Cloud computing

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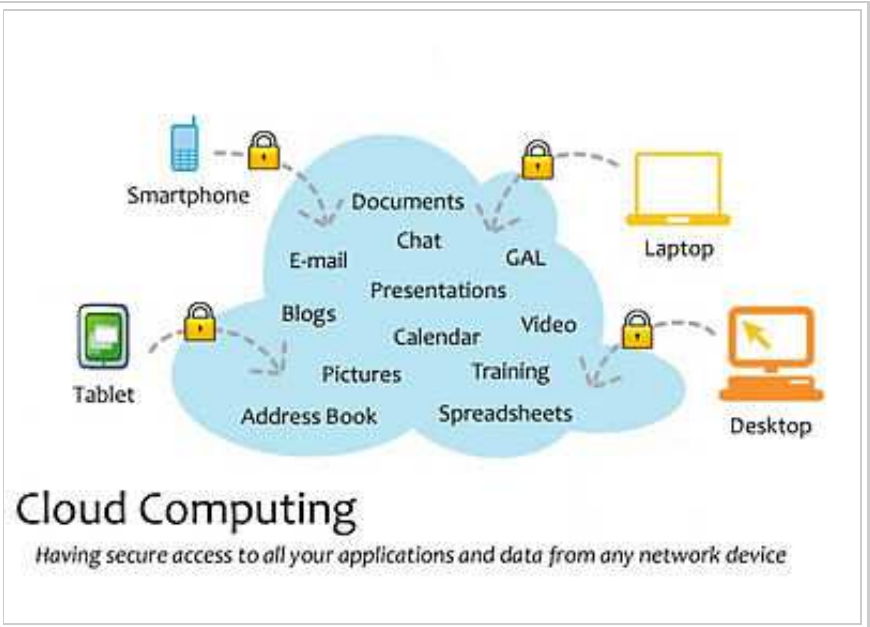
Cloud computing refers to the logical computational resources (data, software) accessible via a computer network (through WAN or Internet etc.), rather than from a local computer. The on-line service can be offered from a cloud provider or it could be private organization's own. In this case these technologies are regarded by some analysts as a technological evolution[1], or are seen as a marketing trap by others like Richard Stallman[2][3].

Contents



Cloud Computing visual diagram

Introduction

Users or clients can perform a task, such as word processing, mailing, with a client such as browser and with service provided through such cloud based computational resources. Since the cloud is the underlying delivery mechanism, cloud-based remote applications and services may support any type of software application or service in use today.

In the past, tasks such as word processing were not possible without the installation of software on a local computer. With the development of local area networks (LAN) and wider bandwidth, multiple CPUs and storage devices could be used to host services like word processing in a remotely managed datacenter. The Cloud computing takes away the installation and upgrades hassles and need for higher computing power from users and gives more control to the service providers on administration of the services.

Consumers now routinely use data-intensive applications driven by cloud technology that were previously unavailable due to cost and deployment complexity.[*citation needed*] In many companies, employees and company departments are bringing a flood of consumer technology into the workplace, which raises legal compliance and security concerns for the corporation.[*citation needed*]

The term "software as a service" is sometimes used to describe programs offered through "The Cloud".

A common shorthand for a provided cloud computing service (or even an aggregation of all existing cloud services) is "The Cloud".

An analogy to explain cloud computing is that of public utilities such as electricity, gas, and water. Centralized and standardized utilities freed individuals from the difficulties of generating electricity or pumping water. All of the development and maintenance tasks involved in doing so was alleviated. With Cloud computing, this translates to a reduced cost in software distribution to providers still using hard mediums such as DVDs. Consumer benefits are that software no longer has to be installed and is automatically updated, but savings in terms of money is yet to be seen.

The principle behind the cloud is that any computer connected to the Internet is connected to the same pool of computing power, applications, and files. Users can store and access personal files such as music, pictures, videos, and bookmarks or play games or do word processing on a remote server rather than physically carrying around a storage medium such as a DVD or thumb drive. Even those using web-based email such as Gmail, Hotmail, Yahoo!, a company-owned email, or even an e-mail client program such as Outlook, Evolution, Mozilla Thunderbird, or Entourage are making use of cloud email servers. Hence, desktop applications that connect to internet-host email providers can also be considered cloud applications.

How it works

Cloud computing utilizes the network as a means to connect the user to resources that are based in the *cloud*, as opposed to actually possessing them. The *cloud* may be accessed via the Internet or a company network, or both. Cloud services may be designed to work equally well with Linux, Mac, and Windows platforms. With smartphones and tablets on the rise, cloud services have changed to allow access from any device connected to the Internet, allowing mobile workers access on-the-go, as in telecommuting, and extending the reach of business services provided by outsourcing.

The service provider may pool the processing power of multiple remote computers in "the cloud" to achieve the task, such as backing up of large amounts of data, word processing, or computationally intensive work. These tasks would normally be difficult, time consuming, or expensive for an individual user or a small company to accomplish, especially with limited computing resources and funds. With *cloud computing*, clients require only a simple computer, such as netbooks, which were created with cloud computing in mind, or even a smartphone, with a connection to the Internet, or a company network, in order to make requests to and receive data from the cloud, hence the term "software as a service" (SaaS). Computation and storage is divided among the remote computers in order to handle large volumes of both, thus the client need not purchase expensive hardware or software to handle the task. The outcome of the processing task is returned to the client over the network, depending on the speed of the Internet connection.

Technical description

The National Institute of Standards and Technology (NIST) provides a concise and specific definition:

> Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.[4]

Cloud computing provides computation, software, data access, and storage services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services. Parallels to this concept can be drawn with the electricity grid, wherein end-users consume power without needing to understand the component devices or infrastructure required to provide the service.

Cloud computing describes a new supplement, consumption, and delivery model for IT services based on Internet protocols, and it typically involves provisioning of dynamically scalable and often virtualized resources[5][6] It is a byproduct and consequence of the ease-of-access to remote computing sites provided by the Internet.[7] This may take the form of web-based tools or applications that users can access and use through a web browser as if they were programs installed locally on their own computers.[8]

Cloud computing providers deliver applications via the internet, which are accessed from a Web browser, while the business software and data are stored on servers at a remote location. In some cases, legacy applications (line of business applications that until now have been prevalent in thin client Windows computing) are delivered via a screen-sharing technology such as Citrix XenApp, while the compute resources are consolidated at a remote data center location; in other cases, entire business applications have been coded using web-based technologies such as AJAX.

Most cloud computing infrastructures consist of services delivered through shared data-centers. The Cloud may appear as a single point of access for consumers' computing needs; notable examples include the iTunes Store and the iOS App Store. Commercial offerings may be required to meet service level agreements (SLAs), but specific terms are less often negotiated by smaller companies.[9]

Risks

Cloud computing's users are exposed to risks mainly associated with:

1) **Information security** and users' **privacy**

- Using a service of *cloud computing* to store data may expose a user to potential violation of privacy. Possession of a user's personal information is entrusted to a provider that can reside in a country other than the user's. In the case of a malicious behavior of the cloud provider, it could access the data in order to perform *market research* and *user profiling*.[10]
- In the case of wireless *cloud computing*, the safety risk increases as a function of reduced security offered by wireless networks. In the presence of illegal acts like misappropriation or illegal appropriation of personal data, the damage could be very serious for the user, with difficulty to reach legal solutions and/or refunds if the provider resides in a state other than the user's country.
- In the case of industries or corporations, all the data stored in external memories are seriously exposed to possible cases of international or industrial espionage.

2)**International**, **political** and **economic** problems

- May arise when the *cloud's archives* with all the stored informations are located in a country other than those of the cloud's users. Crucial and intellectual productions and large amounts of personal informations are increasingly recorded in the form of digital data. And it seems clear that a complete personal/national access and/or property of such archives is of critical interest for every nation.
- Issues are also related with the centralization of the cloud's archives in a few rich countries, rather than decentralizing them in many countries. If supported, the rapid growth of this phenomenon:

1. will greatly increase the digital divide between rich and poor nations,
2. being the intangible property considered as a strategic factor for the modern knowledge-based economies will favorite big corporations with "polycentric bodies" and "monocentric minds" resident in the "cloud's countries".

3)**Continuity of service**

- Delegating their data-managing and processing to an external service, users are severely limited when these services are not operating. A malfunction also affects a large number of users at once because these services are often shared on a large network. As the service provided is supported by a high-speed Internet connection (both in download and upload), even in the event of an interruption of the line connection due to the user's Internet Service Provider (ISP) he or she will face a complete paralysis of the work.

4) **Data migration** problems when changing the *cloud provider*

- Another issue is related with the data migration or porting when a user wants to change his cloud provider. There is no defined standard between the operators and such a change is extremely complex. The case of bankruptcy of the company of the cloud provider could be extremely dangerous for the users.[11][12]

Overview

Comparisons

Cloud computing shares characteristics with:

1. Autonomic computing — "computer systems capable of self-management."[13]
2. Client–server model – *client–server computing* refers broadly to any distributed application that distinguishes between service providers (servers) and service requesters (clients).[14]
3. Grid computing — "a form of distributed computing and parallel 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."
4. Mainframe computer — powerful computers used mainly by large organizations for critical applications, typically bulk data processing such as census, industry and consumer statistics, enterprise resource planning, and financial transaction processing.[15]
5. 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."[16]
6. Peer-to-peer – distributed architecture without the need for central coordination, with participants being at the same time both suppliers and consumers of resources (in contrast to the traditional client–server model).
7. Service-oriented computing – Cloud computing provides services related to computing while, in a reciprocal manner, service-oriented computing consists of the computing techniques that operate on software-as-a-service.[17]

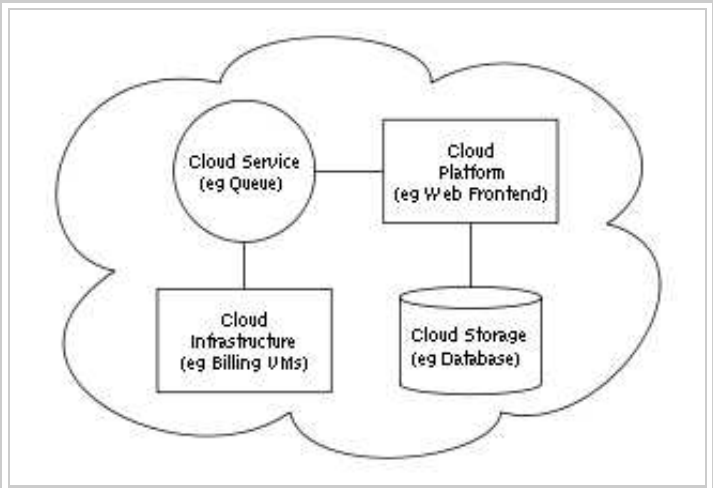
Characteristics

The key characteristic of cloud computing is that the computing is "in the cloud"; that is, the processing (and the related data) is not in a specified, known or static place(s). This is in contrast to a model in which the processing takes place in one or more specific servers that are known. All the other concepts mentioned are supplementary or complementary to this concept.

Architecture

Cloud architecture,[18] the systems architecture of the software systems involved in the delivery of cloud computing, typically involves multiple *cloud components* communicating with each other over loose coupling mechanism such as messaging queue.

The two most significant components of cloud computing architecture are known as the front end and the back end. The front end is the part seen by the client, i.e., the computer user. This includes the client's network (or computer) and the applications used to access the cloud via a user interface such as a web browser. The back end of the cloud computing architecture is the *cloud* itself, comprising various computers, servers and data storage devices.



Cloud computing sample architecture

History

The term "cloud" is used as a metaphor for the Internet, based on the cloud drawing used in the past to

represent the telephone network,[19] and later to depict the Internet in computer network diagrams as an abstraction of the underlying infrastructure it represents.[20]

Cloud computing is a natural evolution of the widespread adoption of virtualization, service-oriented architecture, autonomic, and utility computing. Details are abstracted from end-users, who no longer have need for expertise in, or control over, the technology infrastructure "in the cloud" that supports them.[21]

The underlying concept of cloud computing dates back to the 1960s, when John McCarthy opined that "computation may someday be organized as a public utility." Almost all the modern-day characteristics of cloud computing (elastic provision, provided as a utility, online, illusion of infinite supply), the comparison to the electricity industry and the use of public, private, government, and community forms, were thoroughly explored in Douglas Parkhill's 1966 book, *The Challenge of the Computer Utility*.

The actual term "cloud" borrows from telephony in that telecommunications companies, who until the 1990s offered primarily dedicated point-to-point data circuits, began offering Virtual Private Network (VPN) services with comparable quality of service but at a much lower cost. By switching traffic to balance utilization as they saw fit, they were able to utilize their overall network bandwidth more effectively. The cloud symbol was used to denote the demarcation point between that which was the responsibility of the provider and that which was the responsibility of the user. Cloud computing extends this boundary to cover servers as well as the network infrastructure.[22] The first scholarly use of the term “cloud computing” was in a 1997 lecture by Ramnath Chellappa.[23]

After the dot-com bubble, Amazon played a key role in the development of cloud computing by modernizing their data centers, which, like most computer networks, were using as little as 10% of their capacity at any one time, just to leave room for occasional spikes. Having found that the new cloud architecture resulted in significant internal efficiency improvements whereby small, fast-moving "two-pizza teams" could add new features faster and more easily, Amazon initiated a new product development effort to provide cloud computing to external customers, and launched Amazon Web Service (AWS) on a utility computing basis in 2006.[24][25] The first exposure of the term Cloud Computing to public media is by GoogleEx CEO Eric Schmidt at SES San Jose 2006.[26] It was reported in 2011 that Amazon has thousands of corporate customers, from large ones like Pfizer and Netflix to start-ups. Among them also include many corporations that live on Amazon's web services, including Foursquare, a location-based social networking site; Quora, a question-and-answer service; Reddit, a site for news-sharing and BigDoor, a maker of game tools for Web publishers.[27]

In 2007, Google, IBM and a number of universities embarked on a large-scale cloud computing research project.[28] In early 2008, Eucalyptus became the first open-source, AWS API-compatible platform for deploying private clouds. In early 2008, OpenNebula, enhanced in the RESERVOIR European Commission-funded project, became the first open-source software for deploying private and hybrid clouds, and for the federation of clouds.[29] In the same year, efforts were focused on providing QoS guarantees (as required by real-time interactive applications) to cloud-based infrastructures, in the framework of the IRMOS European Commission-funded project.[30] By mid-2008, Gartner saw an opportunity for cloud computing "to shape the relationship among consumers of IT services, those who use IT services and those who sell them"[31] and observed that "[o]rganisations are switching from company-owned hardware and software assets to per-use service-based models" so that the "projected shift to cloud computing ... will result in dramatic growth in IT products in some areas and significant reductions in other areas."[32]

Key characteristics (From a business prospective)

Taking into account the serious risks listed in the Risk section above, there are some advantages for a company that decides to benefit of a cloud computing service:

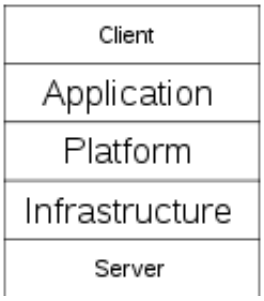
- **Agility** improves with users' ability to re-provision technological infrastructure resources.
- **Application Programming Interface** (API) accessibility to software that enables machines to interact with cloud software in the same way the user interface facilitates interaction between humans and computers. Cloud computing systems typically use REST-based APIs.
- **Cost** is claimed to be reduced and in a public cloud delivery model capital expenditure is converted to operational expenditure.[33] This is purported to lower 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 fewer IT skills are required for implementation (in-house).[34]
- **Device and location independence**[35] enable users to access systems using a web browser regardless of their location or what device they are using (e.g., PC, mobile phone). As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.[34]
- **Multi-tenancy** enables sharing of resources and costs across a large pool of users thus allowing for:
  - **Centralization** of infrastructure in locations 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.[24]
- **Reliability** is improved if multiple redundant sites are used, which makes well-designed cloud computing suitable for business continuity and disaster recovery.[36]
- **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.[34]
- **Security** could improve due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels.[37] Security is often as good as or better than under traditional systems, in part because providers are able to devote resources to solving security issues that many customers cannot afford.[38] However, the complexity of security is greatly increased when data is distributed over a wider area or greater number of devices and in multi-tenant systems that are being shared by unrelated users. In addition, user access to security audit logs may be difficult or impossible. Private cloud installations are in part motivated by users' desire to retain control over the infrastructure and avoid losing control of information security.
- **Maintenance** of cloud computing applications is easier, because they do not need to be installed on each user's computer. They are easier to support and to improve, as the changes reach the clients instantly.

Layers

Once an Internet Protocol connection is established among several computers, it is possible to share services within any one of the following layers.

Provider

See also: Category:Cloud providers



A *cloud provider* is the Company responsible for providing the cloud service.

Client

See also: Category:Cloud clients

A *cloud client* consists of computer hardware and/or computer software that relies on cloud computing for application delivery, or that is specifically designed for delivery of cloud services and that, in either case, is in essence useless without it. Examples include some computers, phones and other devices, operating systems, and browsers.[39][40][41][42][43] Cloud Desktop as a Service or Hosted Desktop, is a term often used to refer to a container of a collection of virtual objects, software, hardware, configurations etc., residing on the cloud, used by a client to interact with remote services and perform computer related tasks.[44]

Application

See also: Category:Cloud applications

Cloud application services or "Software as a Service (SaaS)" deliver software as a service over the Internet, eliminating the need to install and run the application on the customer's own computers and simplifying maintenance and support. People tend to use the terms "SaaS" and "cloud" interchangeably, when in fact they are two different things.[*citation needed*] Key characteristics include:[45]

- Network-based access to, and management of, commercially available (i.e., not custom) software
- Activities that are managed from central locations rather than at each customer's site, enabling customers to access applications remotely via the Web
- Application delivery that typically is closer to a one-to-many model (single instance, multi-tenant architecture) than to a one-to-one model, including architecture, pricing, partnering, and management characteristics
- Centralized feature updating, which obviates the need for downloadable patches and upgrades

Platform

See also: Category:Cloud platforms

Cloud platform services, also known as Platform as a Service (PaaS), deliver a computing platform and/or solution stack as a service, often consuming cloud infrastructure and sustaining cloud applications.[46] It facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers.[47][48]

Infrastructure

See also: Category:Cloud infrastructure

Cloud infrastructure services, also known as Infrastructure as a Service (IaaS), deliver computer infrastructure – typically a platform virtualization environment – as a service. Rather than purchasing servers, software, data-center space or network equipment, clients instead buy those resources as a fully outsourced service. Suppliers typically bill such services on a utility computing basis; the amount of resources consumed (and therefore the cost) will typically reflect the level of activity. IaaS evolved from virtual private server offerings.[49]

Cloud infrastructure often takes the form of a tier 3 data center with many tier 4 attributes, assembled from hundreds of virtual machines.

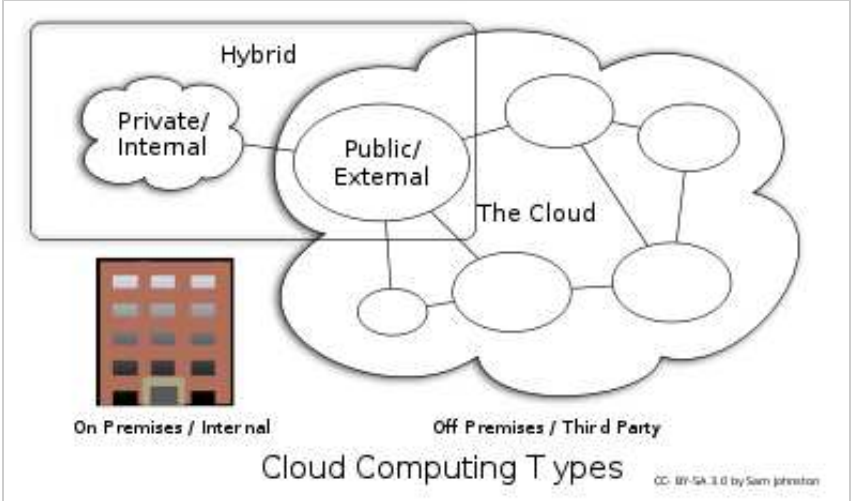
Server

The servers layer consists of computer hardware and/or computer software products that are specifically designed for the delivery of cloud services, including multi-core processors, cloud-specific operating systems and combined offerings.[39][50][51][52]

Deployment models

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 bills on a fine-grained utility computing basis.[34]



Cloud computing types

Community cloud

A community cloud may be established where several organizations have similar requirements and seek to share infrastructure so as to realize some of the benefits of cloud computing. The costs are spread over fewer users than a public cloud (but more than a single tenant). This option may offer a higher level of privacy, security, and/or policy compliance. In addition, it can be economically attractive as the resources (storage, workstations) utilized and shared in the community are already exploited and have reached their return of investment. Examples of community clouds include Google's "Gov Cloud".[53]

Hybrid cloud and hybrid IT delivery

The main responsibility of the IT department is to deliver services to the business. With the proliferation of cloud computing (both private and public) and the fact that IT departments must also deliver services via traditional, in-house methods, the newest catch-phrase has become "hybrid cloud computing."[54] Hybrid cloud is also called hybrid delivery by the major vendors including HP, IBM, Oracle and VMware who offer technology to manage the complexity in managing the performance, security and privacy concerns that results from the mixed delivery methods of IT services.[55]

A hybrid storage cloud uses a combination of public and private storage clouds. Hybrid storage clouds are often useful for archiving and backup functions, allowing local data to be replicated to a public cloud.[56]

Another perspective on deploying a web application in the cloud is using Hybrid Web Hosting, where the hosting infrastructure is a mix between cloud hosting and managed dedicated servers – this is most commonly achieved as part of a web cluster in which some of the nodes are running on real physical hardware and some are running on cloud server instances.[*citation needed*]

Combined cloud

Two clouds that have been joined together are more correctly called a "combined cloud". A combined cloud environment consisting of multiple internal and/or external providers[57] "will be typical for most enterprises".[58] By integrating multiple cloud services, users may be able to ease the transition to *public cloud* services while

By integrating multiple cloud services, users may be able to ease the transition to public cloud services while avoiding issues such as PCI compliance.[59]

Private cloud

Douglas Parkhill first described the concept of a "private computer utility" in his 1966 book *The Challenge of the Computer Utility*. The idea was based upon direct comparison with other industries (e.g., the electricity industry) and the extensive use of hybrid supply models to balance and mitigate risks.

"Private cloud" and "internal cloud" have been described as neologisms, but the concepts themselves pre-date the term cloud by 40 years. Even within modern utility industries, hybrid models still exist despite the formation of reasonably well-functioning markets and the ability to combine multiple providers.

Some vendors have used the terms to describe offerings that emulate cloud computing on private networks. These (typically virtualization automation) products offer the ability to host applications or virtual machines in a company's own set of hosts. These provide the benefits of utility computing – shared hardware costs, the ability to recover from failure, and the ability to scale up or down depending upon demand.

Private clouds have attracted criticism because users "still have to buy, build, and manage them" and thus do not benefit from lower up-front capital costs and less hands-on management,[58] essentially "[lacking] the economic model that makes cloud computing such an intriguing concept".[60] [61] Enterprise IT organizations use their own private cloud(s) for mission critical and other operational systems to protect critical infrastructures. [62] Therefore, for all intents and purposes, "private clouds" are not an implementation of cloud computing at all, but are in fact an implementation of a technology subset: the basic concept of virtualized computing.[*citation needed*]

Cloud engineering

Main article: Cloud engineering

Cloud engineering is the application of a systematic, disciplined, quantifiable, and interdisciplinary approach to the ideation, conceptualization, development, operation, and maintenance of cloud computing, as well as the study and applied research of the approach, i.e., the application of engineering to cloud. It is a maturing and evolving discipline to facilitate the adoption, strategization, operationalization, industrialization, standardization, productization, commoditization, and governance of cloud solutions, leading towards a cloud ecosystem. Cloud engineering is also known as cloud service engineering.

Cloud storage

Main article: Cloud storage

See also: Cloud storage gateway

Cloud storage is a model of networked computer data storage where data is stored on multiple virtual servers, in general hosted by third parties, rather than being hosted on dedicated servers. Hosting companies operate large data centers; and people who require their data to be hosted buy or lease storage capacity from them and use it for their storage needs. The data center operators, in the background, virtualize the resources according to the requirements of the customer and expose them as virtual servers, which the customers can themselves manage. In the physical sense, the resource may span across multiple servers.

The Intercloud

Main article: Intercloud

The Intercloud[63] is an interconnected global "cloud of clouds"[64][65] and an extension of the Internet "network of networks" on which it is based.[66] The term was first used in the context of cloud computing in 2007 when Kevin Kelly stated that "eventually we'll have the intercloud, the cloud of clouds. This Intercloud will have the dimensions of one machine comprising all servers and attendant cloudbooks on the planet.".[64] It became popular in 2009[67] and has also been used to describe the datacenter of the future.[68]

The Intercloud scenario is based on the key concept that each single cloud does not have infinite physical resources. If a cloud saturates the computational and storage resources of its virtualization infrastructure, it could not be able to satisfy further requests for service allocations sent from its clients. The Intercloud scenario aims to address such situations, and in theory, each cloud can use the computational and storage resources of the virtualization infrastructures of other clouds. Such form of pay-for-use may introduce new business opportunities among cloud providers if they manage to go beyond theoretical framework. Nevertheless, the Intercloud raises many more challenges than solutions concerning cloud federation, security, interoperability, quality of service, vendor's lock-ins, trust, legal issues, monitoring and billing.[*citation needed*]

The concept of a competitive utility computing market that combined many computer utilities together was originally described by Douglas Parkhill in his 1966 book, the "Challenge of the Computer Utility". This concept has been subsequently used many times over the last 40 years and is identical to the Intercloud.

Issues

Privacy

The cloud model has been criticized by privacy advocates for the greater ease in which the companies hosting the cloud services control, and, thus, can monitor at will, lawfully or unlawfully, the communication and data stored between the user and the host company. Instances such as the secret NSA program, working with AT&T, and Verizon, which recorded over 10 million phone calls between American citizens, causes uncertainty among privacy advocates, and the greater powers it gives to telecommunication companies to monitor user activity.[69] While there have been efforts (such as US-EU Safe Harbor) to "harmonize" the legal environment, providers such as Amazon still cater to major markets (typically the United States and the European Union) by deploying local infrastructure and allowing customers to select "availability zones."[70]

Compliance

In order to obtain compliance with regulations including FISMA, HIPAA, and SOX in the United States, the Data Protection Directive in the EU and the credit card industry's PCI DSS, users may have to adopt *community* or *hybrid* deployment modes that are typically more expensive and may offer restricted benefits. This is how Google is able to "manage and meet additional government policy requirements beyond FISMA"[71][72] and Rackspace Cloud are able to claim PCI compliance.[73] Customers in the EU contracting with cloud providers established outside the EU/EEA have to adhere to the EU regulations on export of personal data.[74] Many providers also obtain SAS 70 Type II certification (e.g., Amazon,[75] Salesforce.com,[76] Google[77] and Microsoft[78]), but this has been criticised on the grounds that the hand-picked set of goals and standards determined by the auditor and the auditee are often not disclosed and can vary widely.[79] Providers typically make this information available on request, under non-disclosure agreement.[80]

Legal

In March 2007, Dell applied to trademark the term "cloud computing" (U.S. Trademark 77,139,082 (http://tarr.uspto.gov/servlet/tarr?regser=serial&entry=77139082)) in the United States. The "Notice of Allowance" the company received in July 2008 was canceled in August, resulting in a formal rejection of the trademark application less than a week later. Since 2007, the number of trademark filings covering cloud computing brands, goods, and services has increased rapidly. As companies sought to better position themselves for cloud computing branding and marketing efforts, cloud computing trademark filings increased by 483% between 2008 and 2009. In 2009, 116 cloud computing trademarks were filed, and trademark analysts predict that over 500 such marks could be filed during 2010.[81]

Other legal cases may shape the use of cloud computing by the public sector. On October 29, 2010, Google filed a lawsuit against the U.S. Department of Interior, which opened up a bid for software that required that bidders use Microsoft's Business Productivity Online Suite. Google sued, calling the requirement "unduly restrictive of competition."[82] Scholars have pointed out that, beginning in 2005, the prevalence of open standards and open source may have an impact on the way that public entities choose to select vendors.[83]

Open source

Open source software has provided the foundation for many cloud computing implementations, one prominent example being the Hadoop framework.[84] In November 2007, the Free Software Foundation released the Affero General Public License, a version of GPLv3 intended to close a perceived legal loophole associated with free software designed to be run over a network.[85] There are many open source platform offerings including AppScale, CloudFoundry, OpenShift, and Heroku.

Open standards

See also: Category:Cloud standards

Most cloud providers expose APIs that are typically well-documented (often under a Creative Commons license[86]) but also unique to their implementation and thus not interoperable. Some vendors have adopted others' APIs[87] and there are a number of open standards under development, including the OGF's Open Cloud Computing Interface. The Open Cloud Consortium (OCC)[88] is working to develop consensus on early cloud computing standards and practices.

Security

Main article: Cloud computing security

As cloud computing is achieving increased popularity, concerns are been voiced about the security issues introduced through the adoption of this new model. The effectiveness and efficiency of traditional protection mechanisms are being reconsidered, as the characteristics of this innovative deployment model, differ widely from them of traditional architectures.[89]

The relative security of cloud computing services is a contentious issue that may be delaying its adoption.[90] Issues barring the adoption of cloud computing are due in large part to the private and public sectors unease surrounding the external management of security based services. It is the very nature of cloud computing based services, private or public, that promote external management of provided services. This delivers great incentive among cloud computing service providers in producing a priority in building and maintaining strong management of secure services.[91] Security issues have been categorized into sensitive data access, data segregation, privacy, bug exploitation, recovery, accountability, malicious insiders, management console security, account control, and multi-tenancy issues. Solution to various cloud security issues vary through cryptography,

particularly public key infrastructure (PKI),use of multiple cloud providers, standardization of APIs, improving virtual machines support and legal support.[89][92][93]

Organizations have been formed in order to provide standards for a better future in cloud computing services. One organization in particular, the Cloud Security Alliance is a non-profit organization formed to promote the use of best practices for providing security assurance within cloud computing.[94]

Availability and performance

In addition to concerns about security, businesses are also worried about acceptable levels of availability and performance of applications hosted in the cloud.[95] Technologies such as ADN (Application Delivery Network), CDN (Content Delivery Network) and TCP acceleration are commonly leveraged to mitigate these issues at the transport level.

There are also concerns about a cloud provider shutting down for financial or legal reasons, which has happened in a number of cases.[96]

Data usage

Since data that was, in the past, stored locally on a user's computer would now be stored remotely in a data center, an individual's internet usage would soar as large files are sent via the internet between the user's computer and the data center. For instance, a purchased movie needs to be downloaded only once if stored on a user's computer. But, if the same movie is stored in cloud storage, it would, in essence, have to be downloaded every time it is viewed in its entirety. If the user's internet service has a monthly data usage cap, this cap could easily be exceeded if large, frequently accessed files are stored remotely. This would cause the user to incur potentially large overage charges.

Sustainability and siting

Although cloud computing is often assumed to be a form of "green computing", there is as of yet no published study to substantiate this assumption.[97] Siting the servers affects the environmental effects of cloud computing. In areas where climate favors natural cooling and renewable electricity is readily available, the environmental effects will be more moderate. Thus countries with favorable conditions, such as Finland,[98] Sweden and Switzerland,[99] are trying to attract cloud computing data centers.

SmartBay, marine research infrastructure of sensors and computational technology, is being developed using cloud computing, an emerging approach to shared infrastructure in which large pools of systems are linked together to provide IT services. [100]

Use by Hackers

As with privately purchased hardware, Hackers posing as legitimate customers can purchase the services of cloud computing for nefarious purposes. This includes password cracking and as a means of launching attacks.[101] In 2009, a banking trojan illegally used the popular Amazon service as a command and control channel that issued software updates and malicious instructions to PCs that were infected by the malware.[102]

Research

Many universities, vendors and government organizations are investing in research around the topic of cloud computing.[103][104]

computing.[103][104]

Joint government, academic and vendor collaborative research projects include the IBM/Google Academic Cloud Computing Initiative (ACCI). In October 2007 IBM and Google announced the multi-university project designed to enhance students' technical knowledge to address the challenges of cloud computing.[105] In April 2009, the National Science Foundation joined the ACCI and awarded approximately million in grants to 14 academic institutions.[106]

In July 2008, HP, Intel Corporation, and Yahoo! announced the creation of a global, multi-data-center, open-source test bed, called Open Cirrus,[107] designed to encourage research into all aspects of cloud computing, service and data center management.[108] Open Cirrus partners include the NSF, the University of Illinois (UIUC), Karlsruhe Institute of Technology, the Infocomm Development Authority (IDA) of Singapore, the Electronics and Telecommunications Research Institute (ETRI) in Korea, the Malaysian Institute for Microelectronic Systems(MIMOS), and the Institute for System Programming at the Russian Academy of Sciences (ISPRAS).[109] In Sept. 2010, more researchers joined the HP/Intel/Yahoo Open Cirrus project for cloud computing research. The new researchers are China Mobile Research Institute (CMRI), Spain's Supercomputing Center of Galicia (CESGA by its Spanish acronym), Georgia Tech's Center for Experimental Research in Computer Systems (CERCS) and China Telecom.[110][111]

In July 2010, HP Labs India announced a new cloud-based technology designed to simplify taking content and making it mobile-enabled, even from low-end devices.[112] Called SiteonMobile, the new technology is designed for emerging markets where people are more likely to access the internet via mobile phones rather than computers.[113] In November 2010, HP formally opened its Government Cloud Theatre, located at the HP Labs site in Bristol, England.[114] The demonstration facility highlights high-security, highly flexible cloud computing based on intellectual property developed at HP Labs. The aim of the facility is to lessen fears about the security of the cloud.[115] HP Labs Bristol is HP’s second-largest central research location and currently is responsible for researching cloud computing and security.[116]

The IEEE Technical Committee on Services Computing[117] in IEEE Computer Society sponsors the IEEE International Conference on Cloud Computing (CLOUD).[118] CLOUD 2010 was held on July 5–10, 2010 in Miami, Florida

On March 23, 2011, Google, Microsoft, HP, Yahoo, Verizon, Deutsche Telekom, and 17 other companies formed a nonprofit organization called Open Networking Foundation, focused on providing support for a new cloud initiative called Software-Defined Networking.[119] The initiative is meant to speed innovation through simple software changes in telecommunications networks, wireless networks, data centers and other networking areas.[120]

Criticism of the term

Some have come to criticize the term as being either too unspecific or even misleading. CEO Larry Ellison of Oracle Corporation asserts that cloud computing is "everything that we already do", claiming that the company could simply "change the wording on some of our ads" to deploy their cloud-based services.[121][122][123][124][125] Forrester Research VP Frank Gillett questions the very nature of and motivation behind the push for cloud computing, describing what he calls "cloud washing"—companies simply relabeling their products as "cloud computing", resulting in mere marketing innovation instead of "real" innovation.[126][127] GNU's Richard Stallman insists that the industry will only use the model to deliver services at ever increasing rates over proprietary systems, otherwise likening it to a "marketing hype campaign".[128]

See also

- Cloud backup
- Cloud engineering
- Cloud gaming
- Apache Hadoop
- Data center
- Green computing
- High-performance computing
- List of cloud computing providers
- Open Data Center Alliance
- Hosted desktop
- Cloud Computing Modeling Notation (CCMN)
- SOMF Cloud computing modeling capabilities
- ADN (Application Delivery Network)
- CDN (Content Delivery Network)
- TCP acceleration

References

1. ^ *Gartner Says Cloud Computing Will Be As Influential As E-business* (http://www.gartner.com/it/page.jsp?id=707508)
2. ^ *Cloud computing is a trap, warns GNU founder Richard Stallman* (http://www.guardian.co.uk/technology/2008/sep/29/cloud.computing.richard.stallman) , *The Guardian*, par Bobbie Johnson, 29 septembre 2008
3. ^ "What is the Cloud?" (http://www.info.apps.gov/content/what-cloud)
4. ^ "NIST.gov – Computer Security Division – Computer Security Resource Center" (http://csrc.nist.gov/publications/drafts/800-146/Draft-NIST-SP800-146.pdf) . Csrc.nist.gov. http://csrc.nist.gov/publications/drafts/800-146/Draft-NIST-SP800-146.pdf. Retrieved 2010-08-22.
5. ^ "Gartner Says Cloud Computing Will Be As Influential As E-business" (http://www.gartner.com/it/page.jsp?id=707508) . Gartner.com. http://www.gartner.com/it/page.jsp?id=707508. Retrieved 2010-08-22.
6. ^ Gruman, Galen (2008-04-07). "What cloud computing really means" (http://www.infoworld.com/d/cloud-computing/what-cloud-computing-really-means-031) . *InfoWorld*. http://www.infoworld.com/d/cloud-computing/what-cloud-computing-really-means-031. Retrieved 2009-06-02.
7. ^ "Cloud Computing: Clash of the clouds" (http://www.economist.com/displaystory.cfm?story_id=14637206) . The Economist. 2009-10-15. http://www.economist.com/displaystory.cfm?story_id=14637206. Retrieved 2009-11-03.
8. ^ Cloud Computing Defined (http://www.cloudcomputingdefined.com/) 17 July 2010. Retrieved 26 July 2010.
9. ^ Buyya, Rajkumar; Chee Shin Yeo, Srikumar Venugopal (PDF). *Market-Oriented Cloud Computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities* (http://www.gridBus.org/~raj/papers/hpcc2008_keynote_cloudcomputing.pdf) . Department of Computer Science and Software Engineering, University of Melbourne, Australia. pp. 9. http://www.gridBus.org/~raj/papers/hpcc2008_keynote_cloudcomputing.pdf. Retrieved 2008-07-31.
10. ^ Mantelero, Processi di outsourcing informatico e cloud computing: la gestione dei dati personali ed aziendali, in Dir. informaz. Informatica, 2010, p. 673-696 (http://staff.polito.it/alessandro.mantelero/Mantelero_Cloud_computing.pdf) , 7-05-2011
11. ^ Gmail down, il mondo sopravvive (http://www.hwupgrade.it/news/software/gmail-down-il-mondo-sopravvive_29973.html) 2-09-2009
12. ^ Sidekick. Cloud computing, quanto valgono i dati perduti? (http://punto-informatico.it/2725933/PI/News/cloud-computing-quanto-valgono-dati-perduti.aspx) , 2009-10-13
13. ^ "What's In A Name? Utility vs. Cloud vs Grid" (http://www.datacenterknowledge.com/archives/2008/Mar/25/whats_in_a_name_utility_vs_cloud_vs_grid.html) . Datacenterknowledge.com. http://www.datacenterknowledge.com/archives/2008/Mar/25/whats_in_a_name_utility_vs_cloud_vs_grid.html. Retrieved 2010-08-22

Retrieved 2010-08-22.
14. ^ "Distributed Application Architecture" (http://java.sun.com/developer/Books/jdbc/ch07.pdf) . Sun Microsystem. http://java.sun.com/developer/Books/jdbc/ch07.pdf. Retrieved 2009-06-16.
15. ^ "Sun CTO: Cloud computing is like the mainframe" (http://itknowledgeexchange.techtarget.com/mainframe-blog/sun-cto-cloud-computing-is-like-the-mainframe/) . Itknowledgeexchange.techtarget.com. 2009-03-11. http://itknowledgeexchange.techtarget.com/mainframe-blog/sun-cto-cloud-computing-is-like-the-mainframe/. Retrieved 2010-08-22.
16. ^ "It's probable that you've misunderstood 'Cloud Computing' until now" (http://portal.acm.org/citation.cfm?id=1496091.1496100&coll=&dl=ACM&CFID=21518680&CFTOKEN=18800807) . TechPluto. http://portal.acm.org/citation.cfm?id=1496091.1496100&coll=&dl=ACM&CFID=21518680&CFTOKEN=18800807. Retrieved 2010-09-14.
17. ^ "Service-Oriented Computing and Cloud Computing: Challenges and Opportunities" (http://www.computer.org/portal/web/csdl/doi/10.1109/MIC.2010.147) . IEEE Internet Computing. http://www.computer.org/portal/web/csdl/doi/10.1109/MIC.2010.147. Retrieved 2010-12-04.
18. ^ "Building GrepTheWeb in the Cloud, Part 1: Cloud Architectures" (http://developer.amazonwebservices.com/connect/entry.jspa?externalID=1632&categoryID=100) . Developer.amazonwebservices.com. http://developer.amazonwebservices.com/connect/entry.jspa?externalID=1632&categoryID=100. Retrieved 2010-08-22.
19. ^ "Writing & Speaking" (http://www.sellsbrothers.com/writing/intro2tapi/default.aspx?content=pstn.htm) . Sellsbrothers.com. http://www.sellsbrothers.com/writing/intro2tapi/default.aspx?content=pstn.htm. Retrieved 2010-08-22.
20. ^ "The Internet Cloud" (http://www.thestandard.com/article/0,1902,5466,00.html) . Thestandard.com. http://www.thestandard.com/article/0,1902,5466,00.html. Retrieved 2010-08-22.
21. ^ Danielson, Krissi (2008-03-26). "Distinguishing Cloud Computing from Utility Computing" (http://www.ebizq.net/blogs/saasweek/2008/03/distinguishing_cloud_computing/) . Ebizq.net. http://www.ebizq.net/blogs/saasweek/2008/03/distinguishing_cloud_computing/. Retrieved 2010-08-22.
22. ^ "July, 1993 meeting report from the IP over ATM working group of the IETF" (http://mirror.switch.ch/ftp/doc/ietf/ipatm/atm-minutes-93jul.txt) . http://mirror.switch.ch/ftp/doc/ietf/ipatm/atm-minutes-93jul.txt. Retrieved 2010-08-22.
23. ^ "INFORMS meeting in Dallas in 1997" (http://meetings2.informs.org/Dallas97/TALKS/MD19.html) . http://meetings2.informs.org/Dallas97/TALKS/MD19.html. Retrieved 2011-04-21.
24. ^ ***a*** ***b*** Jeff Bezos' Risky Bet (http://www.businessweek.com/magazine/content/06_46/b4009001.htm) .
25. ^ [1] (http://itknowledgeexchange.techtarget.com/cloud-computing/2010/06/17/amazons-early-efforts-at-cloud-computing-partly-accidental/) .
26. ^ http://www.zdnet.com/blog/micro-markets/google-ceos-new-paradigm-cloud-computing-and-advertising-go-hand-in-hand/369
27. ^ Steve Lohr (2011-04-23). "Amazon's Trouble Raises Cloud Computing Doubts" (http://www.nytimes.com/2011/04/23/technology/23cloud.html) . The New York Times, B1. http://www.nytimes.com/2011/04/23/technology/23cloud.html.
28. ^ Google and I.B.M. Join in 'Cloud Computing' Research (http://www.nytimes.com/2007/10/08/technology/08cloud.html?_r=1&ex=1349496000&en=92627f0f65ea0d75&ei=5090&partner=rssuserland&emc=rss&oref=slogin)
29. ^ B. Rochwerger, J. Caceres, R.S. Montero, D. Breitgand, E. Elmroth, A. Galis, E. Levy, I.M. Llorente, K. Nagin, Y. Wolfsthal, E. Elmroth, J. Caceres, M. Ben-Yehuda, W. Emmerich, F. Galan. "The RESERVOIR Model and Architecture for Open Federated Cloud Computing", IBM Journal of Research and Development, Vol. 53, No. 4. (2009)
30. ^ D. Kyriazis, A. Menychtas, G. Kousiouris, K. Oberle, T. Voith, M. Boniface, E. Oliveros, T. Cucinotta, S. Berger, "A Real-time Service Oriented Infrastructure", International Conference on Real-Time and Embedded Systems (RTES 2010), Singapore, November 2010
31. ^ Keep an eye on cloud computing (http://www.networkworld.com/newsletters/itlead/2008/070708itlead1.html) , Amy Schurr, Network World, 2008-07-08, citing the Gartner report, "Cloud Computing Confusion Leads to Opportunity". Retrieved 2009-09-11.
32. ^ Gartner Says Worldwide IT Spending On Pace to Surpass Trillion in 2008 (http://www.gartner.com/it/page.jsp?id=742913) , Gartner, 2008-08-18. Retrieved 2009-09-11.
33. ^ "Recession Is Good For Cloud Computing – Microsoft Agrees" (http://www.cloudave.com/link/recession-is-good-for-cloud-computing-microsoft-agrees) . Cloudave.com. http://www.cloudave.com/link/recession-is-

good-for-cloud-computing-microsoft-agrees. Retrieved 2010-08-22.
34. ^ ***a b c d*** "Defining "Cloud Services" and "Cloud Computing"" (http://blogs.idc.com/ie/?p=190) . Blogs.idc.com. 2008-09-23. http://blogs.idc.com/ie/?p=190. Retrieved 2010-08-22.
35. ^ Farber, Dan (2008-06-25). "The new geek chic: Data centers" (http://news.cnet.com/8301-13953_3-9977049-80.html) . News.cnet.com. http://news.cnet.com/8301-13953_3-9977049-80.html. Retrieved 2010-08-22.
36. ^ King, Rachael (2008-08-04). "Cloud Computing: Small Companies Take Flight" (http://www.businessweek.com/technology/content/aug2008/tc2008083_619516.htm) . Businessweek.com. http://www.businessweek.com/technology/content/aug2008/tc2008083_619516.htm. Retrieved 2010-08-22.
37. ^ "Encrypted Storage and Key Management for the cloud" (http://www.cryptoclarity.com/CryptoClarityLLC/Welcome/Entries/2009/7/23_Encrypted_Storage_and_Key_Management_for_the_cloud.html) . Cryptoclarity.com. 2009-07-30. http://www.cryptoclarity.com/CryptoClarityLLC/Welcome/Entries/2009/7/23_Encrypted_Storage_and_Key_Management_for_the_cloud.html. Retrieved 2010-08-22.
38. ^ Mills, Elinor (2009-01-27). "Cloud computing security forecast: Clear skies" (http://news.cnet.com/8301-1009_3-10150569-83.html) . News.cnet.com. http://news.cnet.com/8301-1009_3-10150569-83.html. Retrieved 2010-08-22.
39. ^ ***a b*** Nimbus Cloud Guide (http://workspace.globus.org/vm/TP2.1/doc/cloud.html)
40. ^ "Microsoft's cloud operating system, Windows Azure, to go live in January" (http://www.geek.com/articles/news/microsofts-cloud-operating-system-windows-azure-to-go-live-in-january-20091118/) . Geek.com. 2009-11-18. http://www.geek.com/articles/news/microsofts-cloud-operating-system-windows-azure-to-go-live-in-january-20091118/. Retrieved 2010-08-22.
41. ^ Claburn, Thomas. "Google Reveals Nexus One 'Super Phone'" (http://www.informationweek.com/news/software/web_services/showArticle.jhtml?articleID=222200331) . Informationweek.com. http://www.informationweek.com/news/software/web_services/showArticle.jhtml?articleID=222200331. Retrieved 2010-08-22.
42. ^ "What Makes a Cloud Computer?" (http://gigaom.com/2008/06/22/what-makes-a-good-cloud-computer/) . Gigaom.com. 2008-06-22. http://gigaom.com/2008/06/22/what-makes-a-good-cloud-computer/. Retrieved 2010-08-22.
43. ^ by Brian BraikerSeptember 02, 2008 (2008-09-02). "The Cloud's Chrome Lining" (http://www.newsweek.com/id/156911) . Newsweek.com. http://www.newsweek.com/id/156911. Retrieved 2010-08-22.
44. ^ Zissis, D.; Lekkas (April 2011). "Securing e-Government and e-Voting with an open cloud computing architecture". *Government Information Quarterly* **28** (2): 239–251. doi:10.1016/j.giq.2010.05.010 (http://dx.doi.org/10.1016%2Fj.giq.2010.05.010) .
45. ^ 2005 Software as a Service Taxonomy and Research Guide (http://www.idc.com/getdoc.jsp?containerId=33453&pageType=PRINTFRIENDLY#33453-S-0001)
46. ^ "An example of a 'Cloud Platform' for building applications" (http://www.eccentex.com/platform/workflow.html) . Eccentex.com. http://www.eccentex.com/platform/workflow.html. Retrieved 2010-08-22.
47. ^ Jack Schofield (2008-04-17). "Google angles for business users with 'platform as a service'" (http://www.guardian.co.uk/technology/2008/apr/17/google.software) . London: Guardian. http://www.guardian.co.uk/technology/2008/apr/17/google.software. Retrieved 2010-08-22.
48. ^ "The Emerging Cloud Service Architecture" (http://aws.typepad.com/aws/2008/06/the-forthcoming.html) . Aws.typepad.com. 2008-06-03. http://aws.typepad.com/aws/2008/06/the-forthcoming.html. Retrieved 2010-08-22.
49. ^ "EMC buys Pi and forms a cloud computing group" (http://searchstorage.techtarget.com/news/article/0,289142,sid5_gci1301852,00.html) . Searchstorage.techtarget.com. 2008-02-21. http://searchstorage.techtarget.com/news/article/0,289142,sid5_gci1301852,00.html. Retrieved 2010-08-22.
50. ^ Myslewski, Rik (2009-12-02). "Intel puts cloud on single megachip" (http://www.theregister.co.uk/2009/12/02/intel_scc/) . Theregister.co.uk. http://www.theregister.co.uk/2009/12/02/intel_scc/. Retrieved 2010-08-22.
51. ^ Duffy, Jim (2009-05-12). "Cisco unveils cloud computing platform for service providers" (http://www.infoworld.com/d/cloud-computing/cisco-unveils-cloud-computing-platform-service-providers-113) . Infoworld.com. http://www.infoworld.com/d/cloud-computing/cisco-unveils-cloud-computing-

platform-service-providers-113. Retrieved 2010-08-22.
52. ^ Microsoft Plans 'Cloud' Operating System (http://www.nytimes.com/2008/10/28/technology/28soft.html)
53. ^ Claburn, Thomas. "Google's "Gov Cloud" Wins Million Los Angeles Contract" (http://www.informationweek.com/news/services/saas/showArticle.jhtml?articleID=221100129) . Informationweek.com. http://www.informationweek.com/news/services/saas/showArticle.jhtml?articleID=221100129. Retrieved 2010-08-22.
54. ^ InternetNews:"VMware Makes Cloud Partner, Product News." David Needle. Feb. 8, 2011 (http://www.internetnews.com/infra/article.php/3924036/VMware+Makes+Cloud+Partner+Product+News.htm)
55. ^ Internet News: "HP Details Hybrid Approach to Cloud Services." David Needle. Nov.2, 2010. (http://www.internetnews.com/software/article.php/3911111)
56. ^ Managing Private and Hybrid Clouds for Data Storage (http://www.snia.org/forums/csi/knowledge/CSI_Private_Hybrid_Cloud_White_Paper_final.pdf) , SNIA, Jan 2010
57. ^ Eric Krangel (2009-02-10). "IBM Embraces Juniper For Its Smart 'Hybrid Cloud', Disses Cisco (IBM)" (http://www.businessinsider.com/2009/2/ibm-embraces-juniper-for-its-smart-hybrid-cloud-disses-cisco-ibm) . Businessinsider.com. http://www.businessinsider.com/2009/2/ibm-embraces-juniper-for-its-smart-hybrid-cloud-disses-cisco-ibm. Retrieved 2010-08-22.
58. ^ ***a*** ***b*** Foley, John. "Private Clouds Take Shape" (http://www.informationweek.com/news/services/business/showArticle.jhtml?articleID=209904474) . Informationweek.com. http://www.informationweek.com/news/services/business/showArticle.jhtml?articleID=209904474. Retrieved 2010-08-22.
59. ^ "Forecast for 2010: The Rise of Hybrid Clouds" (http://gigaom.com/2010/01/01/on-the-rise-of-hybrid-clouds/) . Gigaom.com. 2010-01-01. http://gigaom.com/2010/01/01/on-the-rise-of-hybrid-clouds/. Retrieved 2010-08-22.
60. ^ Haff, Gordon (2009-01-27). "Just don't call them private clouds" (http://news.cnet.com/8301-13556_3-10150841-61.html) . News.cnet.com. http://news.cnet.com/8301-13556_3-10150841-61.html. Retrieved 2010-08-22.
61. ^ "There's No Such Thing As A Private Cloud" (http://www.informationweek.com/cloud-computing/blog/archives/2009/01/theres_no_such.html) . Informationweek.com. 2010-06-30. http://www.informationweek.com/cloud-computing/blog/archives/2009/01/theres_no_such.html. Retrieved 2010-08-22.
62. ^ Viarengo, Vittorio (2010-07-15). "Cutting Through the Cloud Hype" (http://www.forbes.com/2010/07/15/virtualization-automation-resources-technology-cloud-computing.html) . forbes.com. http://www.forbes.com/2010/07/15/virtualization-automation-resources-technology-cloud-computing.html. Retrieved 2010-12-31.
63. ^ Bernstein, David; Ludvigson, Erik; Sankar, Krishna; Diamond, Steve; Morrow, Monique (2009-05-24). *Blueprint for the Intercloud – Protocols and Formats for Cloud Computing Interoperability* (http://www2.computer.org/portal/web/csdl/doi/10.1109/ICIW.2009.55) . IEEE Computer Society. pp. 328–336. doi:10.1109/ICIW.2009.55 (http://dx.doi.org/10.1109%2FICIW.2009.55) . http://www2.computer.org/portal/web/csdl/doi/10.1109/ICIW.2009.55.
64. ^ ***a*** ***b*** "Kevin Kelly: A Cloudbook for the Cloud" (http://www.kk.org/thetechnium/archives/2007/11/a_cloudbook_for.php) . Kk.org. http://www.kk.org/thetechnium/archives/2007/11/a_cloudbook_for.php. Retrieved 2010-08-22.
65. ^ "Intercloud is a global cloud of clouds" (http://samj.net/2009/06/intercloud-is-global-cloud-of-clouds.html) . Samj.net. 2009-06-22. http://samj.net/2009/06/intercloud-is-global-cloud-of-clouds.html. Retrieved 2010-08-22.
66. ^ "Vint Cerf: Despite Its Age, The Internet is Still Filled with Problems" (http://www.readwriteweb.com/archives/vint_cerf_despite_its_age_the.php?mtcCampaign=2765) . Readwriteweb.com. http://www.readwriteweb.com/archives/vint_cerf_despite_its_age_the.php?mtcCampaign=2765. Retrieved 2010-08-22.
67. ^ "SP360: Service Provider: From India to Intercloud" (http://blogs.cisco.com/sp/comments/from_india_to_intercloud/) . Blogs.cisco.com. http://blogs.cisco.com/sp/comments/from_india_to_intercloud/. Retrieved 2010-08-22.
68. ^ Canada (2007-11-29). "Head in the clouds? Welcome to the future" (http://www.theglobeandmail.com/servlet/story/LAC.20071129.TWLINKS29/TPStory/Business) . Toronto: Theglobeandmail.com. http://www.theglobeandmail.com/servlet/story/LAC.20071129.TWLINKS29/TPStory/Business. Retrieved 2010-08-22

69. ^ Cauley, Leslie (2006-05-11). "NSA has massive database of Americans' phone calls" (http://www.usatoday.com/news/washington/2006-05-10-nsa_x.htm) . Usatoday.com. http://www.usatoday.com/news/washington/2006-05-10-nsa_x.htm. Retrieved 2010-08-22.
70. ^ "Feature Guide: Amazon EC2 Availability Zones" (http://developer.amazonwebservices.com/connect/entry.jspa?externalID=1347&categoryID=112) . Developer.amazonwebservices.com. http://developer.amazonwebservices.com/connect/entry.jspa?externalID=1347&categoryID=112. Retrieved 2010-08-22.
71. ^ "FISMA compliance for federal cloud computing on the horizon in 2010" (http://searchcompliance.techtarget.com/news/article/0,289142,sid195_gci1377298,00.html) . Searchcompliance.techtarget.com. http://searchcompliance.techtarget.com/news/article/0,289142,sid195_gci1377298,00.html. Retrieved 2010-08-22.
72. ^ "Google Apps and Government" (http://googleenterprise.blogspot.com/2009/09/google-apps-and-government.html) . Googleenterprise.blogspot.com. 2009-09-15. http://googleenterprise.blogspot.com/2009/09/google-apps-and-government.html. Retrieved 2010-08-22.
73. ^ "Cloud Hosting is Secure for Take-off: Mosso Enables The Spreadsheet Store, an Online Merchant, to become PCI Compliant" (http://www.rackspacecloud.com/blog/2009/03/05/cloud-hosting-is-secure-for-take-off-mosso-enables-the-spreadsheet-store-an-online-merchant-to-become-pci-compliant/) . Rackspacecloud.com. 2009-03-14. http://www.rackspacecloud.com/blog/2009/03/05/cloud-hosting-is-secure-for-take-off-mosso-enables-the-spreadsheet-store-an-online-merchant-to-become-pci-compliant/. Retrieved 2010-08-22.
74. ^ "How the New EU Rules on Data Export Affect Companies in and Outside the EU | Dr. Thomas Helbing – Kanzlei für Datenschutz-, Online- und IT-Recht" (http://www.thomashelbing.com/en/how-new-eu-rules-data-export-affect-companies-and-outside-eu) . Thomashelbing.com. http://www.thomashelbing.com/en/how-new-eu-rules-data-export-affect-companies-and-outside-eu. Retrieved 2010-08-22.
75. ^ "AWS Completes SAS70 Type II Audit" (http://aws.amazon.com/about-aws/whats-new/2009/11/11/aws-completes-sas70-type-ii-audit/) . Aws.amazon.com. http://aws.amazon.com/about-aws/whats-new/2009/11/11/aws-completes-sas70-type-ii-audit/. Retrieved 2010-08-22.
76. ^ "Trust Salesforce.com" (http://trust.salesforce.com/) . Trust Salesforce.com. http://trust.salesforce.com/. Retrieved 2010-08-22.
77. ^ Feigenbaum, Eran (2008-11-04). "SAS 70 Type II for Google Apps" (http://googleenterprise.blogspot.com/2008/11/sas-70-type-ii-for-google-apps.html) . Googleenterprise.blogspot.com. http://googleenterprise.blogspot.com/2008/11/sas-70-type-ii-for-google-apps.html. Retrieved 2010-08-22.
78. ^ "Securing Microsoft's Cloud Infrastructure" (http://blogs.technet.com/gfs/archive/2009/05/27/securing-microsoft-s-cloud-infrastructure.aspx) . Blogs.technet.com. 2009-05-28. http://blogs.technet.com/gfs/archive/2009/05/27/securing-microsoft-s-cloud-infrastructure.aspx. Retrieved 2010-08-22.
79. ^ "Amazon gets SAS 70 Type II audit stamp, but analysts not satisfied" (http://searchcloudcomputing.techtarget.com/news/article/0,289142,sid201_gci1374629,00.html) . Searchcloudcomputing.techtarget.com. 2009-11-17. http://searchcloudcomputing.techtarget.com/news/article/0,289142,sid201_gci1374629,00.html. Retrieved 2010-08-22.
80. ^ "Assessing Cloud Computing Agreements and Controls" (http://wistechnology.com/articles/6954/) . Wistechnology.com. http://wistechnology.com/articles/6954/. Retrieved 2010-08-22.
81. ^ "Inside Trademarks March 24, 2010" (http://insidetrademarks.com/2010/03/24/cloud-computing-trademark-trends/) . Insidetrademarks.com. 2010-03-24. http://insidetrademarks.com/2010/03/24/cloud-computing-trademark-trends/. Retrieved 2010-08-22.
82. ^ Google, Inc. vs. the United States (http://www.scribd.com/doc/40513712/Google-v-US-Complaint)
83. ^ Casson and Ryan, Open Standards, Open Source Adoption in the Public Sector, and Their Relationship to Microsoft's Market Dominance (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1656616)
84. ^ "Open source fuels growth of cloud computing, software-as-a-service" (http://www.networkworld.com/news/2008/072808-open-source-cloud-computing.html) . Networkworld.com. http://www.networkworld.com/news/2008/072808-open-source-cloud-computing.html. Retrieved 2010-08-22.
85. ^ "AGPL: Open Source Licensing in a Networked Age" (http://redmonk.com/sograd y/2009/04/15/open-source-

licensing-in-a-networked-age/) . Redmonk.com. 2009-04-15. http://redmonk.com/sogrady/2009/04/15/open-source-licensing-in-a-networked-age/. Retrieved 2010-08-22.
86. ^ GoGrid Moves API Specification to Creative Commons (http://www.gogrid.com/company/press-releases/gogrid-moves-api-specification-to-creativecommons.php)
87. ^ "Eucalyptus Completes Amazon Web Services Specs with Latest Release" (http://ostatic.com/blog/eucalyptus-completes-amazon-web-services-specs-with-latest-release) . Ostatic.com. http://ostatic.com/blog/eucalyptus-completes-amazon-web-services-specs-with-latest-release. Retrieved 2010-08-22.
88. ^ "Open Cloud Consortium.org" (http://opencloudconsortium.org) . Open Cloud Consortium.org. 1999-02-22. http://opencloudconsortium.org. Retrieved 2010-08-22.
89. ^ ***a b*** Zissis, Dimitrios; Lekkas (2010). "Addressing cloud computing security issues" (http://www.sciencedirect.com/science/article/pii/S0167739X10002554) . *Future Generation Computer Systems*. doi:doi:10.1016/j.future.2010.12.006 (http://dx.doi.org/doi%3A10.1016%2Fj.future.2010.12.006) . http://www.sciencedirect.com/science/article/pii/S0167739X10002554.
90. ^ "Are security issues delaying adoption of cloud computing?" (http://www.networkworld.com/news/2009/042709-burning-security-cloud-computing.html) . Networkworld.com. http://www.networkworld.com/news/2009/042709-burning-security-cloud-computing.html. Retrieved 2010-08-22.
91. ^ "Security of virtualization, cloud computing divides IT and security pros" (http://www.networkworld.com/news/2010/022210-virtualization-cloud-security-debate.html) . Networkworld.com. 2010-02-22. http://www.networkworld.com/news/2010/022210-virtualization-cloud-security-debate.html. Retrieved 2010-08-22.
92. ^ Armbrust, M; Fox, A., Griffith, R., Joseph, A., Katz, R., Konwinski, A., Lee, G., Patterson, D., Rabkin, A., Zaharia, (2010). "A view of cloud computing.". *Communication of the ACM* **53** (4): 50–58. doi:doi:10.1145/1721654.1721672 (http://dx.doi.org/doi%3A10.1145%2F1721654.1721672) .
93. ^ Anthens, G. "Security in the cloud". *Communications of the ACM* **53** (11). doi:10.1145/1839676.1839683 (http://dx.doi.org/10.1145%2F1839676.1839683) .
94. ^ "Cloud Security Alliance Official web page" (http://www.cloudsecurityalliance.org/) . Cloudsecurityalliance.org. http://www.cloudsecurityalliance.org/. Retrieved 2010-08-22.
95. ^ Mullins, Robert (2010-06-16). "IDC Survey: Risk In The Cloud" (http://www.networkcomputing.com/cloud-computing/cloud-minuses-outweigh-pluses-for-businesses.php) . Network Computing. http://www.networkcomputing.com/cloud-computing/cloud-minuses-outweigh-pluses-for-businesses.php. Retrieved 2010-08-22.
96. ^ Scheier, Robert L. (2009-04-20). "What to do if your cloud provider disappears | Cloud Computing" (http://www.infoworld.com/d/cloud-computing/what-do-if-your-cloud-provider-disappears-508) . InfoWorld. http://www.infoworld.com/d/cloud-computing/what-do-if-your-cloud-provider-disappears-508. Retrieved 2010-08-22.
97. ^ James Urquhart (January 7, 2010). "Cloud computing's green paradox" (http://news.cnet.com/8301-19413_3-10428065-240.html) . CNET News. http://news.cnet.com/8301-19413_3-10428065-240.html. Retrieved March 12, 2010. "...there is some significant evidence that the cloud is encouraging more compute consumption"
98. ^ Finland – First Choice for Siting Your Cloud Computing Data Center. (http://www.fincloud.freehostingcloud.com/) . Retrieved 4 August 2010.
99. ^ Swiss Carbon-Neutral Servers Hit the Cloud. (http://www.greenbiz.com/news/2010/06/30/swiss-carbon-neutral-servers-hit-cloud) . Retrieved 4 August 2010.
100. ^ Katrice R. Jalbuena (March 19, 2009). "SmartBay pilot information system operational in Galway Bay" (http://ecoseed.org/en/living-green-article-list/article/6-living-green/1067-smartbay-pilot-information-system-operational-in-galway-bay) . EcoSeed. http://ecoseed.org/en/living-green-article-list/article/6-living-green/1067-smartbay-pilot-information-system-operational-in-galway-bay. Retrieved November 10, 2010. "SmartBay is being developed using Cloud computing, an emerging approach to shared infrastructure in which large pools of systems are linked together to provide IT services."
101. ^ http://www.bloomberg.com/news/2011-05-13/sony-network-said-to-have-been-invaded-by-hackers-using-amazon-com-server.html
102. ^ http://www.theregister.co.uk/2011/05/14/playstation_network_attack_from_amazon/
103. ^ "Cloud Net Directory. Retrieved 2010-03-01" (http://www.cloudbook.net/directories/research-clouds) . Cloudbook.net. http://www.cloudbook.net/directories/research-clouds. Retrieved 2010-08-22.
104. ^ nsf.gov – National Science Foundation (NSF) News – National Science Foundation Awards Millions to

Fourteen Universities for Cloud Computing Research – US National Science Foun... (http://www.nsf.gov/news/news_summ.jsp?cntn_id=114686)
105. ^ ""IBM, Google Team on an Enterprise Cloud." May 2008. Rich Miller Retrieved 2010-04-01" (http://www.datacenterknowledge.com/archives/2008/05/02/ibm-google-team-on-an-enterprise-cloud/) . DataCenterKnowledge.com. 2008-05-02. http://www.datacenterknowledge.com/archives/2008/05/02/ibm-google-team-on-an-enterprise-cloud/. Retrieved 2010-08-22.
106. ^ "National Science Foundation press release. September 2008. "National Science Foundation Awards Millions to Fourteen Universities for Cloud Computing Research." Retrieved 2010-03-01" (http://www.nsf.gov/news/news_summ.jsp?cntn_id=114686) . Nsf.gov. http://www.nsf.gov/news/news_summ.jsp?cntn_id=114686. Retrieved 2010-08-22.
107. ^ "HP News Release. "HP, Intel and Yahoo! Create Global Cloud Computing Research Test Bed." July 2008" (http://www.hp.com/hpinfo/newsroom/press_kits/2008/cloudresearch/index.html?jumpid=reg_R1002_USEN) . Hp.com. 2008-07-29. http://www.hp.com/hpinfo/newsroom/press_kits/2008/cloudresearch/index.html?jumpid=reg_R1002_USEN. Retrieved 2010-08-22.
108. ^ "HP News Release. "HP, Intel and Yahoo! Attract Leading Research Organizations to Collaborative Cloud Computing Test Bed. June 2009" (http://www.hp.com/hpinfo/newsroom/press/2009/090608a.html?jumpid=reg_R1002_USEN) . Hp.com. http://www.hp.com/hpinfo/newsroom/press/2009/090608a.html?jumpid=reg_R1002_USEN. Retrieved 2010-08-22.
109. ^ "Open Cirrus: the Open Cloud Computing Research Testbed." (https://opencirrus.org/)
110. ^ IDG News Service. “More join HP, Intel and Yahoo on Open Cirrus cloud test bed.” Perez. Sept. 2010 (http://www.sfgate.com/cgi-bin/article.cgi?f=/g/a/2010/09/27/urnidgns002570F3005978D8002577AB00480C4E.DTL#ixzz10oru3Xj0)
111. ^ Open Cirrus Video (http://www.youtube.com/watch?v=CEIn59JS1aM)
112. ^ "Information Week: "HP Labs India offers SiteonMobile for emerging markets." Ribeiro, IDG News Service\Bangalore Bureau July 2010" (http://www.informationweek.in/Mobile/10-07-09/HP_Labs_India_offers_SiteonMobile_for_emerging_markets.aspx) . Informationweek.in. 2010-07-09. http://www.informationweek.in/Mobile/10-07-09/HP_Labs_India_offers_SiteonMobile_for_emerging_markets.aspx. Retrieved 2010-08-22.
113. ^ Technology Review India: “From the Labs: Information Technology. Web Access Possible On Low Cost Phone.” August 2010. (http://www.technologyreview.in/computing/25950/page2/)
114. ^ ZDNet UK. “HP Labs unveils G-Cloud demo facility.” (http://www.zdnet.co.uk/news/cloud/2010/11/17/hp-labs-unveils-g-cloud-demo-facility-40090895/?s_cid=938)
115. ^ Wall Street Journal, AllThingsDigital.com: “Seven Questions for Prith Banerjee, Hewlett-Packard’s Head of Research.” Arik Hasseldahl. May 9, 2011. (http://newenterprise.allthingsd.com/20110509/seven-questions-for-prith-banerjee-hewlett-packards-head-of-research/?reflink=ATD_yahoo_ticker)
116. ^ “HP Lifts Curtain on G-Cloud Theatre.” HP News Release. Nov. 2010 (http://www8.hp.com/us/en/hp-news/article_detail.html?compURI=tcm:245-800848&pageTitle=HP%20Lifts%20Curtain%20on%20G-Cloud%20Theatre)
117. ^ "IEEE Technical Committee on Services Computing" (http://tab.computer.org/tcsc) . Tab.computer.org. http://tab.computer.org/tcsc. Retrieved 2010-08-22.
118. ^ "IEEE International Conference on Cloud Computing (CLOUD)" (http://www.thecloudcomputing.org) . Thecloudcomputing.org. http://www.thecloudcomputing.org. Retrieved 2010-08-22.
119. ^ Open Networking Foundation News Release. March 21, 2011. (http://www.openflow.org/wp/2011/03/open-networking-foundation-formed-to-speed-network-innovation/)
120. ^ ComputerWorld: “Google and other titans form Open Networking Foundation.” Noyes, March 23, 2011. (http://www.computerworld.com.au/article/380663/google_other_titans_form_open_networking_foundation/?fp=4&fpid=78268965)
121. ^ “”. "Larry Ellison – What The Hell Is Cloud Computing?" (http://www.youtube.com/watch?v=0FacYAI6DY0) . Youtube.com. http://www.youtube.com/watch?v=0FacYAI6DY0. Retrieved 2010-08-22.
122. ^ Farber, Dan (2008-09-26). "Oracle's Ellison nails cloud computing" (http://news.cnet.com/8301-13953_3-10052188-80.html) . News.cnet.com. http://news.cnet.com/8301-13953_3-10052188-80.html. Retrieved 2010-08-22.
123. ^ "Oracle launches worldwide cloud-computing tour" (http://www.computerworld.com.au/article/335674/oracle_launches_worldwide_cloud-computing_tour/) . Computerworld.com.au. 2010-02-10. http://www.computerworld.com.au/article/335674/oracle_launches_worldwide_cloud-computing_tour/.

Retrieved 2010-08-22.
124. ^ By James Rogers (2009-12-18). "Oracle's Ellison Issues Cloud Challenge" (http://www.thestreet.com/story/10649557/1/oracles-ellison-issues-cloud-challenge.html) . Thestreet.com. http://www.thestreet.com/story/10649557/1/oracles-ellison-issues-cloud-challenge.html. Retrieved 2010-08-22.
125. ^ "Oracle desperately seeking cloud cred" (http://searchcloudcomputing.techtarget.com/news/article/0,289142,sid201_gci1384202,00.html) . Searchcloudcomputing.techtarget.com. 2010-02-16. http://searchcloudcomputing.techtarget.com/news/article/0,289142,sid201_gci1384202,00.html. Retrieved 2010-08-22.
126. ^ “” (2008-09-29). "Cloud Computing is Hyped and Overblown" (http://www.youtube.com/watch?v=f7wv1i8ubng) . Youtube.com. http://www.youtube.com/watch?v=f7wv1i8ubng. Retrieved 2010-08-22.
127. ^ "Cloud Computing is Hyped and Overblown, Forrester's Frank Gillett Big Tech Companies Have "Cloud Envy"" (http://www.beet.tv/2008/09/cloud-computing.html) . Beet.tv. http://www.beet.tv/2008/09/cloud-computing.html. Retrieved 2010-08-22.
128. ^ Cloud computing is a trap, warns GNU founder Richard Stallman (http://www.guardian.co.uk/technology/2008/sep/29/cloud.computing.richard.stallman) The Guardian, Monday 29 September 2008 14.11 BST

External links

- Cloud Computing Dashboard and Resources on Academic Room (http://www.academicroom.com/discipline/385837)
- Grail Research - Cloud Computing: Fact versus Fog (http://www.grailresearch.com/pdf/ContenPodsPdf/2010_Grail_Research_Cloud_Computing.pdf)
- CloudTweaks.com - Cloud Computing Research Articles (http://www.cloudtweaks.com/)

Retrieved from "http://en.wikipedia.org/wiki/Cloud_computing"
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