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Cloud Computing Skills and Technology – A Review

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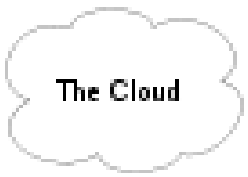
Abstract

Imagine yourself in the world where the users of the computer of today's internet world don't have to run, install or store their application or data on their own computers, imagine the world where every piece of your information or data would reside on the Cloud (Internet).. As a metaphor for the Internet, "the cloud" is a familiar cliché, but when combined with "computing", the meaning gets bigger and fuzzier. Some analysts and vendors define cloud computing narrowly as an updated version of utility computing: basically virtual servers available over the Internet. Others go very broad, arguing anything you consume outside the firewall is "in the cloud", including conventional outsourcing.. This paper deals with an overview of cloud computing technology.

1. Introduction

Cloud computing comes into focus only when you think about what we always need: a way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software. Cloud computing encompasses any subscription-based or pay-per-use service that, in real time over the Internet, extends ICT's existing capabilities. Cloud computing is at an early stage, with a motley crew of providers large and small delivering a slew of cloud-based services, from full-blown applications to storage services to spam filtering. Yes, utility-style infrastructure providers are part of the mix, but so are SaaS (software as a service) providers such as Salesforce.com [1]. Today, for the most part, IT must plug into cloud-based services individually, but cloud computing aggregators and integrators are already emerging.



2. Cloud computing- The Concept

Cloud computing is Internet ("cloud") based development and use of computer technology ("computing"). It is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet.

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Users need not have knowledge of, expertise in, or control over the technology infrastructure "in the cloud" that supports them.

The concept incorporates infrastructure as a service **(IaaS)**, platform as a service **(PaaS)** and software as a service **(SaaS)** as well as Web 2.0 and other recent technology trends which have the common theme of reliance on the Internet for satisfying the computing needs of the users. Examples of SaaS vendors include Salesforce.com and Google Apps which provide common business applications online that are accessed from a web browser, while the software and data are stored on the servers.

The term ***cloud*** is used as a metaphor for the Internet, based on how the Internet is depicted in computer network diagrams, and is an abstraction for the complex infrastructure it conceals as shown below in fig 1.

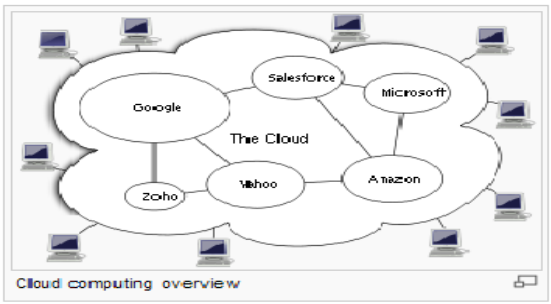

Figure 1. Cloud computing overview

2.1 Comparison:

Cloud computing is often confused with grid computing ("a form of distributed computing whereby a 'super and virtual computer' is composed of a cluster of networked, loosely-coupled computers, acting in concert to perform very large tasks"), utility computing (the "packaging of computing resources, such as computation and storage, as a metered service similar to a traditional public utility such as electricity") and autonomic computing ("computer systems capable of self-management").

Indeed many cloud computing deployments as of 2009 depend on grids, have autonomic characteristics and bill like utilities — but cloud computing can be seen as a natural next step from the grid-utility model. Some successful cloud architectures have little or no centralized infrastructure or billing systems whatsoever, including peer-to-peer networks like Bit Torrent and Skype and volunteer computing like

2.2 Implementation:

The majority of cloud computing infrastructure as of 2009 consists of reliable services delivered through data centers and built on servers with different levels of virtualization technologies. The services are accessible anywhere that has access to networking infrastructure [2]. *The Cloud* appears as a single point of access for all the computing needs of consumers. Commercial offerings need to meet the quality of service requirements of customers and typically offer service level agreements. Open standards are critical to the growth of cloud computing and open source software has provided the foundation for many cloud computing implementations.

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2.3 Characteristics:

As customers generally do not own the infrastructure, they merely access or rent, they can avoid capital expenditure and consume resources as a service, paying instead for what they use. Many cloud-computing offerings have adopted the utility computing model, which is analogous to how traditional utilities like electricity are consumed, while others are billed on a subscription basis. Sharing "perishable and intangible" computing power among multiple tenants can improve utilization rates, as servers are not left idle, which can reduce costs significantly while increasing the speed of application development. A side effect of this approach is that "computer capacity rises dramatically" as customers do not have to engineer for peak loads. Adoption has been enabled by "increased high-speed bandwidth" which makes it possible to receive the same response times from centralized infrastructure at other sites.

2.4 Economics:

Cloud computing users can avoid capital expenditure (CapEx) on hardware, software and services, rather paying a provider only for what they use. Consumption is billed on a utility (e.g. resources consumed, like electricity) or subscription (e.g. time based, like a newspaper) basis with little or no upfront cost. Other benefits of this time sharing style approach are low barriers to entry, shared infrastructure and costs, low management overhead and immediate access to a broad range of applications as shown in fig.2. Users can generally terminate the contract at any time (thereby avoiding return on investment risk and uncertainty) and the services are often covered by service level agreements with financial penalties. According to Nicholas Carr the strategic importance of information technology is diminishing as it becomes standardized and cheaper. He argues that the cloud computing paradigm shift is similar to the displacement of electricity generators by electricity grids early in the 20th century.

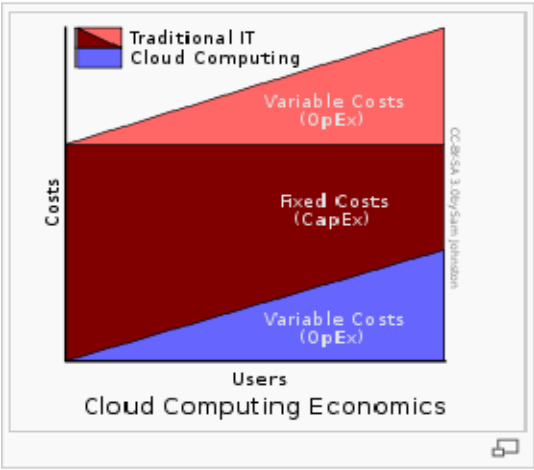

Figure2. Cloud computing economics

2.5 Companies:

Providers including Amazon, Microsoft, Google, Sun and Yahoo exemplify the use of cloud computing. It is being adopted by individual users through large enterprises including General Electric, L'Oréal, and Procter & Gamble.

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3. History

The Cloud is a term with a long history in telephony, which has in the past decade, been adopted as a metaphor for internet based services, with a common depiction in network diagrams as a cloud outline.

The underlying concept dates back to 1960 when John McCarthy opined that "computation may someday be organized as a public utility"; indeed it shares characteristics with service bureaus which date back to the 1960s. The term *cloud* had already come into commercial use in the early 1990s to refer to large ATM networks. By the turn of the 21st century, the term "cloud computing" had started to appear, although most of the focus at this time was on Software as a service (SaaS).

In 1999, Salesforce.com was established by Marc Benioff, Parker Harris, and his fellows. They applied many technologies of consumer web sites like Google and Yahoo! to business applications. They also provided the concept of "On demand" and "SaaS" with their real business and successful customers. The key for SaaS is being customizable by customer alone or with a small amount of help. Flexibility and speed for application development have been drastically welcomed and accepted by business users.

IBM extended these concepts in 2001, as detailed in the Autonomic Computing Manifesto -- which described advanced automation techniques such as self-monitoring, self-healing, self-configuring, and self-optimizing in the management of complex IT systems with heterogeneous storage, servers, applications, networks, security mechanisms, and other system elements that can be virtualized across an enterprise [4]. Amazon.com played a key role in the development of cloud computing by modernizing their data centers after the dot-com bubble and, having found that the new cloud architecture resulted in significant internal efficiency improvements, providing access to their systems by way of Amazon Web Services in 2005 on a utility computing basis. 2007 saw increased activity, with Google, IBM, and a number of universities embarking on a large scale *cloud computing* research project, around the time the term started gaining popularity in the mainstream press. It was a hot topic by mid-2008 and numerous cloud computing events had been scheduled [3]. In August 2008, Gartner Research observed that "organizations are switching from company-owned hardware and software assets to per-use service-based models" and that the "projected shift to cloud computing will result in dramatic growth in IT products in some areas and in significant reductions in other areas."

4. Political Issues

The Cloud spans many borders and "may be the ultimate form of globalization." As such it becomes subject to complex geopolitical issues: providers must satisfy myriad regulatory environments in order to deliver service to a global market. This dates back to the early days of the Internet, where libertarian thinkers felt that "cyberspace was a distinct place calling for laws and legal institutions of its own"; author Neal Stephenson envisaged this as a tiny island data haven called Kinakuta in his classic science-fiction novel Cryptonomicon.

Despite efforts (such as US-EU Safe Harbor) to harmonize the legal environment, as of 2009 providers such as Amazon Web Services cater to the major

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markets (typically the United States and the European Union) by deploying local infrastructure and allowing customers to select "availability zones." Nonetheless, there are still concerns about security and privacy from individual through governmental level, e.g., the USA PATRIOT Act and use of national security letters and the Electronic Communication Privacy Act's *Stored Communications Act*.

5. Legal Issues

In March 2007, Dell applied to trademark the term "cloud computing" (U.S. Trademark 77,139,082) in the United States. The "Notice of Allowance" it received in July 2008 was canceled on August 6, resulting in a formal rejection of the trademark application less than a week later. On 30 September 2008, USPTO issued a "Notice of Allowance" to CGactive LLC (U.S. Trademark 77,355,287) for "CloudOS". A *cloud operating system* is a generic operating system that "manage[s] the relationship between software inside the computer and on the Web", such as Microsoft Azure. Good OS LLC also announced their "Cloud" operating system on 1 December 2008. Richard Stallman, founder of the Free Software Foundation, believes that cloud computing endangers liberties because users sacrifice their privacy and personal data to a third party. In November 2007, the Free Software Foundation released the Affero General Public License, a version of GPLv3 designed to close a perceived legal loophole associated with free software designed to be run over a network, particularly software as a service. An application service provider is required to release any changes they make to Affero GPL open source code

6. Risk Mitigation

Corporations or end-users wishing to avoid not being able to access their data — or even losing it — should research vendors' policies on data security before using vendor services. One technology analyst and consulting firm, Gartner, lists seven security issues which one should discuss with a cloud-computing vendor:

1. Privileged user access—inquire about who has specialized access to data and about the hiring and management of such administrators.

2. Regulatory compliance—makes sure a vendor is willing to undergo external audits and/or security certifications.

3. Data locations—ask if a provider allows for any control over the location of data.

3. Data segregation—make sure that encryption is available at all stages and that these "encryption schemes were designed and tested by experienced professionals".

4. Recovery—find out what will happen to data in the case of a disaster; do they offer complete restoration and, if so, how long that would take.

5. Investigative Support—inquire whether a vendor has the ability to investigate any inappropriate or illegal activity.

6. Long-term viability—ask what will happen to data if the company goes out of business; how will data be returned and in what format.

In practice, one can best determine data-recovery capabilities by experiment: asking to get back old data, seeing how long it takes, and verifying that the

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checksums match the original data. Determining data security is harder. A tactic not covered by Gartner is to encrypt the data yourself. If you encrypt the data using a trusted algorithm, then regardless of the service provider's security and encryption policies, the data will only be accessible with the decryption keys. This leads to a follow-on problem: managing private keys in a pay-on-demand computing infrastructure.

7. Key characteristics

- ***Cost*** is greatly reduced and capital expenditure is converted to operational expenditure. This lowers barriers to entry, as infrastructure is typically provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained with usage-based options and minimal or no IT skills are required for implementation.

- ***Device and location independence*** enable users to access systems using a web browser regardless of their location or what device they are using, e.g., PC, mobile. As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet the users can connect from anywhere.

- ***Multi-tenancy*** enables sharing of resources and costs among a large pool of users, allowing for:
  - **Centralization** of infrastructure in areas with lower costs (such as real estate, electricity, etc.)
  - **Peak-load capacity** increases (users need not engineer for highest possible load-levels)
  - **Utilization and efficiency** improvements for systems that are often only 10-20% utilized.

- ***Reliability*** improves through the use of multiple redundant sites, which makes it suitable for business continuity and disaster recovery. Nonetheless, most major cloud computing services have suffered outages and IT and business managers are able to do little when they are affected.

- ***Scalability*** via dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis near real-time, without users having to engineer for peak loads. Performance is monitored and consistent and loosely-coupled architectures are constructed using web services as the system interface.

- ***Security*** typically improves due to centralization of data, increased security-focused resources, etc., but raises concerns about loss of control over certain sensitive data. Security is often as good as or better than traditional systems, in part because providers are able to devote resources to solving security issues that many customers cannot afford. Providers typically log accesses, but accessing the audit logs themselves can be difficult or impossible.

- ***Sustainability*** comes about through improved resource utilization, more efficient systems, and carbon neutrality. Nonetheless, computers and associated infrastructure are major consumers of energy.

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8. Components

Applications	Facebook · Google Apps ·SalesForce · Microsoft Online
Client	Browser(Chrome) · Firefox · Cloud · Mobile (Android · iPhone) · Netbook (EeePC · MSI Wind) ·Nettop (CherryPal ·Zonbu)
Infrastructure	BitTorrent · EC2 ·GoGrid · Sun Grid · 3tera
Platforms	App Engine · Azure ·Mosso ·SalesForce
Services	Alexa · FPS ·MTurk · SQS
Storage	S3 ·SimpleDB · SQL Services
Standards	Ajax · Atom · HTML 5 · REST

Table 1. Cloud computing components

8.1 Application

A ***cloud application*** leverages the Cloud in software architecture, often eliminating the need to install and run the application on the customer's own computer, thus alleviating the burden of software maintenance, ongoing operation, and support. The cloud components are shown in table 1. **For example**:

- Peer-to-peer / volunteer computing (Bittorrent, BOINC Projects, Skype)
- Web application (Facebook)
- Software as a service (Google Apps, SAP and Salesforce)
- Software plus services (Microsoft Online Services)

8.2 Client

A ***cloud client*** consists of computer hardware and/or computer software which relies on **cloud computing** for application delivery, or which is specifically designed for delivery of cloud services and which, in either case, is essentially useless without it. **For example**:

- Mobile (Android, iPhone, Windows Mobile)
- Thin client (CherryPal, Zonbu, gOS-based systems)
- Thick client / Web browser (Google Chrome, Mozilla Firefox)

8.3 Infrastructure

Cloud infrastructure, such as Infrastructure as a service, is the delivery of computer infrastructure, typically a platform virtualization environment, as a service. **For example**:

- Full virtualization (GoGrid, Skytap)
- Management (RightScale)
- Compute (Amazon Elastic Compute Cloud)
- Platform (Force.com)

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8.4 Platform

A ***cloud platform***, such as Platform as a service, the delivery of a computing platform, and/or solution stack as a service, facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers. **For example**:

- Web application frameworks
    - Python Django (Google App Engine)
    - Ruby on Rails (Heroku)
    - .NET (Azure Services Platform)
- Web hosting (Mosso)
- Proprietary (Force.com)

8.5 Service

A ***cloud service*** includes "products, services and solutions that are delivered and consumed in real-time over the Internet". For example, Web Services ("software system[s] designed to support interoperable machine-to-machine interaction over a network") which may be accessed by other cloud computing components, software, e.g., Software plus service, or end users directly. **Specific examples include**:

- Identity (OAuth, OpenID)
- Integration (Amazon Simple Queue Service)
- Payments (Amazon Flexible Payments Service, Google Checkout, PayPal)
- Mapping (Google Maps, Yahoo! Maps)
- Search (Alexa, Google Custom Search, Yahoo! BOSS)
- Others (Amazon Mechanical Turk)

8.6 Storage

Cloud storage involves the delivery of data storage as a service, including database-like services, often billed on a utility computing basis, e.g., per gigabyte per month**. For example:**

- Database (Amazon SimpleDB, Google App Engine's BigTabledatastore)
- Network attached storage (MobileMeiDisk, NirvanixCloudNAS)
- Synchronization (Live Mesh *Live Desktop* component, MobileMe push functions)
- Web service (Amazon Simple Storage Service, Nirvanix SDN)

9. Architecture

Cloud architecture, the systems architecture of the software systems involved in the delivery of *cloud computing*, comprises hardware and software designed by a *cloud architect* who typically works for a *cloud integrator*. It typically involves multiple *cloud components* communicating with each other over application programming interfaces, usually web services. This closely resembles the UNIX philosophy of having multiple programs doing one thing well and working together

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over universal interfaces. Complexity is controlled and the resulting systems are more manageable than their monolithic counterparts.

Cloud architecture extends to the client, where web browsers and/or software applications access *cloud applications*.

Cloud storage architecture is loosely coupled, where metadata operations are centralized enabling the data nodes to scale into the hundreds, each independently delivering data to applications or user as shown in fig.3.

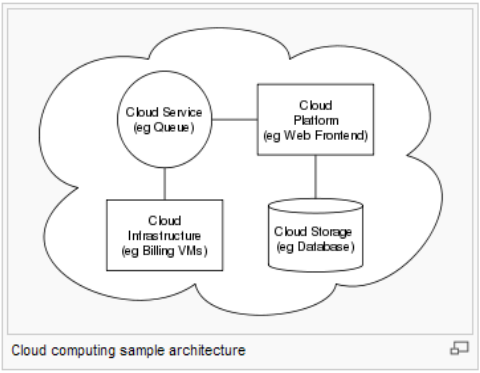

Figure 3. Architecture of Cloud

10. Types

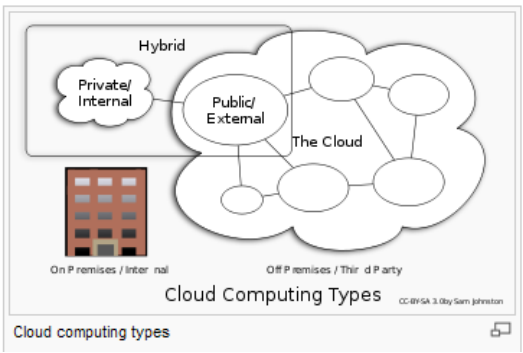

Figure 4. Types of Cloud

10.1 Public cloud

Public cloud or *external cloud* describes cloud computing in the traditional mainstream sense, whereby resources are dynamically provisioned on a fine-grained, self-service basis over the Internet, via web applications/web services, from an off-site third-party provider who shares resources and bills on a fine-grained utility computing basis as shown in fig 4.

10.2 Private_cloud

Private cloud and *internal cloud* are neologisms that some vendors have recently used to describe offerings that emulate cloud computing on private networks. These products claim to "deliver some benefits of cloud computing without the pitfalls", capitalizing on data security, corporate governance, and reliability concerns.

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While an analyst predicted in 2008 that private cloud networks would be the future of corporate IT, there is some uncertainty whether they are a reality even within the same firm. Analysts also claim that within five years a "huge percentage" of small and medium enterprises will get most of their computing resources from external cloud computing providers as they "will not have economies of scale to make it worth staying in the IT business" or be able to afford private clouds.

The term has also been used in the logical rather than physical sense, for example in reference to platform as service offerings, though such offerings including Microsoft's Azure Services Platform are not available for on-premises deployment.

10.3 Hybrid cloud

A *hybrid cloud* environment consisting of multiple internal and/or external providers"will be typical for most enterprises".

11. Roles

11.1 Provider

A *cloud computing provider* or *cloud computing service provider* owns and operates live *cloud computing* systems to deliver service to third parties. The barrier to entry is also significantly higher with capital expenditure required and billing and management creates some overhead. Nonetheless, significant operational efficiency and agility advantages can be realized, even by small organizations, and server consolidation and virtualization rollouts are already well underway. Amazon.com was the first such provider, modernizing its data centers which, like most computer networks, were using as little as 10% of its capacity at any one time just to leave room for occasional spikes. This allowed small, fast-moving groups to add new features faster and easier, and they went on to open it up to outsiders as Amazon Web Services in 2002 on a utility computing basis.

11.2 User

A user is a consumer of *cloud computing*. The privacy of users in cloud computing has become of increasing concern. The rights of users are also an issue, which is being addressed via a community effort to create a bill of rights.

11.3 Vendor

A vendor sells products and services that facilitate the delivery, adoption and use of *cloud computing*.For example:

- Computer hardware (Dell, HP, IBM, Sun Microsystems)
  - Storage (Sun Microsystems, EMC, IBM)
  - Infrastructure (Cisco Systems)
- Computer software (3tera, Hadoop, IBM, RightScale)
  - Operating systems (Solaris, AIX, Linux including Red Hat)
  - Platform virtualization (Citrix, Microsoft, VMware, Sun xVM, IBM)

12. Standards

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Cloud standards, a number of existing, typically lightweight, open standards [6], have facilitated the growth of cloud computing, including:

- Application
  - Communications (HTTP, XMPP)
  - Security (OAuth, OpenID, SSL/TLS)
  - Syndication (Atom)
- **Client**
  - Browsers (AJAX)
  - Offline (HTML 5)
- **Implementations**
  - Virtualization (OVF)
- **Platform**
  - Solution stacks (LAMP)
- **Service**
  - Data (XML, JSON)
  - Web Services (REST)
- **Storage**
  - Database(Amazon Simple DB, Google App Engine BigTableDatastore)
  - Network attached storage (MobileMeiDisk, NirvanixCloudNAS)
  - Synchronization (Live Mesh *Live Desktop* component, MobileMe push functions)
  - Web service (Amazon Simple Storage Service, Nirvanix SDN)

13. Case_Study

13.1 Amazon_EC2

Amazon Elastic Compute Cloud (also known as "EC2") is a commercial web service that allows customers to rent computers on which to run their own computer applications. EC2 allows scalable deployment of applications by providing a web services interface through which a customer can create virtual machines, i.e. server instances, on which the customer can load any software of his choice. A customer can create, launch, and terminate server instances as needed, paying by the hour for active servers, hence the term "elastic". A customer can set up server instances in zones insulated from each other for most failure causes so that one may be a backup for the other and minimize down time. Amazon.com provides EC2 as one of several web services marketed under the blanket term Amazon Web Services (AWS).

History Amazon announced a limited public beta of EC2 on August 25, 2006. Access to EC2 was granted on a first come first served basis. EC2 became generally available on October 23, 2008 along with support for Microsoft Windows Server.

Virtual machines EC2 uses Xen virtualization. Each virtual machine, called an "instance", functions as a virtual private server in one of three sizes; small, large or extra large. Amazon.com sizes instances based on "EC2 Compute Units" — the equivalent CPU capacity of physical hardware. One EC2 Compute Unit equals 1.0-1.2 GHz 2007 Opteron or 2007 Xeon processor.

The system offers the following instance types:
Small Instance

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The small instance (default) equates to "a system with 1.7 GB of memory, 1 EC2 Compute Unit (1 virtual core with 1 EC2 Compute Unit), 160 GB of instance storage, 32-bit platform"

Large Instance

The large instance represents "a system with 7.5 GB of memory, 4 EC2 Compute Units (2 virtual cores with 2 EC2 Compute Units each), 850 GB of instance storage, 64-bit platform".

Extra Large Instance

The extra large instance offers the "equivalent of a system with 15 GB of memory, 8 EC2 Compute Units (4 virtual cores with 2 EC2 Compute Units each), 1690 GB of instance storage, 64-bit platform."

High-CPU Instance

Instances of this family have proportionally more CPU resources than memory (RAM) and address compute-intensive applications.

High-CPU Medium Instance

Instances of this family have the following configuration:

- 1.7 GB of memory
- 5 EC2 Compute Units (2 virtual cores with 2.5 EC2 Compute Units each)
- 350 GB of instance storage
- 32-bit platform
- I/O Performance: Moderate

High-CPU Extra Large Instance

Instances of this family have the following configuration:

- 7 GB of memory
- 20 EC2 Compute Units (8 virtual cores with 2.5 EC2 Compute Units each)
- 1690 GB of instance storage
- 64-bit platform
- I/O Performance: High

Pricing

Amazon charges customers in two primary ways:

- Hourly charge per virtual machine
- Data transfer charge

The hourly virtual machine rate is fixed, based on the capacity and features of the virtual machine [5]. Amazon advertising describes the pricing scheme as "you pay for resources you consume," but defines resources such that an idle virtual machine is consuming resources, as opposed to other pricing schemes where one would pay for basic resources such as CPU time.

Customers can easily start and stop virtual machines to control charges, with Amazon measuring with one hour granularity. Some are thus able to keep each virtual machine running near capacity and effectively pay only for CPU time actually used.

As of March 2009, Amazon's time charge is about $73/month for the smallest virtual machine without Windows and twelve times that for the largest one running

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Windows. The data transfer charge ranges from $.10 to $.17 per gigabyte, depending on the direction and monthly volume.

Amazon does not have monthly minimums or account maintenance charges.

Operating systems

When it launched in August 2006, the EC2 service offered Linux and later Sun Microsystems' OpenSolaris and Solaris Express Community Edition. In October 2008, EC2 added the Windows Server 2003 operating system to the list of available operating systems[9].

Plans are in place for the Eucalyptus interface for the Amazon API to be packaged into the standard Ubuntu distribution.

Persistent Storage

Amazon.com provides persistent storage in the form of Elastic Block Storage (EBS). Users can set up and manage volumes of sizes from 1GB to 1TB. The servers can attach these instances of EBS to one server at a time in order to maintain data storage by the servers

13.2 Salesforce.com

Salesforce.com (NYSE: CRM) is a vendor of Customer Relationship Management (CRM) solutions, which it delivers to businesses over the internet using the software as a service model [7].

Origins Salesforce.com was founded in 1999 by former Oracle executive Marc Benioff. In June 2004, the company went public on the New York Stock Exchange under the stock symbol CRM. Initial investors in salesforce.com were Marc Benioff, Larry Ellison, Halsey Minor, Magdalena Yesil and Igor Sill, Geneva Venture Partners.

Current status Salesforce.com is headquartered in San Francisco, California, with regional headquarters in Dublin (covering Europe, Middle East, and Africa), Singapore (covering Asia Pacific less Japan), and Tokyo (covering Japan). Other major offices are in Toronto, New York, London, Sydney, and San Mateo, California. Salesforce.com has its services translated into 15 different languages and currently has 43,600 customers and over 1,000,000 subscribers. In 2008, Salesforce.com ranked 43rd on the list of largest software companies in the world.

Following the Federal takeover of Freddie Mac and Fannie Mae in September 2008, the S&P 500 removed the two mortgage giants after Wednesday, September 10, 2008, and added Fastenal and Salesforce.com to the index, effective after Friday, September 12, 2008

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Products and Services:

Customer Relationship Management

Salesforce.com's CRM solution is broken down into several applications: Sales, Service & Support, Partner Relationship Management, Marketing, Content, Ideas and Analytics.

Force.com Platform

Salesforce.com's Platform-as-a-Service product is known as the Force.com Platform. The platform allows external developers to create add-on applications that integrate into the main Salesforce application and are hosted on salesforce.com's infrastructure.

These applications are built using Apex (a proprietary Java-like programming language for the Force.com Platform) and Visualforce (an XML-like syntax for building user interfaces in HTML, AJAX or Flex).

AppExchange

Launched in 2005, AppExchange is a directory of applications built for Salesforce by third-party developers which users can purchase and add to their Salesforce environment. As of September 2008, there are over 800 applications available from over 450 ISVs.

Customization

Salesforce users can customize their CRM application. In the system, there are tabs such as "Contacts", "Reports", and "Accounts". Each tab contains associated information. For example, "Contacts" has fields like First Name, Last Name, Email, etc.Customization can be done on each tab, by adding user-defined custom fields.

Customization can also be done at the "platform" level by adding customized applications to a Salesforce.com instance that is adding sets of customized / novel tabs for specific vertical- or function-level (Finance, Human Resources, etc) features.

Web Services

In addition to the web interface, Salesforce offers a Web Services API that enables integration with other systems [8].

13.3 CLOUD (Operating System)

Cloud is a "**browser based Operating system**" created by '**Good OS LLC'**, a Los Angeles-based corporation. The company initially launched a Linux distribution called gOS which is based on Ubuntu, now in its third incarnation

Browser and Operating System

Cloud is a combination of a simplified operating system that runs just a web browser, providing access to a variety of web-based applications that allow the user

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to perform many simple tasks without booting a full-scale operating system [9]. Because of its simplicity, Cloud can boot in just a few seconds. The operating system is designed for Netbooks, Mobile Internet Devices, and PCs that are mainly used to browse the Internet. From Cloud the user can quickly boot into the main OS, because Cloud continues booting the main OS in the background.

Combining a browser with a basic operating system also allows the use of cloud computing, in which applications and data "live and run" on the Internet instead of on the hard drive.

Cloud can be installed and used together with other operating systems, or can act as a standalone operating system. When used as a standalone operating system, hardware requirements are relatively low.

At the moment Cloud is only officially available built into the GIGABYTE M912 Touch Screen Netbook, but a Private Beta test is currently (early February, 2009) running.

Reception-Early reviews compared the operating system's user interface to Mac OS X and noted the similarity of its browser to Google Chrome, although it is actually based on a modified Mozilla Firefox browser.

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