

# Cloud Computing

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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)



A young woman with long brown hair, wearing a red long-sleeved shirt and blue jeans, is sitting on a large, tan-colored suitcase. She is looking towards the camera with a slight smile. In her left hand, she holds a black smartphone, and in her right hand, she holds a blue ticket that says "TICKET" in white letters. The background is plain white.

**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**



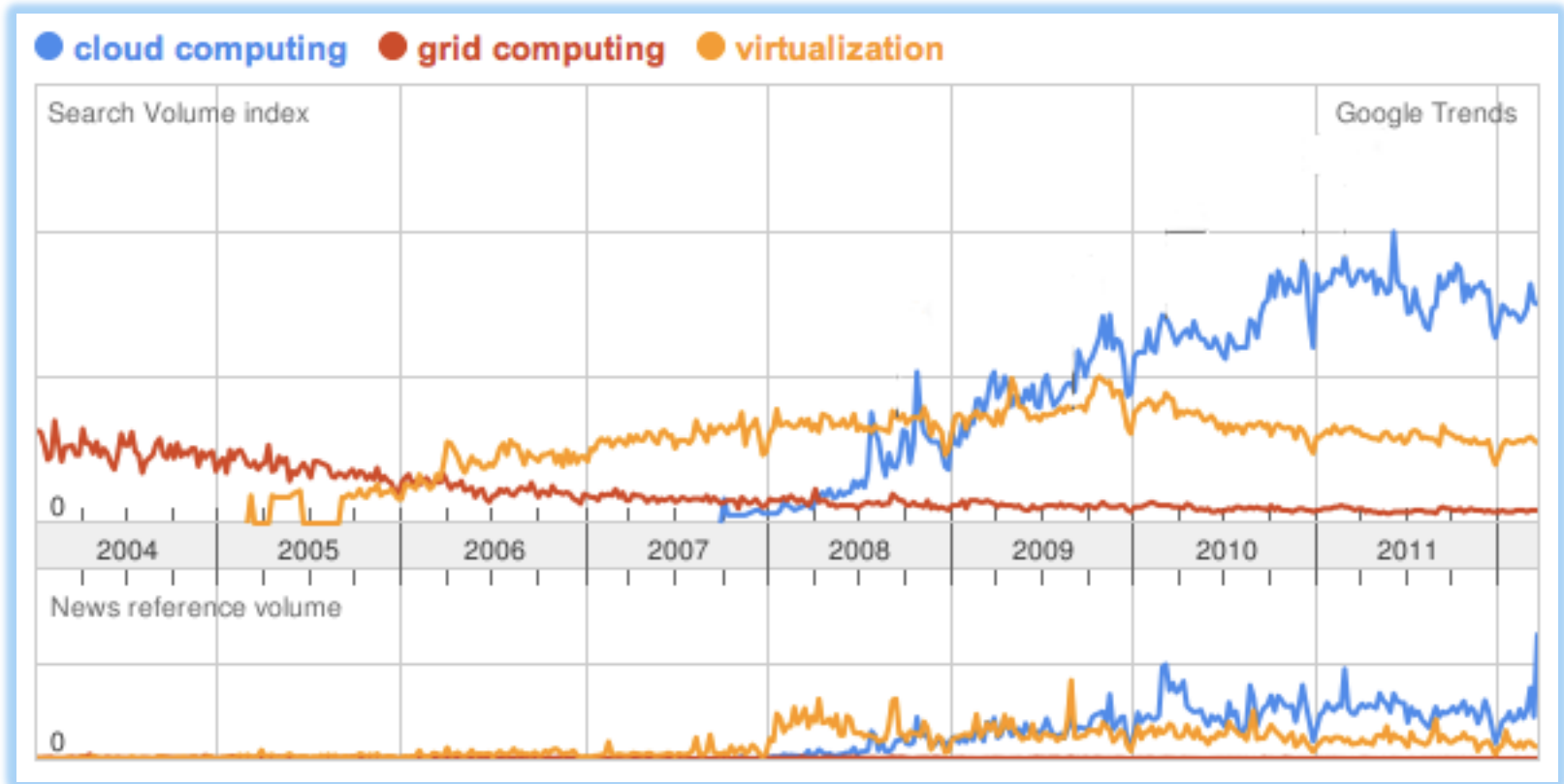


**Easy to move if your requirements change**

# Translating into cloud computing

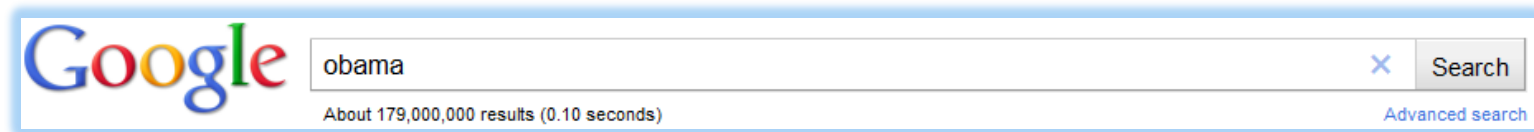
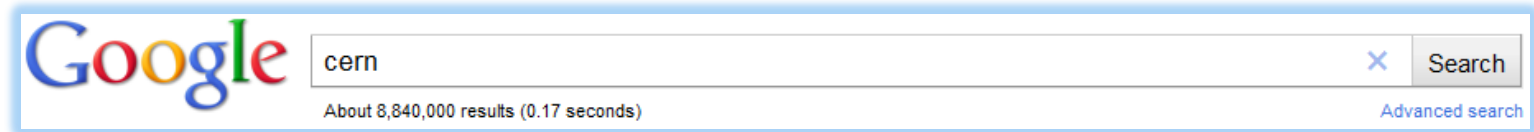
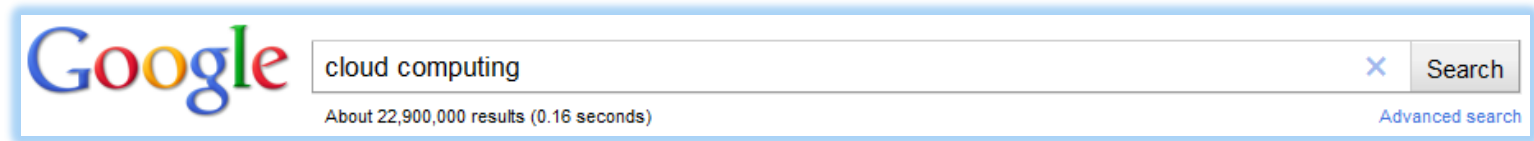
**Flexibility**  
**Pay as you go**  
**No maintenance**

# Cloud Computing Hype?



Google Trends – March 2012

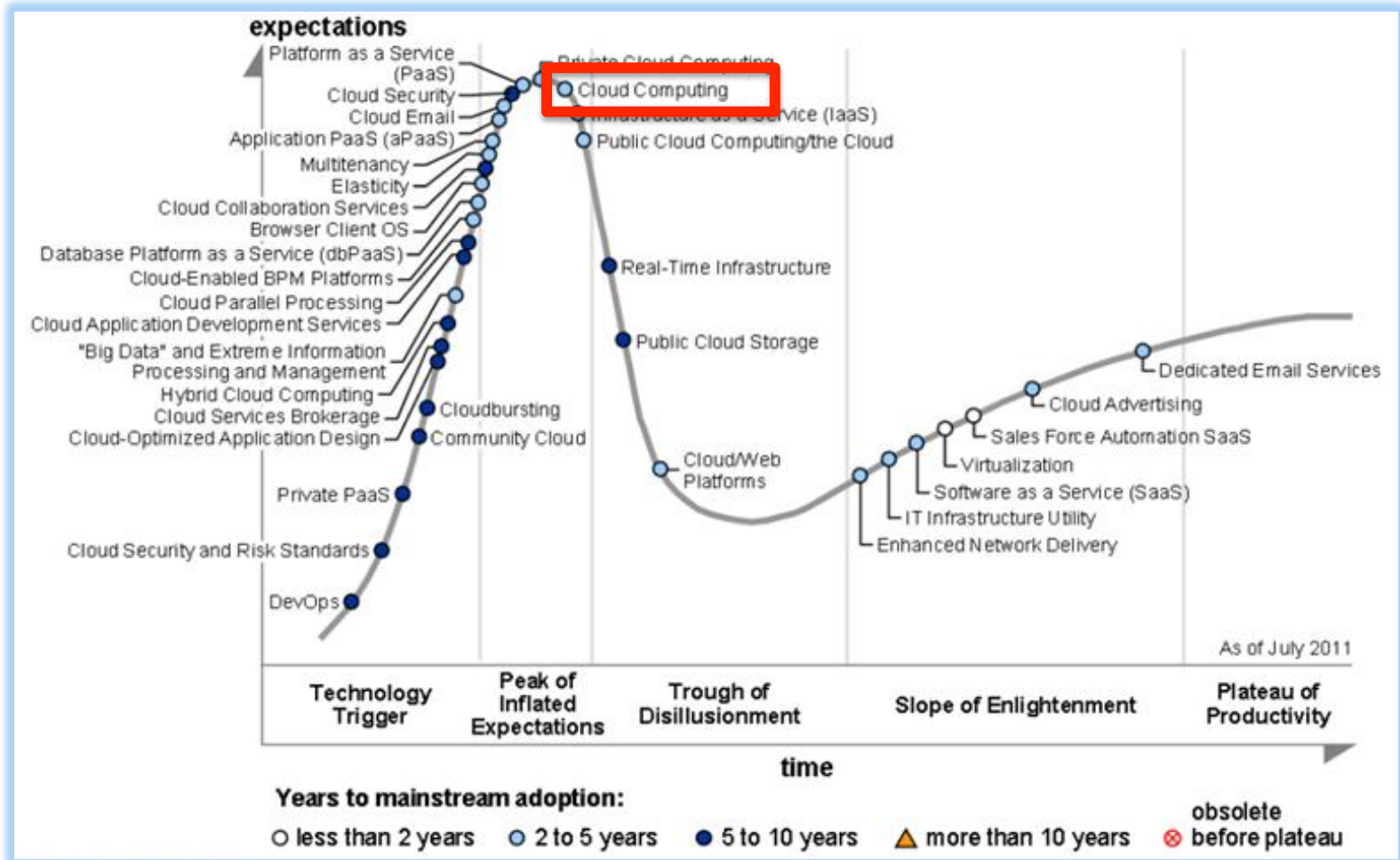
# Cloud Computing Hype?



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

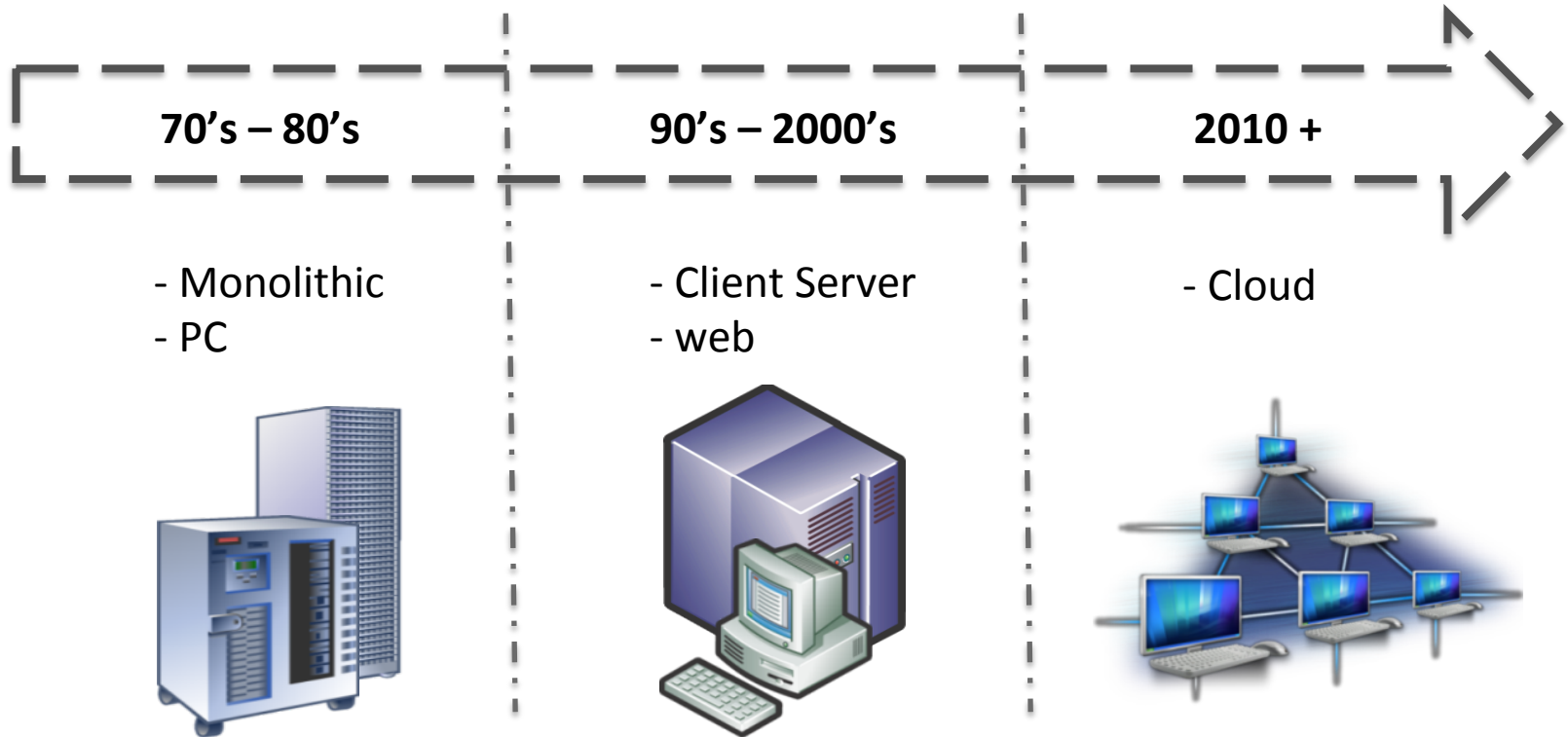
# Cloud Computing Hype?



"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





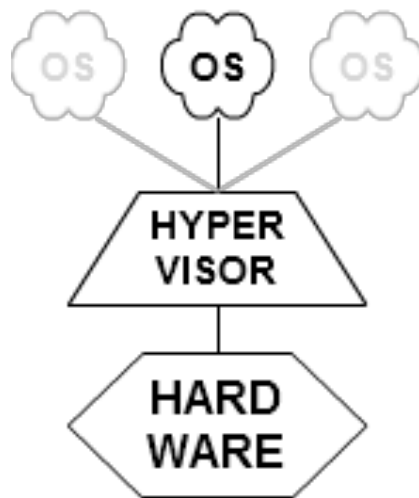
A photograph of a large, brown, rectangular sign for VMware. The sign is mounted on a concrete base and features the VMware logo in a light blue, sans-serif font. Below the logo, the address "3401 Hillview Avenue" is printed in a smaller, light blue font. The sign is surrounded by tall, green grasses. In the background, there are trees, a road, and a bus stop.

vmware®  
3401 Hillview Avenue

**May 99: hypervisor for x86 architecture**

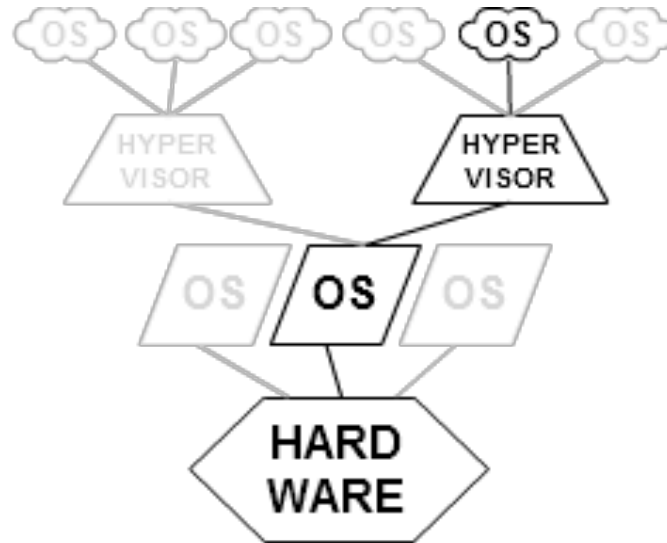
# Virtualization

- Hypervisors types:



**TYPE 1**

*native*  
*(bare metal)*



**TYPE 2**

*hosted*

Source: Wikipedia

# Server Virtualization

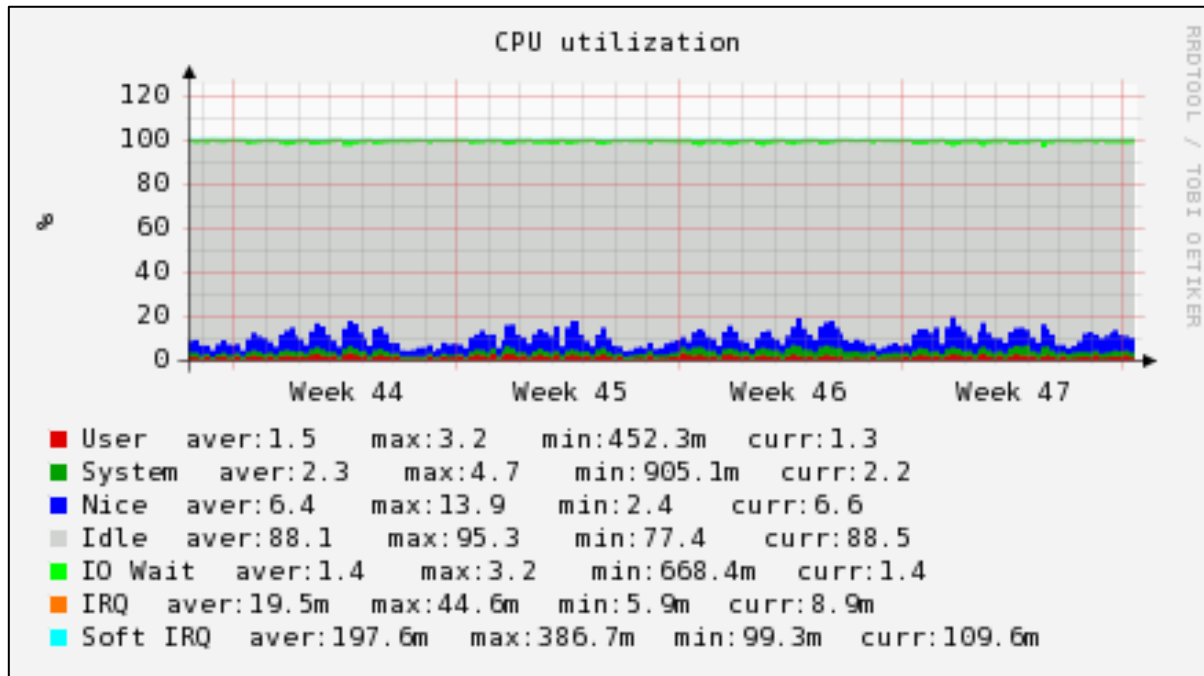
- Masking server resources (including the number and identity of individual physical servers, processors, and operating systems) from server users
- Computing and data isolation
- Increasing resource sharing and utilization





# 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**<sup>®</sup>

**rackspace**<sup>®</sup>



**IBM**

**Microsoft**<sup>®</sup>

**Google**<sup>™</sup>



  
**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

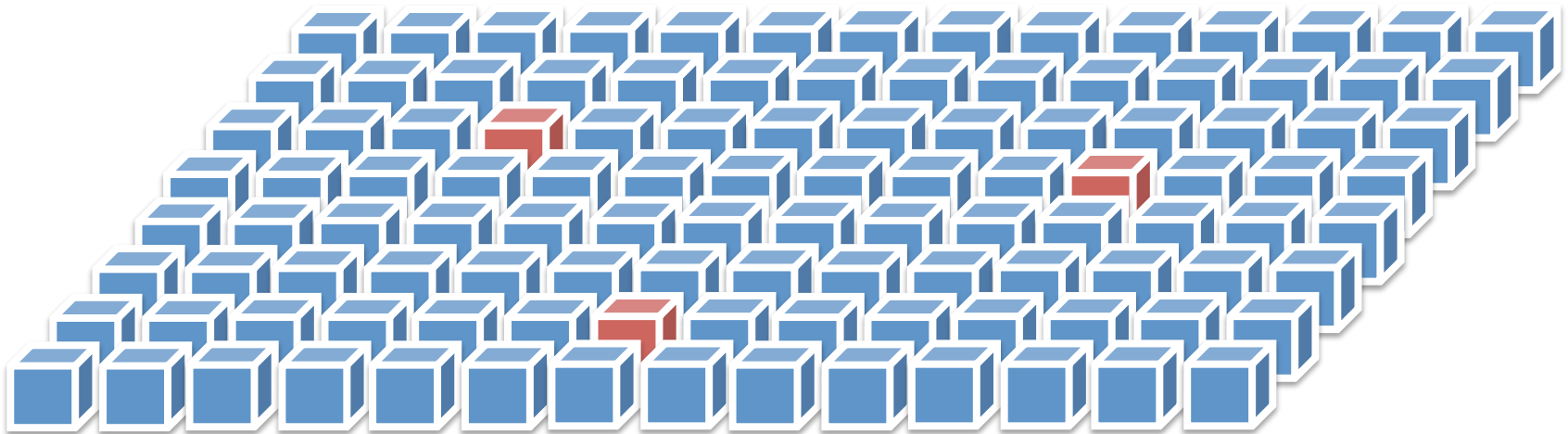
IaaS

# 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

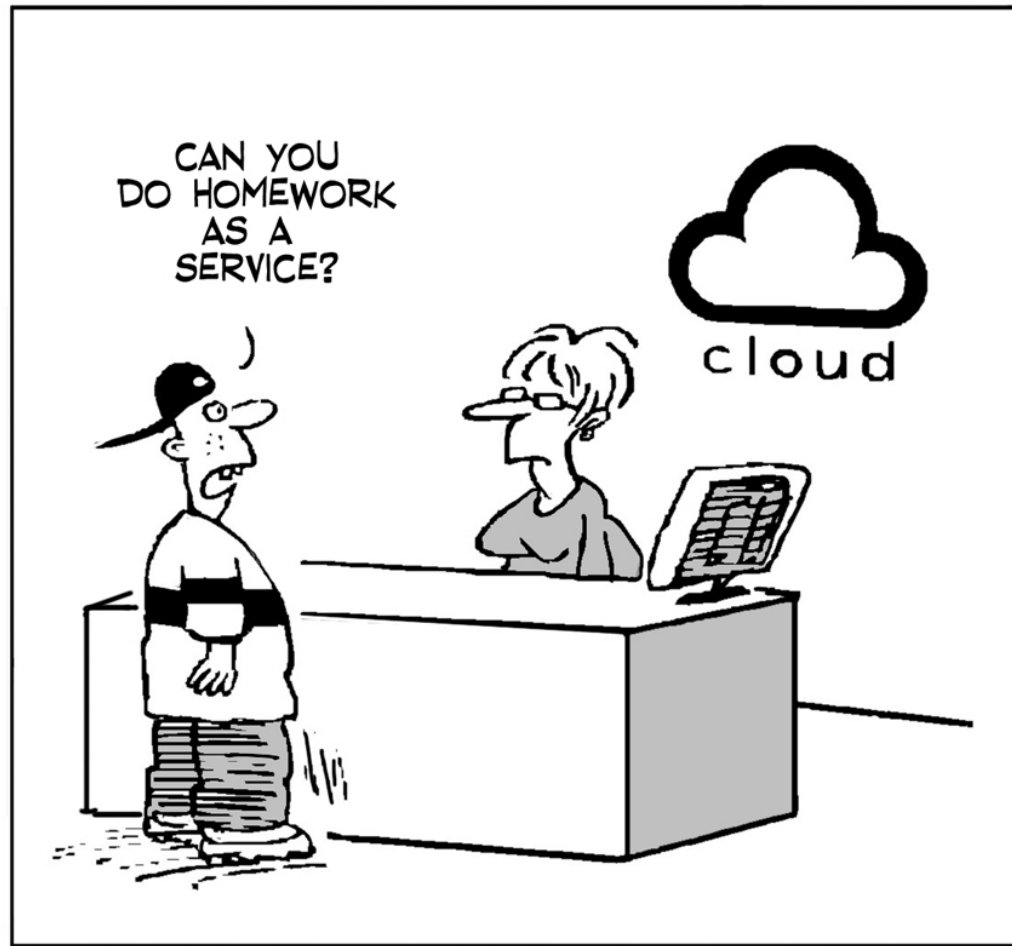
Microsoft Office 365

Atlassian  
Confluence

# Software as a Service

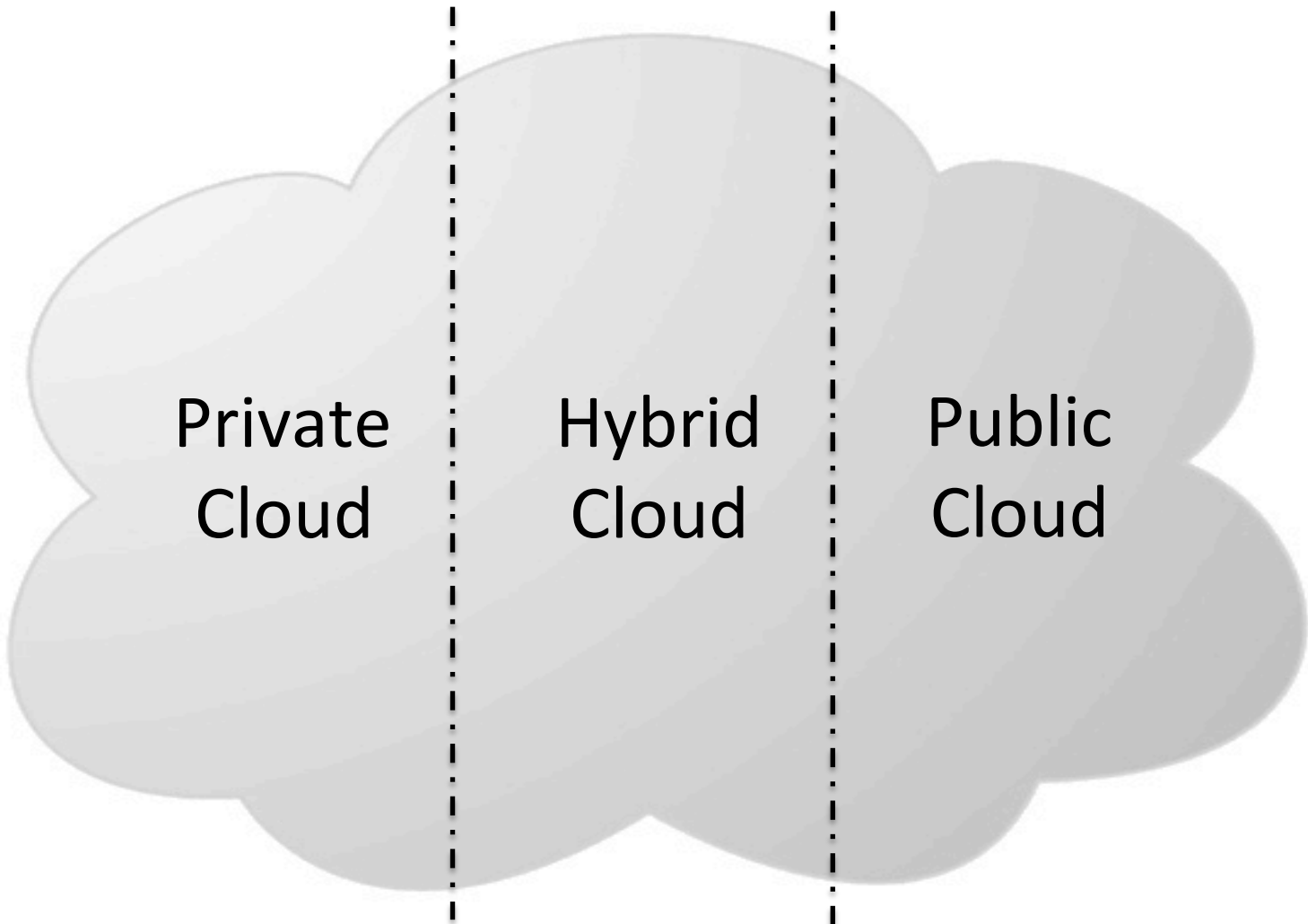
- Salesforce.com
  - Founded in March 1999 by Mark Benioff
  - Best known for its Customer Relationship Management (CRM) that runs as in the “cloud”
  - Price startlingly low compared with traditional CRM systems
  - Bought in 2006 by Oracle

# Service Models



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

# 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

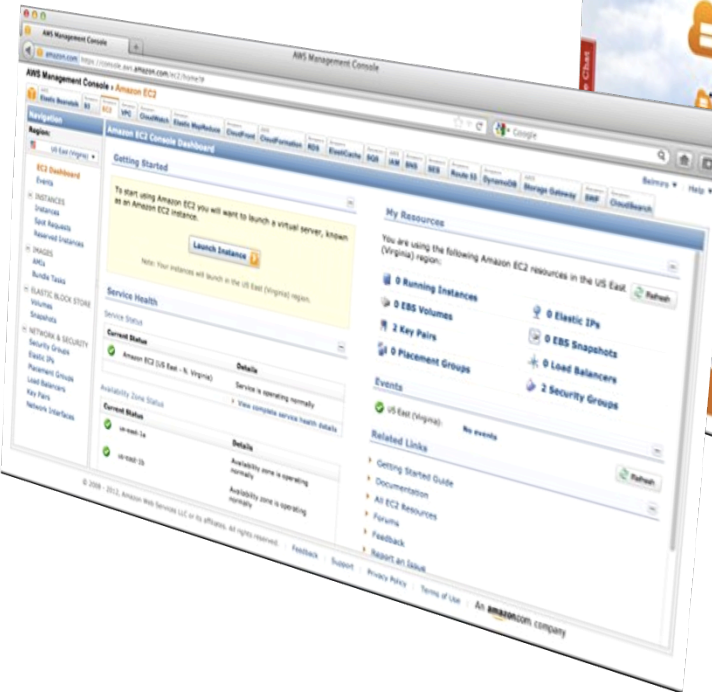
- Software to deploy a private cloud
  - Openstack
  - Eucalyptus
  - Open nebula
  - Platform ISF
  - VMware vCloud

# Public Cloud

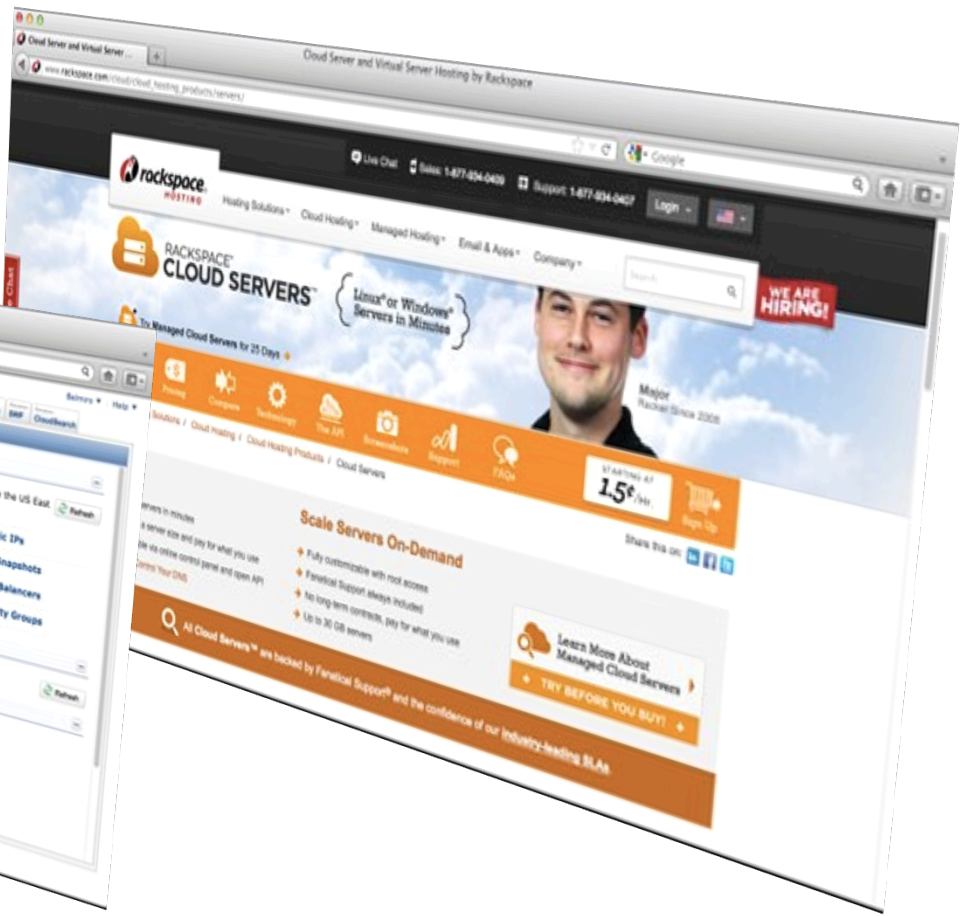
- Infrastructure is owned by a single organization and made available to other organizations / users
- Customer's rent access to resources as needed on a pay-as-you-go basis
- Offer access to large pools of scalable resources on a temporary basis;

# 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

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- “I’m cloud confused” by Handy Arjanto - [http://en.wikipedia.org/wiki/Cloud\\_computing](http://en.wikipedia.org/wiki/Cloud_computing)
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# Thank you

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