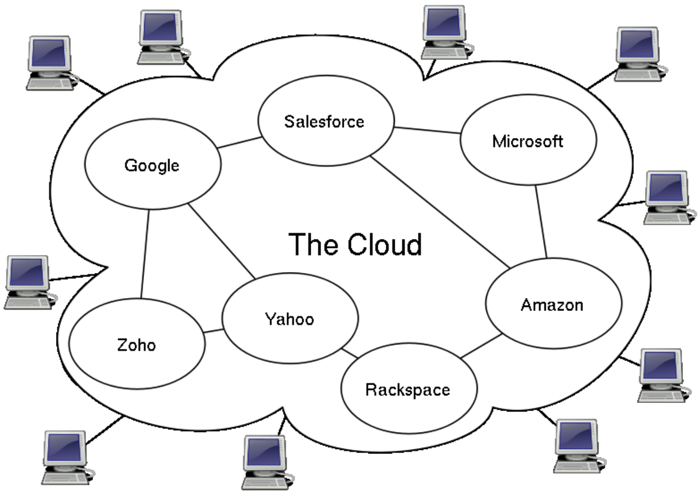
Cloud computing



Cloud computing conceptual diagram

Cloud computing is Internet-based computing, whereby shared servers provide resources, software, and data to computers and other devices on demand, as with the electricity grid. Cloud computing is a natural evolution of the widespread adoption of virtualization, service-oriented architecture and utility computing. Details are abstracted from consumers, who no longer have need for expertise in, or control over, the technology infrastructure "in the cloud" that supports them.[1]

Cloud computing describes a new supplement, consumption, and delivery model for IT services based on the Internet, and it typically involves over-the-Internet provision of dynamically scalable and often virtualized resources.[2] [3] It is a byproduct and consequence of the ease-of-access to remote computing sites provided by the Internet.[4] This frequently takes the form of web-based tools or applications that users can access and use through a web browser as if it were a program installed locally on their own computer.[5]

The National Institute of Standards and Technology (NIST) provides a somewhat more objective and specific definition here.[6] 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,[7] and later to depict the Internet in computer network diagrams as an abstraction of the underlying infrastructure it represents.[8] Typical cloud computing providers deliver common business applications online that are accessed from another Web service or software like a Web browser, while the software and data are stored on servers.

Most cloud computing infrastructures consist of services delivered through common centers and built on servers. Clouds often appear as single points of access for consumers' computing needs. Commercial offerings are generally expected to meet quality of service (QoS) requirements of customers, and typically include service level agreements (SLAs).[9] The major cloud service providers include Amazon, Rackspace Cloud, Salesforce, Skytap, Microsoft and Google.[10] [11] Some of the larger IT firms that are actively involved in cloud computing are Fujitsu, Dell,[12] Red Hat,[13] Hewlett Packard,[14] IBM,[15] VMware, and NetApp.

Overview

Comparisons

Cloud computing derives characteristics from, but should not be confused with:

1. Autonomic computing — "computer systems capable of self-management"[16]
2. Client–server model – *client–server computing* refers broadly to any distributed application that distinguishes between service providers (servers) and service requesters (clients)[17]
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.[18]
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";[19]
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.[20]

Characteristics

The fundamental concept of cloud computing is that the computing is "in the cloud" i.e. that the processing (and the related data) is not in a specified, known or static place(s). This is in opposition to where 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.

Generally, cloud computing customers do not own the physical infrastructure, instead avoiding capital expenditure by renting usage from a third-party provider. They consume resources as a service and pay only for resources that they use. Many cloud-computing offerings employ the utility computing model, which is analogous to how traditional utility services (such as electricity) are consumed, whereas others bill on a subscription basis. Sharing "perishable and intangible" computing power among multiple tenants can improve utilization rates, as servers are not unnecessarily left idle, which can reduce costs significantly while increasing the speed of application development. A side-effect of this approach is that overall computer usage rises dramatically, as customers do not have to engineer for peak load limits.[21] In addition, "increased high-speed bandwidth" makes it possible to receive the same. The cloud is becoming increasingly associated with small and medium enterprises (SMEs) as in many cases they cannot justify or afford the large capital expenditure of traditional IT. SMEs also typically have less existing infrastructure, less bureaucracy, more flexibility, and smaller capital budgets for purchasing in-house technology. Similarly, SMEs in emerging markets are typically unburdened by established legacy infrastructures, thus reducing the complexity of deploying cloud solutions.

Economics

Cloud computing users avoid capital expenditure (CapEx) on hardware, software, and services when they pay a provider only for what they use. Consumption is usually billed on a utility (resources consumed, like electricity) or subscription (time-based, like a newspaper) basis with little or no upfront cost. Other benefits of this approach are low barriers to entry, shared infrastructure and costs, low management overhead, and immediate access to a broad range of applications. In general, users can terminate the contract at any time (thereby avoiding return on investment risk and uncertainty), and the services are often covered by service level agreements (SLAs) with financial penalties.[22] [23]

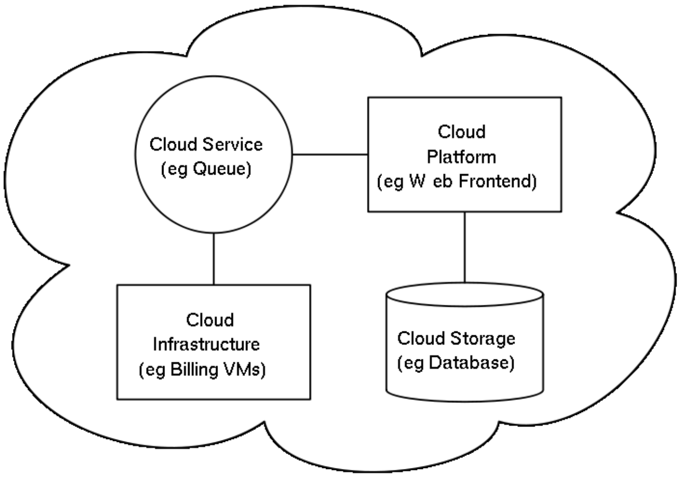
According to Nicholas Carr, the strategic importance of information technology is diminishing as it becomes standardized and less expensive. He argues that the cloud computing paradigm shift is similar to the displacement of frozen water trade by electricity generators early in the 20th century.[24]

Although companies might be able to save on upfront capital expenditures, they might not save much and might actually pay more for operating expenses. In situations where the capital expense would be relatively small, or where the organization has more flexibility in their capital budget than their operating budget, the cloud model might not make great fiscal sense. Other factors having an impact on the scale of potential cost savings include the efficiency of a company's data center as compared to the cloud vendor's, the company's existing operating costs, the level of adoption of cloud computing, and the type of functionality being hosted in the cloud.[25] [26]

Among the items that some cloud hosts charge for are instances (often with extra charges for high-memory or high-CPU instances), data transfer in and out, storage (measured by the GB-month), I/O requests, PUT requests and GET requests, IP addresses, and load balancing. In some cases, users can bid on instances, with pricing dependent on demand for available instances.[27]

Architecture

Cloud architecture,[28] the systems architecture of the software systems involved in the delivery of cloud computing, typically involves multiple *cloud components* communicating with each other over application programming interfaces, usually web services. This resembles the Unix philosophy of having multiple programs each doing one thing well and working together over universal interfaces. Complexity is controlled and the resulting systems are more manageable than their monolithic counterparts.



Cloud computing sample architecture

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.

History

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 was 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 primarily offered 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 from that of the user. Cloud computing extends this boundary to cover servers as well as the network infrastructure.[29] The first scholarly use of the term “cloud computing” was in a 1997 lecture by Ramnath Chellappa.

Amazon played a key role in the development of cloud computing by modernizing their data centers after the dot-com bubble, 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.[30] [31]

In 2007, Google, IBM and a number of universities embarked on a large scale cloud computing research project.[32] 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 [33] . 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"[34] 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."[35]

Key features

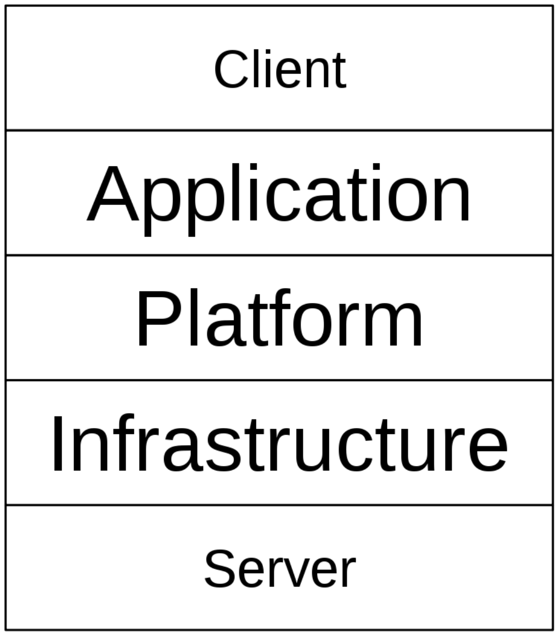
- **Agility** improves with users' ability to rapidly and inexpensively re-provision technological infrastructure resources.[36]
- **Application Programming Interface** (API) accessibility to software that enables machines to interact with cloud software in the same way the user interface facilitates interaction between humans and computers. Cloud Computing systems typically use REST based APIs.
- **Cost** is claimed to be greatly reduced and capital expenditure is converted to operational expenditure.[37] This ostensibly 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 fewer IT skills are required for implementation (in-house).[38]
- **Device and location independence**[39] 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, users can connect from anywhere.[38]
- **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.[30]
- **Reliability** is improved if multiple redundant sites are used, which makes well designed cloud computing suitable for business continuity and disaster recovery.[40] Nonetheless, many major cloud computing services have suffered outages, and IT and business managers can at times do little when they are affected.[41] [42]
- **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.[38] One of the most important new methods for overcoming performance bottlenecks for a large class of applications is data parallel programming on a distributed data grid.[43]
- **Security** could improve due to centralization of data,[44] 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.[45] 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.[46] Providers typically log accesses, but accessing the audit logs themselves can be difficult or impossible. Furthermore, the complexity of security is greatly increased when data is distributed over a wider area and / or number of devices.
- **Maintenance** of cloud computing applications is easier, since they don't have to be installed on each user's computer. They are easier to support and to improve since the changes reach the clients instantly.
- **Metering** means that cloud computing resources usage should be measurable and should be metered per client and application on a daily, weekly, monthly, and yearly basis.

Layers

The Internet functions through a series of network protocols that form a stack of layers, as shown in the figure (or as described in more detail in the OSI model). Once an Internet connection is established among several computers, it is possible to share services within any one of the following layers.

Client

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 essentially useless without it. Examples include some computers, phones and other devices, operating systems and browsers.[47] [48] [49] [50] [51]



Application

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. Key characteristics include:[52]

- 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

Cloud platform services or "*Platform as a Service (PaaS)*" deliver a computing platform and/or solution stack as a service, often consuming *cloud infrastructure* and sustaining *cloud applications*.[53] It facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers.[54] [55]

Infrastructure

Cloud infrastructure services, also known as "*Infrastructure as a Service (IaaS)*", delivers 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 and amount of resources consumed (and therefore the cost) will typically reflect the level of activity. IaaS evolved from virtual private server offerings.[56]

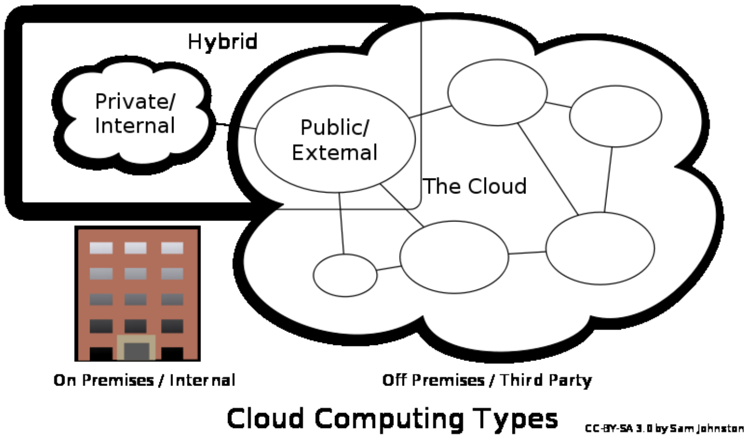
Server

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.[47] [57] [58] [59]

Deployment models

Public cloud

Public cloud or *external cloud* describes cloud computing in the traditional main stream 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.[38]



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. With the costs spread over fewer users than a *public cloud* (but more than a single tenant) this option is more expensive but may offer a higher level of privacy, security and/or policy compliance. Examples of *community cloud* include Google's "Gov Cloud".[60]

Hybrid cloud

There is some confusion over the term "Hybrid" when applied to the cloud - a standard definition of the term "Hybrid Cloud" has not yet emerged. The term "Hybrid Cloud" has been used to mean either two separate clouds joined together (public, private, internal or external), or a combination of virtualized cloud server instances used together with real physical hardware. The most correct definition of the term "Hybrid Cloud" is probably the use of physical hardware and virtualized cloud server instances together to provide a single common service.[61] 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[62] "will be typical for most enterprises".[63] By integrating multiple cloud services users may be able to ease the transition to *public cloud* services while avoiding issues such as PCI compliance.[64]

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.

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.[65]

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, however 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,[63] essentially "[lacking] the economic model that makes cloud computing such an intriguing concept".[66] [67] Enterprise IT organizations uses own Private cloud(s) for mission critical and other operational systems to Protect Critical infractructures. [68]

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

Cloud Storage is a model of networked computer data storage where data is stored on multiple virtual servers, generally 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. Physically, the resource may span across multiple servers.

The Intercloud

The Intercloud[69] is an interconnected global "cloud of clouds"[70] [71] and an extension of the Internet "network of networks" on which it is based.[72] 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.".[70] It became popular in 2009[73] and has also been used to describe the datacenter of the future.[74]

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 situation, 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, QoS, vendor's lock-ins, trust, legal issues, monitoring and billing.

The concept of a competitive utility computing market which 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.[75] 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."[76]

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 which 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"[77] [78] and Rackspace Cloud are able to claim PCI compliance.[79] 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.[80]

Many providers also obtain SAS 70 Type II certification (e.g. Amazon,[81] Salesforce.com,[82] Google[83] and Microsoft[84]), 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.[85] Providers typically make this information available on request, under non-disclosure agreement.[86]

Legal

In March 2007, Dell applied to trademark the term "cloud computing" (U.S. Trademark 77139082 [87]) 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 at an almost exponential rate. 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.[88]

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."[89] 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.[90]

Open source

Open source software has provided the foundation for many cloud computing implementations.[91] 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.[92]

Open standards

Most cloud providers expose APIs which are typically well-documented (often under a Creative Commons license[93]) but also unique to their implementation and thus not interoperable. Some vendors have adopted others' APIs[94] and there are a number of open standards under development, including the OGF's Open Cloud Computing Interface. The Open Cloud Consortium (OCC)[95] is working to develop consensus on early cloud computing standards and practices.

Security

The relative security of cloud computing services is a contentious issue which may be delaying its adoption.[96] Issues barring the adoption of cloud computing is 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 amongst cloud computing service providers in producing a priority in building and maintaining strong management of secure services.[97]

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.[98]

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.[99]

There are also concerns about a cloud provider shutting down for financial or legal reasons, which has happened in a number of cases.[100]

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.[101] 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,[102] Sweden and Switzerland,[103] 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. [104]

Research

A number of universities, vendors and government organizations are investing in research around the topic of cloud computing.[105] Academic institutions include University of Melbourne (Australia), Georgia Tech, Yale, Wayne State, Virginia Tech, University of Wisconsin–Madison, Carnegie Mellon, MIT, Indiana University, University of Massachusetts, University of Maryland, North Carolina State University, Purdue University, University of California, University of Washington, University of Virginia, University of Utah, University of Minnesota, among others.[106]

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.[107] In April 2009, the National Science Foundation joined the ACCI and awarded approximately $5 million in grants to 14 academic institutions.[108]

In July 2008, HP, Intel Corporation and Yahoo! announced the creation of a global, multi-data center, open source test bed, called Open Cirrus,[109] designed to encourage research into all aspects of cloud computing, service and data center management.[110] 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).[111] 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.[112] [113]

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.[114] 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.[115] In Nov. 2010, HP formally opened its Government Cloud Theatre, located at the HP Labs site in Bristol, England.[116] 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. HP Labs Bristol is HP's second-largest central research location and currently is responsible for researching cloud computing and security.[117]

The IEEE Technical Committee on Services Computing[118] in IEEE Computer Society sponsors the IEEE International Conference on Cloud Computing (CLOUD).[119] CLOUD 2010 was held on July 5–10, 2010 in Miami, Florida

Criticism of the term

During a video interview, Forrester Research VP Frank Gillett expresses criticism about the nature of and motivations behind the push for cloud computing. He describes what he calls "cloud washing" in the industry whereby companies relabel their products as cloud computing resulting in a lot of marketing innovation on top of real innovation. The result is a lot of overblown hype surrounding cloud computing. Gillett sees cloud computing as revolutionary in the long term but over-hyped and misunderstood in the short term, representing more of a gradual shift in our thinking about computer systems and not a sudden transformational change.[120] [121]

Larry Ellison, CEO of Oracle Corporation has stated that cloud computing has been defined as "everything that we already do" and that it will have no effect except to "change the wording on some of our ads".[122] [123] Oracle Corporation has since launched a cloud computing center and worldwide tour. Forrester Research Principal Analyst John Rymer dismisses Ellison's remarks by stating that his "comments are complete nonsense and he knows it".[124] [125] [126]

Richard Stallman said that cloud computing was simply a trap aimed at forcing more people to buy into locked, proprietary systems that would cost them more and more over time. "It's stupidity. It's worse than stupidity: it's a marketing hype campaign", he told The Guardian. "Somebody is saying this is inevitable – and whenever you hear somebody saying that, it's very likely to be a set of businesses campaigning to make it true." [127]

External links

- Cloud Computing Dashboard and Resources on Academic Room [128]
- The Microsoft "Cloud computing in government" guide [129]
- Cloud Computing Intel's Research [130]

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