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CLOUD COMPUTING

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Abstract: **Cloud computing in general can be portrayed as a synonym for distributed computing network over a network, with the ability to run a program or application on many connected computers at the same time. It specifically refers to a computing hardware machine or group of computing hardware machines commonly referred as a server connected through a communication network such as the Internet and Intranet, local area network (LAN) and wide area network(WAN) and individual users or user who have permission to access the server can use the server's processing power for their individual computing needs like to run an application, store data or any other computing need. Therefore, instead of using a personal computer every-time to run the application, the individual can now run the application from anywhere in the world, as the server provides the processing power to the application and the server is also connected to a network via internet or other connection platforms to be accessed from anywhere. All this has become possible due to increasing computer processing power available to human kind with decrease in cost as stated in Moore's law.**

Keywords: **Cloud computing.**

I. INTRODUCTION

In common usage, the term "the cloud" is essentially a metaphor for the Internet.[1] Marketers have further popularized the phrase "in the cloud" to refer to software, platforms and infrastructure that are "sold as a service", i.e. remotely through the Internet. Typically, the seller has actual energy-consuming servers which host products and services from a remote location, so end-users don't have to; they can simply log on to the network without installing anything. The major models of cloud computing service are known software services. These cloud services may be offered in a public, private or hybrid network.

Network-based services, which appear to be provided by real server hardware and are in fact served up by virtual hardware simulated by software running on one or more real machines, are often called cloud computing. Such virtual servers do not physically exist and can therefore be moved around and scaled up or down on the fly without affecting the end user, somewhat like a cloud becoming larger or smaller without being a physical object.

II. ADVANTAGES

Cloud computing relies on sharing of resources to achieve coherence economies of sale, similar to a utility over a network. At the foundation of cloud computing is the broader concept converged infrastructure and services. The cloud also focuses on maximizing the effectiveness of the shared resources. Cloud resources are usually not only shared by multiple users but are also dynamically reallocated per demand. This can work for allocating resources to users. For example, a cloud computer facility that serves European users during European business hours with a specific application (e.g., email) may reallocate the same resources to serve North American users during North America's business hours with a different application (e.g., a web server). This approach should maximize the use of computing power thus reducing environmental damage as well since less power, air conditioning, rackspace, etc. are required for a variety of functions. With cloud computing, multiple users can access a single server to retrieve and update their data without purchasing licenses for different applications.

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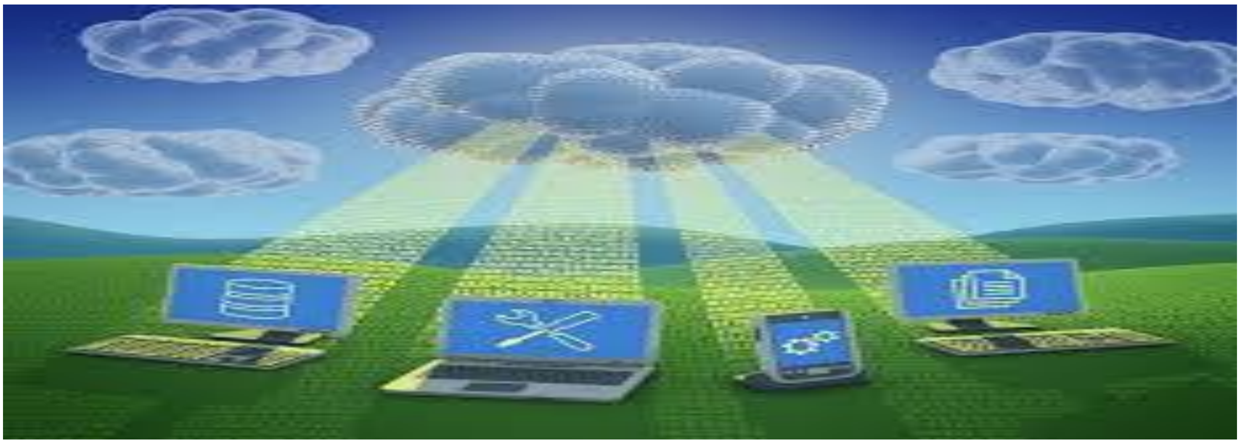
The term "moving to cloud" also refers to an organization moving away from a traditional CAPEX model (buy the dedicated hardware and depreciate it over a period of time) to the OPEX model (use a shared cloud infrastructure and pay as one uses it).

Proponents claim that cloud computing allows companies to avoid upfront infrastructure costs, and focus on projects that differentiate their businesses instead of infrastructure. Proponents also claim that cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and enables IT to more rapidly adjust resources to meet fluctuating and unpredictable business demand. Cloud providers typically use a "pay as you go" model. This can lead to unexpectedly high charges if administrators do not adapt to the cloud pricing model



The term "cloud computing" is mostly used to sell hosted services in the sense of application service provisioning that run client server software at a remote location. Such services are given popular acronyms like 'SaaS' (Software as a Service), 'PaaS' (Platform as a Service), 'IaaS' (Infrastructure as a Service), 'HaaS' (Hardware as a Service) and finally 'EaaS' (Everything as a Service). End users access cloud-based applications through a web browser, thin client or mobile app while the business software and user's data are stored on servers at a remote location. Examples include Amazon Web Services and Google App engine, which allocate space for a user to deploy and manage software "in the cloud".

III. CHARACTERISTICS

Cloud computing exhibits the following key characteristics:

- **Agility** improves with users' ability to re-provision technological infrastructure resources.
- **Application programming interface** (API) accessibility to software that enables machines to interact with cloud software in the same way that a traditional user interface (e.g., a computer desktop) facilitates interaction between humans and computers. Cloud computing systems typically use Representational State Transfer (REST)-based APIs.
- **Cost**: cloud providers claim that computing costs reduce. A public-cloud delivery model converts capital expenditure to operational expenditure. This purportedly 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).The e-FISCAL project's state-of-the-art repository contains several articles looking into cost aspects in more detail, most of them concluding that costs savings depend on the type of activities supported and the type of infrastructure available in-house.

Device and independence: It enable users to access systems using a web browser regardless of their location or what device they use (e.g., PC, mobile phone). As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.

- **Virtualization** technology allows sharing of servers and storage devices and increased utilization. Applications can be easily migrated from one physical server to another.
- **Multitenancy** 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)
- **utilisation and efficiency** improvements forsystems that are often only 10–20% utilised.
- **Reliability** improves with the use of multiple redundant sites, which makes well-designed cloud computing suitable for business continuity and disaster.
- **Scalability and elasticity** via dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis in near real-time(Note, the VM startup time varies by VM type, location, os and cloud providers), 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.
- **Security** can improve due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels. Security is often as good as or better than other traditional systems, in part because providers are able to devote resources to solving security issues that many customers cannot afford to tackle. However, the complexity of security is greatly increased when data is distributed over a wider area or over a greater number of devices, as well as in multi-tenant systems shared by unrelated users. In addition, user access to security audit logs may be difficult or impossible. Private cloud installations are in part motivated by users' desire to retain control over the infrastructure and avoid losing control of information security.
- **Maintenance** of cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places.

The National Institute of Standards and Technology's definition of cloud computing identifies "five essential characteristics":

On-demand self-service. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

Rapid elasticity. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear unlimited and can be appropriated in any quantity at any time.

Measured service. Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

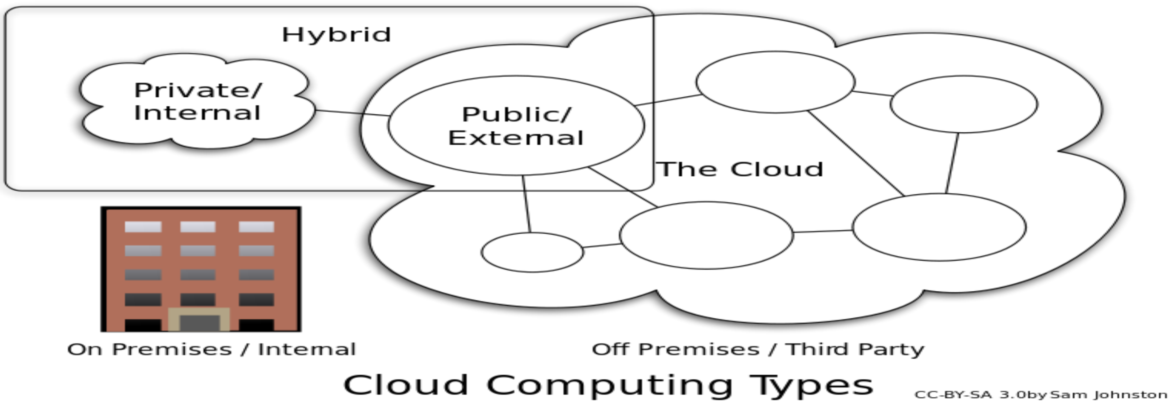
—*National Institute of Standards and Technology*

IV. INFRASTRUCTURE AS a SERVICE (IaaS)

In the most basic cloud-service model, providers of IaaS offer computers – physical or (more often) virtual machines – and other resources, such as openstack, xen, KVM, VMware, , or Hyper-V runs the virtual machines as guests. Pools of hypervisors within the cloud operational support-system can support large numbers of virtual machines and the ability to scale services up and down according to customers' varying requirements.) IaaS clouds often offer additional resources such as a virtual-machine disk image library, raw (block) and file-based storage, firewalls, load balancers, IP addresses, Virtual local area networks (VLANs), and software bundles. IaaS-cloud providers supply these resources on-demand from their large pools installed in data centers. For wide area connectivity, customers can use either the Internet or carrier clouds(dedicated virtual private networks).

To deploy their applications, cloud users install operating-system images and their application software on the cloud infrastructure. In this model, the cloud user patches and maintains the operating systems and the application software. Cloud providers typically bill IaaS services on a utility computing basis:cost reflects the amount of resources allocated and consumed.

Cloud computing types:



Cloud management:

Legacy management infrastructures, which are based on the concept of dedicated system relationships and architecture constructs, are not well suited to cloud environments where instances are continually launched and decommissioned. Instead, the dynamic nature of cloud computing requires monitoring and management tools that are adaptable, extensible and customizable.

Cloud management challenges

Cloud computing presents a number of management challenges. Companies using public clouds do not have ownership of the equipment hosting the cloud environment, and because the environment is not contained within their own networks, public cloud customers do not have full visibility or control. Users of public cloud services must also integrate with an architecture defined by the cloud provider, using its specific parameters for working with cloud components. Integration includes tying into the cloud APIs for configuring IP addresses, subnets, firewalls and data service functions for storage. Because control of these functions is based on the cloud provider's infrastructure and services, public cloud users must integrate with the cloud infrastructure management.

Capacity management is a challenge for both public and private cloud environments because end users have the ability to deploy applications using self-service portals. Applications of all sizes may appear in the environment, consume an unpredictable amount of resources, and then disappear at any time.

Chargeback or, pricing resource use on a granular basis is a challenge for both public and private cloud environments. Chargeback is a challenge for public cloud service providers because they must price their services competitively while still creating profit. Users of public cloud services may find chargeback challenging because it is difficult for IT groups to assess actual resource costs on a granular basis due to overlapping resources within an organization that may be paid for by an individual business unit, such as electrical power. For private cloud operators, chargeback is fairly straightforward, but the challenge lies in guessing how to allocate resources as closely as possible to actual resource usage to achieve the greatest operational efficiency. Exceeding budgets can be a risk.

Hybrid cloud environments, which combine public and private cloud services, sometimes with traditional infrastructure elements, present their own set of management challenges. These include security concerns if sensitive data lands on public cloud servers, budget concerns around overuse of storage or bandwidth and proliferation of mismanaged images. Managing the information flow in a hybrid cloud environment is also a significant challenge. On-premises clouds must share information with applications hosted off-premises by public cloud providers, and this information may change constantly. Hybrid cloud environments also typically include a complex mix of policies, permissions and limits that must be managed consistently across both public and private clouds.

V. ARCHITECTURE

Cloud architecture, the systems architecture of the software systems involved in the delivery of cloud computing, typically involves multiple *cloud components* communicating with each other over a loose coupling mechanism such as a messaging queue. Elastic provision implies intelligence in the use of tight or loose coupling as applied to mechanisms such as these and others.

Cloud clients

Users access cloud computing using networked client devices, such as desktop computers, laptops, tablets and smart phones. Some of these devices – *cloud clients* – rely on cloud computing for all or a majority of their applications so as to be essentially useless without it. Examples are thin clients and the browser-based Chrome book. Many cloud applications do not require specific software on the client and instead use a web browser to interact with the cloud application. With Ajax and HTML5 these Web user interfaces can achieve a similar, or even better, look and feel to native applications. Some cloud applications, however, support specific client software dedicated to these applications (e.g., virtual desktop clients and most email clients). Some legacy applications (line of business applications that until now have been prevalent in thin client computing) are delivered via a screen-sharing technology.

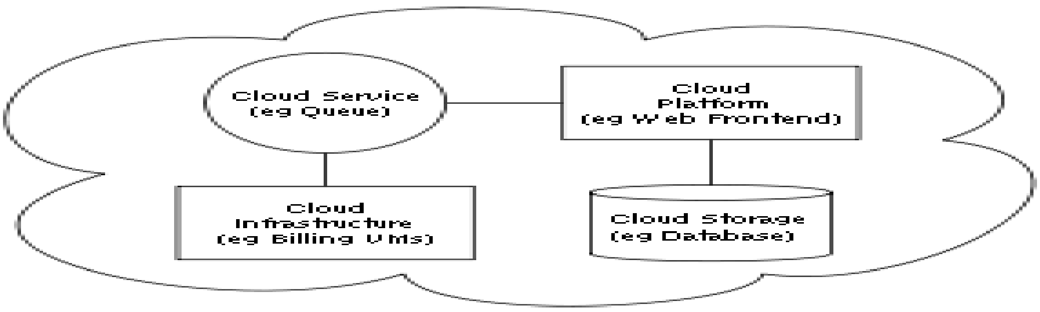


Fig: Cloud computing sample architecture

Private cloud

Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party and hosted internally or externally.Undertaking a private cloud project requires a significant level and degree of engagement to virtualize the business environment, and requires the organization to reevaluate decisions about existing resources. When done right, it can improve business, but every step in the project raises security issues that must be addressed to prevent serious vulnerabilities Self-run data centers[are generally capital intensive. They have a significant physical footprint, requiring allocations of space, hardware, and environmental controls. These assets have to be refreshed periodically, resulting in additional capital expenditures. They have attracted criticism because users "still have to buy, build, and manage them" and thus do not benefit from less hands-on management,essentially "[lacking] the economic model that makes cloud computing such an intriguing concept".

Public cloud

A cloud is called a "public cloud" when the services are rendered over a network that is open for public use. Technically there may be little or no difference between public and private cloud architecture, however, security consideration may be substantially different for services (applications, storage, and other resources) that are made available by a servic**e provider for a public audience and when** communication is effected over a non-trusted network. Generally, public cloud service providers like Amazon AWS, Microsoft and Google own and operate the infrastructure and offer access only via Internet (direct connectivity is not offered).

Community cloud:

Community cloud shares infrastructure between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized.

Hybrid cloud

Hybrid cloud is a composition of two or more clouds (private, community or public) that remain distinct entities but are bound together, offering the benefits of multiple deployment models. Hybrid cloud can also mean the ability to connect collocation, managed and/or dedicated services with cloud resources.

Gartner, Inc. defines a hybrid cloud service as a cloud computing service that is composed of some combination of private, public and community cloud services, from different service providers. A hybrid cloud service crosses isolation and provider boundaries so that it can't be simply put in one category of private, public, or community cloud service. It allows one to extend either the capacity or the capability of a cloud service, by aggregation, integration or customization with another cloud service.

Varied use cases for hybrid cloud composition exist. For example, an organization may store sensitive client data in house on a private cloud application, but interconnect that application to a billing application provided on a public cloud as a software service. This example of hybrid cloud extends the capabilities of the enterprise to deliver a specific business service through the addition of externally available public cloud services.

Another example of hybrid cloud is one where IT organizations use public cloud computing resources to meet temporary capacity needs that can not be met by the private cloud. This capability enables hybrid clouds to employ cloud bursting for scaling across clouds.

Cloud bursting is an application deployment model in which an application runs in a private cloud or data center and "bursts" to a public cloud when the demand for computing capacity increases. A primary advantage of cloud bursting and a hybrid cloud model is that an organization only pays for extra compute resources when they are needed.

Cloud bursting enables data centers to create an in-house IT infrastructure that supports average workloads, and use cloud resources from public or private clouds, during spikes in processing demands

By utilizing "hybrid cloud" architecture, companies and individuals are able to obtain degrees of fault tolerance combined with locally immediate usability without dependency on internet connectivity. Hybrid cloud architecture requires both on-premises resources and off-site (remote) server-based cloud infrastructure.

Distributed cloud:

Cloud computing can also be provided by a distributed set of machines that are running at different locations, while still connected to a single network or hub service. Examples of this include distributed computing platforms such as BOINC and Folding@Home.

Benefits of cloud computing:

1. **Achieve economies of scale** – increase volume output or productivity with fewer people. Your cost per unit, project or product plummets.

2. **Reduce spending on technology infrastructure.** Maintain easy access to your information with minimal upfront spending. Pay as you go (weekly, quarterly or yearly), based on demand.

3. **Globalize your workforce on the cheap.** People worldwide can access the cloud, provided they have an Internet connection.

4. **Streamline processes.** Get more work done in less time with less people.

VI. ISSUES OF CLOUD COMPUTING

Threats and opportunities of the cloud:

Critical voices including GNU project initiator Richard Stallman and Oracle founder Larry Ellison warned that the whole concept is rife with privacy and ownership concerns and constitute merely a fad.

However, cloud computing continues to gain steam[with 56% of the major European technology decision-makers estimate that the cloud is a priority in 2013 and 2014, and the cloud budget may reach 30% of the overall IT budget.

According to the *TechInsights Report 2013: Cloud Succeeds* based on a survey, the cloud implementations generally meets or exceedes expectations across major service models, such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

Several deterrents to the widespread adoption of cloud computing remain. Among them, are: reliability, availability of services and data, security, complexity, costs, regulations and legal issues, performance, migration, reversion, the lack of standards, limited customization and issues of privacy. The *cloud* offers many strong points: infrastructure flexibility, faster deployment of applications and data, cost control, adaptation of cloud resources to real needs, improved productivity, etc. The early 2010s cloud market is dominated by software and services in SaaS mode and IaaS (infrastructure), especially the private cloud. PaaS and the public cloud are further back.

Privacy:

The increased use of cloud computing services such as Gmail and Google Docs has pressed the issue of privacy concerns of cloud computing services to the utmost importance. The provider of such services lie in a position such that with the greater use of cloud computing services has given access to a plethora of data. This access has the immense risk of data being disclosed either accidentally or deliberately. Privacy advocates have criticized the cloud model for giving hosting companies' greater ease to control—and thus, to monitor at will—communication between host company and end user, and access user data (with or without permission). Instances such as the secret NSA program, working with AT&T, and Verizon, which recorded over 10 million telephone calls between American citizens, causes uncertainty among privacy advocates, and the greater powers it gives to telecommunication companies to monitor user activity. A cloud service provider (CSP) can complicate data privacy because of the extent of virtualization (virtual machines) and cloud storage used to implement cloud service.CSP operations, customer or tenant data may not remain on the same system, or in the same data center or even within the same provider's cloud; this can lead to legal concerns over jurisdiction. While there have been efforts (such as US-EU Safe Harbor) to "harmonise" the legal environment, providers such as Amazon still cater to major markets (typically to the United States and the European Union) by deploying local infrastructure and allowing customers to select "regions and availability zones". Cloud computing poses privacy concerns because the service provider can access the data that is on the cloud at any time. It could accidentally or deliberately alter or even delete information. This becomes a major concern as these service providers, who employ administrators which can leave room for potential unwanted disclosure of information on the cloud.

VII. CONCLUSION

According to Gartner's Hype cycle, Cloud computing has reached a maturity that leads it into a productive phase. This means that most of the main issues with Cloud computing have been addressed to a degree that Clouds have become interesting for full commercial exploitation. This however does not mean that all the problems listed above have actually been solved, only that the according risks can be tolerated to a certain degree. Cloud computing is therefore still as much a research topic, as it is a market offering.

In 2012 the European Commission has issued an analysis of the relevance of the open research issues for commercial stabilisation in which various experts from industry and academia identify in particular the following major concerns:

- Open inter operation across (proprietary) cloud solutions at IaaS, PaaS and SaaS levels.
- Managing multi tenancy at large scale and in heterogeneous environments.
- Dynamic and seamless elasticity from in house clouds to public clouds for unusual (scale, complexity) and/or infrequent requirements.
- Data management in a cloud environment, taking the technical and legal constraints into consideration.

These findings have been refined into a research roadmap proposed by the Cloud Computing Expert Group on Research in December 2012 which tries to lay out a timeline for the identified research topics according to their commercial relevance. With the 8thFramework Programmes for Research and Technological Development the European Commission is trying to support the according research work along the lines of the Europe 2020 strategy.