



**COMPUTER SCIENCE PROJECT WORK**

**(2075)**

CLOUD COMPUTING

**SUBMITTED BY: SUBMITTED TO:** SALINA SHRESTHA (76760163C)

HEM PRASAD THAPALIYA

(FACULTY OF COMPUTER SCIENCE)

**PREFACE**

Cloud computing is the latest evolution of computing, where IT resources are offered as services. If Cloud computing is properly applied within an overall IT strategy, it can help Small and Medium Business Enterprises and governments to lower their IT costs, by taking advantage of economies of scale and automated IT operations, while at the same time optimizing investment in in-house computing infrastructure. The benefit of such an environment is efficiency and flexibility, through creation of a more dynamic computing enterprise, where the supported functionalities are no longer fixed or locked to the underlying infrastructure. This offers tremendous automation opportunities in a variety of computing domains including, but not limited to, e-Government, e-Research, high-performance computing, web hosting, social networking, multi-media, and e-Business

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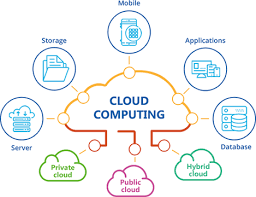
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**Cloud Computing**

Cloud computing is the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. The term is generally used to describe data centers available to many users over the Internet. Large clouds, predominant today, often have functions distributed over multiple locations from central servers. If the connection to the user is relatively close, it may be designated an edge server.



Clouds may be limited to a single organization (enterprise clouds,) be available to many organizations (public cloud,) or a combination of both (hybrid cloud.) The largest public cloud is Amazon AWS.

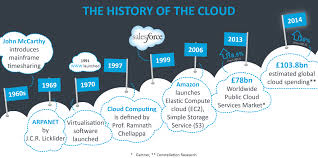
Cloud computing relies on sharing of resources to achieve coherence and economies of scale.

Advocates of public and hybrid clouds note that cloud computing allows companies to avoid or minimize up-front IT infrastructure costs. Proponents also claim that cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and that it enables IT teams to more rapidly adjust resources to meet fluctuating and unpredictable demand. Cloud providers typically use a "pay-as-you-go" model, which can lead to unexpected operating expenses if administrators are not familiarized with cloud-pricing models.

The availability of high-capacity networks, low-cost computers and storage devices as well as the widespread adoption of hardware virtualization, service oriented architecture, and autonomic and utility computing has led to growth in cloud computing.

**History**

In 1963, DARPA (the Defense Advanced Research Projects Agency), presented MIT with $2 million for Project MAC. The funding included a requirement MIT develop technology allowing for a “computer to be used by two or more people, simultaneously.” In this case, one of those gigantic, archaic computers using reels of magnetic tape for memory and was the precursor to what has now become collectively known as Cloud Computing. It acted as a primitive Cloud with two or three people accessing it. The word “Virtualization” was used to describe this situation, though the word’s meaning later expanded.



In 1969, J. C. R. Licklider helped develop the ARPANET (Advanced Research Projects Agency Network), a “very” primitive version of the Internet. JCR, or “Lick” was both a psychologist and a computer scientist, and promoted a vision called the “Intergalactic Computer Network,” in which everyone on the planet would be interconnected by way of computers, and able to access information from anywhere. (What could such an unrealistic, impossible-to-pay-for, fantasy of the future look like?) The Intergalactic Computer Network, otherwise known as the Internet, is necessary for access to the Cloud.

The meaning of Virtualization began shifting in the 1970s, and now describes the creation of a virtual machine, that acts like a real computer, with a fully functional operating system. The concept of Virtualization has evolved with the Internet, as businesses began offering “virtual” private networks as a rentable service. The use of virtual computers became popular in the 1990s, leading to the development of the modern Cloud Computing infrastructure.

The Late 1990s

In its early stages, the Cloud was used to express the empty space between the end user and the provider. In 1997, Professor Ramnath Chellapa of Emory University defined Cloud Computing as the new “computing paradigm, where the boundaries of computing will be determined by economic rationale, rather than technical limits alone.” This somewhat ponderous description rings true in describing the Cloud’s evolution.

The Cloud gained popularity as companies gained a better understanding of its services and usefulness. In 1999, Sales force became a popular example of using Cloud Computing successfully. They used it to pioneer the idea of using the Internet to deliver software programs to the end users. The program (or application) could be accessed and downloaded by anyone with Internet access. Businesses could purchase the software in an on-demand, cost-effective manner, without leaving the office.

The Early 2000s

In 2002, Amazon introduced its web-based retail services. It was the first major business to think of using only 10% of their capacity (which was commonplace at the time) as a problem to be solved. The Cloud Computing Infrastructure Model gave them the flexibility to use their computer’s capacity much more efficiently. Soon after, other large organizations followed their example.

In 2006, Amazon launched Amazon Web Services, which offers online services to other websites, or clients. One of Amazon Web Services’ sites, called Amazon Mechanical Turk, provides a variety of Cloud-based services including storage, computation and “human intelligence.” Another of Amazon Web Services’ sites is the Elastic Compute Cloud (EC2), allowing individuals to rent virtual computers and use their own programs and applications.

In the same year, Google launched the Google Docs services. Google Docs was originally based on two separate products, Google Spreadsheets and Writely. Google purchased Writely, which offers renters the ability to save documents, edit documents, and transfer them into blogging systems. (These documents are compatible with Microsoft Word.) Google Spreadsheets (acquired from 2Web Technologies, in 2005) is an Internet-based program allowing users to develop, update, and edit spreadsheets, and to share the data online. An Ajax-based program is used, which is compatible with Microsoft Excel. The spreadsheets can be saved in an HTML format.

In 2007, IBM, Google, and several universities joined forces to develop a server farm for research projects needing both fast processors and huge data sets. The University of Washington was the first to sign up and use resources provided by IBM and Google. Carnegie Mellon University, MIT, Stanford University, the University of Maryland, and the University of California at Berkeley, quickly followed suit. The universities immediately realized computer experiments can be done faster and for less money, if IBM and Google were supporting their research. Since much of the research was focused on problems IBM and Google had interests in, they also benefitted from the arrangement. 2007 was also the year when Netflix launched its streaming video service, using the Cloud, and provided support for the practice of “binge-watching.”

Eucalyptus offered the first AWS API compatible platform, which was used for distributing private Clouds, in 2008. In the same year, NASA’s Open Nebula provided the first open-source software for deploying Private and Hybrid Clouds. Many of its most innovative features focused on the needs of major businesses.

In 2011, IBM introduced the IBM Smart Cloud framework, in support of Smarter Planet (a cultural thinking project). Then, Apple launched the ICloud, which focuses on storing more personal information (photos, music, videos, etc.). Also, during this year, Microsoft began advertising the Cloud on television, making the general public aware of its ability to store photos, or video, with easy access.

Oracle introduced the Oracle Cloud in 2012, offering the three basics for business, IaaS (Infrastructure-as-a-Service), PaaS (Platform-as-a-Service), and SAAS (Software-as-a-Service).

Similar concepts

The goal of cloud computing is to allow users to take benefit from all of these technologies, without the need for deep knowledge about or expertise with each one of them. The cloud aims to cut costs, and helps the users focus on their core business instead of being impeded by IT obstacles. The main enabling technology for cloud computing is virtualization. Virtualization software separates a physical computing device into one or more "virtual" devices, each of which can be easily used and managed to perform computing tasks. With operating system–level virtualization essentially creating a scalable system of multiple independent computing devices, idle computing resources can be allocated and used more efficiently. Virtualization provides the agility required to speed up IT operations, and reduces cost by increasing infrastructure utilization. Autonomic computing automates the process through which the user can provision resources on-demand. By minimizing user involvement, automation speeds up the process, reduces labor costs and reduces the possibility of human errors.

Users routinely face difficult business problems. Cloud computing adopts concepts from Service-oriented Architecture (SOA) that can help the user break these problems into services that can be integrated to provide a solution. Cloud computing provides all of its resources as services, and makes use of the well-established standards and best practices gained in the domain of SOA to allow global and easy access to cloud services in a standardized way.

Cloud computing also leverages concepts from utility computing to provide metrics for the services used. Such metrics are at the core of the public cloud pay-per-use models. In addition, measured services are an essential part of the feedback loops in autonomic computing, allowing services to scale on-demand and to perform automatic failure recovery. Cloud computing is a kind of grid computing; it has evolved by addressing the QoS (quality of service) and reliability problems. Cloud computing provides the tools and technologies to build data/compute intensive parallel applications with much more affordable prices compared to traditional parallel computing techniques.

Cloud computing shares characteristics with:

Client–server model: Client–server computing refers broadly to any distributed application that distinguishes between service providers (servers) and service requestors (clients).

Computer bureau: A service bureau providing computer services, particularly from the 1960s to 1980s.

Grid computing: A form of distributed and parallel computing, whereby a 'super and virtual computer' is composed of a cluster of networked, loosely coupled computers acting in concert to perform very large tasks.

Fog computing: Distributed computing paradigm that provides data, compute, storage and application services closer to client or near-user edge devices, such as network routers. Furthermore, fog computing handles data at the network level, on smart devices and on the end-user client side (e.g. mobile devices), instead of sending data to a remote location for processing.

Mainframe computer: Powerful computers used mainly by large organizations for critical applications, typically bulk data processing such as: census; industry and consumer statistics; police and secret intelligence services; enterprise resource planning; and financial transaction processing.

Utility computing: The "packaging of computing resources, such as computation and storage, as a metered service similar to a traditional public utility, such as electricity.

Peer-to-peer: A distributed architecture without the need for central coordination. Participants are both suppliers and consumers of resources (in contrast to the traditional client–server model).

Cloud sandbox: A live, isolated computer environment in which a program, code or file can run without affecting the application in which it runs.

The five essential characteristics of cloud computing:

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).

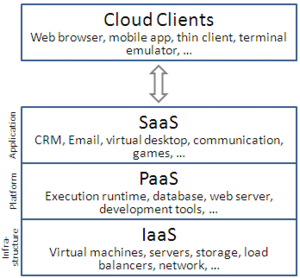
Resource pooling: The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state or datacenter). Examples of resources include storage, processing, memory and network bandwidth.

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 to be 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 the provider and consumer.

**Service models**

Cloud-computing providers offer their "services" according to different models, of which the three standard models per NIST are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). These models offer increasing abstraction; they are thus often portrayed as layers in a stack: infrastructure-, platform- and software-as-a-service, but these need not be related. For example, one can provide SaaS implemented on physical machines (bare metal), without using underlying PaaS or IaaS layers, and conversely one can run a program on IaaS and access it directly, without wrapping it as SaaS.



Infrastructure as a service (IaaS)

"Infrastructure as a service" (IaaS) refers to online services that provide high-level APIs used to dereference various low-level details of underlying network infrastructure like physical computing resources, location, data partitioning, scaling, security, backup etc. A hypervisor runs the virtual machines as guests. Pools of hypervisors within the cloud operational system can support large numbers of virtual machines and the ability to scale services up and down according to customers' varying requirements. Linux containers run in isolated partitions of a single Linux kernel running directly on the physical hardware. Linux groups and namespaces are the underlying Linux kernel technologies used to isolate, secure and manage the containers. IaaS clouds often offer additional resources such as a virtual-machine disk-image library, raw block storage, file or object storage, firewalls, load balancers, IP addresses, virtual local area networks (VLANs), and software bundles.

The NIST's definition of cloud computing describes IaaS as "where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

IaaS-cloud providers supply these resources on-demand from their large pools of equipment 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.

Benefits of IaaS:

* No need to invest in your own hardware
* Infrastructure scales on demand to support dynamic workloads
* Flexible, innovative services available on demand

Platform as a service (PaaS)

The NIST's definition of cloud computing defines Platform as a Service as:

The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

PaaS vendors offer a development environment to application developers. The provider typically develops toolkit and standards for development and channels for distribution and payment. In the PaaS models, cloud providers deliver a computing platform, typically including operating system, programming-language execution environment, database, and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers. With some PaaS offers like Microsoft Azure, Oracle Cloud Platform and Google App Engine, the underlying computer and storage resources scale automatically to match application demand so that the cloud user does not have to allocate resources manually. The latter has also been proposed by an architecture aiming to facilitate real-time in cloud environments.

Some integration and data management providers have also embraced specialized applications of PaaS as delivery models for data solutions. Examples include iPaaS (Integration Platform as a Service) and dPaaS (Data Platform as a Service). iPaaS enables customers to develop, execute and govern integration flows. Under the iPaaS integration model, customers drive the development and deployment of integrations without installing or managing any hardware or middleware. DPaaS delivers integration and data-management products as a fully managed service. Under the dPaaS model, the PaaS provider, not the customer, manages the development and execution of data solutions by building tailored data applications for the customer. dPaaS users retain transparency and control over data through data-visualization tools. Platform as a Service (PaaS) consumers do not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but have control over the deployed applications and possibly configuration settings for the application-hosting environment.

Benefits of PaaS:

* Develop application and get to market faster
* Deploy new web applications to the cloud in minutes
* Reduce complexity with middleware as a service

Software as a service (SaaS)

The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

In the software as a service (SaaS) model, users gain access to application software and databases. Cloud providers manage the infrastructure and platforms that run the applications. SaaS is sometimes referred to as "on-demand software" and is usually priced on a pay-per-use basis or using a subscription fee. In the SaaS model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. Cloud users do not manage the cloud infrastructure and platform where the application runs. This eliminates the need to install and run the application on the cloud user's own computers, which simplifies maintenance and support. Cloud applications differ from other applications in their scalability—which can be achieved by cloning tasks onto multiple virtual machines at run-time to meet changing work demand. Load balancers distribute the work over the set of virtual machines. This process is transparent to the cloud user, who sees only a single access-point. To accommodate a large number of cloud users, cloud applications can be multitenant, meaning that any machine may serve more than one cloud-user organization.

The pricing model for SaaS applications is typically a monthly or yearly flat fee per user, so prices become scalable and adjustable if users are added or removed at any point. Proponents claim that SaaS gives a business the potential to reduce IT operational costs by outsourcing hardware and software maintenance and support to the cloud provider. This enables the business to reallocate IT operations costs away from hardware/software spending and from personnel expenses, towards meeting other goals. In addition, with applications hosted centrally, updates can be released without the need for users to install new software. One drawback of SaaS comes with storing the users' data on the cloud provider's server. As a result, there could be unauthorized access to the data.

Benefits of SaaS:

* You can sign up and rapidly start using innovative business apps
* Apps and data are accessible from any connected computer
* No data is lost if your computer breaks, because the data is in the cloud
* The service is able to dynamically scale to usage needs

Mobile "backend" as a service (MBaaS)

In the mobile "backend" as a service model, also known as Backend as a Service (BaaS), web app and mobile app developers are provided with a way to link their applications to cloud storage and cloud computing services with Application Programming Interfaces (APIs) exposed to their applications and custom software development kits (SDKs). Services include user management, push notifications, integration with social networking services and more. This is a relatively recent model in cloud computing, with most BaaS startups dating from 2011 or later but trends indicate that these services are gaining significant mainstream traction with enterprise consumers.

Serverless computing

Serverless computing is a cloud computing code execution model in which the cloud provider fully manages starting and stopping virtual machines as necessary to serve requests, and requests are billed by an abstract measure of the resources required to satisfy the request, rather than per virtual machine, per hour. Despite the name, it does not actually involve running code without servers. Serverless computing is so named because the business or person that owns the system does not have to purchase, rent or provision servers or virtual machines for the back-end code to run on.

Function as a service (FaaS)

Function as a service (FaaS) is a service-hosted remote procedure call that leverages serverless computing to enable the deployment of individual functions in the cloud that run in response to events. FaaS is included under the broader term serverless computing, but the terms may also be used interchangeably.

**Types of Cloud:**

Private cloud

Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third party and hosted either internally or externally. Undertaking a private cloud project requires significant engagement to virtualize the business environment, and requires the organization to reevaluate decisions about existing resources. 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 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. Public cloud services may be free. 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 service provider for a public audience and when communication is effected over a non-trusted network. Generally, public cloud service providers like Amazon Web Services (AWS), Oracle, Microsoft and Google own and operate the infrastructure at their data center and access is generally via the Internet. AWS, Oracle, Microsoft, and Google also offer direct connect services called "AWS Direct Connect", "Oracle Fast Connect", "Azure Express Route", and "Cloud Interconnect" respectively, such connections require customers to purchase or lease a private connection to a peering point offered by the cloud provider.

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 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 business intelligence 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. Hybrid cloud adoption depends on a number of factors such as data security and compliance requirements, level of control needed over data, and the applications an organization uses.

Another example of hybrid cloud is one where IT organizations use public cloud computing resources to meet temporary capacity needs that cannot 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 pays for extra compute resources only 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. The specialized model of hybrid cloud, which is built atop heterogeneous hardware, is called "Cross-platform Hybrid Cloud". A cross-platform hybrid cloud is usually powered by different CPU architectures underneath. Users can transparently deploy and scale applications without knowledge of the cloud's hardware diversity. This kind of cloud emerges from the rise of ARM-based system-on-chip for server-class computing.

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 either 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.

Distributed cloud

A cloud computing platform can be assembled from a distributed set of machines in different locations, connected to a single network or hub service. It is possible to distinguish between two types of distributed clouds: public-resource computing and volunteer cloud.

Public-resource computing: This type of distributed cloud results from an expansive definition of cloud computing, because they are more akin to distributed computing than cloud computing. Nonetheless, it is considered a sub-class of cloud computing.

Volunteer cloud: Volunteer cloud computing is characterized as the intersection of public-resource computing and cloud computing, where a cloud computing infrastructure is built using volunteered resources. Many challenges arise from this type of infrastructure, because of the volatility of the resources used to build it and the dynamic environment it operates in. It can also be called peer-to-peer clouds, or ad-hoc clouds. An interesting effort in such direction is, it aims to implement a cloud computing infrastructure using volunteered resources providing a business-model to incentivize contributions through financial restitution.

Multicloud

Multicloud is the use of multiple cloud computing services in a single heterogeneous architecture to reduce reliance on single vendors, increase flexibility through choice, mitigate against disasters, etc. It differs from hybrid cloud in that it refers to multiple cloud services, rather than multiple deployment modes.

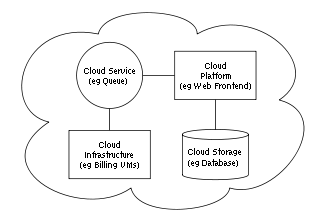
Big Data cloud

The issues of transferring large amounts of data to the cloud as well as data security once the data is in the cloud initially hampered adoption of cloud for big data, but now that much data originates in the cloud and with the advent of bare-metal servers, the cloud has become a solution for use cases including business analytics and geospatial analysis.

HPC cloud

HPC cloud refers to the use of cloud computing services and infrastructure to execute high-performance computing (HPC) applications. These applications consume considerable amount of computing power and memory and are traditionally executed on clusters of computers. Various vendors offer servers that can support the execution of these applications. In HPC cloud, the deployment model allows all HPC resources to be inside the cloud provider infrastructure or different portions of HPC resources to be shared between cloud provider and client on-premise infrastructure. The adoption of cloud to run HPC applications started mostly for applications composed of independent tasks with no inter-process communication. As cloud providers began to offer high-speed network technologies, multiprocessing tightly coupled applications started to benefit from cloud as well.

**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 engineering

Cloud engineering is the application of engineering disciplines to cloud computing. It brings a systematic approach to the high-level concerns of commercialization, standardization, and governance in conceiving, developing, operating and maintaining cloud computing systems. It is a multidisciplinary method encompassing contributions from diverse areas such as systems, software, web, performance, information technology engineering, security, platform, risk, and quality engineering.

**Security and privacy**

Cloud computing poses privacy concerns because the service provider can access the data that is in the cloud at any time. It could accidentally or deliberately alter or delete information. Many cloud providers can share information with third parties if necessary for purposes of law and order without a warrant. That is permitted in their privacy policies, which users must agree to before they start using cloud services. Solutions to privacy include policy and legislation as well as end users' choices for how data is stored. Users can encrypt data that is processed or stored within the cloud to prevent unauthorized access.

According to the Cloud Security Alliance, the top three threats in the cloud are Insecure Interfaces and API's, Data Loss & Leakage, and Hardware Failure which accounted for 29%, 25% and 10% of all cloud security outages respectively. Together, these form shared technology vulnerabilities. In a cloud provider platform being shared by different users there may be a possibility that information belonging to different customers resides on same data server. Additionally, Eugene Schultz, chief technology officer at Emagined Security, said that hackers are spending substantial time and effort looking for ways to penetrate the cloud. "There are some real Achilles' heels in the cloud infrastructure that are making big holes for the bad guys to get into". Because data from hundreds or thousands of companies can be stored on large cloud servers, hackers can theoretically gain control of huge stores of information through a single attack a process he called "hyper jacking". Some examples of this include the Drop box security breach, and iCloud 2014 leak. Drop box had been breached in October 2014, having over 7 million of its user’s passwords stolen by hackers in an effort to get monetary value from it by Bitcoins (BTC). By having these passwords, they are able to read private data as well as have this data be indexed by search engines.

There is the problem of legal ownership of the data. Many Terms of Service agreements are silent on the question of ownership. Physical control of the computer equipment is more secure than having the equipment off site and under someone else's control. This delivers great incentive to public cloud computing service providers to prioritize building and maintaining strong management of secure services. Some small businesses that don't have expertise in IT security could find that it's more secure for them to use a public cloud. There is the risk that end users do not understand the issues involved when signing on to a cloud service (persons sometimes don't read the many pages of the terms of service agreement, and just click "Accept" without reading). This is important now that cloud computing is becoming popular and required for some services to work, for example for an intelligent personal assistant. Fundamentally, private cloud is seen as more secure with higher levels of control for the owner, however public cloud is seen to be more flexible and requires less time and money investment from the user.

**Advantages**

Cloud computing has many advantages or merits. Some merits are listed below:

1. Less Costs

The services are free from capital expenditure. There are no huge costs of hardware in cloud computing. You just have to pay as you operate it and enjoy the model based on your subscription plan.

2. 24 X 7 Availability

Most of the cloud providers are truly reliable in offering their services, with most of them maintaining an uptime of 99.9%. The workers can get onto the applications needed basically from anywhere. Some of the applications even function off-line.

3. Flexibility in Capacity

It offers flexible facility which could be turned off, up or down as per the circumstances of the user. For instance, a promotion of sales is very popular, capacity can be immediately and quickly added to it for the avoidance of losing sales and crashing servers. When those sales are done, the capacity can also be shrunk for the reduction of costs.

4. All over Functioning

Cloud computing offers yet another advantage of working from anywhere across the globe, as long as you have an internet connection. Even while using the critical cloud services that offer mobile apps, there is no limitation of the device used.

5. Automated Updates on Software

In cloud computing, the server suppliers regularly update your software including the updates on security, so that you do not need to agonize on wasting your crucial time on maintaining the system. You find extra time to focus on the important things like ‘How to grow your businesses.

6. Security

Cloud computing offers great security when any sensitive data has been lost. As the data is stored in the system, it can be easily accessed even if something happens to your computer. You can even remotely wipe out data from the lost machines for avoiding it getting in the wrong hands.

7. Carbon Footprint

Cloud computing is helping out organizations to reduce their carbon footprint. Organizations utilize only the amount of resources they need, which helps them to avoid any over-provisioning. Hence, no waste of resources and thus energy.

8. Enhanced Collaboration

Cloud applications enhance collaboration by authorizing diverse groups of people virtually meet and exchange information with the help of shared storage. Such capability helps in improving the customer service and product development and also reducing the marketing time.

9. Control on the Documents

Before cloud came into being, workers needed to send files in and out as the email attachments for being worked on by a single user at one time ultimately ending up with a mess of contrary titles, formats, and file content. Moving to cloud computing has facilitated central file storage.

10. Easily Manageable

Cloud computing offers simplified and enhanced IT maintenance and management capacities by agreements backed by SLA, central resource administration and managed infrastructure. You get to enjoy a basic user interface without any requirement for installation. Plus you are assured guaranteed and timely management, maintenance, and delivery of the IT services.

11. Adaptable

Cloud computing allows for adaptable programs and applications that are customizable, while allowing owners control over the core code.

12. Multitenant

Cloud software provides the opportunity to provide personalized applications and portals to a number of customers or tenants.

13. Reliable

Because it is hosted by a third party, businesses and other users have greater assurance of reliability, and when there are problems, easy access to customer support.

14. Scalable

With the Internet of Things, it is essential that software functions across every device and integrates with other applications. Cloud applications can provide this.

15. Secure

Cloud computing can also guarantee a more secure environment, thanks to increased resources for security and centralization of data.

**Disadvantages**

With advantages, cloud computing also has Disadvantages or demerits. Some of the demerits are listed and described below:

1. Abuse of the Cloud

There are hackers and thieves out there who will take advantage of the vulnerabilities of cloud-based computing services. Encryption keys, for example, are sometimes easier to break than they would be if the data was simply stored on a computer or physical data center. Cloud providers may also be more vulnerable to things like malware attacks. When storing, sharing, accessing, working with and collaborating on content in the cloud, it’s important to be aware of the threats that are out there.

2. Breach of Data

Organizations must be most specifically concerned about breaches of data in their cloud system. The Cloud Security Alliance identified breaches of data as the biggest threat to the security of cloud computing last year. If you think hackers might be interested in stealing your most critical data, you should think carefully about your options before storing it in the cloud.

3. Denial of Service

Denial of service is a big threat for organizations relying on cloud services today. Certain vulnerabilities of cloud computing services can make it easier for attackers to flood your network with connection requests until it no longer functions for your end users. There are all sorts of malicious entities out there, perhaps even among your competition, who may want to see your service decline. It’s a problem among cloud data centers that doesn’t seem to be slowing down.

4. Lack of Due Diligence

This disadvantage is often avoidable, but the fact is that far too many companies fall into the trap of under-preparedness when they switch over to the cloud because they simply don’t know what to expect and what they’re getting into. It’s important to know what the risks are, what the potential benefits are and what all the different options are within the spectrum of cloud services. You wouldn’t want to switch your data to a cloud-based platform only to find out it goes against your contractual obligations or conflicts with your operational functions; yet, many companies do just that when they fail to do their due diligence before getting into the cloud.

1. Loss of Data

You don’t only have to worry about hackers stealing or altering your data; you also have to worry about data being destroyed and lost altogether, without a trace in the world. There are many reputable cloud service providers that offer top-notch protection from data loss, but there are still all sorts of errors that can occur. The most common causes for loss of data are simple matters of human error. This makes a good case for backing up all data on a physical device before working on it in the cloud.

1. Spiteful Activity

One of the most unfortunate disadvantages of cloud computing is the potential for spiteful people to do harm, which would be much more difficult to do with a physical server. There may be former employees, disgruntled employees, unhappy contractors, displeased business partners or even industry insiders working for the competition interested in doing harm to your data, network or system. It may sound like fiction or fantasy, but this kind of malicious activity goes on far more often than most people imagine.

1. Weaknesses of Shared Technology

Cloud computing simply has potential weaknesses that more traditional computing models don’t. The technological vulnerabilities of cloud computing stem from the use of shared applications, infrastructures and platforms. All it takes is for one little component to be exposed to a threat for everything in your cloud network to be breached, opening the door for potential data breach and loss. There are, however, security precautions you can take to reduce all these threats. Now that you know the risks, you should be better prepared to consider the potential solutions.

While cloud computing brings great opportunity, it can also introduce challenges for business leaders and IT departments. By far, the most common disadvantages that continue to taint perceptions about cloud computing are security problems and inconsistent performance.

The good news is that these challenges can be overcome with a cloud architecture built specifically for your workloads and through the efforts of a strong, reliable cloud service provider.

EXAMPLES OF CLOUD COMPUTING

1. Scalable Usage:

Cloud computing offers scalable resources through various subscription models. This means that you will only need to pay for the computing resources you use. This helps in managing spikes in demands without the need to permanently invest in computer hardware.

Netflix, for instance, leverages this potential of cloud computing to its advantage. Due to its on-demand streaming service, it faces large surges in server load at peak times. The move to migrate from in-house data centres to cloud allowed the company to significantly expand its customer base without having to invest in setup and maintenance of costly infrastructure.

2. Chatbots:

The expanded computing power and capacity of the cloud enables us to store information about user preferences. This can be used to provide customized solutions, messages and products based on the behavior and preferences of users.

Siri, Alexa and Google Assistant - all are cloud-based natural-language intelligent bots. These chatbots leverage the computing capabilities of the cloud to provide personalized context-relevant customer experiences. The next time you say, “Hey Siri!” remembers that there is a cloud-based AI solution behind it.

Know More: What is an Artificially Intelligent Chatbot and how are they developed?

3. Communication:

The cloud allows users to enjoy network-based access to communication tools like emails and calendars. Most of the messaging and calling apps like Skype and WhatsApp are also based on cloud infrastructure. All your messages and information are stored on the service provider’s hardware rather than on your personal device. This allows you access your information from anywhere via the internet.

4. Productivity

Office tools like Microsoft Office 365 and Google Docs use cloud computing, allowing you to use your most-productive tools over the internet. You can work on your documents, presentations and spreadsheets - from anywhere, at any time. With your data stored in the cloud, you don’t need to bother about data loss in case your device is stolen, lost or damaged. Cloud also helps in sharing of documents and enables different individuals to work on the same document at the same time.

5. Business Process:

Many business management applications like customer relationship management (CRM) and enterprise resource planning (ERP) are also based on a cloud service provider. Software as a Service (SAAS) has become a popular method for deploying enterprise level software.

Salesforce, Hubspot, Marketo etc. are popular examples of this model. This method is cost-effective and efficient for both the service provider and customers. It ensures hassle free management, maintenance and security of your organization’s critical business resources and allows you to access these applications conveniently6. Backup and recovery:

When you choose cloud for data storage the responsibility of your information also lies with your service provider. This saves you from the capital outlay for building infrastructure and maintenance. Your cloud service provider is responsible for securing data and meeting legal and compliance requirements. The cloud also provides more flexibility in the sense that you can enjoy large storage and on-demand backups. Recovery is also performed faster in the cloud because the data is stored over a network of physical servers rather than at one on-site data centre. Dropbox, Google Drive and Amazon S3 are popular examples of cloud backup solutions.

7. Application development:

Whether you are developing an application for web or mobile or even games, cloud platforms prove to be a reliable solution. Using cloud, you can easily create scalable cross-platform experiences for your users. These platforms include many pre-coded tools and libraries — like directory services, search and security. This can speed up and simplify the development process. Amazon Lumberyard is a popular mobile game development tool used in the cloud.

8. Test and development:

The cloud can provide an environment to cut expenses and launch your apps in the market faster. Rather than setting up physical environments developers can use the cloud to set up and dismantle test and development environments. This saves the technical team from securing budgets and spending critical project time and resources. These dev-test environments can also be scaled up or down based on requirements. Load Storm and Blaze Meter are popular testing tools.

Our Offering in testing as a service

9. Big data analytics:

Cloud computing enables data scientists to tap into any organizational data to analyze it for patterns and insights, find correlations make predictions, forecast future crisis and help in data backed decision making. Cloud services make mining massive amounts of data possible by providing higher processing power and sophisticated tools. There are many open source big data tools that are based on the cloud for instance Hadoop, Cassandra, HPCC etc. Without the cloud, it won’t be very difficult to collect and analyze data in real time, especially for small companies.

10. Social Networking:

Social Media is the most popular and often overlooked application of cloud computing. Facebook, LinkedIn, MySpace, Twitter, and many other social networking sites use cloud computing. Social networking sites are designed to find people you already know or would like to know. In course of finding people, we end up sharing a lot of personal information. Of course, if you're sharing information on social media then you are not only sharing it with friends but also with the makers of the platform. This means that the platform will require a powerful hosting solution to manage and store data in real-time - making use of cloud critical.

**Usage of cloud computing**

FOR ENTERPRISES

For businesses, the cloud has the potential to transform operations, as well as cut costs. Offices running computer networks would no longer have to deal with software installation for each computer, as well as licenses. This alleviates a tremendous IT load. Uses of the cloud include data storage, offering remote access to any work related data.

The role of cloud computing on a corporate level can be either for the in house operations, or as a deployment tool for software or services the company develops for the public. Through the PaaS, much of the administration, maintenance and deployment of the software becomes the job of a third party, the PaaS.

MOBILITY

One of the other most obvious uses of cloud computing is the mobility that it brings, both to the recreational user, as well as to the corporate and business user. Many of us are already familiar with some cloud computing services, like Google Docs, or even email services. With these apps we can access documents or mail that is not stored on our PCs, but is available to use because it is stored on a cloud, or remote location.

Businesses who wish to create a cloud computing platform for their operations can choose between either a private or a public cloud, depending on their need. A customized PaaS can be created for them b by companies that specialize in cloud computing, such as Apprenda.

In addition to all the uses of cloud computing, from an IT or administrational view point of view, cloud computing is fairly easy to manage. Cloud computing reduces the load on servers, and the IT team as well. It centralizes and unifies computing standards. A new implementation can quickly take on cloud behavior as soon as it is deployed on the cloud. Every user who accesses the product will have access to the same standard product.

Because of the many uses of cloud computing, both consumers and enterprises are taking advantage of it, and enlisting the help of companies that specialize in Paas and SaaS.