

Cloud Computing

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CERN - IT-PES-PS

Lecture 1 – May 30, 2012

Disclaimer



"The Lighter Side Of The Cloud" Comic by CloudTweaks – David Fletcher

What is Cloud Computing?

- Cloud computing is a computing paradigm shift where computing is moved away from personal computers or an individual server to a “cloud” of computers.

Wikipedia - December, 2007

- Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet.

Wikipedia - July, 2009

- Cloud computing is a metaphor used by Technology or IT Services companies for the delivery of computing requirements as a service to a heterogeneous community of end-recipients.

Wikipedia - May, 2012

What is Cloud Computing?

"maybe I'm an idiot, but I have no idea what anyone is talking about. What is it? It's complete gibberish. It's insane. When is this idiocy going to stop? We'll make cloud computing announcements. I'm not going to fight this thing. But I don't understand what we would do differently in the light of cloud computing other than change the wording of some our ads."

@Oracle OpenWorld 2008

Larry Ellison

*co-founder and chief executive officer of
Oracle Corporation*



What is Cloud Computing?

- Cloud Computing is a style of computing where scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies.

Thomas Bittman - Gartner

- Cloud Computing is an emerging IT development, deployment and delivery model, enabling real-time delivery of products, services and solutions over the Internet.

Frank Gens - IDC

What is Cloud Computing?

(an analogy)





**You move to a new city
and you need to find a new place to live**



Two opposite approaches:

- Build a house
- Book a hotel room



Building a house is a big investment



But you can customize...

You are responsible for the maintenance





Book a room in a hotel is much simpler

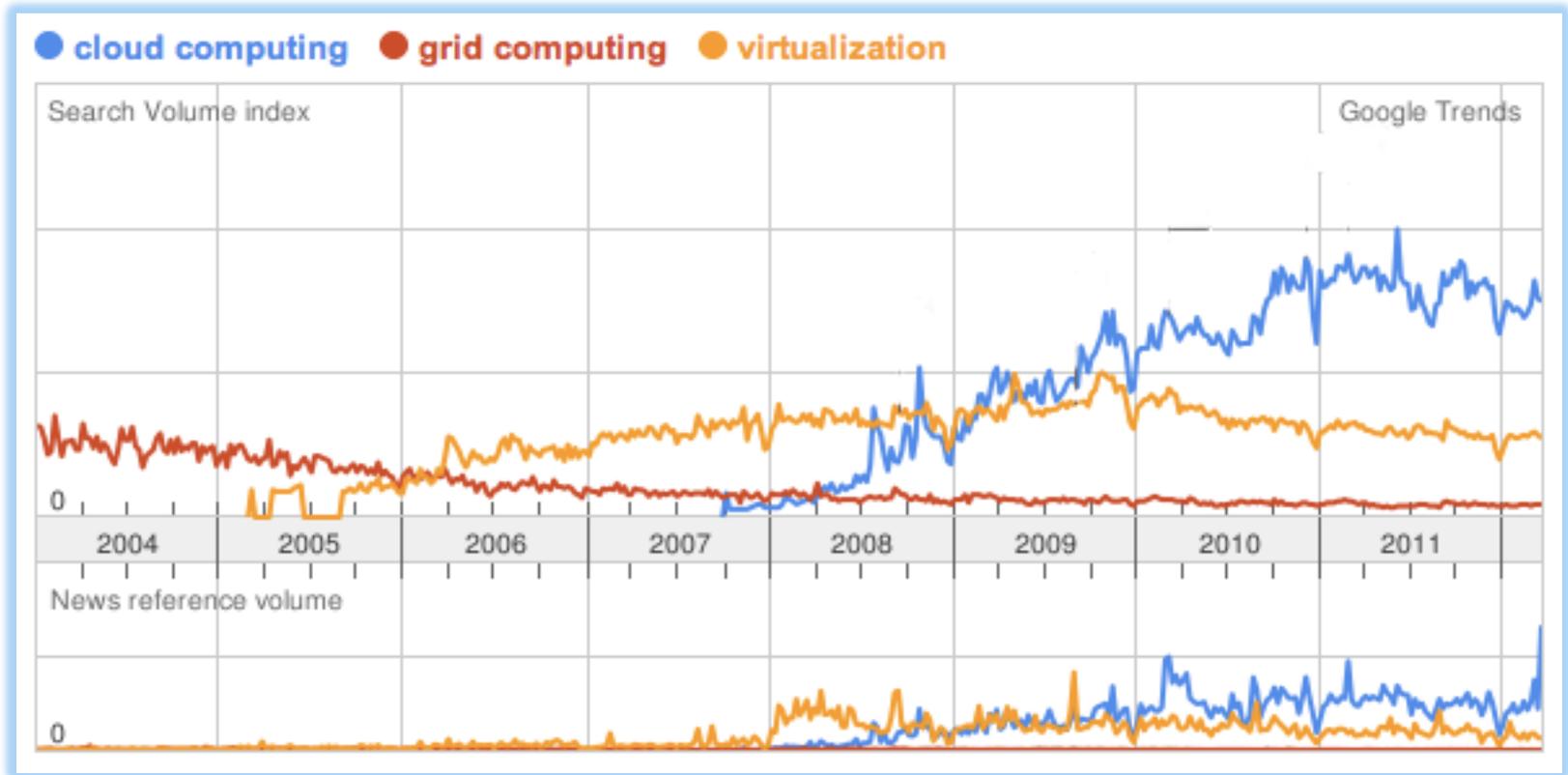


Easy to move if your requirements change

Translating into cloud computing

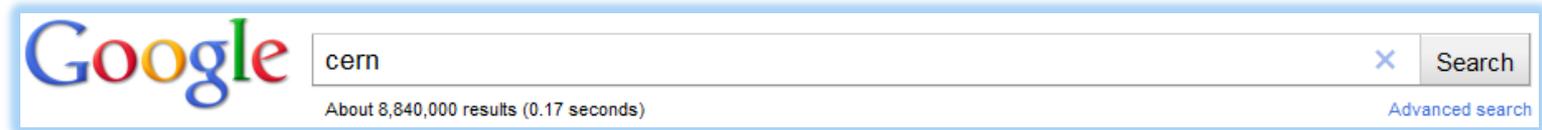
Flexibility
Pay as you go
No maintenance

Cloud Computing Hype?



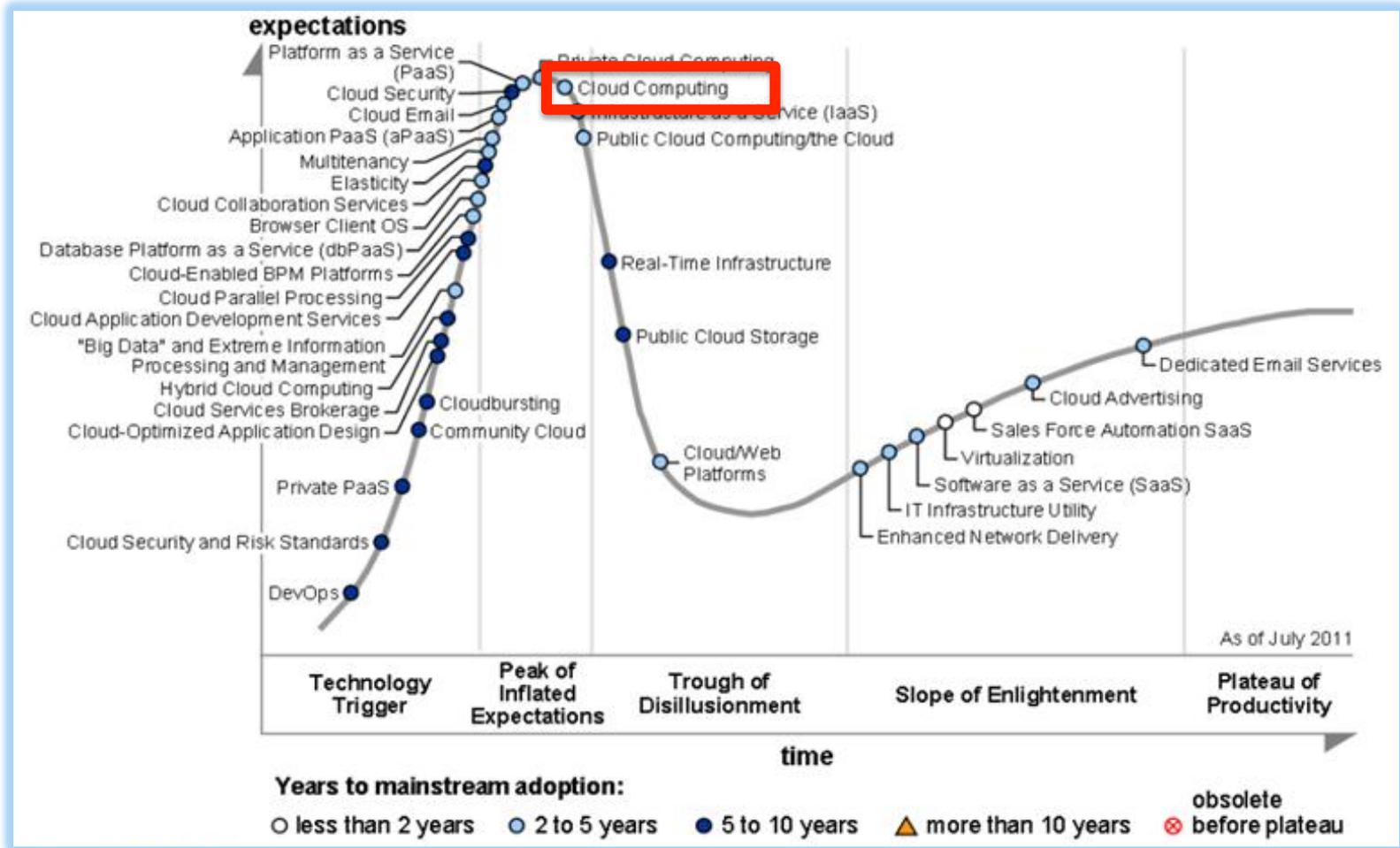
Google Trends – March 2012

Cloud Computing Hype?



Google Search – February 2011

Cloud Computing Hype?



Gartner – July 2011

Cloud Computing Hype?

- IT spending on cloud computing
 - The most important significant change in the IT priorities of ESG's 2011 survey is the increased importance attached to cloud computing services. - *ESG Research*.
 - 66% of midsize firms surveyed have cloud computing projects in progress or in planning stage. - *IBM, "Inside the Midmarket: a 2011 perspective"*.
 - 65% or more of new enterprise IT spending to be cloud-based by 2015. - *Saugatuck Technology Inc.*

Cloud Computing Hype?

- Believe it or not you are using cloud computing



Windows Live™
Hotmail



Google™ Docs

Gmail™
by Google

flickr™

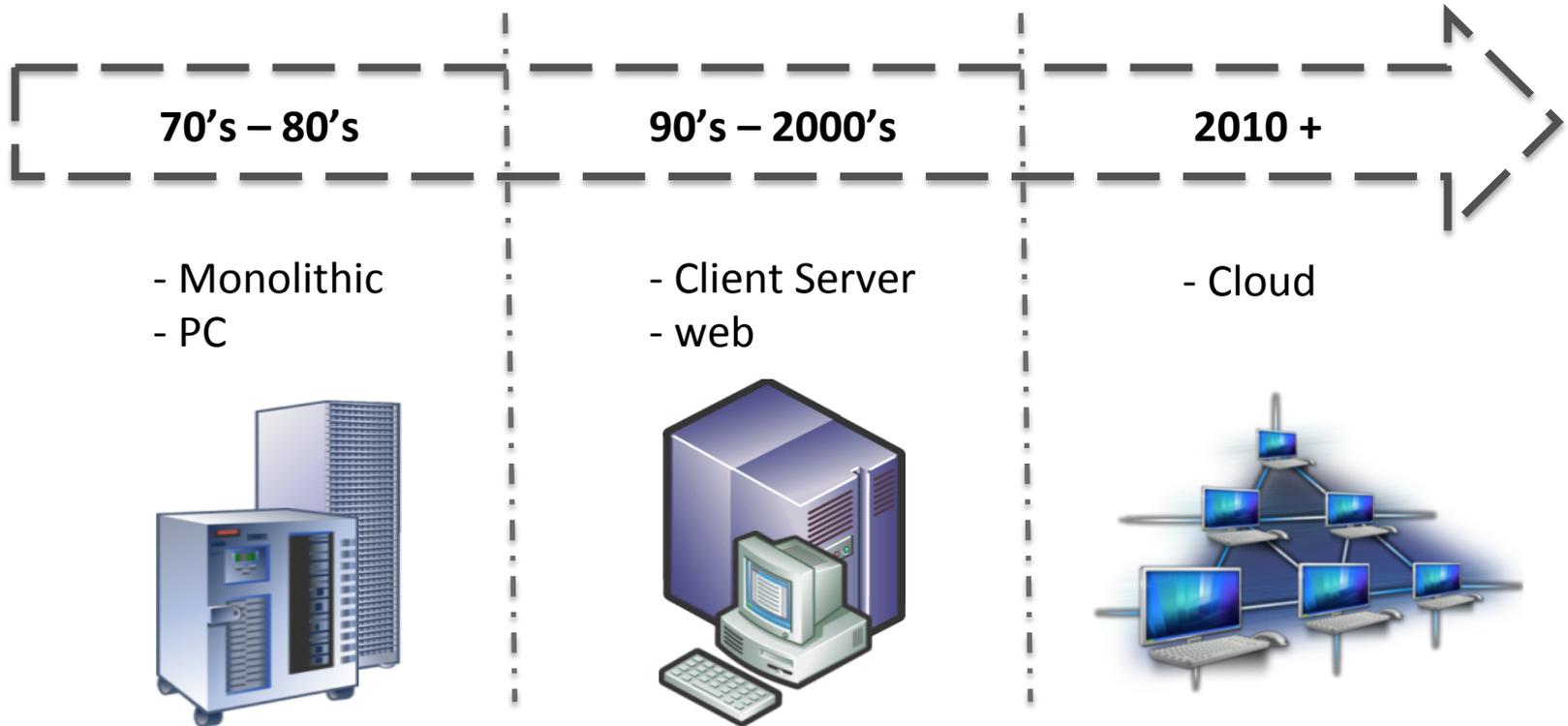
You Tube

Cloud Computing Hype?



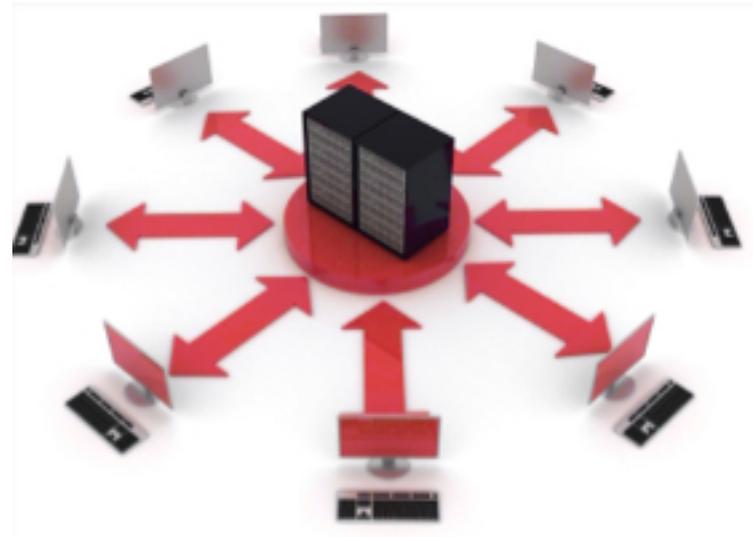
"The Lighter Side Of The Cloud" Comic by CloudTweaks – David Fletcher

Computational Models



Computational Models

- 70's - 80's: Mainframe Era
 - powerful computers used mainly by large organizations for critical applications
 - centralized computing
 - no communication with outside
 - Time-sharing



Computational Models

- 90's - 2000's: Client Server Era
 - maybe there is more than one computer in the world
 - common hardware becomes more powerful
 - distributed computing
 - web



Computational Models

- 2010 - beyond: Cloud Era?
 - increased network bandwidth and reliability
 - no need to invest large amounts of money in hardware
 - large data centers



What is Cloud Computing?

- Cloud computing describes a service model that combines a general organizing principle for IT delivery, infrastructure components, an architectural approach and an economic model – basically, a confluence of grid computing, virtualization, utility computing...

Dan Kusnetzky, Rachel Chalmers - 451 Group

Virtualization

- Virtualization in computing is the creation of a virtual version of something, such as a hardware platform, operating system, storage device, or network resources



Virtualization

not





60's - 70's: IBM mainframe

80's: IBM Personal Computer





... cheap hardware



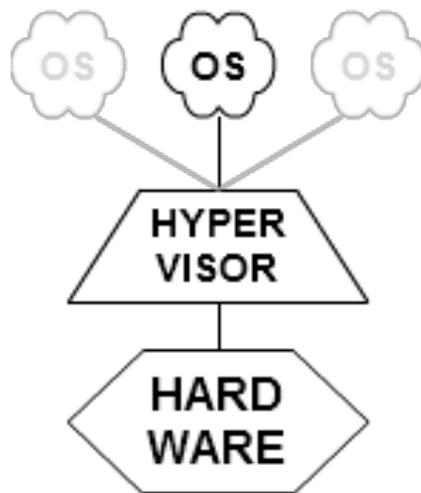
A photograph of a large, brown, rectangular sign for VMware. The sign features the VMware logo in a light blue, lowercase, sans-serif font, followed by a registered trademark symbol (®). Below the logo, the address "3401 Hillview Avenue" is written in a smaller, light blue, sans-serif font. The sign is set against a background of green grass and trees. In the background, there is a paved road, a bus stop shelter, and a yellow pedestrian crossing sign. The overall scene is outdoors on a sunny day.

vmware®
3401 Hillview Avenue

May 99: hypervisor for x86 architecture

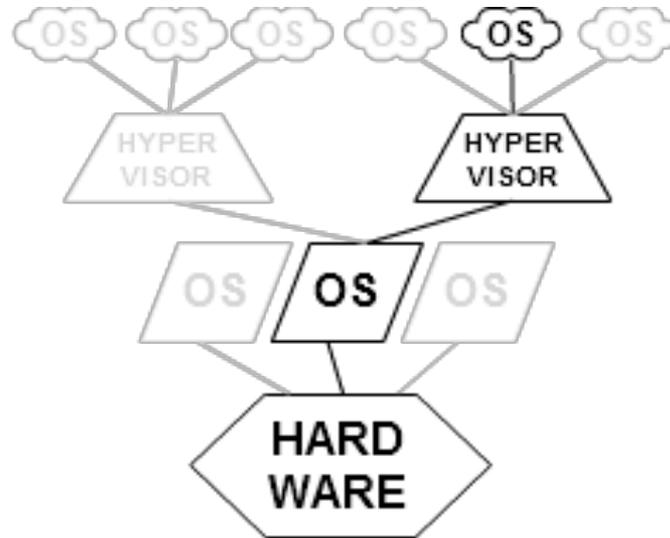
Virtualization

- Hypervisors types:



TYPE 1

native
(bare metal)



TYPE 2

hosted

Source: Wikipedia

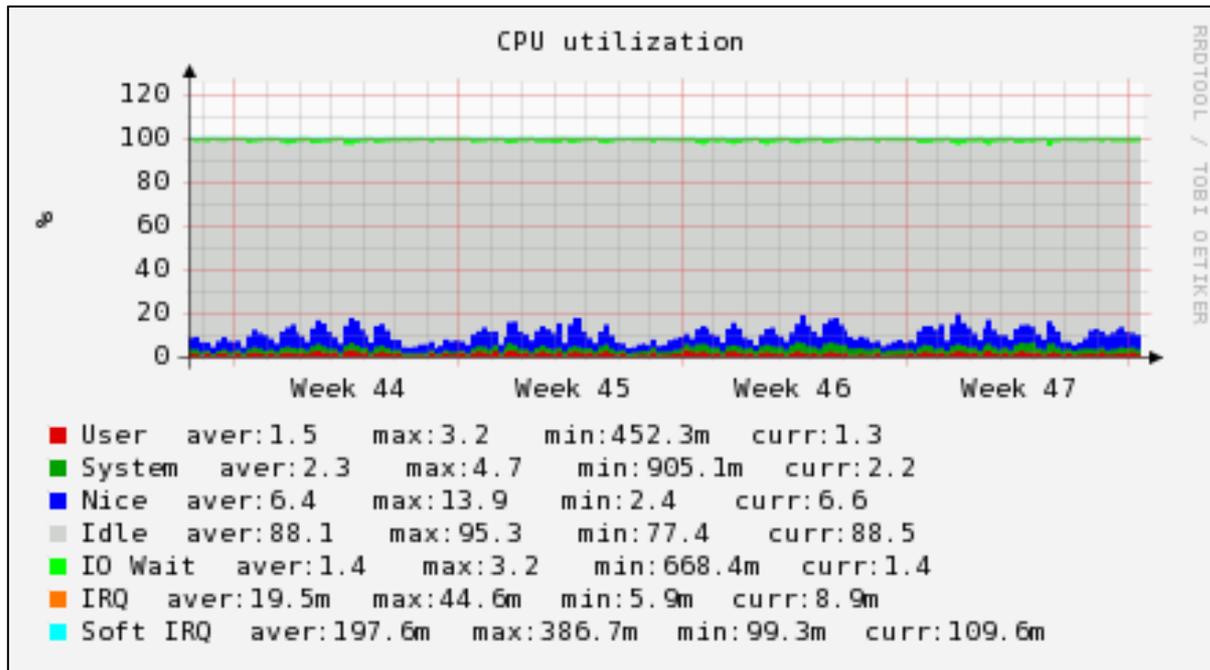
Server Virtualization

- Masking server resources (including the number and identity of individual physical servers, processors, and operating systems) from server users
- Computing and data isolation
- Increasing resource sharing and utilization



Server Virtualization

- Typical server utilization



CPU utilization – CERN Lxplus cluster – November 2011

Server Virtualization

- Benefits:
 - Multiple operating systems running on a single server
 - Reduce server idle time / increases efficiency
 - Reduce number of physical servers
 - Reduce power costs
 - Reduce cooling requirements
 - Eases maintenance and patching

Server Virtualization

Is Server Virtualization Cloud Computing?

NO

Utilities

- A public utility (usually just utility) is an organization that maintains the infrastructure for a public service (often also providing a service using that infrastructure)
- Utilities also refer to the set of services provided by these organizations consumed by the public: electricity, natural gas, water and sewage



- Home Insurance Building
- Chicago, Illinois
- Completed in 1885
- 10 storeys
- Height of 42 m
- Steel framed construction
- Architect: William Le Baron Jenney

Utilities

- People depended on a steady and reliable supply of electricity to support their operations
- They relied on electrical power generators installed in their basements



Utilities

- During the 1910s companies that owned and operated skyscrapers began considering outside vendors to supply their electricity

Advantages

- No more expensive electricity generators
- No more coal deliveries
- No more mechanical and electrical engineers on staff
- Lower and lower costs compared to the in-house electric power generators

Concerns

- New power grid is reliable?
- Why? The building is already self-sufficient
- Performance and security risk
- Would all vendors stay in business?
- How vendors guarantee security outside power supplies?

Utilities

- We all know which arguments won!
 - By the 1920's the debate about whether to rely on in-house power generation or to outsource to an electric power supply was over
 - Early power grid adopters had a competitive advantage over others
 - Companies redirected the money they once spent on generating power to core business activities



Huge Power Plants

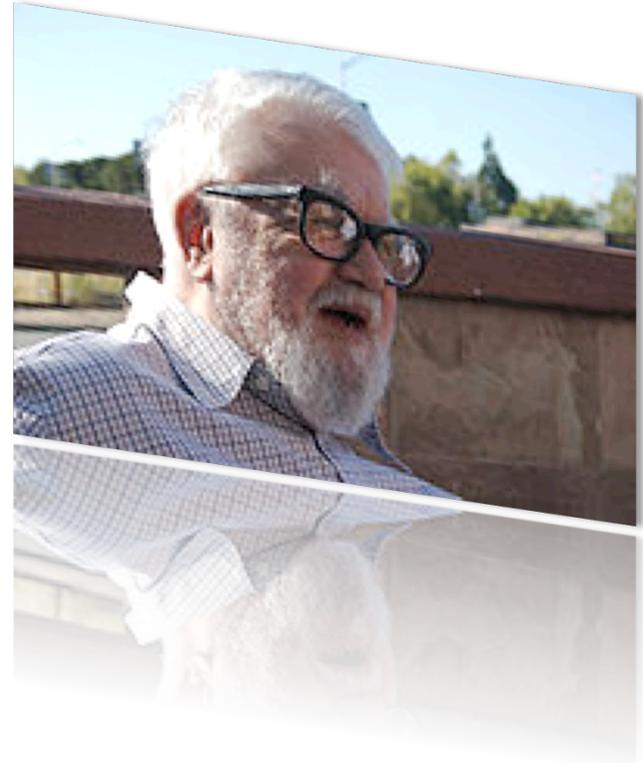
Utility Computing

“If computers of the kind I have advocated become the computers of the future, then computing may someday be organized as a public utility just as the telephone system is a public utility... The computer utility could become the basis of a new and important industry.”

@MIT Centennial in 1961

John McCarthy

Professor at Stanford University



Utility Computing

- Now, in 2012, just replace “electrical power” by “cloud” and the analogy is complete
 - as we debate the pros and cons of outsourcing computing functions to computing utilities, the arguments and concerns are similar
 - Why should a company maintain a large data center, along with resources and the staff to operate it?
- “What business are we in?”

Utility Computing

- Now, several providers sell computing power and storage space to companies and general public

amazon[®]

rackspace[®]



IBM

Microsoft[®]

Google[™]




DreamHost

Huge Data Centers



Utility Computing

- Renting of computing resources as-required, on-demand basis
- Pay what is used
- What was earlier considered products, are treated as services

Utility Computing

Is Utility Computing Cloud Computing?

NO

Grid Computing

- A distributed system consists of multiple autonomous computers that communicate through a computer network
 - The computers interact with each other in order to achieve a common goal
 - A problem is divided into many tasks, each of which is solved by one or more computers

Grid Computing

- The grid can be thought of as a distributed system with non-interactive workloads
- Use of computer resources from multiple administrative domains to reach a common goal
- What distinguishes grid computing from conventional high performance computing systems is that grids tend to be more loosely coupled, heterogeneous, and geographically dispersed
 - Grids are often constructed with the aid of general-purpose grid software libraries — “middleware”

Grid Computing

Is Grid Computing Cloud Computing?

NO

What is Cloud Computing?

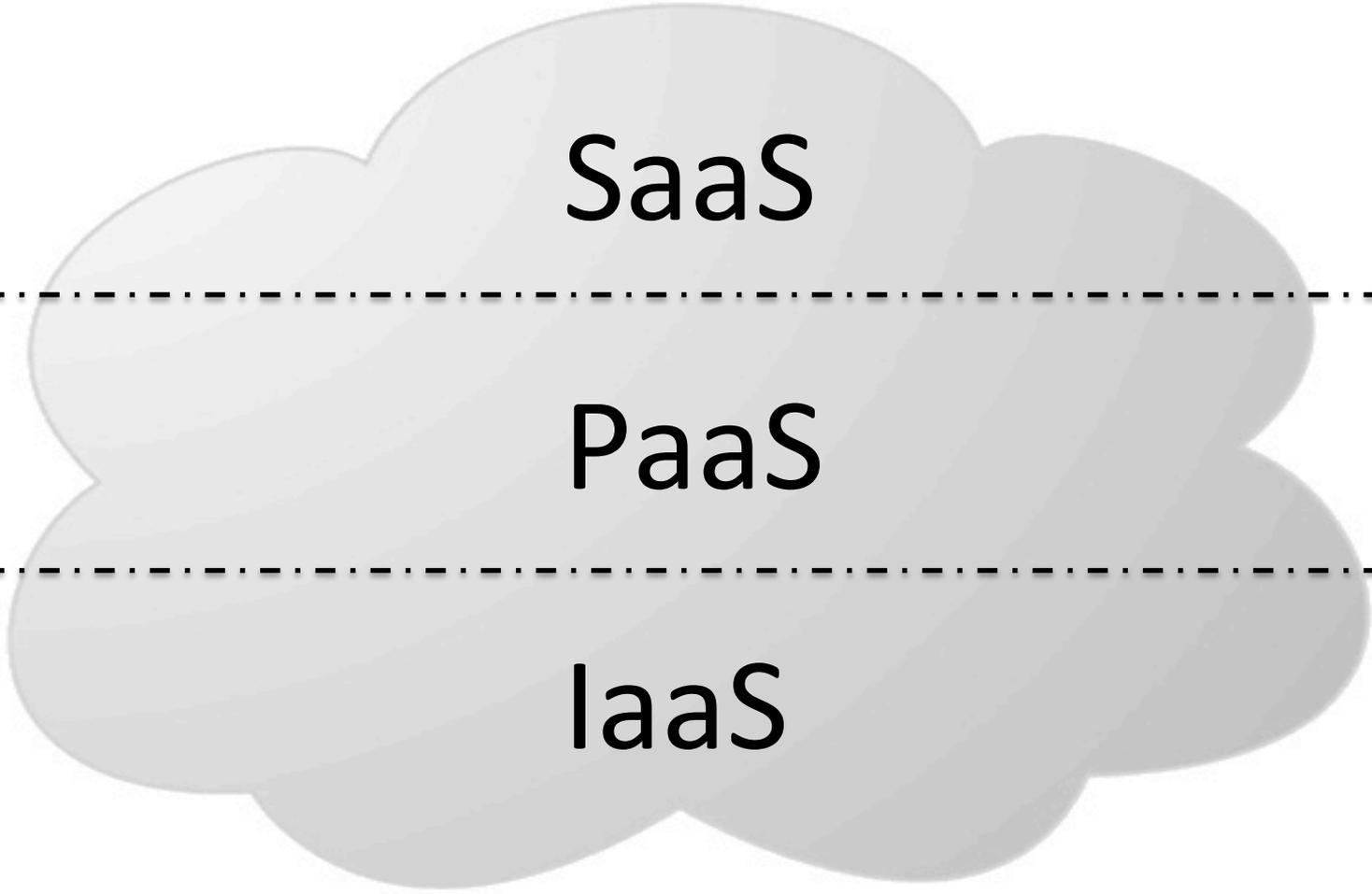


Cloud computing is the next stage in the evolution of the Internet. The cloud in cloud computing provides the means through which everything — from computing power to computing infrastructure, applications, business process to personal collaboration — can be delivered to you as a service wherever and whenever you need it. (...)

There are three models of Clouds: Infrastructure as a Service, Platform as a Service, and Software as a service.

Cloud Computing in Dummies.com

Service Models



SaaS

PaaS

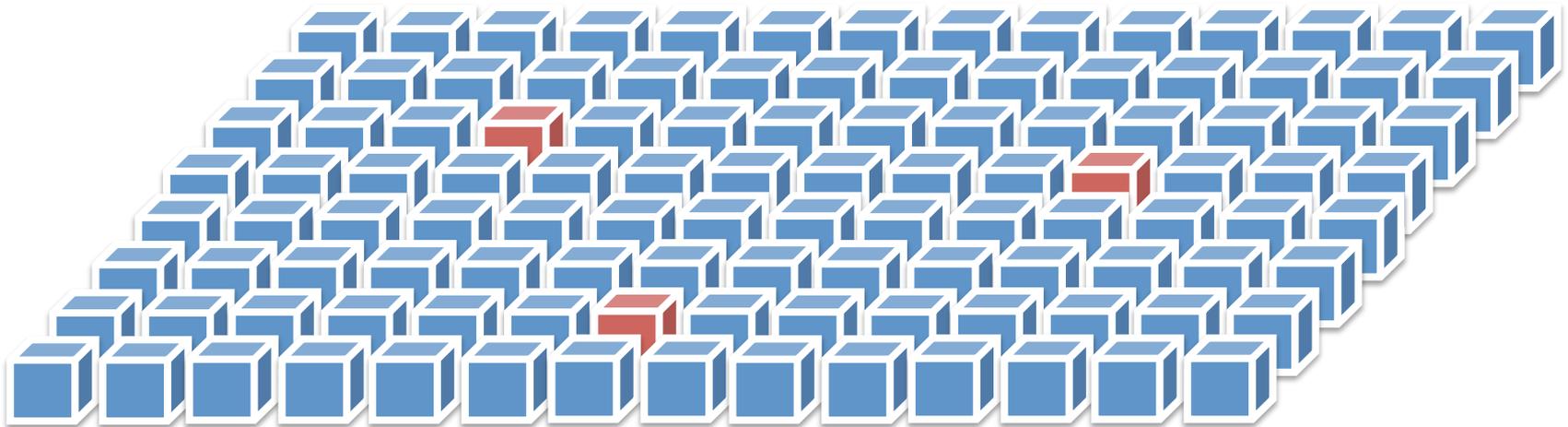
IaaS

Infrastructure as a Service

- Provide access to collections of virtualized computer hardware resources (machines, network, storage)
- Users assemble their own virtual cluster
- They are responsible for maintaining the nodes in their cluster
- Typically billed on a utility computing basis

Infrastructure as a Service

- Instances location is transparent to the user



Infrastructure as a Service

- Some IaaS providers



Infrastructure as a Service

- Amazon EC2 – “Elastic Compute Cloud”
 - Announced a limited public beta on August 2006
 - Allows users to rent virtual computers on which to run their own computer applications
 - A user can boot an Amazon Machine Image to create a virtual machine, which Amazon calls an "instance"
 - A user can create, launch, and terminate server instances as needed, paying by the hour for active servers

Infrastructure as a Service

- Amazon AWS – Some services reference:
 - EC2 – “Elastic Compute Cloud”
 - S3 – “Simple Storage Service”
 - provides a simple web services interface that can be used to store and retrieve any amount of data, at any time, from anywhere on the web
 - EBS – “Elastic Block Store”
 - provides block level store volumes for use with Amazon EC2 instances
 - CloudWatch
 - provides monitoring for AWS cloud resources and the applications customers run on AWS

Platform as a Service

- Facilitate the deployment of applications without the cost and complexity of buying and managing the underlying hardware, software and provisioning hosting capabilities
- Users develop, test deploy, host and maintain their own applications within an environment offered by the service provider
- Environment with scalable compute and data structures embedded in it

Platform as a Service

- PaaS key characteristics:
 - Services to develop, test, deploy, host and maintain applications in the same integrated development environment
 - Web based user interface creation tools
 - Multi-tenant architecture
 - Integration with web services and databases
 - Support for development team collaboration
 - Typically billed on a utility computing basis

Platform as a Service

- Some PaaS providers



Platform as a Service

- Google App Engine
 - Announced in 2008,
 - Platform for developing and hosting web applications in Google-managed data centers
 - Supported programming languages
 - Python, Java, Go
 - Google App Engine is free up to a certain level of consumed resources. Fees are charged for additional storage, bandwidth, or instance hours required by the application
 - Google App Engine's datastore has a SQL-like syntax called "GQL"

Software as a Service

- Delivery model in which software and associated data are centrally hosted
- Easy access to hosted applications over the network.
 - Most likely using a browser
- No local server installation. Controlled and executed on the provider's infrastructure
- System maintenance often included in the service
- Providers generally price applications using a subscription fee, most commonly a monthly fee or an annual fee

Software as a Service

- Some SaaS providers

37signals 



Google Docs

Gmail
by Google



ZOHO
Work. Online

Service-now.com
On Demand IT Service Management

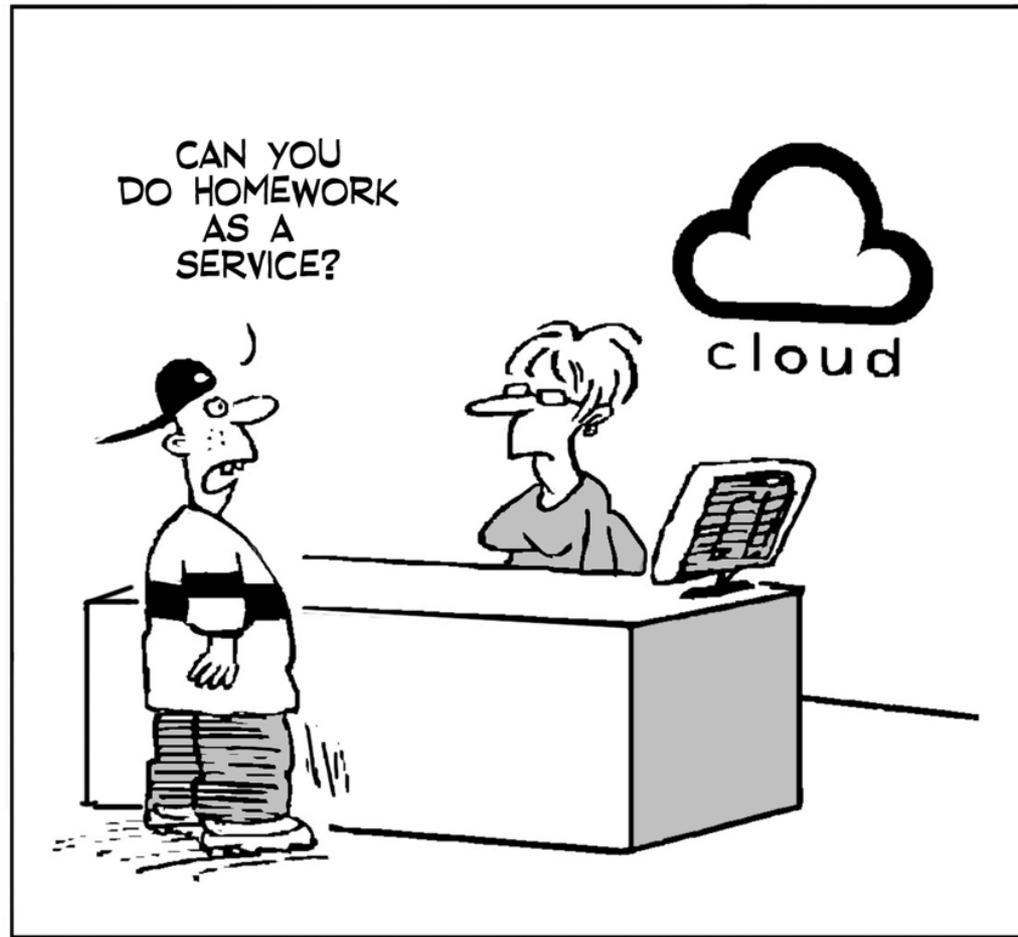
Microsoft Office 365

Atlassian
Confluence

Software as a Service

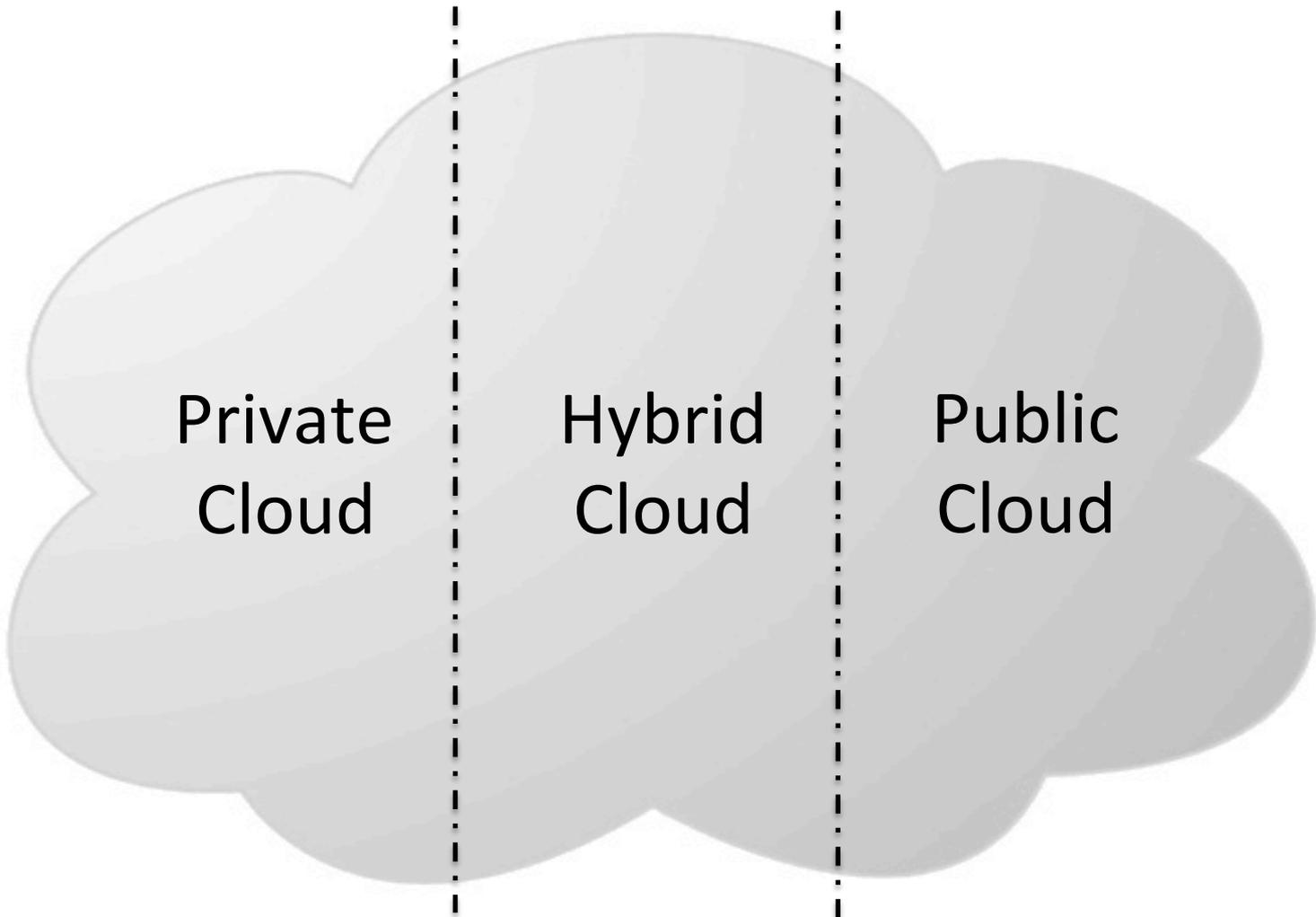
- Salesforce.com
 - Founded in March 1999 by Mark Benioff
 - Best known for its Customer Relationship Management (CRM) that runs as in the “cloud”
 - Price startlingly low compared with traditional CRM systems
 - Bought in 2006 by Oracle

Service Models



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Cloud Deployments



Private Cloud

- Infrastructure is owned by a single organization and made available only to the organization
- Is subject to the organization's physical, electronic, and procedural security measures
- Improve data center efficiency while reducing operational expense

Private Cloud

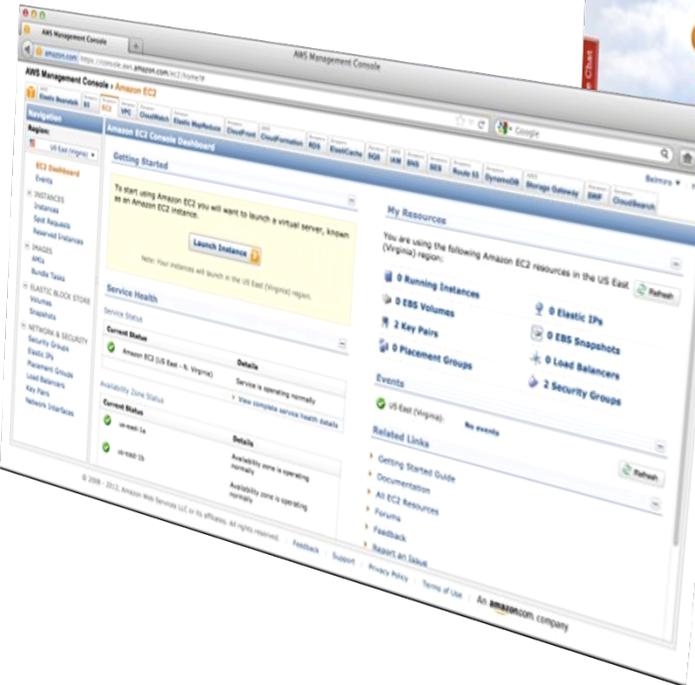
- Software to deploy a private cloud
 - Openstack
 - Eucalyptus
 - Open nebula
 - Platform ISF
 - VMware vCloud

Public Cloud

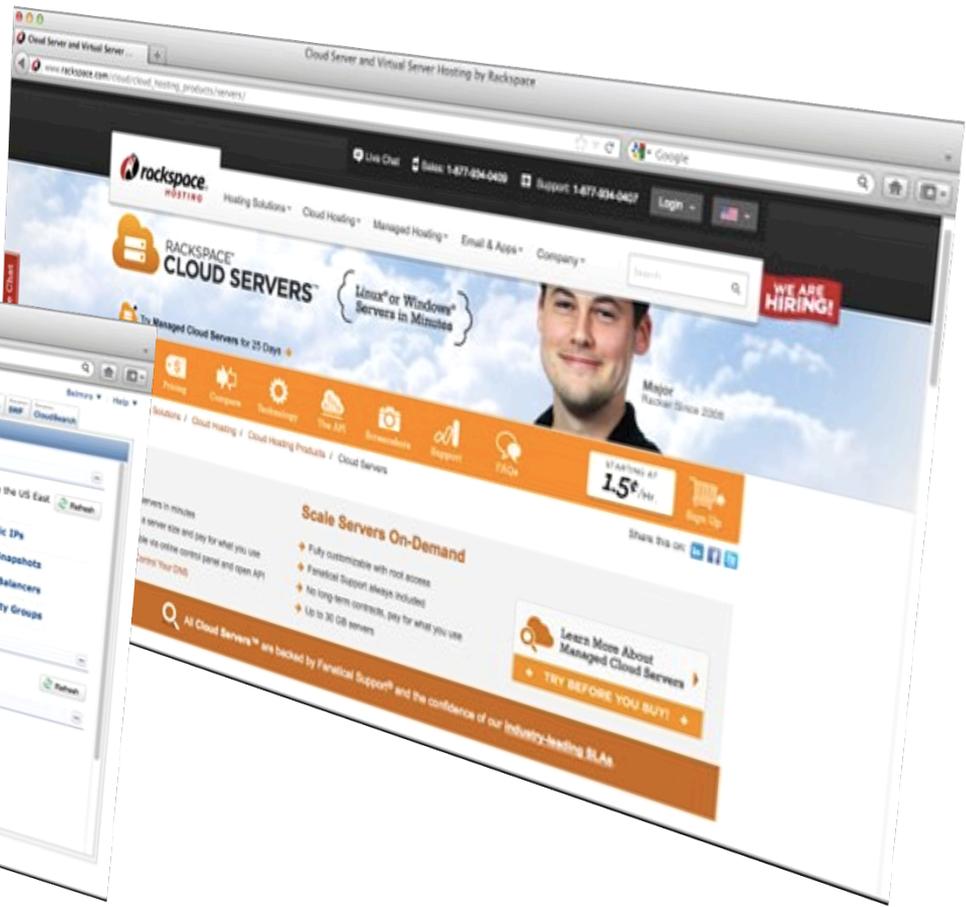
- Infrastructure is owned by a single organization and made available to other organizations / users
- Customer's rent access to resources as needed on a pay-as-you-go basis
- Offer access to large pools of scalable resources on a temporary basis;

Public Cloud

- Examples:



Amazon AWS



Rackspace Cloud Servers

Hybrid Cloud

- Combines computing resources drawn from one or more public clouds and one or more private clouds
 - Benefit from a custom private cloud
 - Burst to a public cloud when the load in the private cloud increases
 - Transparent for the applications, users

What is Cloud Computing?

- The National Institute of Standards and Technology's (NIST) published in October 2011 a definition of Cloud Computing
 - Started in 2009
 - Finally after 15 drafts versions
- The NIST definition lists five essential characteristics of cloud computing: **on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service.**

What is Cloud Computing?

- On-demand self-service:
 - A consumer can unilaterally provision computing capabilities as needed automatically without requiring human interaction with each service's provider;
- Broad network access:
 - Capabilities are available over the network and accessed through standard mechanisms.
- Resource pooling:
 - The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources.

What is Cloud Computing?

- Rapid elasticity:
 - Capabilities can be rapidly and elastically provisioned... To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
- Measured Service:
 - Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service. Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service

References

- “The Big Switch – rewiring the world, from Edison to Google” – Nicholas Carr
- “Business in the Cloud” – Michael Hugos, Derek Hulitzky
- “Cloud Computing – Principles and Paradigms” – edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski
- Sotomayor, B. and Montero, R.S. and Llorente, I.M. and Foster, I.; “Virtual infrastructure management in private and hybrid clouds”; IEEE Internet Computing; 2009.
- Vaquero, L.M. and Rodero-Merino, L. and Caceres, J. and Lindner, M.; “A break in the clouds: towards a cloud definition”; ACM SIGCOMM Computer Communication Review; 2008.
- Renato J. Figueiredo and Peter A. Dinda and José A. B. Fortes; “A Case For Grid Computing On Virtual Machines”; 23rd International Conference on Distributed Computing Systems; 2003.
- Marshall, P. and Keahey, K. and Freeman, T; “Elastic Site: Using Clouds to Elastically Extend Site Resources”; 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing; 2010.
- Ian Foster, Yong Zhao, Ioan Raicu, Shiyong Lu; "Cloud Computing and Grid Computing 360-Degree Compared"; Grid Computing Environments Workshop; 2008.
- Cloud computing definitions and references: <http://jameskaskade.com/?p=594>
- Cloud Tweaks – Cloud Computing Community: <http://www.cloudtweaks.com>
- All illustrations (cartons) from www.cloudtweaks.com – David Fletcher
- Wikipedia – “Cloud Computing” - http://en.wikipedia.org/wiki/Cloud_computing
- “I’m cloud confused” by Handy Arjanto - http://en.wikipedia.org/wiki/Cloud_computing
- “In cloud we trust” by Handy Arjanto - <http://www.slideshare.net/Gupperts/in-cloud-we-trust>

Thank you

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