

The Cloud Computing Revolution:  
How Cloud Computing Is Taking the World by Storm

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**Abstract**

Cloud computing refers to the notion of offering different types of software and storage services through the means of the Internet. Different business models of cloud computing have been developed and are being adopted by increasing numbers of businesses. Cloud computing users can save costs, save time, and provide resources necessary to run a business in an efficient manner. However, there are many legal and security risks that come along with keeping large amounts of data on the Internet that have affected cloud computing in a damaging way. The cloud computing industry has a bright future, but there are still obstacles to be overcome before the technology will become a ubiquitous force in the world.

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**Introduction**

The “cloud” is a commonly used metaphor for the Internet. The term comes from the outlines of cloud-shaped diagrams used to represent the transportation of data across networks. The phrase “cloud computing” had a very broad definition when it started to become more prevalent in the technology literature. It was unknown what constituted cloud computing because many different services already took place in the cloud. Cloud computing included anything that had to do with the delivery of computational resources from a location other than the one in which the actual computing was taking place. It even caused enough confusion for CEO Larry Ellison of the major software company Oracle to say, “The interesting thing about cloud computing is that we’ve redefined cloud computing to include everything we already do” (BadIdea2008, 2008). However, in 2011 the National Institute of Standards and Technology clarified the modern meaning of the term by officially defining cloud computing as “a model for enabling ubiquitous, 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” (National Institute of Standards and Technology, 2008).

In order for certain services to constitute cloud computing they must 1) be an on-demand self-service where consumers can independently manage the different aspects of their own computer capabilities such as network storage and server time, 2) have broad network access where applications can be accessed through standard platforms, 3)

provide computing resources to multiple consumers, 4) allow rapid and elastic management of computing provision by the consumer, and 5) be measured depending on the type of service being offered (National Institute of Standards and Technology, 2008). As cloud computing has become a more popular tool for businesses to use, the primary service models that have come to exist in the market consist of software as a service, infrastructure as a service, and platform as a service.

Cloud computing has gained much appeal over the years because it has the ability for short-term usage, no upfront costs, and infinite capacity on demand (Armbrust et al., 2010). Cloud computing can deliver high quality, advanced IT services to organizations with reduced costs, less hardware, and less electricity consumption. Therefore, it is crucial to know about cloud computing because many people are using it every day without even knowing it. From social media to President Obama's 2008 campaign website, services are being used that rely on cloud computing. The technology has started to disseminate across a wide variety of services and products, indicating that it will be the technology of the future.

This paper will discuss the different service models of cloud computing in depth, as well as explore how cloud computing has developed over the last 50 years. It will also discuss various uses of cloud computing, the different types of deployment methods, legal issues of cloud computing, security risks, and what the future holds for this technology.

## Description

### Development of Cloud Computing

Cloud computing is often thought of as a novice idea, but the concept of delivering computing facilities began as early as in the 1960s. When J. C. R. Licklider developed ARPNET in 1969, he did so by envisioning the creation of an “Intergalactic Network” where all people across the world could be interconnected with access to data and applications anytime they wanted (Cantu, 2011). His vision came to fruition when the Internet was created years later. The idea of offering computing resources as a public utility can be attributed to computer scientist John McCarthy in the 1970s. Throughout the 1960s and 1970s, service bureaus began to pop up that would help other companies manage their computing resources. In most cases they were for banks and other financial corporations that could often not afford to own a computer.

While the idea of cloud computing was promising, the public did not yet have the resources for it to become a successful business. By the late 1990s, cloud computing achieved a better environment for business due to the European Organization for Nuclear Research’s release of non-commercial use of the World Wide Web, a dramatic increase in the number of personal computers owned, prevalent high-speed bandwidth, and universal software interoperability standards. In 1999, Salesforce.com became the first company to offer applications through the Internet (“Complete History,” 2013). It was a stepping-stone for other software businesses to offer software as a service online. In 2002, Amazon.com launched Amazon Web Services, which was one of the first services that gave consumers the ability to store data on the cloud. Four years later, Amazon released Elastic Computer cloud, which permitted users to run their own applications on

the Internet using different computers. In 2009, Google Apps was launched to allow applications, such as Google Docs, to let users store entire documents on the Internet.

One reason for the increased development of cloud computing in the noughties can be attributed to the dot-com bubble burst. After the burst, many companies had to rethink their business model for their Internet companies. Companies began to realize the power and potential of the Internet, and there were many more uses for it than simply being a channel to communicate with users. They also began to notice that there were many benefits of incorporating the cloud technology into their business plans, such as storability, flexibility, and cost reduction.

### **Different Types of Cloud Computing Technologies**

One caveat to keep in mind when talking about cloud computing is the difference between grid computing and cloud computing. The two terms are not synonymous. Grid computing refers to using a large amount of computers to work on different aspects of one specific program. Cloud computing can include grid computing, but, in general, they are not the same thing (Myerson, 2009).

**Software as a Service.** SaaS is an acronym for the term Software as a Service. SaaS occurs when an application is hosted at a remote data center and provided as a service to various customers across the Internet (Cloud Computing Wire, 2012). The SaaS model allows customers to access software through an Internet browser without needing to purchase a physical copy of the software. SaaS has taken off as a common new model for businesses, allowing them to save money by paying subscription-based licensing fees for software instead of paying large capital investments for hardware and software. Usually the customer only has to pay minimal, upfront costs and never actually obtains ownership

of the software. When SaaS is used for multiple employees in a company, a common pricing technique for the SaaS provider is to charge based on the cost of the number of employees who use the software. The number of employees using the software can signal the value to the company. Other ways of pricing include number of servers in use, central processing unit cycles, memory space, or disk space. The freemium model offers the software for free but charges for additional services. An example of a freemium service would be Dropbox, which initially offers a free two gigabytes to users that can then be updated to one terabyte depending on the plan (Dropbox, n.d.).

SaaS is a very popular growing industry for entrepreneurs. Gartner, a technology research company, forecasts that SaaS markets will grow 19.5% by 2016, from \$13.5 billion in 2011 to an estimated \$32.8 billion in 2016 (Leong, Toombs, Gil, Petri, & Haynes, 2013). This increase in revenue can be explained by LinkedIn CEO Jeff Weiner's belief that cloud computing "makes it easier and cheaper than ever for anyone anywhere to be an entrepreneur and to have access to all the best infrastructure of innovation" (Parker, 2012).

**Infrastructure as a Service.** Another type of cloud computing business is Infrastructure as a Service (IaaS). IaaS is a service that provides different equipment, such as servers, storage, and other hardware, for customers. However, IaaS does not provide software for the customer. The service provider owns the equipment being offered and is responsible for storing and maintaining the gear. The actual consumer will not have the equipment with them, but instead it stays at the data centers of the service provider. Similar to SaaS, customers "pay as they go" for IaaS. Paying as you go saves costs for businesses because it allows them to only use as much hardware as they need at

any given time. Many IaaS companies allow customers to pay by the hour, which is very beneficial for companies where the demand for computing resources is undetermined. Paying based on demand is often the case with start-up companies that are not sure at what point their websites will have an increase or decrease in users. It is also ideal for seasonal operations, such as a holiday photo service, that would have different amounts of website traffic at different parts of the year. An important aspect of IaaS that makes it efficient to use is the element of self-service. Customers can easily modify the amount of computing resources they require online without needing to go through a service provider representative to adjust an agreement. This technology helps the service provider save service costs and allows the customers to deal with dynamic scaling that their company has to handle.

**Platform as a Service.** Platform as a Service, or PaaS, is the final main business model for cloud computing. PaaS is a computing platform that allows users to rapidly create their own software. PaaS can be viewed as the same as SaaS except instead of delivering software to the customer over the Internet the service providers deliver a platform that is used by the customer to create other computer applications.

Similar to the other cloud computing business models, a benefit of PaaS is cost reductions. Organizations using PaaS techniques have reported operational savings of up to 50% compared to the cost of individual project teams managing their own technology. (Oracle, n.d.). A major source of the cost savings comes from consolidating resources. Not only does the platform reduce the amount of hardware needed, but it also eliminates redundant work by different employees. PaaS provides an environment where the gap between development and testing is almost nonexistent. The platform can be accessed by

multiple users at once, which saves time and money. The platform can also expedite the process it takes to deploy the applications created by the client to testers or the market.

This ability for quick market entry gives the developers more time to focus on the application and fix potential errors

### **Deployment Methods**

There are four types of cloud deployment methods that can be used in cloud computing. The public cloud (also known as the shared cloud) provides various services or infrastructure to customers either free of charge or on a pay-per-user basis. Anyone can access a public cloud, and it is generally cheaper for the cloud provider. An example of a public cloud is Google Apps. The private cloud can only be accessed by one organization. In most cases they are used in businesses and are not available to the general public. The benefits of a private cloud are that the organization has control over security, system preferences, and all the corporate data. However, unlike the public cloud, the private cloud is more expensive for cloud providers because they need to purchase both the software and hardware.

The hybrid cloud has the benefits of both the public and the private clouds. Hybrid clouds permit businesses to maintain the security and data hosting that private clouds provide, but keep the costs down by storing applications and shared data on the public cloud. Hybrid clouds can be troublesome because the company has to keep track of multiple platforms and make sure that they communicate with each other (Grove, 2012).

A cloud community occurs when multiple organizations share a cloud and agree to follow the same set of standards for using the cloud. In addition, a community cloud cuts down on costs.

### **Cloud Computing Uses**

**Adoption of the cloud.** Cloud computing has started to become more common in the workplace but still has yet to reach critical mass. In the 2013 State of the Cloud survey administered by RightScale Inc., a leader in cloud computing, companies were asked about their level of cloud computation. Results from 625 respondents, including a wide range of company sizes and industries, were categorized into four adoption groups. Seventeen percent were categorized as Cloud Watchers who have developed cloud strategies and plans but have not yet implemented projects. Twenty-six percent were deemed Cloud Beginners who are new to cloud computing and still working on their first cloud project. Twenty-three percent were Cloud Explorers who had implemented some cloud projects and are running applications in the cloud. Finally, 26% were Cloud Focused respondents who heavily used cloud computing as a strategic initiative to transform business. Only 8% percent of respondents reported having no plans to use the cloud (RightScale, 2013).

**SaaS applications.** SaaS is becoming used as a delivery model for an increasing number of Internet applications. Using SaaS for business collaboration and meetings has become more prevalent in the workplace. Citrix Online focuses on such web hosting services with applications, such as “GoToMeeting” that allows online meetings with up to 25 other people and ”GoToWebinar” that allows people to host online seminars to up to 100 people (Citrix, n.d.).

Customer Relationship Management, or CRM, is an information industry term for methodologies, software, and most commonly Internet capabilities that help an enterprise manage customer relationships in an organized way (Rouse, 2006). The use of SaaS

based CRM databases allows businesses to store all their customers' information in one location that is easily accessible in an efficient manner. At the end of 2012, 40% of CRM systems sold were SaaS based. Salesforce.com, one of the first businesses to use cloud computing, had the leading share in the SaaS-based CRM market, with 14% at the end of 2012 (Columbus, 2013). SaaS has also aided in the ability for companies to manage their employees. Concur Technologies is an example of such applications that help companies to save time by automating the process of paying for employee expenses. Concur achieves its strategy by primarily focusing on managing the travel expenses of employees.

Cloud computing is being used in a myriad of services, including accounting, human resources, enterprise resource planning, and many more. The benefits of using the cloud are that it allows increased security, permits broadened accessibility, and is very adaptable for the customer.

**Amazon Web Services.** Amazon Web Services, or AWS, is one of the most dominant IaaS providers offered today. Gartner Research placed Amazon Web Services in the leading quadrant of the new Magic Quadrant for Cloud Infrastructure as a Service in August 2013. The Magic Quadrant is defined as "computing resources, along with associated storage and network resources, offered to the customer via self-service in a highly-automated way, on-demand and in near-real-time" (Leong et al., 2013). AWS has more than five times the combined capacity of its next 14 rivals and generates around \$3 billion in annual revenue (Greene, 2013).

One service that AWS provides is Elastic Compute Cloud, or EC2. Like most IaaS services, EC2 rents virtual computing resources to clients so that they can run their own

applications. EC2 provides computing capabilities for big name companies, such as Netflix, Yelp, Dropbox, reddit, Instagram, Spotify, Lamborghini, and Pinterest. EC2 also provides cloud computing for a variety of organizations, such as the 2012 Obama for America Campaign and Harvard Medical School. The service is called elastic because it provides users with the ability to easily access and modify the amount of computing resources they need. Amazon CloudWatch enables the customer to monitor all AWS resources and collect metrics about the resources they are running. AWS also offers Simple Storage Service, or S3, to clients. S3 is a web interface that allows the client to store and retrieve their data anytime through the Internet.

The efficiency of EC2 can be seen in the fact that it took *The New York Times* 36 hours to process terabytes of data using hundreds of Amazon's EC2 virtual servers. If EC2 had not been used, it would have taken *The New York Times* days or even months to process the data (Myerson, 2009).

### **Security and Privacy**

Security is an ongoing issue with the emergence of cloud computing. The Cloud Security Alliance announced at their 2013 conference that data breaches and data loss were the two most dangerous security threats to cloud computing (Samson, 2013). Cloud providers will often store the private data they are holding for a company in a foreign country where there are cheaper resources. One risk of doing so is that there is no universal law for data protection. The country where the data are being stored may, therefore, have access to a company's data depending on the laws of that country. When data is not stored locally, it is difficult to control who has access to the information. This lack of security can lead to data breaches and exposure of private information.

Data loss causes potential disasters for cloud computing companies as well. Natural disasters and cyber terrorists can cause data to disappear forever. Cloud computing companies have taken approaches to enhance their security, but often their attempts have been futile because they cause new problems. For example, making back-up copies of data can help secure against data loss, but it will also open up more opportunities for hackers. Attempting to increase security by encrypting data could stop breaching, but if something happens to the encryption code it can result in a significant amount of data loss.

In 2011, a hacker used EC2 to attack Sony Play Station Network resulting in 77 million records stolen—the second largest data loss in history (Quinn & Arthur, 2011). When hackers sign up for EC2, they have temporary access to servers that hold their data. Customers can sign up for EC2 anonymously without giving their real personal information, making it much harder for them to be tracked. This situation can occur with other IaaS companies as well and causes a real security threat.

### **Risks in Cloud Computing**

There are many potential risks that come into play with cloud computing. As more companies adapt to using cloud computing, a lot of internal changes need to be made. For example, new business processes have to be designed, new Information Technology (IT) roles need to be distinguished, and frequently the IT department has to be downsized to prepare the company for the transition to the cloud. Integrating these changes into a company can lead to some employee frustration and job dissatisfaction among IT department members. Furthermore, if a company switches to using the cloud but finds themselves unhappy with the change, it can be very expensive and time consuming to

switch back. Another risk of cloud computing is the possibility that the Internet is not working. If the Internet were to ever not be accessible to a company, that company would no longer have access to their data and applications they use through cloud computing. This situation can be problematic when data is needed in a time of crisis but cannot be obtained due to unavailable Internet access.

There is always a legal liability when a company agrees to provide cloud computations for a customer. An agreement has to be made with the client about the duration of the service, as well as the level of responsibility the service provider has in regards to the data they are responsible for. Data loss is always possible and if an agreement is not made between the customer and the provider beforehand, then the provider can be held liable if something happens.

### **Recent Events**

The ability to use SaaS, IaaS, and PaaS is making it easier for users to start up their own company or create their own applications by saving costs on hardware and software. However, there are many more factors in play besides economic benefits that are making cloud computing a lucrative option.

### **Environment**

As pressure increases for companies to be more aware about the impact they are having on the environment, cloud computing businesses will have to find a way to run their data centers with clean energy. Facebook plans to open its fourth data center in 2015, running completely on power from a wind farm (Fehrenbacher, 2013). Using clean power is an upcoming trend among cloud computing service providers. The benefits of

ecofriendliness not only include helping with a company's public image but also can actually make a significant change to the environment.

A report released from Global e-Sustainability Initiative predicts that cloud computing can potentially reduce greenhouse gases up to 95% and save \$2.2 billion globally. An example of the potential positive effects cloud computing can have on the environment is that if 80% of public and private organizations in Europe, Brazil, China, Canada, and Indonesia switched to cloud-based CRM and e-mail, there would be a decrease of 4.5 million metric tons of carbon dioxide emissions annually from the reduction in services. This amount of energy is equivalent to 25% of the energy consumed by London annually ("Cloud Computing 'Can Reduce,'" 2013). While it would be nice to have 80% of public and private companies using the cloud, the actual numbers are nowhere near that desired percentage. Part of the reason for the retarded integration could be a lack of government standardization.

### **Government Involvement**

The United States government is getting involved in cloud computing and not only in the regulatory sense. In 2009, the U.S. government passed the Federal Cloud Computing Initiative, or FCCI, in hopes to transition all government technology to web-based IT services and as a result reduce the \$19 billion a year spent on IT infrastructure costs (Fischer & Figliola, 2013). However, the FCCI has been criticized for lack of clarification of standardization in regards to security.

The U.S. government also created the Federal Risk and Authorization Management Program, or FedRamp, in 2011 to help provide a standardized approach to the security assessment of cloud products and services for federal agencies adapting to the cloud.

However, the strict security standards of the FedRamp has prevented cloud computing contractors from getting approval to work on government agency adaptation. This program has created an unfair business advantage for contractors who have passed the FedRamp standards and has resulted in a slow FCCI transition process. In fact, as of November 4<sup>th</sup>, 2013, only eight companies passed FedRamp regulations (PRWeb, 2013). As the government continues to make the transition to cloud based agencies the question of security will come into play even more for agencies with very sensitive information.

### **Discussion**

Cloud computing soon will become a part of everyday life for technology users. While, according to the 2013 State of the Cloud survey, only 26% percent of businesses are heavily invested in using cloud computing as a business strategy, the numerous benefits the cloud technology provides assure its continuous growth. Price cutting benefits, such as pay-per use pricing, not needing to invest in hardware or software, and cutting IT employee costs, are too attractive for businesses to pass up. In addition to price cutting, the advantages the cloud computing can provide for companies, such as superior CPAs and more efficient consolidating of resources, will add value to company's products and services. When a company has a choice to create a more valued product by switching to cloud computing, they most likely are not going to shy away from this opportunity.

In the age of startups and increased entrepreneurship, cloud computing is making it much easier for people to create their own applications and companies. More specifically, platform as a service gives customers the chance to quickly create and share their applications with others while they are still working on it. The ability of continuously

sharing a project while it is still in the development phase is going to increase the quality and speed of applications and software as we move into the future. Services offered by companies like AWS are promoting the entrepreneurial spirit and giving start-up companies that might not have the finances needed to invest in the essential hardware the ability to store data at reasonable prices.

The effect that cloud computing can have on the environment will play an important role with the creation of future data centers. As more companies feel pressure to create environmental friendly data centers, they will have to adopt clean energy techniques for managing their data. Additionally, as more businesses switch to the cloud, there will be a reduction in the number of data centers needed because cloud computing does not require a company to have as much data storage.

The main issue with cloud computing going into the future is going to be data security. As of this writing, there is no guarantee when a company stores data on the Internet that some of it, or a majority of it, is not going to be lost or stolen. Often companies do not know what country their data is even stored in. As more and more companies convert to using cloud computing, and more data goes onto the Internet, the world as a whole is going to become more vulnerable to cyber-attacks. As it can be seen with the Play Station Network hackings, it is difficult for companies to provide the benefits of easy access to computing resources while maintaining the necessary standards for strong security. There is a fine line between simplicity and security that is going to need to be contemplated as more businesses make the jump to cloud computing.

In addition to companies' data being breached, another main risk to society is a government's data being hacked. As more governments start the transition to cloud

computing, they are being extra cautious in making the switch. National agencies tend to have very sensitive information, and it is always going to be a risk once it becomes stored over the Internet.

The main point to take away from the cloud computing revolution is that the technology can be a trade-off. While it is clear that there are many benefits to using cloud computing, the risks could potentially outweigh the advantages in the future. If proper security adjustments are not made as more people start using cloud computing, there may be some dark stormy clouds ahead.

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