Cloud Computing
It gets Bigger and Fuzzier Now

Nikhil Dahake
nikhildahake@hotmail.com

***Abstract*—Cloud computing is an emerging computing technology that uses the internet and central remote servers to maintain data and applications. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any computer with internet access. This technology allows for much more efficient computing by centralizing storage, memory, processing and bandwidth. Cloud computing is a compelling paradigm. Its mission is to make computing available on retail basis. The cloud is a virtualization of resources that maintains and manages itself.**

This paper discusses the era of change that cloud computing will bring about, giving in depth knowledge about the way it will influence our life and it also takes a quick glance at the pros and cons associated with the new technology.

I. Introduction

LET'S say you're an executive at a large corporation. Your particular responsibilities include making sure that all of your employees have the right hardware and software they need to do their jobs. Buying computers for everyone isn't enough -- you also have to purchase software or *software licenses* to give employees the tools they require. Whenever you have a new hire, you have to buy more software or make sure your current software license allows another user.

Soon, there may be an alternative for executives like you. Instead of installing a suite of software for each computer, you'd only have to load one application. That application would allow workers to log into a Web-based service which hosts all the programs the user would need for his or her job. Remote machines owned by another company would run everything from e-mail to word processing to complex data analysis programs. It's called *cloud computing*, and it could change the entire computer industry.

Local computers no longer have to do all the heavy lifting when it comes to running applications. The network of computers that make up the cloud handles them instead. Hardware and software demands on the user's side decrease. The only thing the user's computer needs to be able to run is the cloud computing system's *interface software*, which can be as simple as a Web browser, and the cloud's network takes care of the rest.

There's a good chance you've already used some form of cloud computing. If you have an e-mail account with a Web-based e-mail service like Hotmail, Yahoo! Mail or Gmail, then you've had some experience with cloud computing. Instead of running an e-mail program on your computer, you log in to a Web e-mail account remotely. The software and storage for your account doesn't exist on your computer -- it's on the service's computer cloud.

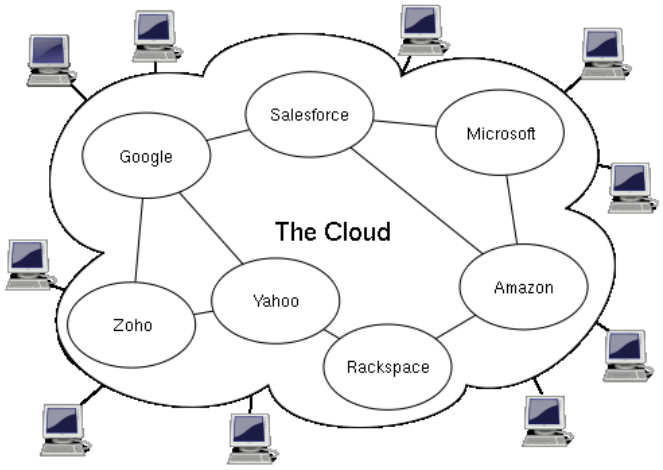

Figure 1

The underlying concept of cloud computing dates back to 1960, when John McCarthy opined that "computation may someday be organized as a public utility"; indeed it shares characteristics with service bureaus that date back to the 1960s. In 1997, the first academic definition was provided by Ramnath K. Chellappa who called it a *computing paradigm where the boundaries of computing will be determined by economic rationale rather than technical limits*. The term *cloud* had already come into commercial use in the early 1990s to refer to large Asynchronous Transfer Mode (ATM) networks.

II. WHAT IS CLOUD COMPUTING?

A technical definition is "a computing capability that provides an abstraction between the computing resource and its underlying technical architecture, enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction." This definition states that clouds have five essential characteristics: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service.

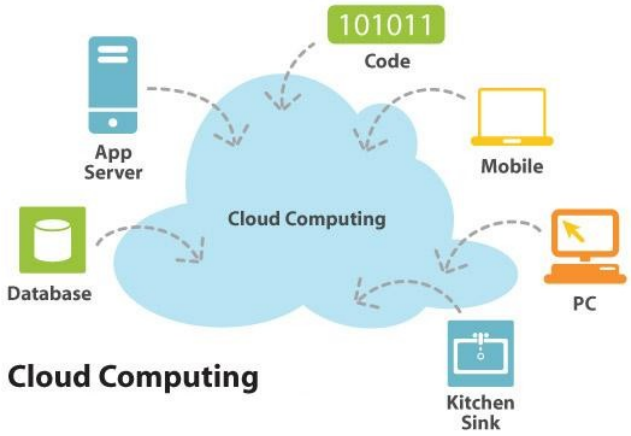

Figure 2

In general, 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. A side-effect of this approach is that overall computer usage rises dramatically, as customers do not have to engineer for peak load limits. In addition, "increased high-speed bandwidth" makes it possible to receive the same response times from centralized infrastructure at other sites.

Other benefits of this time sharing-style approach are low barriers to entry, shared infrastructure and costs, low management overhead, and immediate access to a broad range of applications. 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.

- **Who is Offering On Demand Software?**
  - Salesforce.com (CRM)
  - Google (GOOG)
  - NetSuite (N)
  - Taleo (TLEO)
  - Concur Technologies (CNQR)
- **Who is Offering Traditional Software?**
  - SAP AG (SAP)
  - Oracle (ORCL)
  - Blackbaud (BLKB)
  - Lawson Software (LWSN)
  - Blackboard (BBBB)

III. How CLOUD COMPUTING WORKS—THE ARCHITECTURE

The majority of cloud computing infrastructure, as of 2009, consists of reliable services delivered through data centers and built on servers. Clouds often appear as single points of access for all consumers' computing needs. Commercial offerings are generally expected to meet quality of service (QoS) requirements of customers and typically offer SLAs. Open standards are critical to the growth of cloud computing, and open source software has provided the foundation for many cloud computing implementations.

When talking about a cloud computing system, it's helpful to divide it into two sections: the *front end* and the *back end*. They connect to each other through a network, usually the Internet. The front end is the side the computer user, or client, sees. The back end is the "cloud" section of the system.

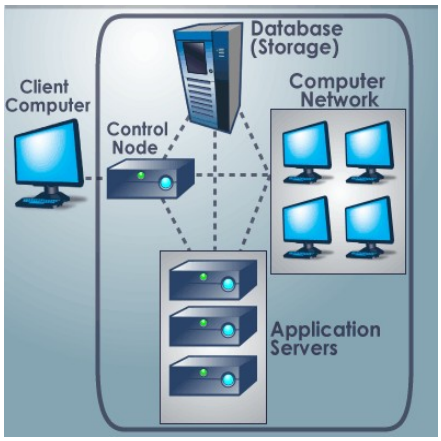

Figure 3: Cloud Computing Architecture

The front end includes the client's computer and the application required to access the cloud computing system. Not all cloud computing systems have the same user interface. Services like Web-based e-mail programs leverage existing Web browsers like Internet Explorer or Firefox. Other systems have unique applications that provide network access to clients.

On the back end of the system are the various computers, servers and data storage systems that create the "cloud" of computing services. In theory, a cloud computing system could include practically any computer program you can imagine, from data processing to video games. Usually, each application will have its own dedicated server.

A central server administers the system, monitoring traffic and client demands to ensure everything runs smoothly. It follows a set of rules called *protocols* and uses a special kind of software called *middleware*. Middleware allows networked computers to communicate with each other.

IV. SOME APPLICATIONS OF CLOUD COMPUTING

The applications of cloud computing are practically limitless. With the right middleware, a cloud computing system could execute all the programs a normal computer could run. Potentially, everything from generic word processing software to customized computer programs designed for a specific company could work on a cloud computing system.

- Clients can access the cloud computing system using any computer linked to the Internet. Data wouldn't be

confined to a hard drive on one user's computer or even a corporation's internal network.

- Cloud computing systems would reduce the need for advanced hardware on the client side. You wouldn't need to buy the fastest computer with the most memory, because the cloud system would take care of those needs for you.
- Cloud computing systems give the organizations company-wide access to computer applications. The companies don't have to buy a set of software or software licenses for every employee. Instead, the company could pay a metered fee to a cloud computing company.
- If the cloud computing system's back end is a grid computing system, then the client could take advantage of the entire network's processing power.

V. The Cloud's Impact

Eventually, according to CNET's Farber, we'll be serving up data, applications, and the writing of those applications directly in the cloud.

If you buy into the general concept of "network of networks in the sky," then you can start to see how cloud computing could affect all aspects of IT architecture. Who needs application architecture, for example, when you can just hop onto a cloud and use it to develop and manage your applications?

Five ways in which cloud computing will change businesses:

1. *The creation of a new generation of products and services.*
2. *A new lightweight form of real-time partnerships and outsourcing with IT suppliers.*
3. *A new awareness and leverage of the greater Internet and Web 2.0 in particular.*
4. *A reconciliation of traditional Service Oriented Architecture (SOA) with the cloud and other emerging IT models.*
5. *The rise of new industry leaders and IT vendors.*

Cloud Computing will eliminate these three technologies:

1. *Design-time service governance.*
2. *Older and smaller clouds.*
3. *Tier 2 enterprise software.*

- **Software Producers that could gain from a shift towards cloud computing include:**
  - Google (GOOG)
  - NetSuite (N)
  - Salesforce.com (CRM)
  - Taleo (TLEO)
  - Right Now Technologies (RNOW)
  - Concur Technologies (CNQR)

- **Internet-based companies that could gain from a shift towards cloud computing include:**
  - Amazon.com (AMZN)
  - Yahoo! (YHOO)
  - Microsoft (MSFT)
  - Google (GOOG)

- **Consulting companies that could gain from a shift towards cloud computing include:**
  - Cloud Technology Partners
  - SAVVIS (SVVS)

- **Traditional software producers that could have some catching up to do if cloud computing ultimately wins out include:**
  - Oracle (ORCL)
  - SAP AG (SAP)
  - Blackbaud (BLKB)

VI. A Critique of Cloud Computing

Figure 4 Pros and Cons

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 electricity generators by electricity grids early in the 20th century. 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 impacting the scale of any 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.

Figure 5 Nicholas Carr

Perhaps the biggest concerns about cloud computing are *security* and *privacy*. The idea of handing over important data to another company worries some people. Corporate executives might hesitate to take advantage of a cloud computing system because they can't keep their company's information under lock and key.

The counterargument to this position is that the companies offering cloud computing services live and die by their reputations. It benefits these companies to have reliable security measures in place. Otherwise, the service would lose all its clients. It's in their interest to employ the most advanced techniques to protect their clients' data.

Privacy is another matter. If a client can log in from any location to access data and applications, it's possible the client's privacy could be compromised. Cloud computing companies will need to find ways to protect client privacy. One way is to use *authentication* techniques such as user names and passwords. Another is to employ an *authorization* format -- each user can access only the data and applications relevant to his or her job.

Some questions regarding cloud computing are more philosophical. Does the user or company subscribing to the cloud computing service own the data? Does the cloud computing system, which provides the actual storage space, own it? Is it possible for a cloud computing company to deny a client access to that client's data? Several companies, law firms and universities are debating these and other questions about the nature of cloud computing.

Cloud computing could turn home computers into simple terminal interfaces. In some ways, this is a step backward. Early computers included hardwired user terminals. Each terminal had a computer monitor and keyboard, but they only served as an interface to the main computer. There was no way to store information locally on a terminal.

VII. Some Very Recent Development

Microsoft CEO Steve Ballmer recently declared that within a year, 90% of Microsoft employees will be doing something that carries out the company's commitment to cloud computing. At the Cloud Connect event in Santa Clara, Calif., two Microsoft executives offered a few tidbits of what the software behemoth is doing today.

Microsoft is building six large data centers in North America, Northern Europe, and Asia to support its cloud computing initiatives in the word's major economies, said Matt Thompson, an 18-year Sun Microsystems veteran until a year-and-a-half ago, when he became Microsoft's general manager, developer and platform evangelism for the Azure cloud.

"We want to put Microsoft data centers in the most important economies of the world. This is the single biggest build-out in the company's history. Only a few companies could make this kind of investment," Thompson added. He was one of the featured speakers opening yesterday's conference general session at the Santa Clara Convention Center.

It was early in the month of March that Microsoft unveiled Windows Azure for the first time in India, it's offering in the cloud computing arena. That was, however, targeted more at the corporate sector and was a technology that promised companies a dramatic 50 percent cut in the IT expenses.

VIII. Conclusion

In the long run, I see a big value in cloud computing. If economic woes continue to plague the world as they have in the past few years, cloud computing is poised to make a real impact on businesses of all sizes. It gives smaller businesses a chance to play on a more level playing field with the big boys, and it helps the big boys cut costs and trim technology needs to compete on a more personal level with customers.

Those who dismiss it as "just another trend" are likely to miss out on the opportunities that cloud computing provides for organizations of all sizes. Take a look back at Microsoft in the early 1990s to see how they initially missed the boat with the Internet.

The question isn't really "What can cloud computing do for me?" so much as it is "How am I going to manage the use of cloud computing in my organization?" If you're not asking that yet, you should be.

References

[1] http://en.wikipedia.org/wiki/Cloud_computing.
[2] http://cloudcomputingexpo.com/
[3] http://labs.yahoo.com/cloud_computing
[4] http://news.cnet.com/8301-30685_3-10378782-264.html
[5] http://www.wikinvest.com/concept/Cloud_Computing.
[6] http://www.infoworld.com/d/cloud-computing/what-cloud-computing-really-means-031
[7] http://cloudcomputing.sys-con.com/node/579826.
[8] http://communication.howstuffworks.com/cloud-computing.htm
[9] http://cloudcomplete.blogspot.com/2009/08/cloud-computing-why-do-we-need-it.html
[10] http://www.ibm.com/developerworks/opensource/library/ar-valuecloudcomputing/index.html
[11] http://www.infoworld.com/t/cloud-computing/why-we-hate-and-need-cloud-computing-465
[12] http://www.ibm.com/developerworks/opensource/library/ar-valuecloudcomputing/index.html
[13] http://www.slideshare.net/asvirskas/cloud-computing-introduction
[14] http://www.articlesbase.com/computers-articles/cloud-computing-how-will-it-affect-you-841516.html