
Distributed systems – Techs

12. Cloud Computing

Motto: “The computer industry is the only industry that is more fashion-driven than women’s fashion” [Oracle]

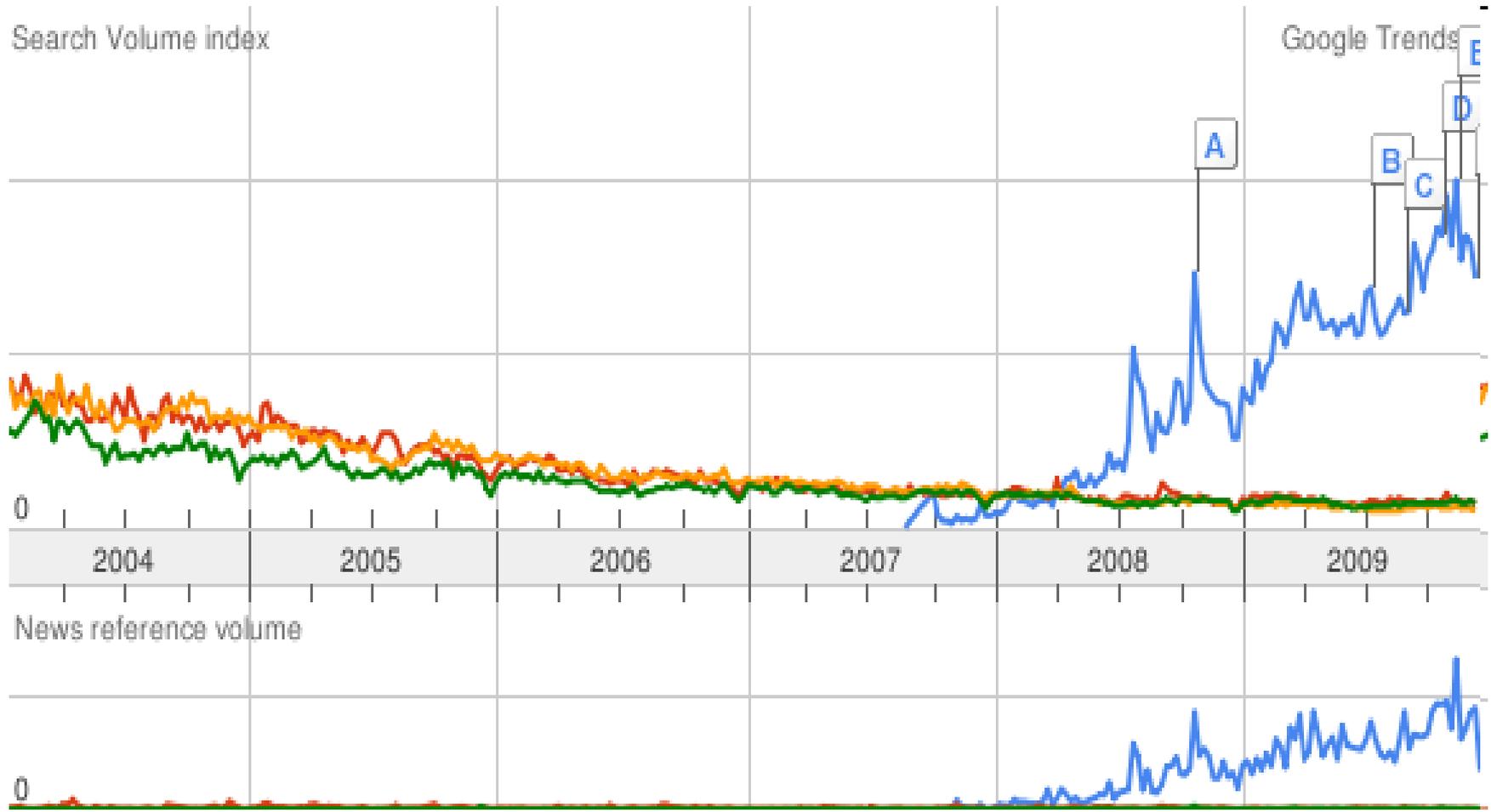
Cloud computing (CC) a buzzword?

cloud computing

grid computing

peer-to-peer

distributed systems



What is Cloud Computing?



- Ask ten different professionals what cloud computing is, and you'll get ten different answers!
 - CC is everywhere!
 - Gets its name as a metaphor for the Internet.
 - Typically, the Internet is represented in network diagrams as a cloud
 - Cloud icon represents “all that other stuff” that makes the network work
 - Promise:
 - To cut operational and capital costs
 - Let IT departments focus on strategic projects instead of keeping the datacenter running.
 - *In essence*,
 - is a construct that allows you to access applications that actually reside at a location other than your computer or other Internet-connected device
 - the use of computer technology that harnesses the processing power of many inter-networked computers while concealing the structure that is behind it
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Understanding CC

- ? How to increase capacity or add capabilities to their infrastructure dynamically without
 - investing money in the purchase of new infrastructure
 - needing to conduct training for new personnel
 - the need for licensing new software
 - CC gives a solution to the aforementioned needs!
 - Cloud computing models
 - encompass a subscription-based or pay-per-use paradigm
 - provide a service that can be used over the Internet
 - extends an IT shop's existing capabilities.
 - approach provides a return on investment
 - Cloud service:
 - The service is accessible via a web browser (nonproprietary) or web services API.
 - Zero capital expenditure is necessary to get started.
 - You pay only for what you use as you use it.
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NIST definition

Cloud computing

is a pay-per-use model

for enabling available, convenient, on-demand
network access

to a shared pool of configurable computing
resources (e.g., networks, servers, storage,
applications, services)

that can be rapidly provisioned and released with
minimal management effort or service-provider
interaction.

Key characteristics (1/2)

1. *On-demand self-service*

- A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed without requiring human interaction with each service's provider.

2. *Ubiquitous network access.*

- Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).

3. *Location-independent resource pooling.*

- The provider's computing resources are pooled to serve all consumers using a multitenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.
 - The customer generally has no control over or knowledge of the exact location of the provided resources.
 - Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.
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Key characteristics (2/2)

4. *Rapid elasticity.*

- Capabilities can be rapidly and elastically provisioned to quickly scale up, and rapidly released to quickly scale down.
- To the consumer, the capabilities available for rent often appear to be infinite and can be purchased in any quantity at any time.

5. *Pay per use.*

- Capabilities are charged using a metered, fee-for-service, or advertising-based billing model to promote optimization of resource use.
- Examples are measuring the storage, bandwidth, and computing resources consumed and charging for the number of active user accounts per month.
- Clouds within an organization accrue cost among business units and may or may not use actual currency.

Other benefits

- Reduced implementation and maintenance costs
 - Increased mobility for a global workforce
 - Flexible and scalable infrastructures
 - Quick time to market
 - IT department transformation (focus on innovation vs. maintenance and implementation)
 - “Greening” of the data center
 - Increased availability of high-performance applications to small/medium-sized businesses
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Cloud components

1. Clients

- ❑ Mobile, terminals or regular computers
- ❑ Benefits: Lower hardware costs, Lower IT costs, Security, Data security, Less power consumption, Ease of repair or replacement, Less noise

2. Data centers

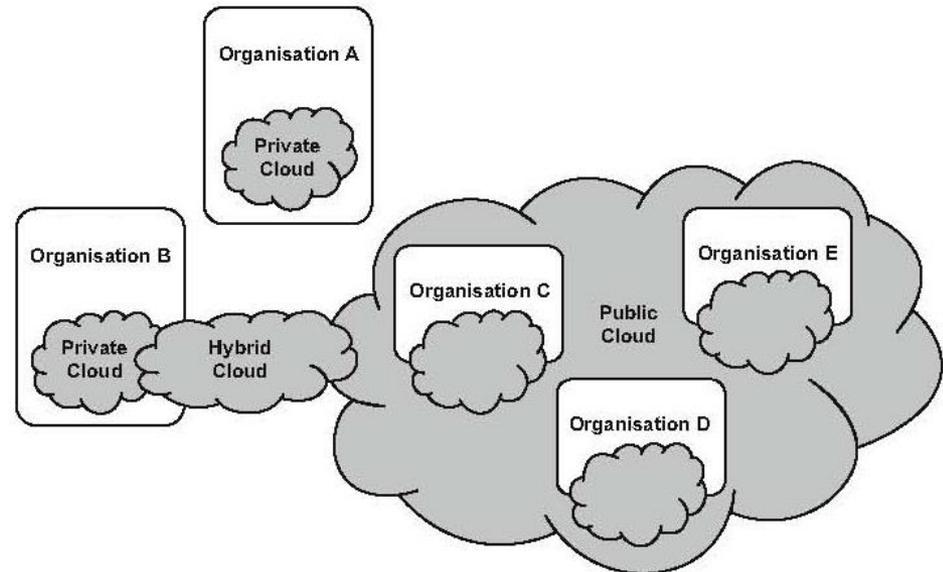
- ❑ collection of servers where the application to subscribe is housed
- ❑ could be a large room in the basement of your building or a room full of servers on the other side of the world
- ❑ virtualizing servers: software can be installed allowing multiple instances of virtual servers to be used
 - a dozen virtual servers can run on one physical server.

3. Distributed servers

- ❑ servers don't all have to be housed in the same location
 - can be in geographically disparate locations
 - ❑ if something were to happen at one site, causing a failure, the service would still be accessed through another site
 - ❑ If the cloud needs more hardware, they can add them at another site
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Types of Clouds

- *Private cloud*
 - owned or leased by a single organization and is operated solely for that organization.
- *Community cloud*
 - shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations).
- *Public cloud*
 - owned by an organization selling cloud services to the general public or to a large industry group.
- *Hybrid cloud*
 - a composition of two or more clouds (internal, 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).



Utility computing vs. Cloud computing

- 1961, John McCarthy suggested that
 - computer time-sharing technology might lead to a future where computing power and even specific applications might be sold through a utility-type business mode
 - This idea became very popular in the late 1960s, but by the mid-1970s the idea faded away when it became clear that the IT-related technologies of the day were unable to sustain such a futuristic computing model.
 - Since the turn of the millennium, the concept has been revitalized.
- *Utility computing* can be defined as the provision of computational and storage resources as a metered service, similar to those provided by a traditional public utility company
- Some people believe that CC it is just another variation of the utility computing model that has been repackaged in this decade as something new and cool
- Utility model may become outdated
 - with CC vendors are able to provide so much more to their customers: they have more flexibility and can offer more services in one than utilities would be able to.

Grid computing vs. cloud computing

- GC applies the resources of numerous computers in a network to work on a single problem at the same time
 - Usually done to address a scientific or technical problem.
 - Use software that can divide and then send out pieces of the program to thousands of computers
 - In GC, a large project is divided among multiple computers to make use of their resources
 - GC is a form of distributed computing that implements a *virtual supercomputer* made up of a cluster of networked or Internetworked computers acting in unison to perform very large tasks.
 - CC
 - allows multiple smaller applications to run at the same time
 - should be seen as an evolved next step away from the grid utility model
 - there is a growing list of providers that have successfully used cloud architectures with little or no centralized infrastructure or such as the P2P networks or volunteer computing initiatives
 - the server environment does not necessarily need to be high end
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CC brings improvements (1/2)

- Lower barriers to entry in the marketplace
 - Service offerings are most often made available to specific consumers and small businesses that see the benefit of use because their capital expenditure is minimized.
 - The infrastructure used to provide these offerings is owned by the cloud service provider and need not be purchased by the customer.
 - Users are not tied to a specific device (they need only the ability to access the Internet) and Internet allows for location independence,
 - use of the cloud enables CC service providers' customers to access cloud-enabled systems regardless of where they may be located or what device they choose to use.
 - Multitenancy enables sharing of resources and costs among a large pool of users - key benefits:
 - Centralization of infrastructure and lower costs
 - Increased peak-load capacity
 - Efficiency improvements for systems that are often underutilized
 - Dynamic allocation of CPU, storage, and network bandwidth
 - Consistent performance that is monitored by the provider of the service
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CC brings improvements (2/2)

- Reliability is often enhanced in CC environments
 - service providers utilize multiple redundant sites.
 - attractive to enterprises for business continuity and disaster recovery reasons
 - Scalability
 - can vary dynamically based on changing user demands
 - Security
 - Service provider manages the necessary infrastructure, security often is vastly improved
 - As a result of data centralization, there is an increased focus on protecting customer resources maintained by the service provider
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Services in Cloud computing

- Service in CC: the concept of being able to use reusable, fine-grained components across a vendor's network.
 - “as a service.”
 - Offerings:
 - Low barriers to entry, making them available to small businesses
 - Large scalability
 - Multitenancy allowing resources to be shared by many users
 - Device independence, which allows users to access the systems on different hardware
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Software as a Service (SaaS)

- Model in which an application is hosted as a service to customers who access it via the Internet
 - The provider does all the patching and upgrades as well as keeping the infrastructure running
 - The traditional model of software distribution, in which software is purchased for and installed on personal computers, is referred to as Software-as-a-Product.
 - Delivers apps through a browser to thousands of customers using a multiuser architecture
 - The focus for SaaS is on the end user as opposed to managed services
 - Types of software that lend themselves to the SaaS model
 - Typically, software that performs a simple task without much need to interact with other systems
 - For customers who are not inclined to perform software development but have need of high-powered applications
 - Also known as Application-as-a-service (AaaS),
 - application that is delivered over the platform of the Web to an end user, typically leveraging the application through a browser.
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SaaS apps and examples

- Applications include

- Customer resource management (CRM)
- Video conferencing
- IT service management
- Accounting
- Web analytics
- Web content management

- Examples:

- office automation applications, e.g. Google Apps including Google Docs, Gmail, and Google Calendar
- managed services - application that is accessible to an organization's IT infrastructure rather than to end users
 - virus scanning for email, antispam services such as Postini
 - desktop management services such as CenterBeam or Everdream
- Enterprise applications such as Salesforce SFA
 - Application developers are using the Force.com platform to build core business applications, like enterprise resource planning (ERP), Human Resource Management (HRM), and supply chain management (SCM).

Organisation	Cloud Service
fluidOps	eCloudManager SAP Edition
Google	Google Docs
Google	Google Maps API
Google	OpenSocial
OpenID Foundation	OpenID
Microsoft	Office Live
Salesforce	Salesforce.com

Key characteristics of SaaS

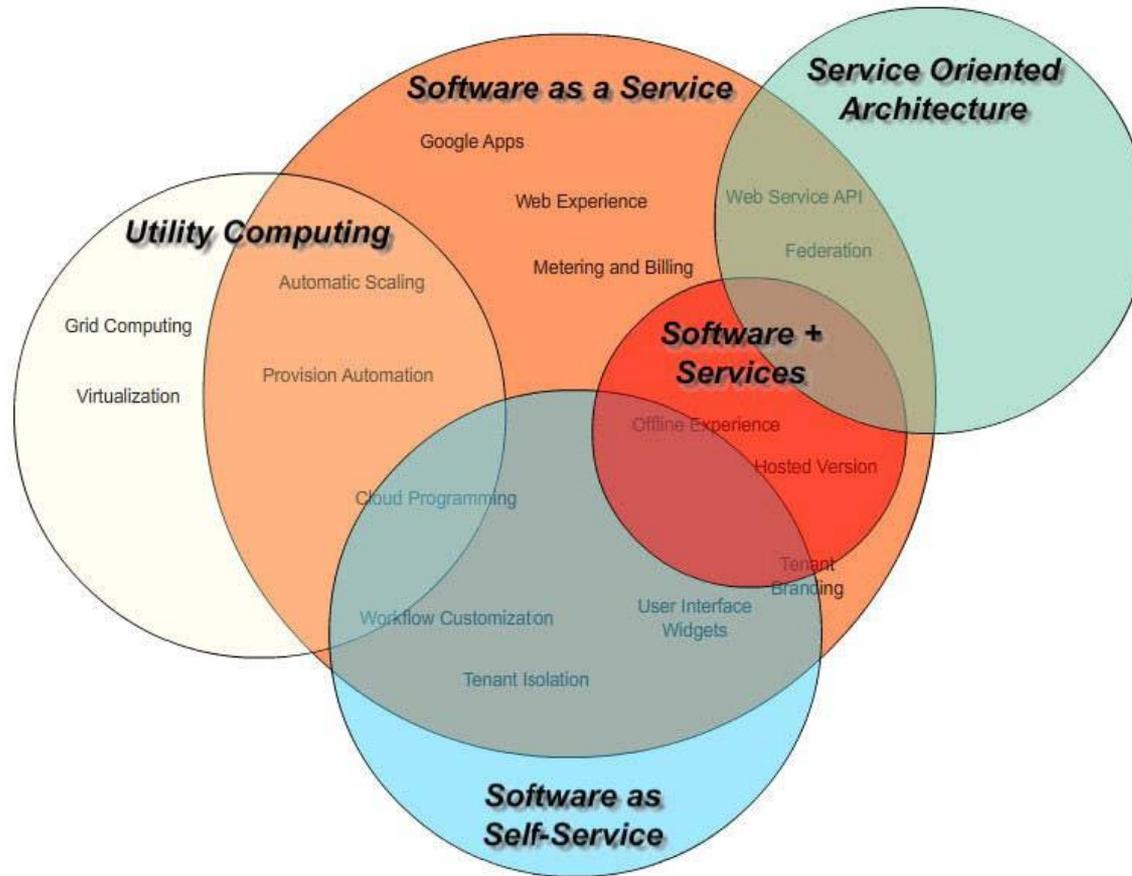
■ Characteristics

1. Software applications or services are stored remotely
2. A user can then access these services or software applications via the Internet
3. In most cases, a user does not have to install anything onto their host machine,
 - all they require is a web browser to access these services
 - in some cases, a browser may require additional plug-in/add-on for certain services
4. Network-based manag & access to commercially available software from central locations
 - rather than at each customer's site,
 - enabling customers to access applications remotely via the Internet
 - Centralized enhancement and patch updating
5. Application delivery from a one-to-many model,
 - as opposed to a traditional one-to-one model.
 - single-instance, multitenant architecture

- ## ■ Level of maturities: Ad-hoc/Custom, Configurability, Multitenant efficiency, Scalable
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Related forms with SaaS

http://www.theartofservice.net/UserFiles/Flash/cloud_computing.swf



SaaS vs. Software + Service (S+S)

■ SaaS

- involves making an application an entirely hosted one, which resides remotely outside of an organization's internal infrastructure.

■ Software plus Service

- something of a middle ground technology,
 - it provides the complete functionality of traditional software applications but also the benefits of external hosted software applications.
 - achieved by installing an application in a traditional way, where they reside on a machine locally but by also complementing them with remote services
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SaaS vs. ASP (Application Service Providers)

- two terms that are often used to describe the same thing: the delivery of outsourced software applications via the Internet
 - SaaS and ASP are very similar to one another
- SaaS developed from ASPs
 - ASPs first created the outsourced software delivery model
 - ASP software delivery model first started being implemented during the early 90s
- ASP was not very successful
 - each clients' applications or set of applications would require their own mini-data centre within an ASPs premises
 - require massive data centers if they were going to host software applications for many clients
 - ASPs just could not provide any help or documentation for each one of their clients' software applications.
 - Clients keep their software applications in-house
- SaaS is different
 - in the way that they are designed to be delivered
 - ASPs delivered their software applications on a one-to-one basis to their customers.
 - SaaS software services & applications are designed to be delivered to multiple customers.
 - cheaper upfront costs when compared to the ASP software delivery model
 - ASP is only hosting a single copy of the software applications for the client
 - SaaS providers can provide same set of services or software applications to many users.

Interest of the parties in SaaS

- For the customer, there are no up-front investment costs in servers or software licensing.
 - rather than pay for it once and be done with it, the more you use it, the more you'll be billed.
 - in some cases you don't have to pay as much up front and you are only billed based on your use of the application.
 - For vendors, SaaS has the appeal of providing
 - stronger protection of their intellectual property
 - creating a continuous stream of income.
 - for the service provider, with just one product to maintain, costs are relatively low compared to the costs incurred with a conventional hosting model.
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Benefits of SaaS

- Streamlined administration
- Automated update and patch management services
- Data compatibility across the enterprise (all users have the same version of software)
- Facilitated, enterprise-wide collaboration
- Global accessibility
- Familiarity with the WWW
- Smaller staff IT
- Customization
- Better marketing
- Web reliability
- Security Secure Sockets Layer
- More bandwidth

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Platform as a Service (PaaS)

- Another application delivery model
 - Known also
 - cloudware
 - web services in the cloud
 - Supplies all the resources required to build applications and services completely from the Internet, without having to download or install software
 - Services include:
 - application design, development, testing, deployment, and hosting.
 - team collaboration, web service integration, database integration, security, scalability, storage, state management, and versioning.
 - PaaS is closely related to SaaS but delivers a platform from which to work rather than an application to work with
 - Offer APIs that enable developers to exploit functionality over the Internet, rather than delivering full-blown applications
 - Delivers development environments to programmers, analysts, and software engineers as a service
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PaaS

- Example: Google App Engine, Eucalyptus
 - APIs
 - offers some support to help the creation of user interfaces, and is normally based on HTML or JavaScript.
 - designed with that sort of use in mind, and generally provides automatic facilities for concurrency management, scalability, failover, and security.
 - supports web development interfaces such as SOAP and REST which allow the construction of multiple web services, sometimes called mashups
 - the interfaces are also able to access databases and reuse services that are within a private network
 - A general model is implemented under which developers build apps
 - designed to run on the provider's infrastructure
 - delivered to users in via an Internet browser.
 - Downfall: a lack of interoperability and portability among providers
 - if you create an appl with one cloud provider & decide to move to another, you may not be able to do so or you'll have to pay a high price
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Examples

Organisation	Cloud Service
Akamai	EdgePlatform
Facebook	Facebook Platform
Google	App Engine
Microsoft	Azure
Microsoft	Live Mesh
NetSuite	SuiteFlex
Salesforce	Force.com
Sun	Project Caro- line
Zoho	Zoho Creator

PaaS

- Found in one of three different types of systems:
 - Add-on development facilities - these allow existing SaaS applications to be customized
 - Stand-alone environments - these environments do not include licensing, technical, or financial dependencies on specific SaaS apps and are used for general developments
 - Application delivery-only environments - these environments support hosting level services, like security and on-demand scalability.
 - They do not include development, debugging, and test capabilities.
 - Factors influencing adoption include
 - ability of geographically isolated development teams to work together
 - ability to merge web services from multiple sources
 - ability to realize cost savings from using built-in services for security, scalability, failover
 - ability to realize cost savings from using higher-level prog. abstractions
 - Obstacle:
 - vendors use proprietary services or development languages => locked into a single provider
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Infrastructure as a Service (IaaS or HaaS)

- Hardware as a Service (HaaS)
 - SaaS and PaaS are providing apps to customers, HaaS doesn't.
 - It offers the hardware so that your organization can put whatever they want onto it
 - Rather than purchase servers, software, racks, and having to pay for the datacenter space for them, the service provider rents those resources:
 - Server space
 - Network equipment
 - Memory
 - CPU cycles
 - Storage space
 - Examples: Amazon EC2, Rackspace Mosso, GoGrid
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Examples

Organisation	Cloud Service
Amazon	Elastic Compute Cloud (EC2)
Amazon	Dynamo
Amazon	Simple Storage Service (S3)
Amazon	SimpleDB
Amazon	CloudFront
Amazon	SQS
AppNexus	AppNexus Cloud
Bluelock	Virtual Cloud Computing
Bluelock	Virtual Recovery
Dropbox	Dropbox Cloud Storage
Emulab	Emulab Network Testbed
ENKI	Virtual Private Data Centers
Reservoir	Open Nebula
FlexiScale	FlexiScale Cloud Computing
GoGrid	Cloud Hosting
GoGrid	Cloud Storage
Google	Google Big Table
Google	Google File System
HP	iLO
HP	Tycoon

Organisation	Cloud Service
Joyent	Accelerator
Joyent	Connector
Joyent	BingoDisk
Nirvanix	Storage Delivery Network
Openflow	OpenFlow
Rackspace	Mosso Cloud Sites
Rackspace	Mosso Cloud Storage
Rackspace	Mosso Cloud Servers
Skytap	Skytap Virtual Lab
Terremark	Infinistructure
Globus	Nimbus
todo GmbH	flexIT
UCSB	Eucalyptus
Zimory	Zimory Public Cloud Market
Zumodrive	Hybrid Cloud Storage
10gen	Mongo DB
10gen	Babble Application Server

HaaS needs and benefits

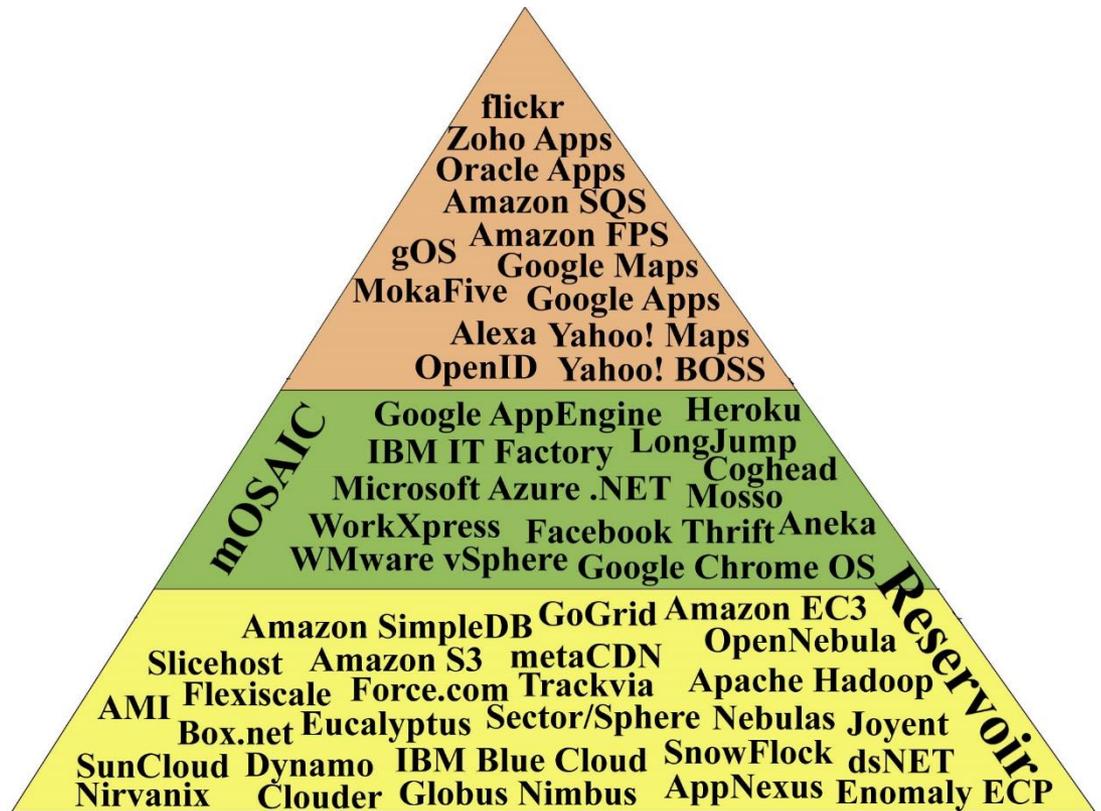
- Needs:
 - Service level agreements
 - Computer hardware
 - Network
 - Internet connectivity
 - Platform virtualization environment
 - Utility computing billing
 - Benefits:
 - The infrastructure can be dynamically scaled up or down, based on th application resource needs.
 - Multiple tenants can be on the equipment at the same time.
 - Resources are typically billed based on a utility computing basis, so providers charge by how many resources are consumed.
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Virtualization

- Relevant to CC because it is one of the ways in which you will access services on the cloud
 - the remote datacenter may be delivering services in a virtualized format
 - Full virtualization has been successful for several purposes:
 - Sharing a computer system among multiple users
 - Isolating users from each other and from the control program
 - Emulating hardware on another machine
 - the entire system is emulated (BIOS, drive etc)
 - Paravirtualization
 - Allows multiple OSs to run on a single hardware device at the same time by more efficiently using system resources, like processors and memory
 - The management module operates with an OS that has been adjusted to work in a VM
 - Runs better than the full virtualization model:
 - in a fully virtualized deployment, all elements must be emulated.
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The Cloud pyramid

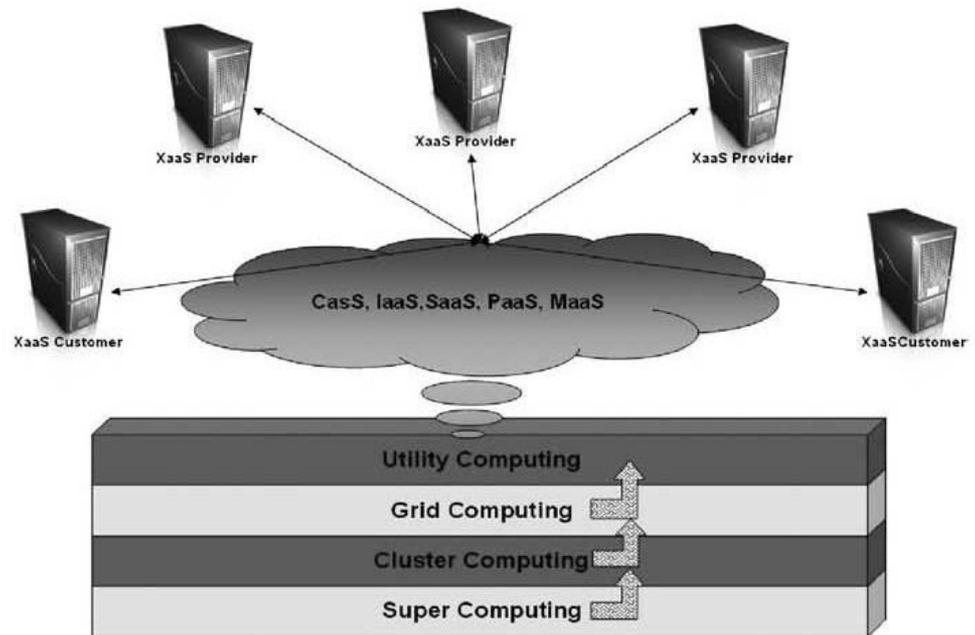
- Bottom: IaaS
- Middle: PaaS
- Top: SaaS



Anything as a Service (XaaS)

- Storage as a Service
- Database as a Service
- Communication as a Service
- Network as a Service
- Monitoring as a Service
- Testing as a Service
- HPC as a Service
- Human as a Service
- Process as a Service
- Information as a Service
- Identity as a Service
- Application as a Service
- Integration as a Service
- Governance as a Service
- Security as a Service
- Backup as a Service

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Storage as a Service

- Also known as disk space on demand
 - The ability to leverage storage that physically exists at a remote site but is logically a local storage resource to any application that requires storage.
 - Means that a third-party provider rents space on their storage to end users who lack the budget or capital budget to pay for it on their own
 - Ideal when
 - technical personnel are not available or
 - have inadequate knowledge to implement and maintain that storage infrastructure
 - Given the complexity of current backup, replication, and disaster recovery needs, the service has become popular
 - Hundreds of cloud storage providers on the Web,
 - more seem to be added each day.
 - The biggest advantage is cost savings:
 - Storage rented from provider using a cost-per-gigabyte-stored or per-data-transferred model
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Examples of specialized providers

- Google Docs
 - Web email providers like Gmail, Hotmail, and Yahoo! Mail
 - Flickr and Picasa
 - YouTube
 - Hostmonster and GoDaddy store files and data for many client web sites.
 - Facebook and MySpace are social networking sites
 - MediaMax and Strongspace offer storage space for any kind of digital data.
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Database as a Service (DaaS)

- Databases: repositories for information with links within the information that help make the data searchable.
 - Distributed databases, like Amazon's SimpleDB, spread information among physically dispersed hardware
 - To the client, the information seems to be located in one place.
 - Idea behind DaaS is to avoid the complexity and cost of running your own database
 - The power is to leverage database technology that would typically cost thousands of dollars in hardware and software licenses.
 - Provides the ability to leverage the services of a remotely hosted database, sharing it with other users and having it logically function as if the database were local.
 - Benefits:
 - Ease of use
 - Power
 - Integration
 - Management
-

Information as a Service

- refers to the ability to consume any type of remotely hosted information
 - E.g. stock price information, address validation, credit reporting,
 - through a well-defined interface such as an API
 - ability to mix and match a variety of information from many different sources through a single application or mashup.
 - We can get stock quotes from one information-as-a-service provider, census data from another
 - GeoNames Web API, from geonames.org,
 - a geographical database containing over 8 million geographical names
 - provides a broad range of information on each, from its population and form of government to its topology to its road and railway systems and more
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Communication as a Service (CaaS)

- CaaS is an outsourced enterprise communications solution
 - Providers of this type of cloud-based solution are responsible for the management of hardware and software
 - Deliver
 - Voice over IP (VoIP) services,
 - Instant Messaging (IM), and
 - video conferencing capabilities
 - Advanced features: chat, multimedia conferencing, Microsoft Outlook integration, real-time presence, “soft” phones (software-based telephones), video calling, unified messaging and mobility etc
 - Designed on a utility-like pricing model
 - Requires little to no management oversight from customers.
 - Network capacity and feature sets can be changed dynamically, so functionality keeps pace with consumer demand and provider-owned resources are not wasted.
-

Identity as a Service

- Offers a digital identity—a set of bytes—to describe the user
 - Based on this information, the application can determine who the user is and what he or she is allowed to do.
 - In-house applications rely on services like Active Directory to provide this information.
 - Clouds, however, have to use their own identity services.
 - If you sign on to Amazon cloud services, you have to sign on using an Amazon-defined identity.
 - Google's App Engine requires a Google account
 - Windows uses Windows Live ID for use with Microsoft's cloud applications.
 - OpenID
 - is an open, decentralized, single sign-on standard that allows users to log in to many services using the same digital identity.
 - is in the form of a uniform resource locator (URL) and does not rely on a central authority to authenticate a user's identity.
 - Since a specific type of authentication is not required, nonstandard forms of authentication may be used, including smart cards, biometric, or passwords.
 - Used by many organizations, including: Google, IBM, Microsoft, Yahoo!
-

Monitoring as a Service (MaaS)

- Outsourced provisioning of security, primarily on business platforms that leverage the Internet to conduct business.
 - Security monitoring involves protecting an enterprise or government client from cyber threats
 - *Security-as-a-service*, is the ability to deliver core security services remotely over the Internet.
 - While the typical security services provided are rudimentary, more sophisticated services such as identity management are becoming available.
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Process as a Service

Integration as a Service

■ *Process-as-a-service*

- remote resource that can bind many resources together, e.g. services & data hosted within the same CC resource or remotely to create business processes
 - business process: meta-application that spans systems, leveraging key services & information combined into a sequence to form a process
 - these processes are easier to change than are apps and thus provide agility to those who leverage these process engines delivered on demand

■ *Integration-as-a-service*

- the ability to deliver a complete integration stack from the cloud
 - including interfacing with applications, semantic mediation, flow control, integration design, and so on.
 - includes most of the features and functions found within traditional enterprise application integration technology, but delivered as a service
-

MaaS and TaaS

- *Management/governance-as-a-service (MaaS and GaaS)*
 - any on-demand service that provides the ability to manage one or more cloud services.
 - these are typically simple things such topology, resource utilization, virtualization, and uptime management
 - governance systems are becoming available as well, offering, for instance, the ability to enforce defined policies on data and services.
 - *Testing-as-a-service (TaaS)*
 - ability to test local or cloud-delivered systems using testing software and services that are remotely hosted.
 - while a cloud service requires testing unto itself, TaaS systems have the ability to test other cloud applications, Web sites, and internal enterprise systems, and they do not require a hardware or software footprint within the enterprise.
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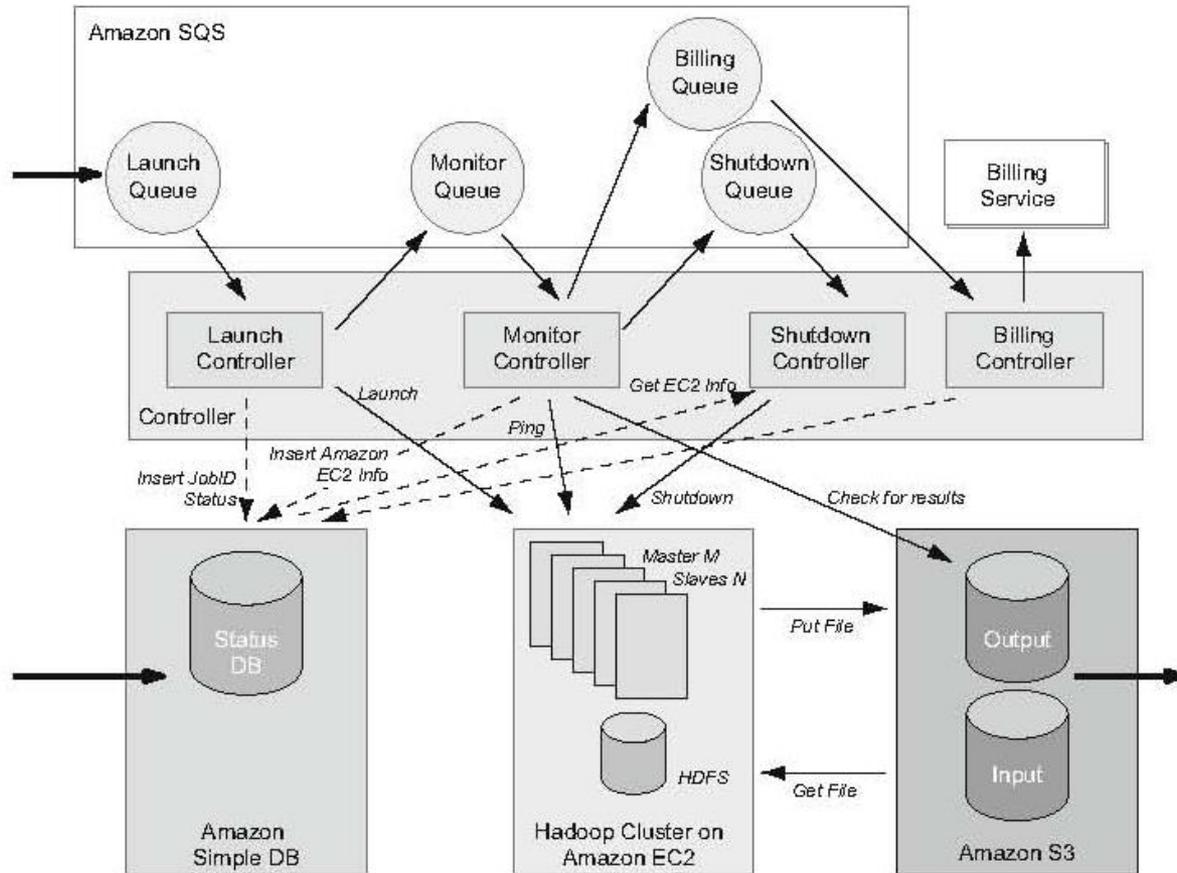
Backup as a Service

- online backup SaaS
 - Example: EMC's Mozy
 - Monthly subscription service
 - Two offerings:
 1. a consumer product and
 2. a corporate enterprise version.
 - Offers secure and automatic offsite backup for client desktops, laptops, and Microsoft Windows servers
 - Configured, deployed, and centrally managed via a web-based, multi-tenant administrative console.
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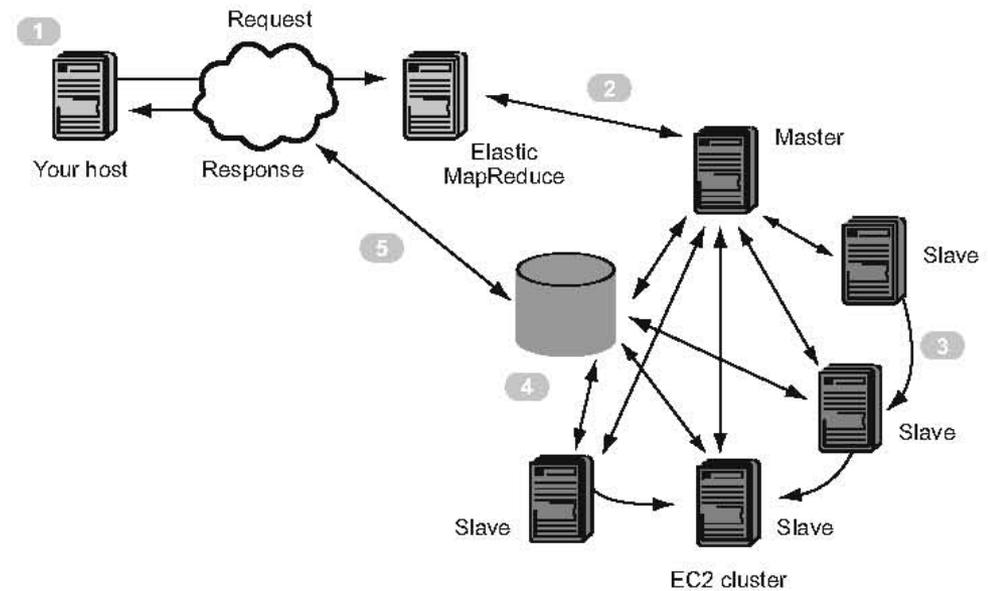
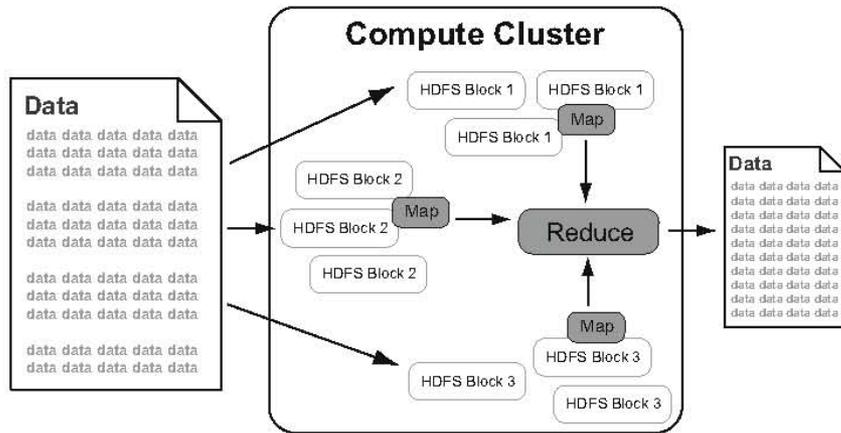
Amazon services

- Amazon was one of the first companies to offer cloud services to the public, and they are very sophisticated
 - most extensive cloud service to date
 - Offers a number of cloud services
 1. *Elastic Compute Cloud* (EC2) offers virtual machines and extra CPU cycles for your organization.
 2. *Simple Storage Service* (S3) allows you to store items up to 5GB in size in Amazon's virtual storage service.
 3. *Simple Queue Service* (SQS) allows your machines to talk to each other using this message-passing API.
 4. *SimpleDB* is a web service for running queries on structured data in real time. This service works in close conjunction with S3 and EC2, collectively providing the ability to store, process, and query data sets in the cloud.
 5. *CloudFront* enables to place online content at the edges of the network, meaning that content is delivered from a location close to the user requesting it.
 - These services can be difficult to use:
 - they have to be done through the command line
 - Amazon's VMs are versions of Linux distributions,
 - Appls can be written on own machine and then uploaded to the cloud
-

Usage of AWS



Apache Hadoop as a Service: Amazon Elastic MapReduce



Google

■ Google's App Engine

- get the most out of App Engine by writing a layer of Python that sits between the user and the database
- in stark contrast to Amazon's offerings is.
 - on Amazon you get root privileges, but on App Engine, you can't write a file in your own directory
 - security measure, and to store data you must use Google's database
 - Reduced the web applications to a core set of features, and built a good framework for delivering them
 - Offers handy debugging features

■ Google Apps

- Offers online documents and spreadsheets, and encourages developers to build features for those and other online software, using App Engine.

■ Google's Chrome

- is the first generation of internet browsers whose purpose is to be able to run online applications
 - Its ability to read more complex code is streamlined
 - Its tabbed functions are each its own running process to keep applications running smoothly and securely.
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Google App Engine

- Features:
 - Dynamic web serving, with full support for common web technologies
 - Persistent storage with queries, sorting, and transactions
 - Automatic scaling and load balancing
 - APIs for authenticating users and sending email using Google Accounts
 - A fully featured local development environment that simulates Google App Engine on your computer
 - The runtime environment includes the full Python language and most of the Python standard library
 - For extremely lightweight development, cloud-based mashup platforms (Ajax modules that are assembled in code) abound, such as Yahoo Pipes or Dapper.net.
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Google Appls

- Gmail
 - Google Talk
 - instant messaging and VOIP (voice over Internet protocol) software solution
 - Google Calendar
 - online calendar service
 - Google Docs
 - Web-based application suite that is made available to users for free.
 1. A word processor application,
 2. A spreadsheet application
 3. A presentation application
 - It allow users to
 - create and edit documents online for free
 - share their documents & collaborate with other users in real time
 - save documents onto their own machine
 - support for a no. different file formats including ODF (OpenDocument format), .doc and .xls
 - access using their mobile phones
 - Google Sites
 - used to create Websites or secure wikis
 - Google Maps
 - Web-based mapping application currently offered by Google for free
 - Services include street maps, route planning, find building, stores, landmarks, etc
-

Microsoft's solution for CC: Windows Azure

- an OS that allows organizations to run Windows apps and store files and data using Microsoft's datacenters
 - Azure Services Platform includes services that allow developers to:
 - establish user identities,
 - manage workflows,
 - synchronize data, and
 - perform other functionsas they build software programs on Microsoft's online computing platform.
 - Key components of Azure Services Platform include
 - provides service hosting and management and low-level scalable storage, computation, and networking.
 - SQL Services - provides database services and reporting.
 - .NET Services - provides service-based implementations of .NET Framework concepts such as workflow.
 - Live Services - used to share, store, and synchronize documents, photos, and files across PCs, phones, PC applications, and web sites.
 - SharePoint Services and Dynamics CRM Services - used for business content, collaboration, and solution development in the cloud
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Microsoft's other solutions

- Windows Live Messenger
 - IM appl offering users their own personal spaces, a calendar application, the ability to create contacts etc
 - Live ID
 - single sign-on service which allows users to log-on into many websites and services using one account
 - Office Live Small Business
 - a suite of web-based services designed in such a way so that small businesses can easily create a solid online presence.
 - providing small businesses with their own domain name and hosting space so that they can create and host their own website
 - Next version of Office will offer a browser-based option so that users
 - can read and edit documents online as
 - can collaborate using web, mobile, and client versions of Office
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HP

- HP Adaptive Infrastructure as a Service (AlaaS),
 - lets customers host applications in HP data centers optimized for Microsoft Exchange, SAP applications, and other critical business applications.
 - CloudPrint
 - It is a free mobile service for your cell phone or mobile device.
 - locating a local printer service provider
 - MagCloud
 - allows you to publish your own magazine online.
 - you have to upload your magazine content,
 - the cloud service provides the printing, mailing, subscription services, and so on.
 - Snapfish
 - offers the ability to store photos online
 - NetSuite's management suite
 - accounting, enterprise resource planning (ERP), customer relationship management (CRM), and eCommerce.
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SUN

- Sun's offering is currently a development environment only.
 - NephOS
 - operates through existing virtualization hypervisor technologies
 - users
 - provision their own virtual data centers through a web interface by specifying which virtualized resources are needed for the application they are seeking to provision.
 - select components like the server, storage, and network bandwidth needed.
 - provide an application environment where the delivered services can be scaled up and down.
 - Roles
 - Cloud providers offering these virtualized data center resources provide and manage the physical, commodity hardware-based infrastructure,
 - Client subscribers manage their own virtual data centers layered on the cloud provider's resources.
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Salesforce

- Force.com - on-demand cloud computing platform (PaaS) offers:
 - Apex, an integrated development environment
 - Programmable interface, User interface options
 - Business logic, Workflow and approvals engine
 - Automatic mobile device deployment
 - Web services integration, A relational database
 - Reporting and analytics
 - Visualforce
 - framework for creating new interface designs
 - enables user interactions that can be built and delivered with no software or hardware infrastructure requirements
 - uses HTML, AJAX, and Flex, for business applications
 - CRM (customer relationship management) offering consists of the Sales Cloud and the Service Cloud with five core applications:
 - Sales, Marketing, Service, Collaboration, Analytics, Custom applications
 - AppExchange
 - is a directory of applications built for Salesforce.com by third-party developers.
 - users can purchase and add to their Salesforce.com environment.
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EMC

- world leader in products, services, and solutions for information storage and management
 - Symmetric V-Max system, April 2009
 - first management system to support high-end virtual datacenters
 - allows customers with vast storage needs to easily manage and expand storage systems without interfering with day-to-day operations.
 - allows multiple datacenters to be run as if they were one, making their management much easier and more efficient.
 - Others:
 - Archiving
 - Backup and recovery
 - Enterprise content management
 - Intelligent information management
 - IT management
 - Replication
 - Security
 - EMC expanded virtualization offerings when they acquired VMware
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Others

- Adobe SaaS:
 - Acrobat Connect
 - Adobe Document Centre Applications
 - Axentis
 - specialize in governance, risk and compliance software solutions
 - GoGrid
 - service provider of Windows and Linux cloud-based server hosting
 - first Infrastructure as a Service (IaaS) providers to offer Windows Server 2008 “in the cloud.”
 - SuccessFactors
 - deal human resources (HR) software services
 - specifically with performance and talent management software services, in other words
 - RightScale
 - offers an integrated management dashboard, where applications can be deployed once and managed across these and other clouds
 - support for FlexiScale, GoGrid, Amazon’s EC2, Rackspace’s Mosso and CloudFS.
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Standards

■ Communication:

- Http
- XMPP – to emerge as Cloud standard
 - Extensible Messaging and Presence Protocol (XMPP)
 - developed for instant messaging and presence,
 - To solve the problem of the current CC services:
 - including SOAP or other HTTP-based protocols are all one-way information exchanges.
 - clouds do not operate in real time and might have difficulties clearing a firewall.
 - allows for two-way communication and eliminates polling

■ Security

- SSL
- OpenID
- PCI DSS - Payment Card Industry Data Security Standards

■ Client:

- HTML, DHTML, DOM, XHTML, JavaScript

■ Infrastructure

- VMHI - Virtual Machine Hypervisor Interfaces
- Open Virtualization Format (OVF)
 - how virtual appliances can be packaged in a vendor-neutral format to be run on any hypervisor

■ Service

- Data – in XML or JSON
 - Web services – SOAP or REST
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