

Features, Benefits, Futuristic Projections of Cloud and Inter-Cloud Extensions to the Internet

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ABSTRACT

“Cloud” has become an everyday term in majority of the large scale IT enterprises. Clouds now are the new building blocks of major businesses spread around the world. They help in transporting platforms and services across the globe to support various infrastructures. 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. The initial concept of clouds was spawned way back during the mid 1960s. 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. Struggles during the recession era and the developments in the post-recession era across the globe made the Cloud a revolutionary term. In this paper, we provide an overview of clouds and their features. Services provided by the clouds are discussed with primary focus on Interclouds. Also the present view of the futuristic stance of Cloud computing is analyzed and the results are provided for further study.

Keywords - Clouds, Cloud Computing, Virtualization, VPNs, as a Service (aaS), Utility Computing, the Intercloud, Internet Clouds, Private Clouds, etc.

1. INTRODUCTION

Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid.

Cloud computing is a paradigm shift following the shift from mainframe to client-server in the early 1980s. Details are abstracted from the users, who no longer have need for expertise in, or control over, the technology infrastructure “in the cloud” that supports them. [1] explores 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. 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. It is a byproduct and consequence of the ease-of-access to remote computing sites provided by the Internet. This frequently takes the form of web-based tools or applications that users can access and use through a web browser as if it was a program installed locally on their own computer. NIST (National Institute of Standards and Technology) provides a somewhat more objective and specific defini-

tion here. 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, and later to depict the Internet in computer network diagrams as an abstraction of the underlying infrastructure it represents. 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. Fig. 1 shows how cloud providers & clients use the cloud computing platform and different techniques in their business and development.



Fig. 1. Service providers and Clients utilize Cloud Computing

Most cloud computing infrastructures consist of services delivered through common 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 include SLAs.

From [4], we can conclude that Cloud Computing directly results in Cost Saving & Hassel Free Data Management, many experts feel that this is the future of computing & will be widely accepted by the small businesses, to start with. Provided Scaling-on Demand, Interoperability & Efficiency can be

achieved with Virtualization in a more Secure & Transparent way, Cloud Computing surely is the Next Big Thing in the world of computers – for both Small Businesses as well as Large Businesses. The cloud is a virtualization of resources that maintains and manages itself. There are of course people resources to keep hardware, operation systems and networking in proper order. But from the perspective of a user or application developer only the cloud is referenced. Cloud computing enables users and developers to utilize services without knowledge of, expertise with, nor control over the technology infrastructure that supports them. The major cloud service providers include Microsoft, Salesforce, Skytap, HP, IBM, Amazon and Google.

2. FEATURES

The main and salient features of cloud computing involve two different concepts.

A. The Three Abilities – “as a Service (aaS)” Concept

The first is the “Three Abilities” concept. They are Accessibility, Availability, and Scalability. When boiled down to brass tacks, cloud computing is just a new take on an old idea. Businesses are drawn to the facilities that cloud computing has to offer because the availability of resources dictates current needs and needs always expand beyond the capacity of resources. Cloud computing provides tangible benefits, available to users on request. Providing these features “as a service” means that the resources can be shared between several users without any noticeable decrease in performance.

The possible delivery models are:

- Software as a Service (SaaS) reduces the need to install and upgrade software on users’ desktops. The user always opens the most up-to-date copy of the software, because it is maintained at all times. Google Apps and Zoho are examples of companies providing common application software. Both systems even provide an offline mode for times when users aren’t connected to the Internet. Their files are uploaded as soon as their computers are reconnected.
- 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. The service is typically billed on a utility computing basis and amount of resources consumed (and therefore the cost) will typically reflect the level of activity. It is an evolution of virtual private server offerings.
- Platform as a Service (PaaS) is another growing enterprise. [5] specifies that these shared hosting systems provide a development environment for developers to build their own applications using prebuilt modules or custom code. It delivers a computing platform and/or solution stack as a service, often consuming cloud infrastructure and sustaining cloud applications. It facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers.

The possible deployment models are:

- Private cloud: The cloud infrastructure is owned or leased by a single organization and is operated solely for that organization.
- Community cloud: The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations).
- Public cloud: The cloud infrastructure is owned by an organization selling cloud services to the general public or to a large industry group.
- Hybrid cloud: The cloud infrastructure is a composition of two or more clouds (internal, community, or public) that remain unique entities but are bound together by standardized or proprietary technology).

B. The Five Characteristics Concept

This is the NIST simplified version of Cloud Computing. From [6], according to Maria Spinola, we can state that Cloud Computing allows business to increase IT capacity (or add capabilities) on the fly and in real time (Internet-enabled), without investing in new infrastructure, training new personnel or licensing new software, and as a pay-per-use service. The following specific characteristics define exactly what Cloud Computing is to help evaluate if a specific offer is truly Cloud Computing, or simply a pre-existing offering that has the Cloud label slapped on it. The five characteristics are:

- On-demand self-service: Individuals can set themselves up without needing anyone’s help,
- Ubiquitous network access: Available through standard Internet-enabled devices,
- Location independent resource pooling: Processing and storage demands are balanced across a common infrastructure with no particular resource assigned to any individual user,
- Rapid elasticity: Consumers can increase or decrease capacity at will,
- Pay per use: Consumers are charged fees based on their usage of a combination of computing power, bandwidth use and/or storage.

From Fig. 2, we can summarize the NIST definition that Cloud Computing is nothing more than a service model where business workloads such as software applications (SaaS), and/or Platforms (PaaS) such as programming tools, and/or Infrastructures (IaaS) such as processing, storage, networking, etc., are used in accordance with the following characteristics:

- Services are provisioned quickly without requiring excessive administrative intervention on the part of the end user’s organization
- Usage of a shared resource model (pool of virtualized resources) to support a cost-effective pricing structure (only pay what you consume), either housed locally within the four walls of the your data center (Private Cloud) or outside the data center at a secondary site or third party hosting facility (Public Cloud)
- Providing self-service interfaces that let customers acquire resources at any time and get rid of them the instant they are no longer needed.

3. THE INTERCLOUD

The Intercloud is an interconnected global "cloud of clouds" and an extension of the Internet "network of networks" on which it is based. In [2], the term was first used in the context of cloud computing in 2007 where Kevin Kelly opined 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". It became popular in 2009 and has also been used to describe the datacenter of the future.

The Internet, after all, is a "network of networks": a commons of internetworking protocols that dominate precisely because they get the benefit of Metcalf-esque network-effects across a federation of both public and private (intranet) investments.

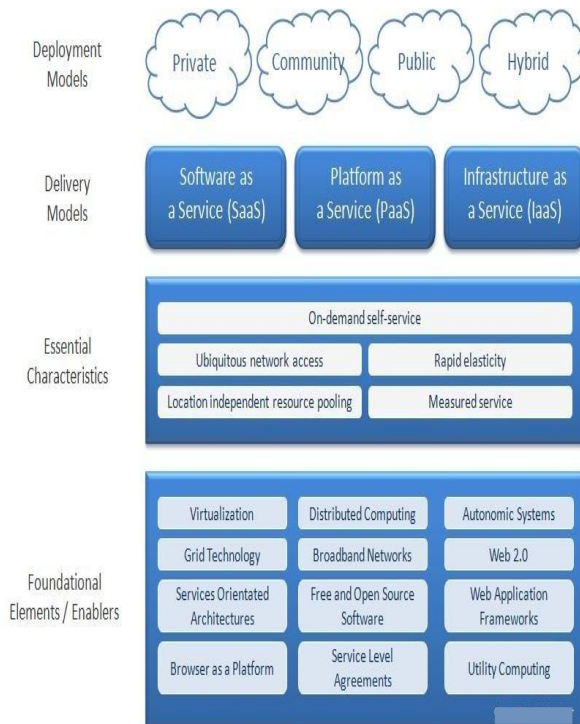


Fig. 2 Chart showing NIST working definition of Cloud Computing

From [7], Greg P states that the congruent concept is the "Intercloud", a term that Cisco has been popularizing recently. The "Intercloud" is similarly a "cloud of clouds". Both public and private versions (intraclouds) not only co-exist, but interrelate. Intraclouds (private clouds) will exist for the same reasons that intranets do: for security and predictability. Clouds will interrelate through networking protocols themselves and the Intercloud. But we have the collective opportunity to create something much more interesting and vital. We should tear out a page from the internet playbook and work towards an open set of interoperable standards and all contribute to a software commons of open implementations. Particularly important are standards for virtual machine representation (e.g. OVF), data in/exgest (e.g. WebDAV), code ingest and provisioning (e.g. Eucalyptus), distributed/parallel data access (pNFS, MogileFS, HDFS), orchestration and messaging (OpenESB, ActiveMQ) accounting, and identity/security (SAML2, OpenID, OpenSSO).

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, in fact, each cloud can use the computational and storage resources of the virtualization infrastructures of other clouds. Such form of pay-for-use introduces new business opportunities among cloud providers. Nevertheless, the Intercloud raises many challenges concerning cloud federation, security, interoperability, QoS, monitoring and billing.

4. BENEFITS AND ADVANTAGES

The benefits of the cloud computing is that it's a win-win situation for both suppliers and clients:

A. An inexpensive option to access technology

With cloud computing is a play technology it is no more a capital spending. It more like how you consume normal resources like electricity, pay for what you use and pay until it's used by you. This in turn authorizes corporations to focus their money on key business activities. Similarly it gives tiny and medium companies a chance to access technology as a resource.

B. Ideal utilization and dispersion of cost

While incorporating infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS) cloud computing brings economies of costs and resources to the various providers and clients utilizing it. Pooling of resources in addition leads to better performance, load balancing (as the load capacity is centrally managed) and fuller use of server capacity. So cloud computing ends up in boosted resource consumption, which is excellent from supportability viewpoint.

C. Larger autonomy and remote access

In cloud computing the infrastructure is maintained by a 3rd party supplier and accessed by buyers thru web using internet browser. Therefore users can access the use independent of place and infrastructure from a Personal computer, laptop PC or a hand held device. This in addition has popularized the concept of offshore software engineering thru the places offering relatively low cost IT outsourcing.

D. Augmented monitoring and simplified use

On one hand where the model increases security and monitoring thru a centralized information access, it simplifies usability by providing self service system interfaces on the other. The user needn't be worried about backend engineering and parameters. As well as this, user does not have to install the application on his system, saving him from the effort of software upkeep, continuing operation, and support.

The idea is blossoming everyday and there's more to it in the future to come. With Offshore outsourcing beginning to become well-liked more entrepreneurs are making an investment in the states with low infrastructure and development cost and then dispatching their cloud computing application models globally. India is one such destination offering low cost application engineering options.

The advantages of cloud computing are that it makes a lot of online and offline work simpler. The web is now fast and trustworthy making cloud computing doable and cheap. For

an SME, cloud computing can supply an ideal platform to host the business system requirements. The system is maintained in a safe environment where the info is backed up daily.

The business does not need to invest in a dear IT infrastructure. Neither is it important to employ staff or a company to run the PC system. All that's needed is an easy renting contract and fast Web access. Cloud computing can eliminate the requirement for documents and spreadsheets to be saved on a local machine. Instead, these can be saved on the cloud. Notebook PCs were developed thanks to the need to hold information with you. The ever-present possibility of burglary or damage made this solution less than ideal.

Delicate info carried on a notebook could place strategic projects in jeopardy. On the cloud computing implies that everything is placed in a safe environment on the internet. There's no longer a requirement to copy the documents onto the notebook. All that's needed at the destination is fast Web access. You might even leave the notebook at home, getting rid of the hazards of physical loss as well as the chance of a security break. Naturally, cloud computing can be extended to the individual. Keep your private documents on the cloud and access them from any PC - even from your telephone - anywhere, anytime.

Google, eyeing the way forward for cloud computing, has started with the development of its Chrome system software. The new operating software will be lean. Its first *raison d'être* will be to provide fast and trustworthy access to the Net. The Chrome operating software is being built for on the cloud computing. With your information, documents, displays and systems hosted online, PCs that are presently under pressure because of the demands of Windows have the likelihood of a new lease of life. Some years back the Net was jokingly known as the world wide wait. The change has been dramatic. Fast broadband is spreading round the globe at great speed.

5. RESEARCH, FINDINGS AND INFERENCES

A. Surveys

Various surveys were conducted through online questionnaires to which a selected group of experts and the highly engaged Internet public have been invited to respond. The surveys present potential-future scenarios to which respondents react with their expectations based on current knowledge and attitudes towards Cloud Computing Technology.

The surveys are conducted to help accurately identify current attitudes about the potential future for networked communications and are not meant to imply any type of futures forecast. Respondents to the survey were asked to consider the future of the Internet-connected world between now and 2020 and the likely innovation that will occur. [8] shows that they were asked to assess 10 different "tension pairs" – each pair offering two different 2020 scenarios with the same overall theme and opposite outcomes – and they were asked to select the one most likely choice of two statements. The tension pairs and their alternative outcomes were constructed to reflect previous statements about the likely evolution of the Internet. [3] gives an expanded view into the various types of results. Some of the responses to a tension pair that relates to the future of the Internet and cloud computing is discussed below.

B. Findings

A solid majority of technology experts and stakeholders participating in the fourth Future of the Internet survey expect that by 2020 most people will access software applications online and share and access information through the use of remote server networks, rather than depending primarily on tools and information housed on their individual, personal computers. They say that cloud computing will become more dominant than the desktop in the next decade. In other words, most users will perform most computing and communicating activities through connections to servers operated by outside firms.

From [9], we can easily identify that the most popular cloud services now are social networking sites (the 500 million people using Facebook are being social in the cloud), webmail services like Hotmail and Yahoo mail, microblogging and blogging services such as Twitter and WordPress, video-sharing sites like YouTube, picture-sharing sites such as Flickr, document and applications sites like Google Docs, social-bookmarking sites like Delicious, business sites like eBay, and ranking, rating and commenting sites such as Yelp and TripAdvisor.

This does not mean, however, that most of these experts think the desktop computer will disappear soon. The majority sees a hybrid life in the next decade, as some computing functions move towards the cloud and others remain based on personal computers.

The highly engaged, diverse set of respondents to an online, opt-in survey included 895 technology stakeholders and critics. The study was fielded by the Pew Research Center's Internet & American Life Project and Elon University's Imagining the Internet Center. Some 71% agreed with the statement:

* "By 2020, most people won't do their work with software running on a general-purpose PC. Instead, they will work in Internet-based applications such as Google Docs, and in applications run from smartphones. Aspiring application developers will develop for smartphone vendors and companies that provide Internet-based applications, because most innovative work will be done in that domain, instead of designing applications that run on a PC operating system."

Some 27% agreed with the opposite statement, which posited:

* "By 2020, most people will still do their work with software running on a general-purpose PC. Internet-based applications like Google Docs and applications run from smartphones will have some functionality, but the most innovative and important applications will run on (and spring from) a PC operating system. Aspiring application designers will write mostly for PCs."

Most of those surveyed noted that cloud computing will continue to expand and come to dominate information transactions because it offers many advantages, allowing users to have easy, instant, and individualized access to tools and information they need wherever they are, locatable from any networked device. Some experts noted that people in technology-rich environments will have access to sophisticated-yet-affordable local networks that allow them to "have the cloud in their homes."

Many of the people who agreed with the statement that cloud computing will expand as the internet evolves said the desktop will not die out but it will be used in new, improved ways in tandem with remote computing. Some survey participants said they expect that a more sophisticated desktop-cloud hybrid

will be people's primary interface with information. They predicted the desktop and individual, private networks will be able to provide most of the same conveniences as the cloud but with better functionality, overall efficiency, and speed. Some noted that general-purpose in-home PC servers can do much of the work locally via a connection to the cloud to tap into resources for computing-intensive tasks.

Among the defenses for a continuing domination of the desktop, many said that small, portable devices have limited appeal as a user interface and they are less than ideal for doing work. They also expressed concern about the security of information stored in the "cloud" (on other institutions' servers), the willingness of cloud operators to handle personal information in a trustworthy way, and other problems related to control over data when it is stored in the cloud, rather than on personally-controlled devices.

A number of people said cloud computing presents difficult security problems and further exposes private information to governments, corporations, thieves, opportunists, and human and machine error.

Survey participants noted that there are also quality of service and compatibility hurdles that must be crossed successfully before cloud computing gains more adopters. Among the other limiting factors the expert respondents mentioned were: the lack of broadband spectrum to handle the load if everyone is using the cloud; the variability of cost and access in different parts of the world and the difficulties that lie ahead before they can reach the ideal of affordable access anywhere, anytime; and complex legal issues, including cross-border intellectual property and privacy conflicts.

Among the other observations made by those taking the survey were: large businesses are far less likely to put most of their work "in the cloud" anytime soon because of control and security issues; most people are not able to discern the difference between accessing data and applications on their desktop and in the cloud; low-income people in least-developed areas of the world are most likely to use the cloud, accessing it through connection by phone.

C. Inferences

Survey participants were encouraged to explain their choice after they selected one of the tension-pair scenarios. They were asked to share their views about how major programs and applications will be designed, how they will function, and the role of cloud computing by 2020. The following are some of the inferences drawn from the session.

- Cloud computing will continue to expand and dominate users' information transactions because it offers many advantages, allowing users to have easy instant and individualized access to tools and information they need, wherever they are, locatable from any networked device,
- Mobile phones and other "pocket" devices are and will continue to be driving people to cloud-based services and applications,
- Control over actions on the Internet will change with mass adoption of the cloud. When people store their information and applications on their own computers as they have been up till now, a certain amount of choice and control is distributed to the edges of the network. A switch to the cloud places users' data and tools behind walls owned by others, and the people

in control of cloud companies may take action that constricts individual choice and restricts openness and innovation,

- Cloud computing presents security problems and further exposes private information to governments, corporations, thieves, opportunists, and human and machine error,
- People will generally not be able to distinguish the difference between when they are working within their local device and when they are accessing the cloud,
- The evolution of desktop and cloud-based computing will continue in tandem,
- From [10] we can also infer that the current mainstream discussion on cloud computing is not figuring in the expected development of bringing the "cloud to the desktop." It also does not always consider the potential of the internet of things, which includes a variety of networked smart appliances in smaller home and small-business networks that may also be tied into larger networks,
- The very essence of the idea of cloud computing continues to evolve, as does every aspect of the internet; it is difficult to predict what will happen because there are continuous adjustments to new realities and limitations, but we know that the drive to gain access to information everywhere and the rapid evolution of the tools to do this will continue to bring massive change.

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