical interface or API (Applications Programming Interface).

What is Cloud Computing?

- In addition, the platform provides on demand services, that are always on, anywhere, anytime and any place.
- Pay for use and as needed, elastic
  - scale up and down in capacity and functionalities
- The hardware and software services are available to
  - general public, enterprises, corporations and businesses markets

What is Cloud Computing



- Shared pool of configurable computing resources
- On-demand network access
- Provisioned by the Service Provider

Cloud Definition By NIST

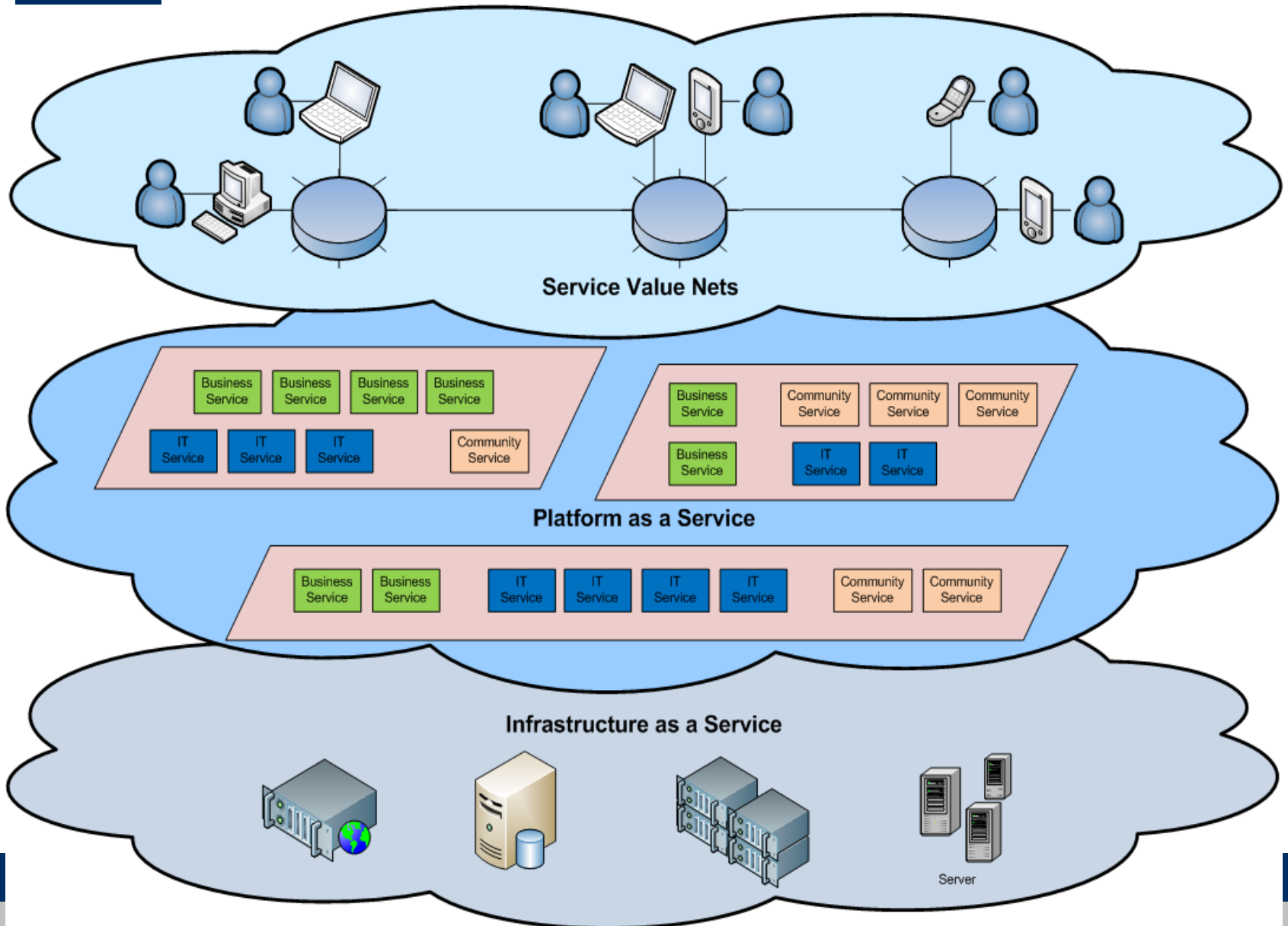
The U.S. National Institute of Standards and Technology (NIST) defines cloud computing as:

- Cloud computing is 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.

Cloud characteristics

- Rapid elasticity
  - You can go from 5 servers to 50 or from 50 servers to 5
- Measured service
  - You pay for what you use
- On-demand self-service
  - You get elasticity automatically
- Ubiquitous network access
  - You can access the cloud from anywhere
- Location-independent resource pooling
  - You work with virtual machines that could be hosted anywhere

Cloud Architecture



CLOUD COMPONENTS

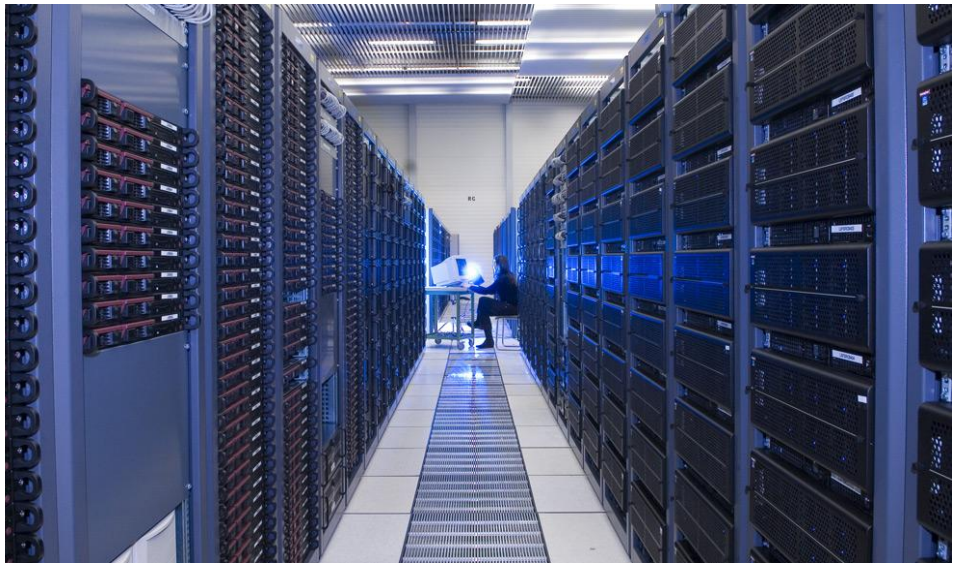
- 3 components
  - Clients
  - Datacenter
  - Distributed servers

CLOUD COMPONENTS

- **Clients**
  - **Mobile**
    - SmartPhones, Tablets, Service Hubs
  - **Thin**
    - no internal hard drives, lets servers do all work, displays info
  - **Thick**
    - Laptops, desktop computers
  - **Which is the best?**
    - Thin - lower costs, security, power consumption, easy to replace, less noise

DATA CENTER

- Data Center – facility used to house computer systems and associated components



DISTRIBUTED SERVERS

- **Servers host the resources needed by cloud users**
  - **Compute nodes**
    - Provides CPU, Memory, Scratch Storage, and Networking resources through virtualized interfaces.
    - Hosts guest operating systems (Virtual Machines) using one or more VM hypervisors
    - Resource interface depends on the type of cloud (horizontal/vertical cloud)
  - **Storage nodes**
    - Compute nodes only provide temporary storage space for users/applications
    - Storage nodes provide long term data storage solutions
    - Can be mapped to specific processes running on compute

TYPES OF CLOUDS

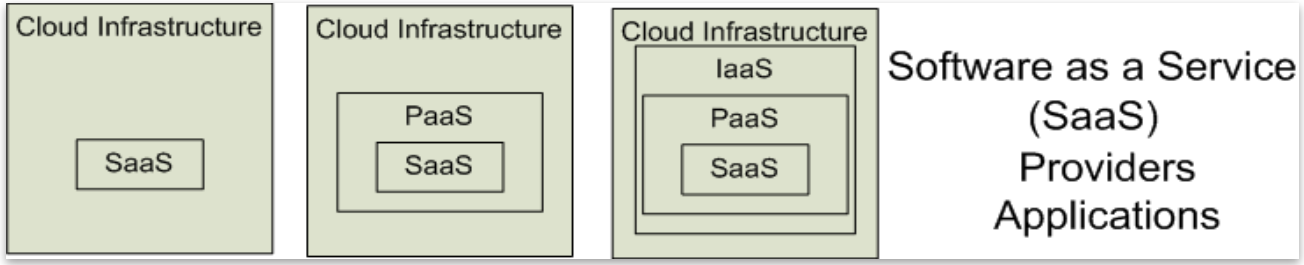
- **Public Cloud**
  - —Marketed based on
    - Resources offered, availability, security, price
- **Local/Private Cloud**
  - —Cloud architectures tailored to an organization's needs.
- **Hybrid Cloud**
  - —Combination of public and local cloud resources.

Cloud Service Models

Software as a Service (SaaS)	Platform as a Service (PaaS)	Infrastructure as a Service (IaaS)

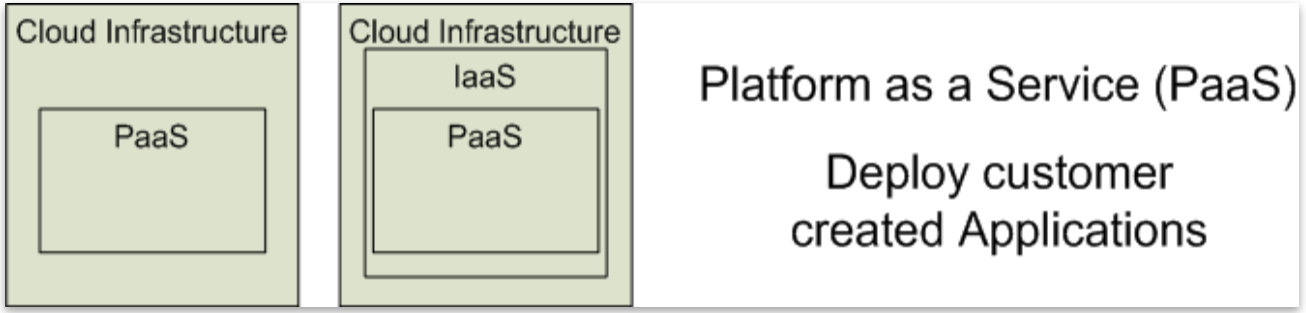
SalesForce CRM

LotusLive



Google App

Windows Azure
The Future Made Familiar



amazon web services™

rackspace HOSTING

Different Cloud Computing Layers

Application Service (SaaS)	MS Live/ExchangeLabs, IBM, Google Apps; Salesforce.com Quicken Online, Zoho, Cisco
Application Platform	Google App Engine, Mosso, Force.com, Engine Yard, Facebook, Heroku, AWS
Server Platform	3Tera, EC2, SliceHost, GoGrid, RightScale, Linode
Storage Platform	Amazon S3, Dell, Apple, ...

Cloud services

- Machines in the cloud
  - Can I move my VM elsewhere?
- Storage in the cloud
  - Can I move my data elsewhere?
- Databases in the cloud
  - Can I move my data elsewhere?
- Applications in the cloud
  - Can I run my application elsewhere?

Cloud services

There are four basic things people are doing in the cloud:

- Machines in the cloud
- Storage in the cloud
- Databases in the cloud
- Applications in the cloud

In addition to these four basics, cloud providers offer other services such as message queues and data mining All of these things are lumped into the generic term “cloud computing”

Machines in the cloud

Many cloud providers allow you to create a Virtual Machine (VM) and deploy it in the cloud:

- Your VM images are stored in cloud storage
- You can create as many images as you need
- You can automatically start and stop running instances of those images as needed

This is the simplest way to get started in the cloud, particularly if you've been using virtualization already

Storage in the cloud

Most cloud storage systems are designed as distributed, redundant systems

- Your data are stored on more than one disk in more than one place
- If one part of the system goes down, the rest of the system keeps going
- “There should never be a single point of failure” is a stated design goal

But you can’t think of cloud storage as just another hard drive

Databases in the cloud

Cloud databases have similar design points Datasets are distributed for reliability

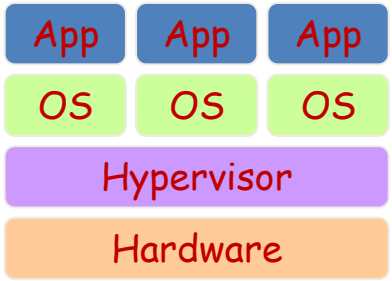
- Some cloud databases support schemas, some don’t
- Some cloud databases support joins, most don’t Some cloud databases are relational, almost all aren’t
- Some cloud databases are transactional, some aren’t

Software as a Service (SaaS)

- SaaS is a model of software deployment where an application is hosted as a service provided to customers across the Internet.
- Saas soothes the load of software maintenance/support
  - but users quit control over software versions and requirements.
- Terms that are used in this field include
  - **Platform as a Servic**e (PaaS) and
  - **Infrastructure as a Service** (IaaS)

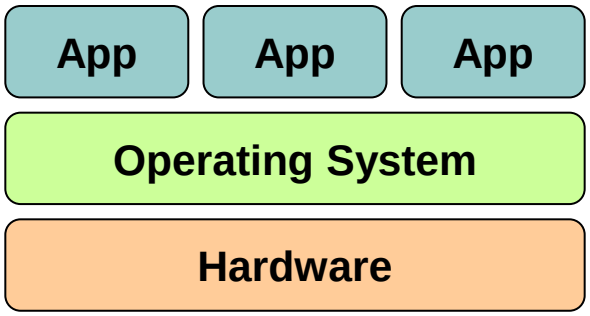
Virtualization

- Virtual workspaces:
  - An abstraction of an execution environment that can be made dynamically available to authorized clients by using well-defined protocols,
  - Resource quota (e.g. CPU, memory share),
  - Software configuration (e.g. O/S, provided services).
- Implement on Virtual Machines (VMs):
  - Abstraction of a physical host machine,
  - Hypervisor intercepts and emulates instructions from VMs, and allows management of VMs,
  - VMWare, Xen, etc.
- Provide infrastructure API:
  - Plug-ins to hardware/support structures

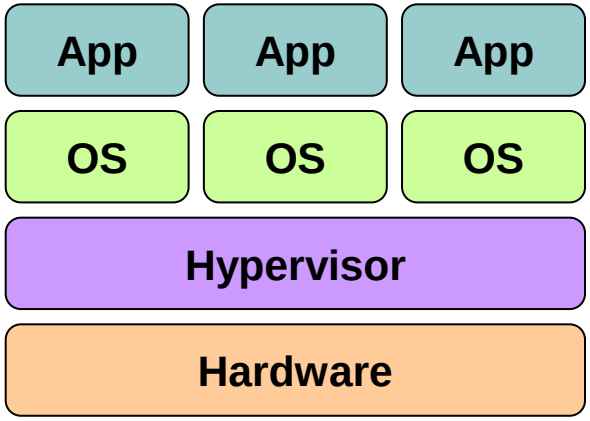


Virtualized Stack

Virtual Machines



Traditional Stack



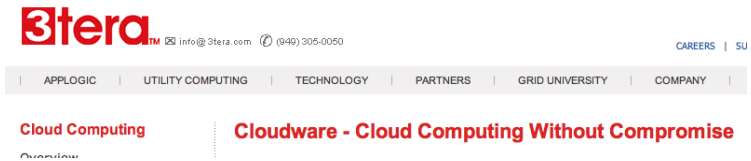
Virtualized Stack

What is the purpose and benefits?

- Cloud computing enables companies and applications, which are system infrastructure dependent, to be infrastructure-less.
- By using the Cloud infrastructure on “pay as used and on demand”, all of us can save in capital and operational investment!
- Clients can:
  - Put their data on the platform instead of on their own desktop PCs and/or on their own servers.
  - They can put their applications on the cloud and use the servers within the cloud to do processing and data manipulations etc.

Some Commercial Cloud Offerings

Amazon Elastic Compute Cloud (Amazon EC2) - *Beta*



Cloud Storage

- Several large Web companies are now exploiting the fact that they have data storage capacity that can be hired out to others.
  - allows data stored remotely to be temporarily cached on desktop computers, mobile phones or other Internet-linked devices.

- Amazon's Elastic Compute Cloud (EC2) and Simple Storage Solution (S3) are well known examples
  - Mechanical Turk

Opportunities and Challenges

- The use of the cloud provides a number of opportunities:
  - It enables services to be used without any understanding of their infrastructure.
  - Cloud computing works using economies of scale:
    - It potentially lowers the outlay expense for start up companies, as they would no longer need to buy their own software or servers.
    - Cost would be by on-demand pricing.
    - Vendors and Service providers claim costs by establishing an ongoing revenue stream.
  - Data and services are stored remotely but accessible from “anywhere”.

Opportunities and Challenges

- In parallel there has been backlash against cloud computing:
  - Use of cloud computing means dependence on others and that could possibly limit flexibility and innovation:
    - The others are likely become the bigger Internet companies like Google and IBM, who may monopolise the market.
  - Security could prove to be a big issue:
    - It is still unclear how safe out-sourced data is and when using these services ownership of data is not always clear.
  - There are also issues relating to policy and access:
    - If your data is stored abroad whose policy do you adhere to?
    - What happens if the remote server goes down?
    - How will you then access files?
    - There have been cases of users being locked out of accounts and losing access to data.

Advantages of Cloud Computing

- Lower computer costs:
  - You do not need a high-powered and high-priced computer 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, more efficient processor...
  - In fact, your PC in this scenario does not even need a CD or DVD drive, as no software programs have to be loaded and no document files need to be saved.

Advantages of Cloud Computing

- Improved performance:
  - With few large programs hogging your computer's memory, you will see better performance from your PC.
  - Computers in a cloud computing system boot and run faster because they have fewer programs and processes loaded into memory…
- Reduced software costs:
  - Instead of purchasing expensive software applications, you can get most of what you need for free-ish!
    - most cloud computing applications today, such as the Google Docs suite.
  - better than paying for similar commercial software
    - which alone may be justification for switching to cloud applications.

Advantages of Cloud Computing

- Instant software updates:
  - Another advantage to cloud computing is that you are no longer faced with choosing between obsolete software and high upgrade costs.
  - When the application is web-based, updates happen automatically
    - available the next time you log into the cloud.
  - When you access a web-based application, you get the latest version
    - without needing to pay for or download an upgrade.

- Improved document format compatibility.
  - You do not have to worry about the documents you create on your machine being compatible with other users' applications or OSes
  - There are potentially no format incompatibilities when everyone is sharing documents and applications in the cloud.

Advantages of Cloud Computing

- Unlimited storage capacity:
  - Cloud computing offers virtually limitless storage.
  - Your computer's current 1 Tbyte hard drive is small compared to the hundreds of Pbytes available in the cloud.
- Increased data reliability:
  - Unlike desktop computing, in which if a hard disk crashes and destroy all your valuable data, a computer crashing in the cloud should not affect the storage of your data.
    - if your personal computer crashes, all your data is still out there in the cloud, still accessible
  - In a world where few individual desktop PC users back up their data on a regular basis, cloud computing is a data-safe computing platform!

Advantages of Cloud Computing

- Universal document access:
  - That is not a problem with cloud computing, because you do not take your documents with you.
  - Instead, they stay in the cloud, and you can access them whenever you have a computer and an Internet connection
  - Documents are instantly available from wherever you are
- Latest version availability:
  - When you edit a document at home, that edited version is what you see when you access the document at work.
  - The cloud always hosts the latest version of your documents
    - as long as you are connected, you are not in danger of having an outdated version

Advantages of Cloud Computing

- Easier group collaboration:
  - Sharing documents leads directly to better collaboration.
  - Many users do this as it is an important advantages of cloud computing
    - multiple users can collaborate easily on documents and projects
- Device independence.
  - You are no longer tethered to a single computer or network.
  - Changes to computers, applications and documents follow you through the cloud.
  - Move to a portable device, and your applications and documents are still available.

Disadvantages of Cloud Computing

- Requires a constant Internet connection:
  - Cloud computing is impossible if you cannot connect to the Internet.
  - Since you use the Internet to connect to both your applications and documents, if you do not have an Internet connection you cannot access anything, even your own documents.
  - A dead Internet connection means no work and in areas where Internet connections are few or inherently unreliable, this could be a deal-breaker.

Disadvantages of Cloud Computing

- Does not work well with low-speed connections:
  - Similarly, a low-speed Internet connection, such as that found with dial-up services, makes cloud computing painful at best and often impossible.
  - Web-based applications require a lot of bandwidth to download, as do large documents.
- Features might be limited:
  - This situation is bound to change, but today many web-based applications simply are not as full-featured as their desktop-based applications.
    - For example, you can do a lot more with Microsoft PowerPoint than with Google Presentation's web-based offering

Disadvantages of Cloud Computing

- Can be slow:
  - Even with a fast connection, web-based applications can sometimes be slower than accessing a similar software program on your desktop PC.
  - Everything about the program, from the interface to the current document, has to be sent back and forth from your computer to the computers in the cloud.
  - If the cloud servers happen to be backed up at that moment, or if the Internet is having a slow day, you would not get the instantaneous access you might expect from desktop applications.

Disadvantages of Cloud Computing

- Stored data might not be secure:
  - With cloud computing, all your data is stored on the cloud.
    - The questions is How secure is the cloud?
  - Can unauthorised users gain access to your confidential data?
- Stored data can be lost:
  - Theoretically, data stored in the cloud is safe, replicated across multiple machines.
  - But on the off chance that your data goes missing, you have no physical or local backup.
    - Put simply, relying on the cloud puts you at risk if the cloud lets you down.

Disadvantages of Cloud Computing

- General Concerns:
  - Each cloud systems uses different protocols and different APIs
    - may not be possible to run applications between cloud based systems
  - Amazon has created its own DB system (not SQL 92), and workflow system (many popular workflow systems out there)
    - so your normal applications will have to be adapted to execute on these platforms.

The Future

- Many of the activities loosely grouped together under cloud computing have already been happening and centralised computing activity is not a new phenomena
- Grid Computing was the last research-led centralised approach
- However there are concerns that the mainstream adoption of cloud computing could cause many problems for users
- Many new open source systems appearing that you can install and run on your local cluster
  - should be able to run a variety of applications on these systems