Cloud Computing for Education & Research

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Outline

- Introduction of Cloud Computing
- Services Models
- Deployments Models
- Cloud for Education and Research Institutions
- Conclusion

Are you using Cloud Computing?

YES !


facebook


Insta


flickr


Gmail


YouTube


Picasa


SAP


Office


iCloud


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History

History

1999 : One of the first movers to cloud computing was Salesforce.com, which introduced the concept of delivering enterprise applications (CRM) via a simple website.

2002 : Amazon Web Services providing services like storage, computation

2006 : Amazon's Elastic Compute cloud (EC2) as a commercial web service that allowed small companies and individuals to rent computers on which to run their own computer applications

History

2006 : Google Docs

2009 : Key turning point in the evolution of cloud computing, with the arrival of browser based cloud enterprise applications

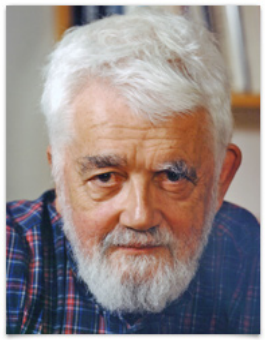
History

2009 : Microsoft enters into cloud computing with the launch of Windows Azure (cloud platform)

2010 : Office 365 was announced

Is Cloud Computing really NEW ?

Is cloud computing really new?



1960 : John McCarthy wrote that "***computation may someday be organized as a public utility***."

1990 : Grid computing, an idea for making computer power as easy to access as an electric power grid

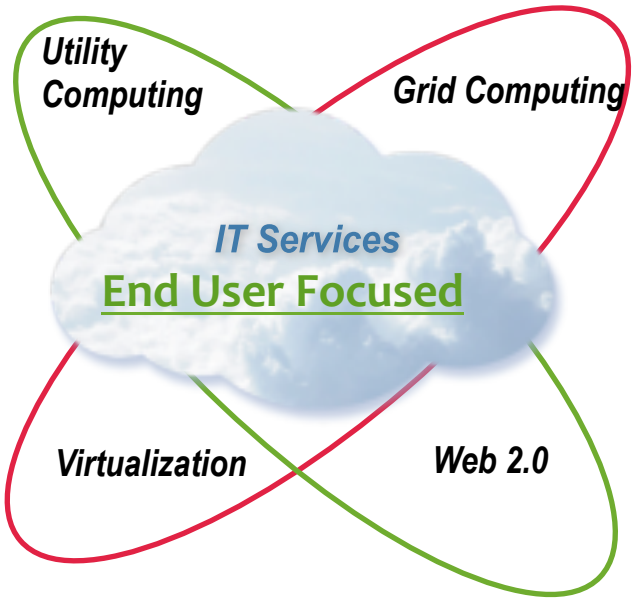
Is cloud computing really new?

NO

- The technology is not new
- Cloud computing is a **buzzword** used to repackage old technologies

YES

- **New consumption and delivery model**
- End user focus of self-service and self-management is new



Traditional IT vs. Cloud Computing

Traditional	Cloud
■ Manually Provisioned	■ Self-Provisioned
■ Dedicated Hardware	■ Shared Hardware
■ Fixed Capacity	■ Elastic Capacity
■ Pay for Capacity	■ Pay for Use
■ Resources & Operational Expenses	■ Operational Expenses
■ Managed via System admins	■ Managed via APIs

What is Cloud Computing?

Definition

- Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction

NIST
National Institute of Standards and Technology

- Cloud computing is Internet-based computing, whereby shared resources, software and information are provided to computers and other devices on-demand, like electricity

WIKIPEDIA
The Free Encyclopedia

Five key cloud characteristics

① Shared / pooled resources

- Resources are retrieved from a common pool

② Broad network access

- Available from anywhere with an internet connection using any platform

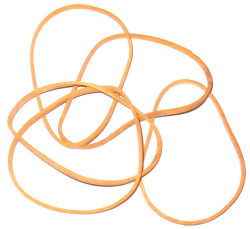
③ On-demand self-service

- Consumer can reserve resources as needed automatically without requiring human interaction with cloud service provider

Five key cloud characteristics

④ Rapid elasticity

- Resources can be rapidly scale up and down as needed to satisfy customer demands
- Fully automated

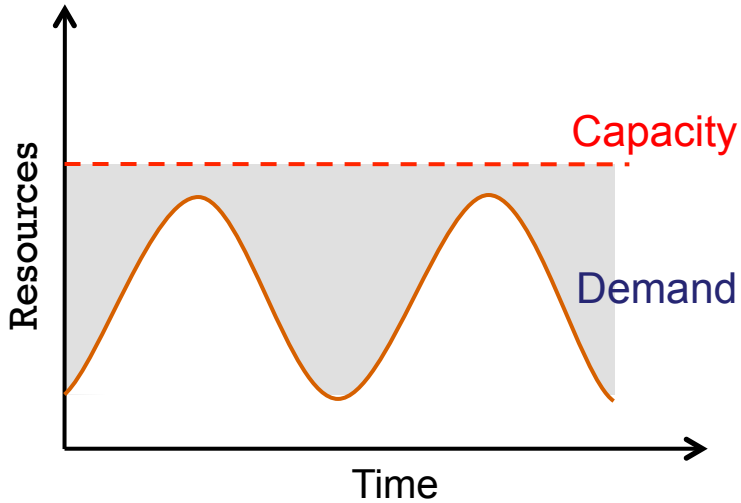


⑤ Pay by use

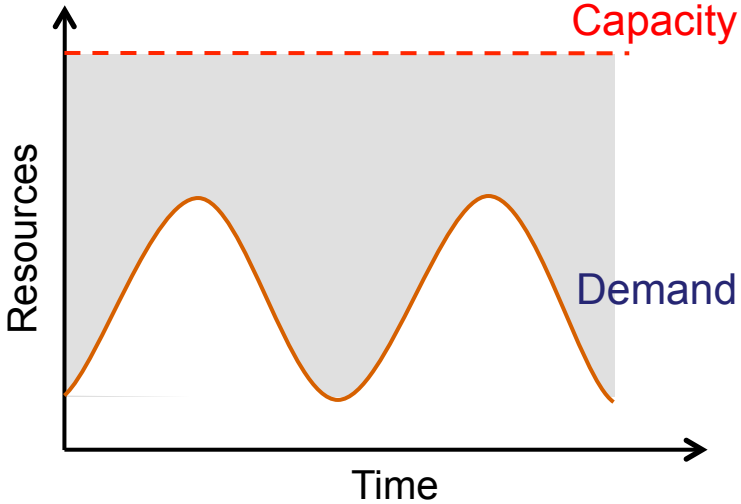
- Services are metered, like a utility
- Users pay only for used services
- Services can be cancelled at any time

Resources Provision

Provisioning for peak



Over-provisioning

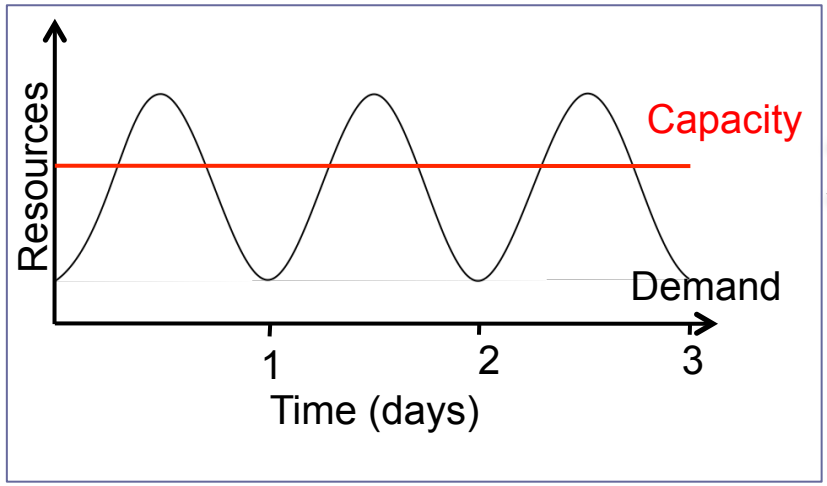


Underutilization !

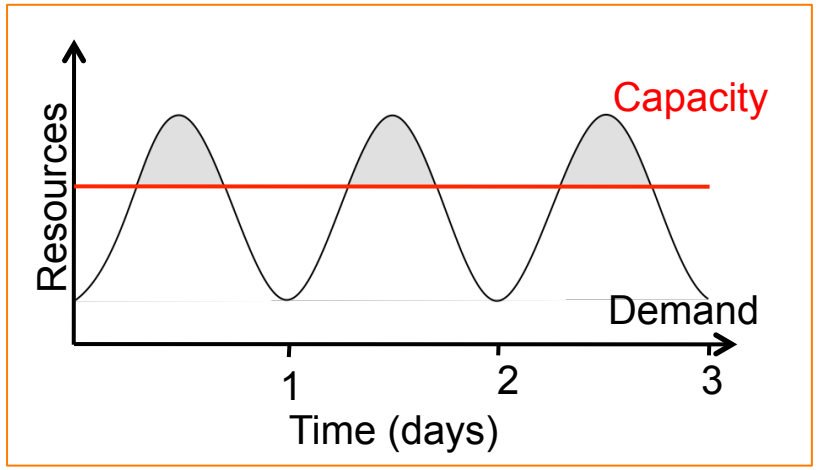
Unused resources

Resources Provision

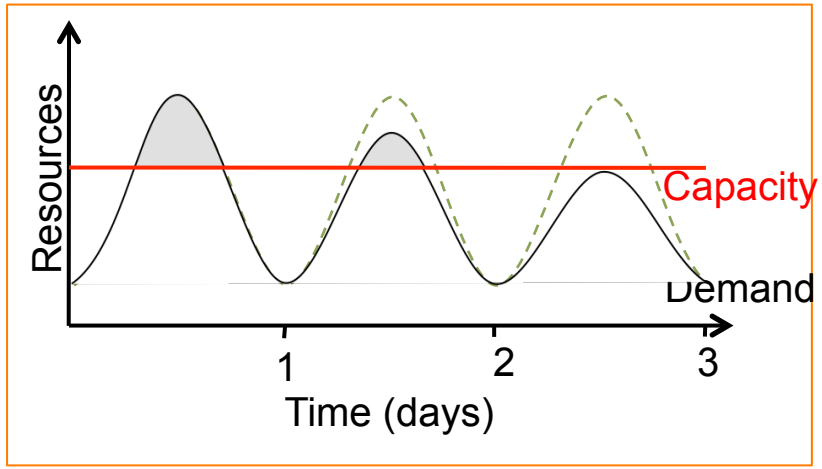
Under-provisioning



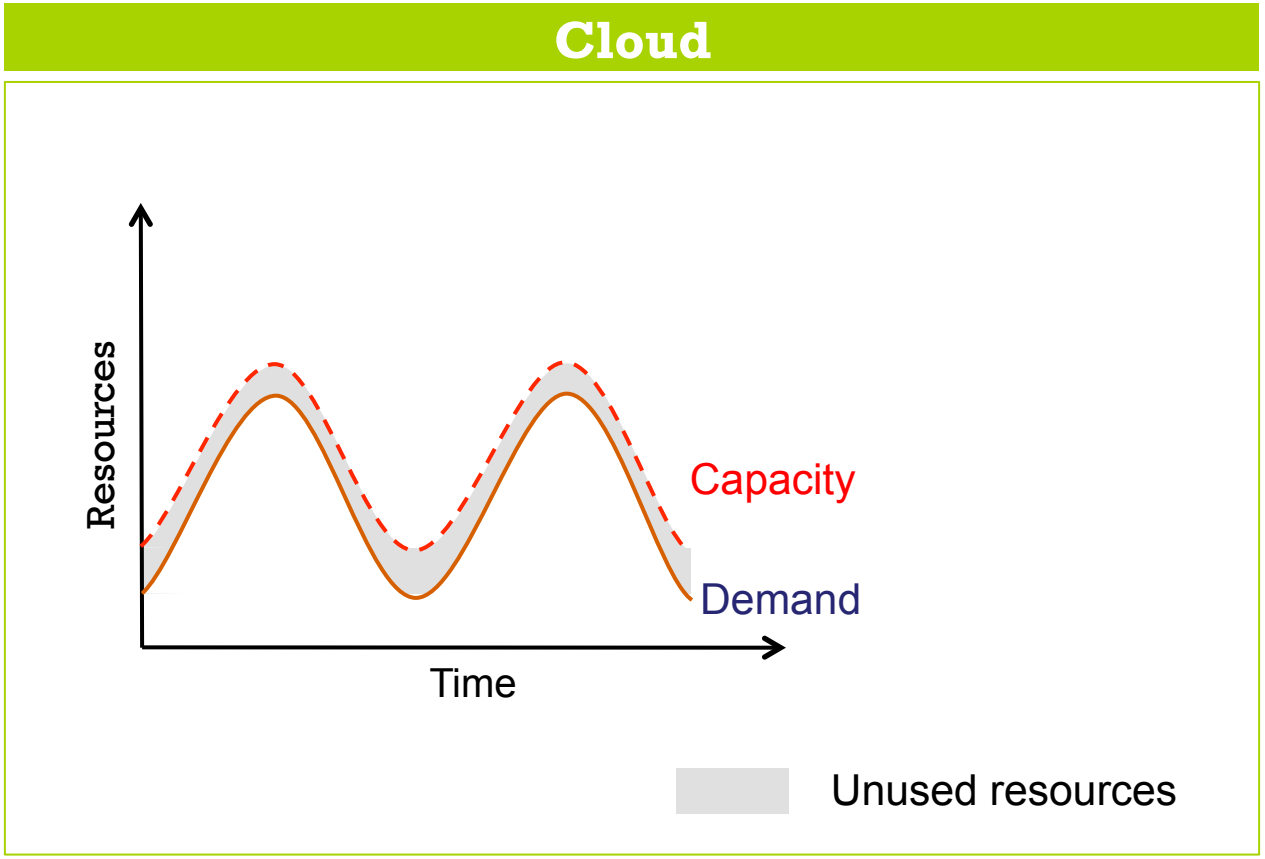
Lost revenue !



Lost users !

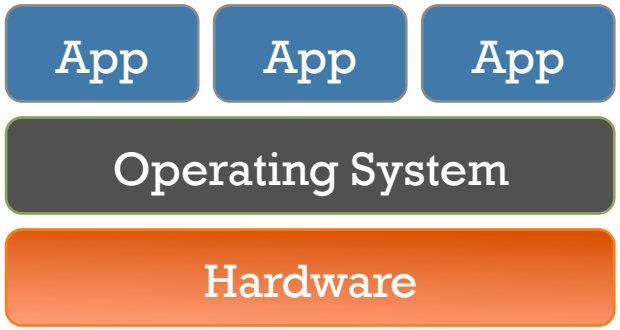


Resources Provision

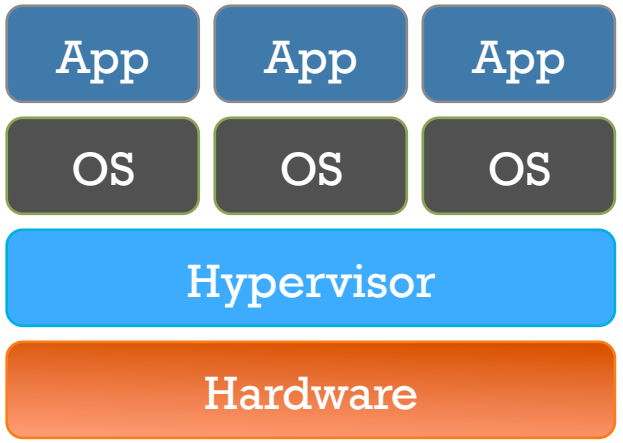


Virtualization

- Abstraction of computing resources
  - A technique for hiding the physical characteristics of computing resources from the way in which systems, applications, or end users interact with those resources



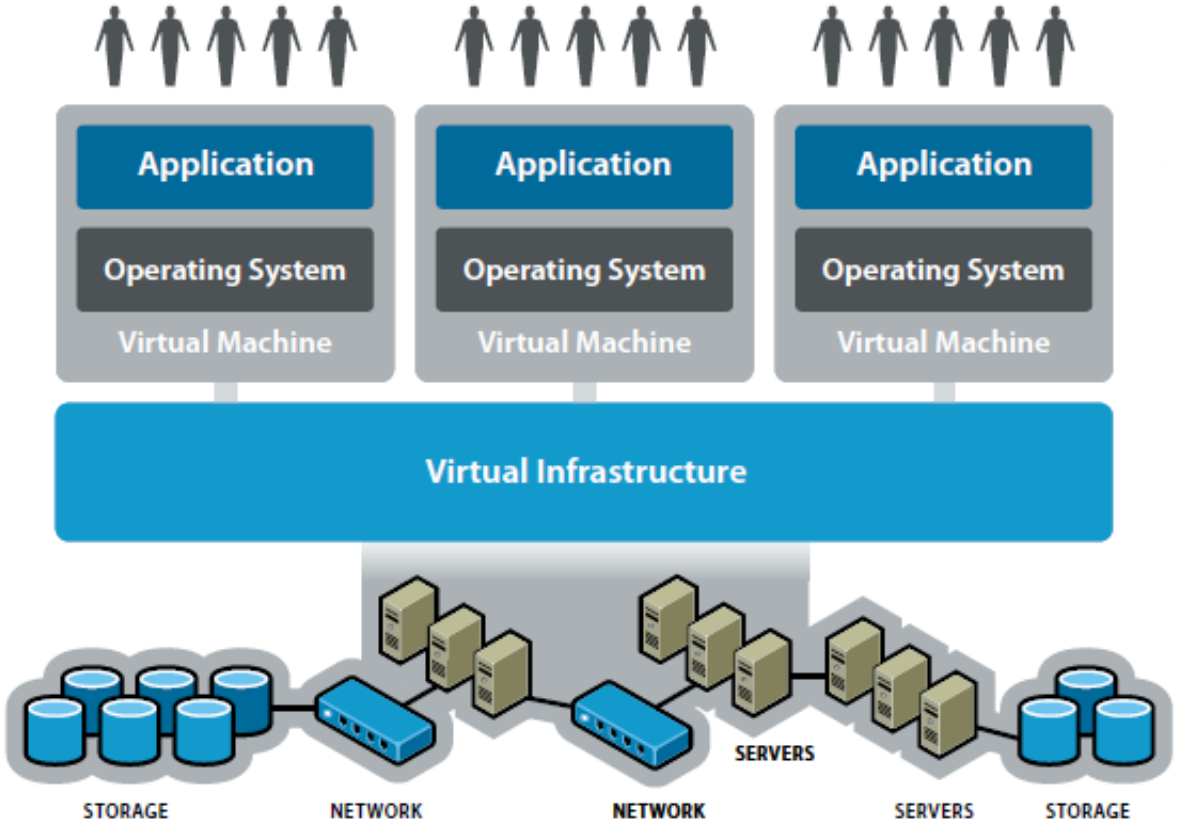
Traditional Stack



Virtualized Stack

Virtualization

- Indispensable ingredient for Cloud Computing



Multi-tenancy

Single-tenancy

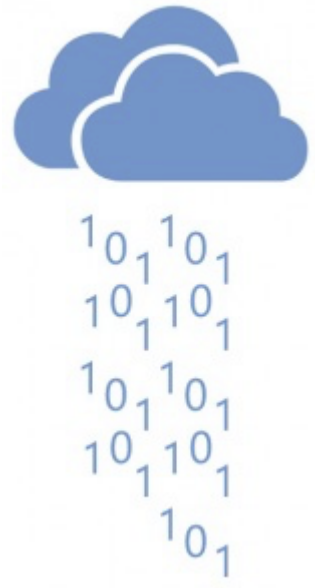
- Each customer has its own software instance;
- Requires a dedicated set of resources to fulfill the needs of just one customer

Multi-tenancy

- Multiple customers (tenants) share the **same application**, on the same hardware, with the same data-storage mechanism
- Analogous to users running various applications on the same operating system
  - share management and hardware costs among a number of tenants

- Multi-tenancy is the fundamental technology that cloud uses to share IT resources cost-efficiently and securely among tenants (businesses, organizations, ...)
- Cloud uses virtualization to isolate tenants, each one doses not share or see each other's data

What can cloud computing provide ?



The layers of IT-as-a-Service

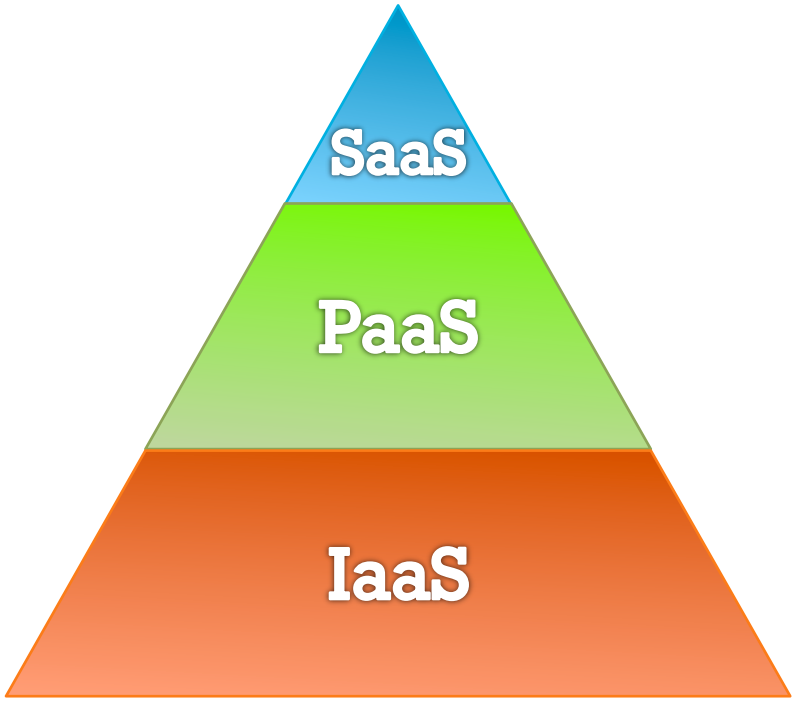
Software as a Service

Platform as a Service

Infrastructure as a Service

Cloud Service Models

- **Software as a Service (SaaS)**
  - **End User** : Just run the software for me!
- **Platform as a Service (PaaS)**
  - **Application developer** : Give us nice API and take care of the implementation
- **Infrastructure as a Service (IaaS)**
  - **System Admin**: Why buy machines when we can rent them?



SaaS

- First, most used and know service of cloud services
- Applications delivered as a service, on demand, to end-users over the Internet, through a browser
- Service includes software, hardware and support
- Software upgrades and other maintenance are performed by the cloud provider, not the end-user
- Users access the service through authorized device

PaaS

- Delivers a computing platform including operating system, programming language execution environment, database, and web server
  - Set of tools and services designed to make coding and deploying SaaS quickly and efficiently
  - Provides all the facilities necessary to support the complete process of building and delivering applications and services, all available over the internet

Google App Engine

IBM Bluemix

Windows Azure

IaaS

- Delivers cloud computing infrastructure, servers, storage, network and operating systems, as an on-demand service.
  - **Fully outsourced service** : rather than purchasing servers, software, datacenter space or network equipment, clients instead buy those resources on demand
  - Resources are distributed as a service
  - Scalable computing resources
  - Variable cost, utility pricing model

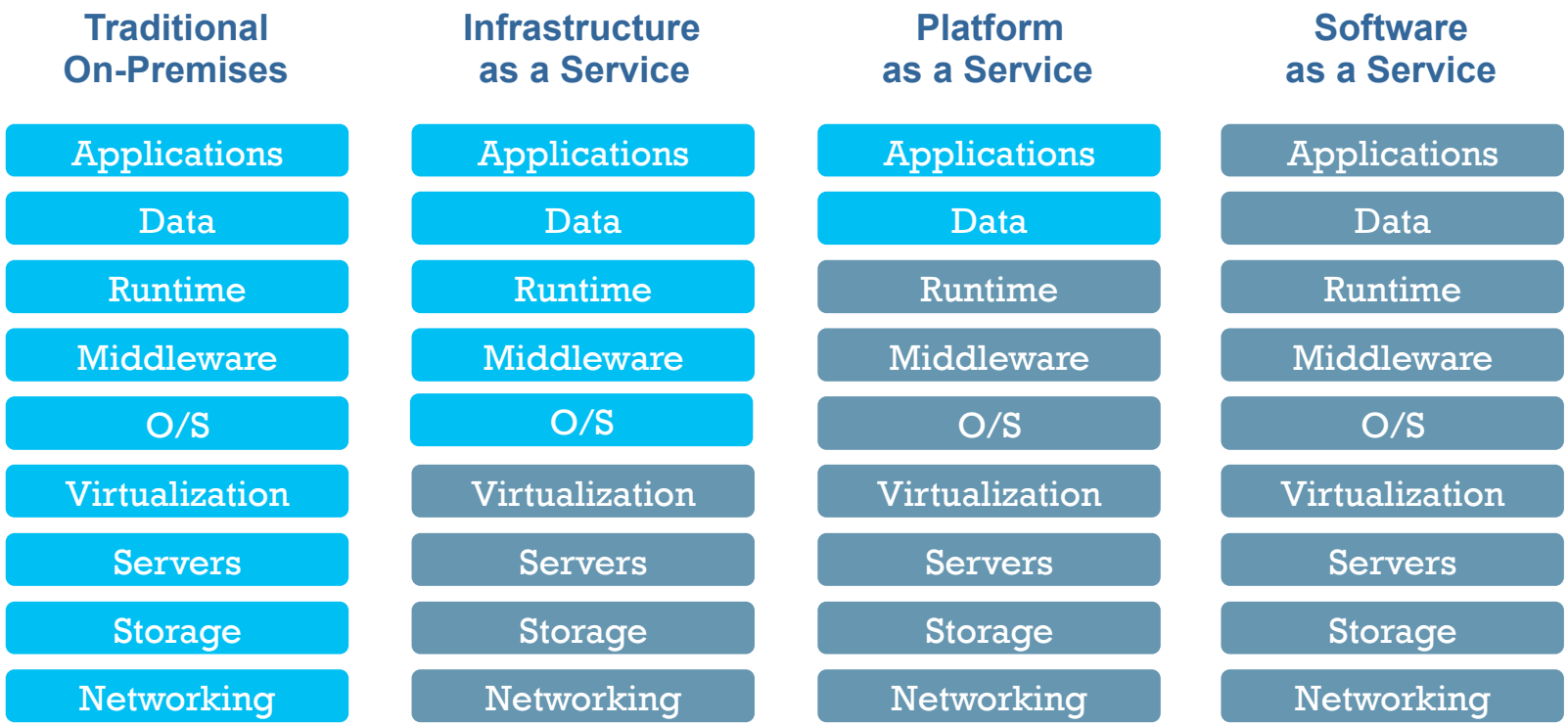
Google Cloud Platform

amazon

Windows Azure

rackspace HOSTING

Workloads


Traditional On-Premises
Applications
Data
Runtime
Middleware
O/S
Virtualization
Servers
Storage
Networking
Infrastructure as a Service
Applications
Data
Runtime
Middleware
O/S
Virtualization
Servers
Storage
Networking
Platform as a Service
Applications
Data
Runtime
Middleware
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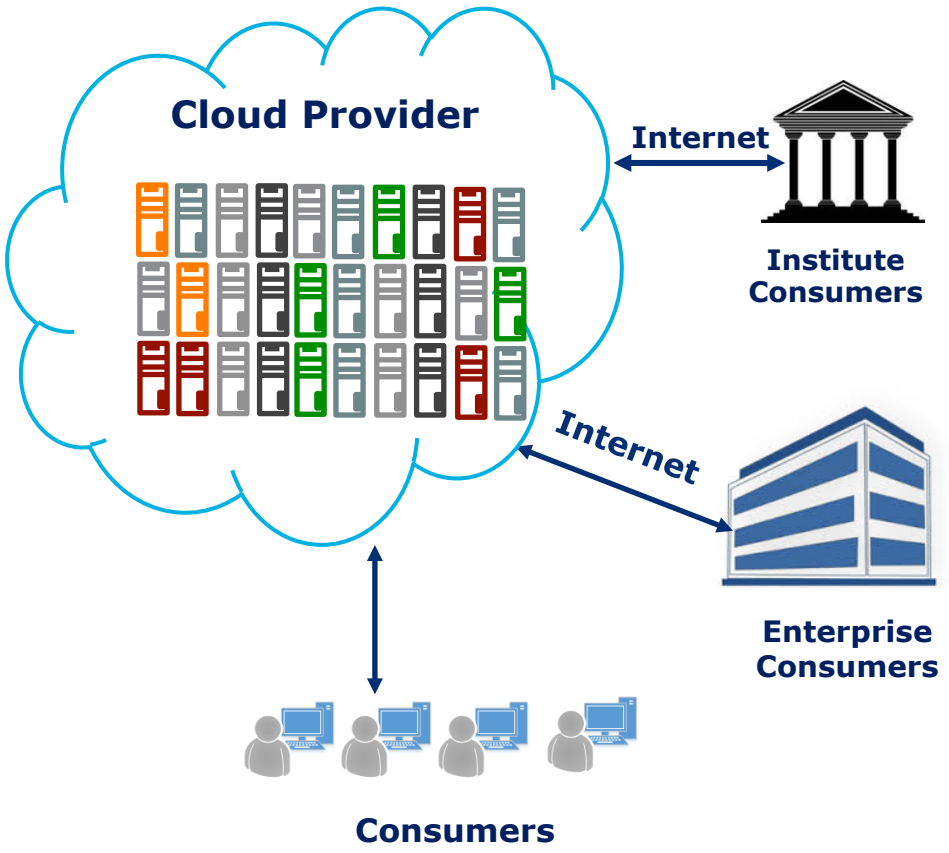
Servers
Storage
Networking
Software as a Service
Applications
Data
Runtime
Middleware
O/S
Virtualization
Servers
Storage
Networking
Vendor Manages in Cloud
Client Manages

Deployments models

- A cloud deployment model represents a specific type of cloud environment, distinguished by ownership, size, and access.
  - Public Cloud
  - Private Cloud
  - Community Cloud
  - Hybrid Cloud

Public Cloud

- Consumer : general public
- Cloud provider : organization selling cloud services and owns and manages the cloud infrastructure
- Resources location : all resources exist on the premises of the cloud provider
- Multi-tenancy model : co-existence of many different consumers in one cloud

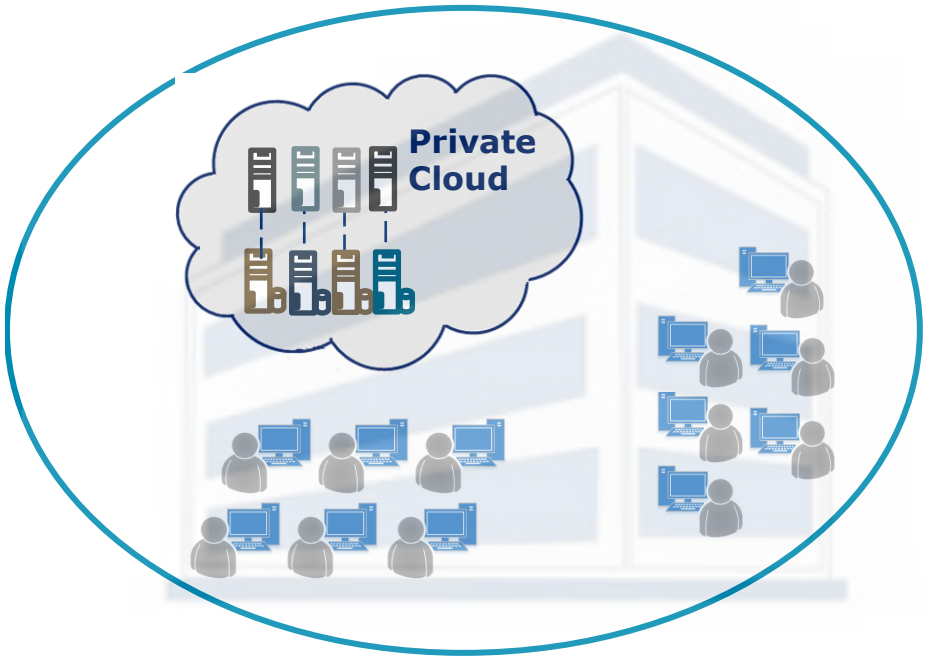


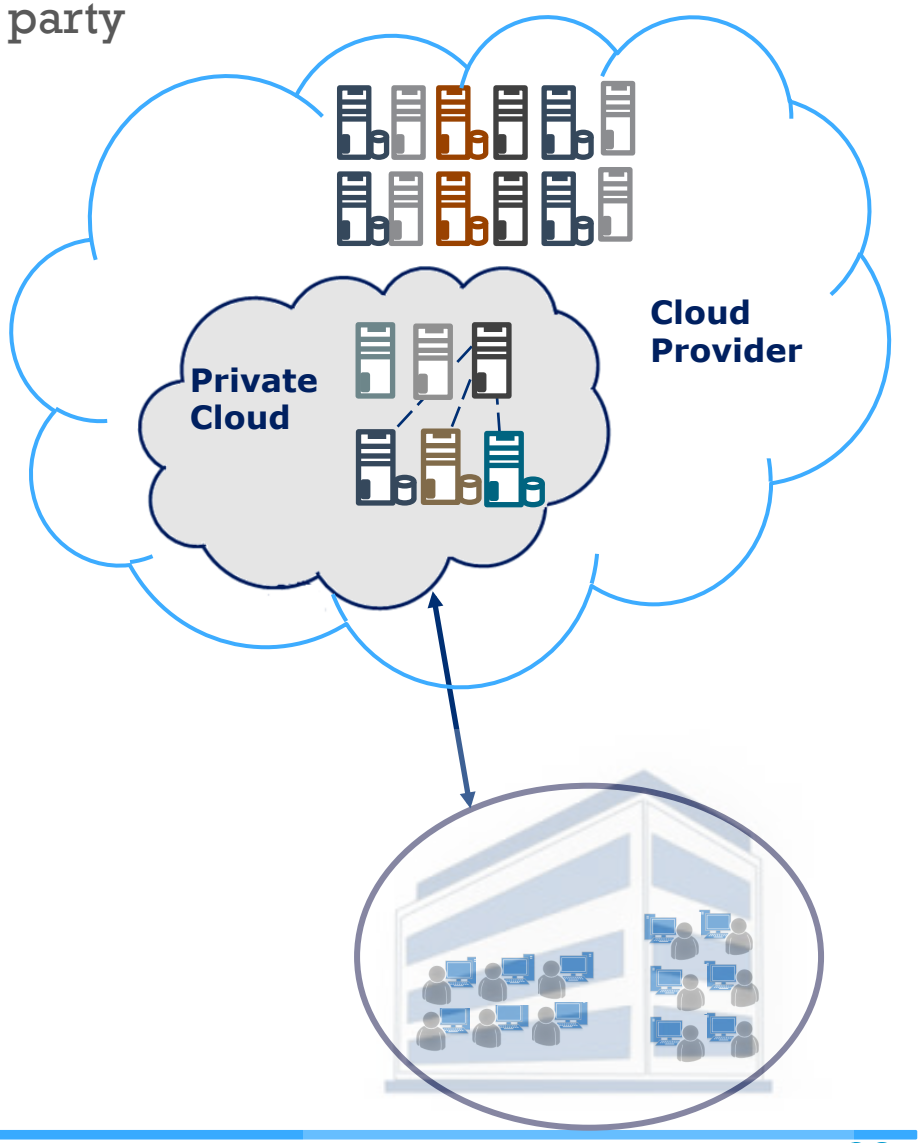
Private cloud

- Consumer : exclusive use of an organization
- Resource could be owned and managed by the consuming organization or another party
- Services are managed and provided within the organization
- Less restriction on network bandwidth, fewer security exposures and other legal requirements compared to the public Cloud

Private Cloud

Off-premises : the organization aims at extending its IT capability by using an exclusive private cloud that is remotely accessible and provisioned by another party

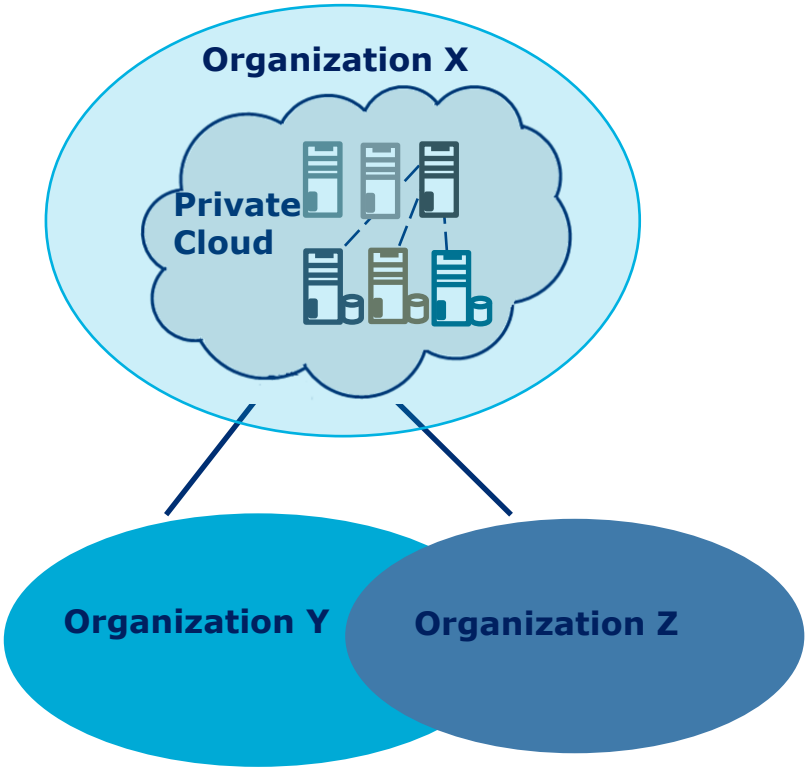




On-premises : the organization doesn't want to remotely host their data, so it uses the cloud to improve its resource utilization and automate the management of such resources

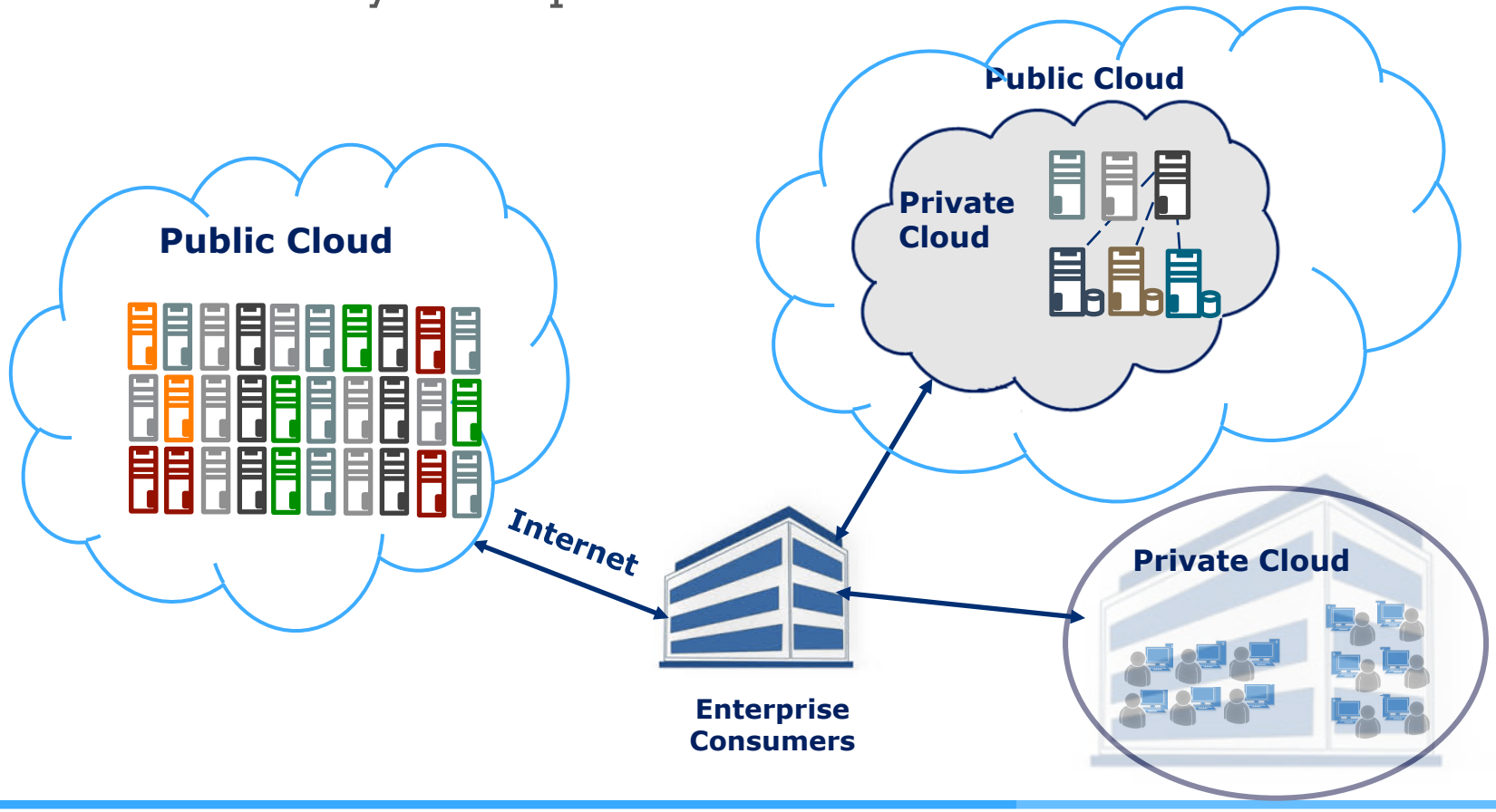
Community Cloud

- A community, composed of one or several organization, shares common concerns such as their **mission**, **policies** and **security** considerations
- The cloud community exposes its resources only to such community
- The cloud is owned and managed by one of the collaborators in the community and it may exist either on or off-premise
- Example : a cloud community for research and academic organizations to conduct large scale scientific experiments (e-science)



Hybrid Cloud

- This model combines multiple clouds : private, community or public that retain their unique identities, but are bound together as a unit
- For instance, an organization may use a public cloud for some aspects of its business and may have a private cloud for its **sensitive data**



Cloud Computing for Education and Research

Challenges in education and research

- Emergence of new communication, collaboration and mobile platforms
- Bring Your Own Device (BYOD) : Students increasingly come to schools and universities with their own mobile devices
- Access to course content and educational services from anywhere and at any time.
- Interactive Multimedia Learning Environments
  - e-Learning platforms, Moodle…
  - MOOC – Massive Open Online Courses
- **Challenges**
  - Important compute resources are required for media (video, voice, …) processing, broadcasting, storing and analysis
  - Traditional educational services and models can not meet these requirements

SaaS for Education and Research

Microsoft® Live@edu

Office 365

PaaS for Education and Research

Google App Engine

IBM Bluemix

Windows Azure

IaaS for Education and Research

IaaS Services

- **IaaS-hosted Virtual Server**
  - **Server** virtualization
  - Research sector and Business Workflow
- **IaaS-hosted Virtual Desktop**
  - **Desktop** virtualization
  - Education sector
- **IaaS-hosted Storage**
  - **Storage** virtualization
  - Education and Research sectors

Benefits of Cloud for Education and Research

- **Cost Saving**
  - The *pay as you go* characteristic of public cloud allows institutions to decrease cost
  - Several educational tools and services such as email, office suite, are offered for free by external providers (like Google and Microsoft)
    - Hardware for such services can be redeployed or removed
    - Personnel costs can be cut or staff redeployed
- **Elasticity**
  - Cloud allows institutions to begin with small-scale services and build them up gradually without significant investment
  - Rapid elasticity in demand at peak times such as at the start of the academic year or during exam periods
  - No need to plan usage levels in advance nor to purchase and deploy additional materials

Benefits of Cloud for Education and Research

- **Availability**
  - Cloud ensures high availability for the host educational services, such as the LMS, Collaboration tools, where any unplanned outage can be devastating and unacceptable
    - Google offers 99.9% availability for its educational application suite and appears to outperform this target
  - Teachers and students increasingly dependent on on-line services for learning and assessment should be offered the best possible availability
  - Data will be accessible from any where and using any device (smartphone, tablets..).

- **Energy efficiency**
  - There are "green" targets for reductions in power usage by organizations
  - Cloud enables educational institutions to reduce their own electricity consumption
  - Cloud providers should be able to optimize power usage over a group of customers following idle resource utilization and advanced cloud power management

Benefits of Cloud for Education and Research

- **Cost of setup and maintenance**
  - Cloud moves the burden of complex new technology and applications setup and maintenance to the cloud service providers
  - Technology setup and maintenance workload make up a large chunk of the time spent by the teachers and faculty members
  - Faculty staff members will be more productive and efficient since they will focus on their core activities (course assessment, experimental environment set up…)
- **End user satisfaction**
  - Students or researchers can use office applications for free without having to purchase, install and keep these applications up to date on their computers
  - No worry about losing data as it should be safely stored in the cloud, with large storage capacity provided for free
  - Data are accessible from any location or from a range of devices such as mobile phones
  - Technologies such as HTML5 and JavaScript will increasingly allow users to work offline when Internet access is intermittent

Risks of cloud computing

- **Data Security**
  - Transferring data to a third party for hosting in a remote data center presents a risk
    - **How secure is the cloud**?
    - Can unauthorized users gain access to your **confidential** data?
  - Strict data protection on laws in some countries restrict the storage of personal data to other countries with which agreements have been signed
- **Single point of failure**
  - Provision of cloud services through a single provider is a single point of failure. It would be better to contract more than one cloud provider in order to minimize risk
    - If compute or storage servers go down, all supported services and data are affected.

Risks of cloud computing

- **Network Dependency**
  - Cloud access is dependent on the Internet availability
  - It does not work well with low-speed connections
    - A low-speed Internet connection makes cloud computing painful at best and often impossible
- **Vendor lock-in**
  - Lack of interoperability: Major actors offer solutions that are platform-dependent with proprietary software or hardware

Guidelines for selection and deployment of CC

- **Functionality required by users**
  - Specify the functionalities required by users including mailing, storage, total allocation per user
  - It is also helpful to assess the level of interoperability between the different applications provided within a product suite.

- **Technical issues**
  - Automating the creation of user accounts on the cloud system based on data of student information systems or facilitate single sign-on across systems. There may also be a necessity to monitor usage, remove accounts or perform other systems management activities

Guidelines for selection and deployment of CC

- **User experience**
  - Some systems may provide a better overall user experience than others. Usability is important, a necessity to install any additional software to the web browser may make the software less attractive
- **Contract**
  - The provider will have a standard contract (Service Level Agreement) which should be studied closely (initial term of the contract, penalties for early withdrawal, costs and future potential costs, support,…)
- **Costs**
  - While costs for cloud services may appear minimal or even non-existent, the real costs to institutions can be considerable. It is helpful to estimate costs for any legal advice associated with the contractual negotiations, project and change management, technical integration and staffing an institutional helpdesk.

Conclusion

- Cloud Computing is outpacing the IT industry
- Cloud solutions are simple to acquire, don't require long term contracts and are easier to scale up and down as needed
- Monitoring services ensure customers are getting the most of their cloud environment
- Institutions can cut an important part of their IT budget by moving applications to the cloud.
- Institutions must first develop a comprehensive cloud-computing strategy that addresses the challenges to make a smooth transition and optimal outcomes
- Proper planning and migration services are needed to ensure a successful implementation
- Public and Private Clouds can be deployed together to leverage the best of both


Thank You