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GCC Cloud Computing

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Cloud computing in the GCC is still at a very early stage, and although there is a lot of potential for its wide spread usage, concerns regarding security risks deter its fast adoption. Cost reduction in hardware and software licenses, speed of adoption, improving IT productivity and seamless transition between providers are attractive to companies. On the other hand, data loss or theft, and privacy risks are seen as major challenges. Recent surveys and trends indicate that cloud computing is opening up in a big way in the GCC countries, and that companies are taking a serious look to increase their competitive advantage.

Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS) and Business Process-as-a-Service (BPaaS) are the most sought after cloud computing services in the region. Companies in the MENA region are expected to invest around USD 4.7bn by 2018, with governments, and organizations rapidly identifying innovative ways to leverage the technology. Some governments are keen to adapt the technology and to solve issues of national interest, but lack the necessary funding. Other issues that worry organizations are related to safety and return on investment. Many of the pertaining issues have been addressed by cloud computing service providers, and it is evident that the world is moving forward to usher in an era, where computing sans investment in hardware is a reality. In the GCC, the cloud computing market is forecasted to grow strongly across the region, with most forecasts predicting large double-digit growth till 2018.

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Cloud Computing: Introduction

The term "cloud" refers to the metaphoric representation of internet used in the earlier times.

In layman terms, cloud computing is accessing applications, via the internet, rather than on a local hard drive. With cloud computing, we can customize and configure the applications to suit our needs, and it also allows for online data storage.

The applications are accessed and paid for on-the-go, which reduces infrastructure requirements and costs. The term "cloud" refers to the metaphoric representation of internet that had existed in the early days of the World Wide Web. This representation used to denote the global network architecture present at a remote location that facilitates information transfer from one end to another, but is needed to be known in order to utilize the service.

Fig 1: Internet as a cloud

With cloud computing, one can create, configure, and customize applications online at any time, without installing any software.

Source: cloudecomputingsite.tumblr.com

Cloud computing has various advantages. Similar to how utilities such as electricity and water are used across the globe, cloud computing allows us to access applications that aren't present in the local hard drive, via the internet. One can create, configure, manipulate and customize applications online at any time, without installing any software. Cloud computing provides a platform independent access to all type of clients and is highly cost effective, as it maximizes resource utilization.

Many telecom operators in the GCC moved into cloud computing space over the last year.

Cloud Computing in the GCC

In the past few years, the ICT sector in the GCC countries has made rapid progress. With increased investments in fixed and mobile networks, liberalization and regulation, the GCC countries are poised to take rapid strides in cloud computing. Although cloud networks gained entry in the gulf only in 2012, it is growing rapidly across the region. While significant foreign investment has been pouring into the market, the sector is still in its infancy in the GCC.

With the GCC governments investing heavily in the IT sector, the International Data Corporation (IDC) has a positive outlook for the cloud services market for 2014. Many telecom operators moved into cloud computing space over the last year. In Jan 2013, Virtustream announced a partnership with Etihad Etisalat (Mobily), the largest telecom operator in the Middle East and Africa to provide cloud services in the Kingdom of Saudi Arabia (KSA) as well as other parts of the region with a suite of cloud based tools and services. The public and hybrid cloud deployment, jointly provided by both companies, offers cloud services to enterprises and small-to-medium enterprises (SMEs).

SMEs in the Middle East are forecasted to increase their expenditure on information and communication technology (ICT) services by 10 per cent to $22 billion in 2014. This would represent a 23 per cent share in ICT spending in the region, driven by expansion and their need for key ICT services, such as web-presence, e-commerce and cloud computing.

Huawei launched a mobile cloud center in Dubai, which provides a variety of cloud and data center services.

Data storage and network specialist firms like Cisco Systems, Hewlett Packard, EMC, Germany's Siemens, Japan's NEC, China's Huawei have already entered the market to forefront the cloud computing adoption in the region. Huawei launched a mobile cloud center in Dubai, which provides a variety of cloud and data center services to companies in the region.

IDC believes that Middle East telecom operators will play a central role by controlling network (as well as non-network) aspects such as delivery, storage, solutions, and support services. Investment in datacenters will remain in focus, as they plan to add a new cloud services layer to their operations. Operators may also become 'cloud brokers' or 'cloud aggregators', whereby they aggregate services from different cloud providers, and grant customers a single user interface.

At present, Dubai is the primary hub for IT solutions and cloud computing, with the Dubai Internet City as the focal point. Many organizations in the UAE are exploring the viability of capitalizing on such services. Other GCC countries, especially Qatar and Saudi Arabia, are still in the early stages of cloud computing adoption, but are a huge potential market. End-user organizations have been slow to adopt cloud technologies and have traditionally preferred to manage IT services internally, but there is growing interest in outsourcing models. Large data storage solutions are in high demand in Gulf countries. An EMC survey conducted in the Middle East, reported that 87 percent of IT decision makers regard big data solutions as a tool to make better decisions, while 45 percent regard it as essential to stay competitive.

MENA's public cloud services is reported to be growing at a rate of 21.3 per cent in 2014, and is valued at USD 620mn.

According to Cisco, from 2012 to 2017, the Middle East and Africa region is expected to have the highest cloud workload growth rate, at 45 per cent CAGR, compared to 40 per cent in Asia-Pacific and 31 per cent in Eastern Europe. Middle East and Africa will also have the highest cloud traffic growth rate in the world, at 57 per cent CAGR, followed by Asia-Pacific (43 per cent) and Eastern Europe (36 per cent)[1].

In another report released by Gartner earlier this year, the public cloud services market in the Middle East and North Africa (MENA) region is reported to be growing at a rate of 21.3 per cent in 2014, and is estimated to be valued at USD 620mn, up from USD 511mn in 2013. Software-as-a-Service is estimated to grow at 29.1 per cent, and will be worth USD 126mn by the year end. Growth in the MENA region is expected to be higher than the rest of the world led by strong growth in SaaS, PaaS and IaaS.

[1] Cloudcomputing-news.net

Table 1: GCC Cloud Service Providers

Country	Cloud Service Providers
Bahrain	The Cloud
	IBM
	Cloud IT
	Batelco
Kuwait	Unisys International
	IBM
	Zajil
	Evosys - Oracle RIght Now
	HP CloudSystem
Oman	Oman data park
Qatar	MEEZA
	Qatar Datamation Systems
	Ooredoo
KSA	ClouDEX
	RackHigh Saudi Arabia Private Clouds
	Awal Services
	BT
	Mobily Virtustream
UAE	Hostware
	SkyeUAE
	BIOS
	IBT
	eHosting Data Fort
	Pacific Controls Cloud Services (PCCS)

Source: Various

The idea for cloud computing started in the 1950s with the implementation of mainframe computers in large organizations and universities.

The dot com revolution of the 1990s and increasing demand for higher bandwidth, led to the search for more efficient use of available bandwidth.

Evolution & Present Status

The idea for cloud computing started in the 1950s with the implementation of mainframe computers in large organizations and universities. These computers were accessible via static clients or terminal computers, which were used mainly for communication, as they had little internal processing capabilities. To improve efficiency in the use of mainframe computers, multiple users were allowed to share both physical access to the mainframe and "CPU time" from various terminal computers, a concept that came to be known as time-sharing. This not only eliminated periods of inactivity on the mainframe, but also allowed for greater return on investment.

With the advent of personal desktops and birth of IT services in the 1960s, decentralized computing became the norm. The dot com revolution of the 1990s and increasing demand for higher bandwidth, led to the search for more efficient use of available bandwidth. Virtual Private Networks (VPNs), virtual point-to-point connections that were established using tunneling protocols, were introduced. VPNs enabled formation of private networks across a public network, such as the Internet, thereby allowing secure data sharing. At the turn of the century, some

companies outsourced their IT infrastructure and increased use of virtualization platforms, for hardware, software and storage.

2010 witnessed the emergence of various "as a service" models.

The year 2008 marked the deployment of private and hybrid clouds through open-source softwares, OpenNebula and Eucalyptus. Eucalyptus was the first Amazon Web Service, API-compatible platform for deploying private and hybrid clouds, while OpenNebula was the first open-source software for deploying private and hybrid clouds. With increasing usage of cloud computing, efforts began to focus on providing greater quality of service to cloud infrastructures. Organizations began switching from using company-owned hardware and software to a pay-per-use model, marking a dramatic shift in how IT and IT enabled services were beginning to be perceived.

In early 2011, the IBM SmartCloud framework was introduced.

2010 witnessed the emergence of various "as a service" models, such as Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), Network-as-a-Service (NaaS), and Infrastructure-as-a-Service (IaaS). During mid-2010, Rackspace Inc. and NASA jointly launched an open-source cloud-software initiative known as OpenStack that intended to help organizations offer cloud-computing services running on standard hardware. In early 2011, the IBM SmartCloud framework was introduced, while in mid-2012, Oracle announced the Oracle Cloud, which is set to be the first to provide users with access to an integrated set of IT solutions, including the Applications (SaaS), Platform (PaaS), and Infrastructure (IaaS) layers.

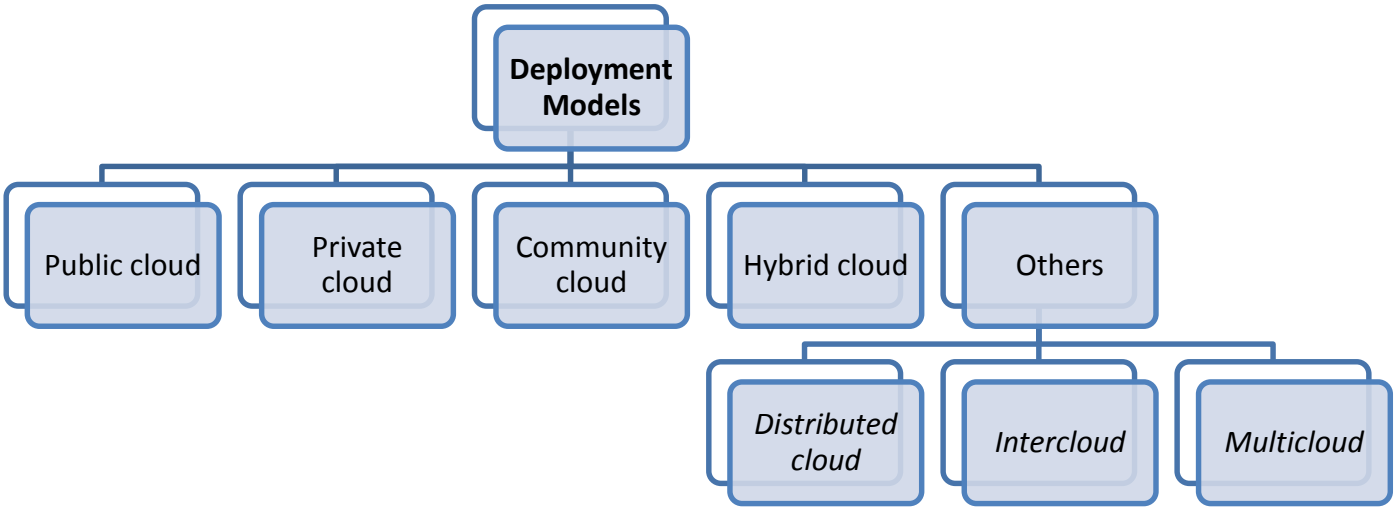
Global cloud traffic was estimated at 1.2 zettabytes in 2012.

The Cisco Global Cloud Index estimates data center and cloud-based Internet Protocol (IP) traffic growth and trends, and provides new insights and visibility into emerging trends affecting data centers and cloud architectures. In its Global Cloud Index report, released in Oct 2013, the global cloud traffic was estimated at 1.2zettabytes in 2012, while the cloud workload was estimated at 32million for the same year.

Deployment Models

Deployment models are classified based on where the cloud is located, and the type of access there is to the cloud. There are five types of models, as shown in Fig 3: Public, Private, Community, Hybrid and Others. Others are a collection of cloud models that do not fit into the other four categories.

Fig 2: Model types



Source: whatiscloud.com, cloudtweaks.com, IBM, Slideshare, Various sources

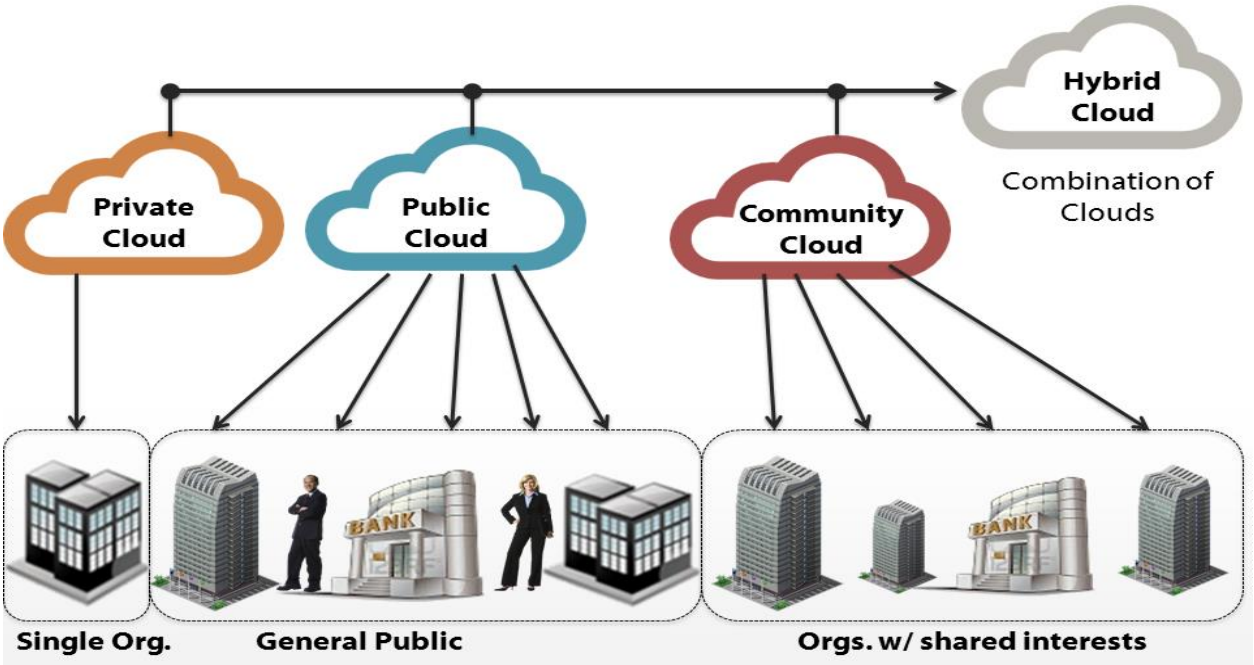
A public cloud has low upfront costs, but may have high on-the-go costs.

A public cloud allows access to services (applications and storage) and infrastructure to the general public, via a cloud service provider. The services may be offered free of cost or on a pay-as-you-go model, where the user pays for the services used. Public cloud offers the greatest level of efficiency and cost savings, and is best suited for business requirements that need to manage workload spikes, host SaaS applications, utilize interim infrastructure for developing and testing applications, and manage applications that are consumed by many users. A public cloud has low upfront costs, but may have high on-the-go costs. It may not be suitable for working with highly sensitive or regulated information that require a more secure access and a trusted network. Also, in a public cloud the users compromise on flexibility in configuring services to suit their needs, in favor of greater visibility and efficiency. Some of the well-known public cloud providers are Microsoft Azure, Google App Engine, Amazon Web Services and Rackspace.

To set up a private cloud a company requires significant upfront costs, but lower ongoing costs.

A private cloud is a cloud infrastructure that is operated solely for a single organization. It is either managed internally by that organization or by a third-party, and can be located either inside the organization or outside the premises. Unlike a public cloud, a private cloud requires allocation of space for hardware and storage devices that must be refreshed periodically. This has led to the criticism that users still have to buy, build and manage software and devices, forgoing the economic advantages of cloud computing. To set up a private cloud a company requires significant upfront costs, but lower ongoing costs. A private cloud offers the best in terms of security, quality of service, customization, and integration, although security threats must be addressed constantly as they evolve. Organizations where data or applications are required to conform to various regulatory standards may require data to be managed for privacy.

Fig 3: Deployment Models



Source: elementsolutions.com

A community cloud allows for services and infrastructures to be shared by a group of organizations from a specific community, whether managed internally or by a third-party, and either hosted internally or externally. A community cloud is chosen

when organizations with common concerns (security, compliance, jurisdiction, etc.) share a cloud to achieve their individual goals. The cost of a community cloud is less than that of a private cloud, but more than a public cloud, and is shared among the community users. Hence, the cost savings potential of community cloud is lesser than that of a public cloud, but more than that of a private cloud. A community cloud also allows opportunities for knowledge sharing and collaboration between organizations, as all their collective data is located on a common platform. In terms of security, a community cloud is more secure than a public cloud, but less so than a private cloud, as private and proprietary data may be accessible by other organizations that share the cloud. Many government departments that service a particular geographic area may require access to the data relating to the local population or infrastructure, such as hospitals, roads, electrical stations, etc., and can utilize a community cloud to manage applications and data Google-managed government cloud is an example for community cloud.

The cost of a community cloud is less than that of a private cloud, but more than a public cloud.

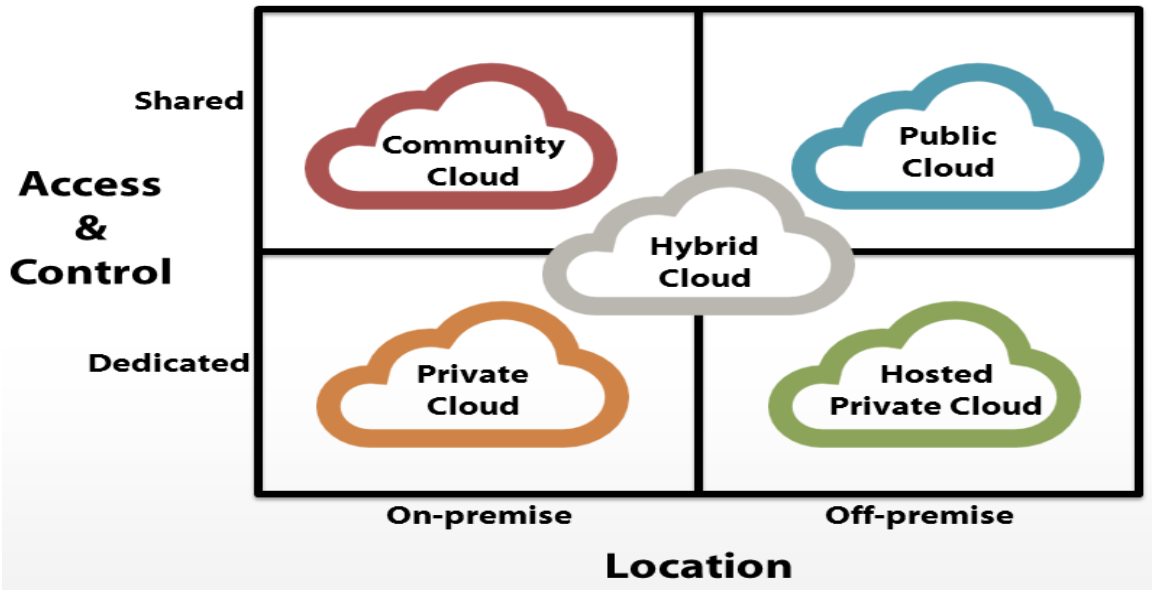
A hybrid cloud is formed by a combination of two or more of the above three cloud types. In a hybrid cloud, each of the cloud types continue to remain as unique entities but are connected using technology that allows for data and application portability. While the critical activities are performed using private cloud, the non-critical activities are performed using public cloud. Many organizations that need for varying levels of security, control, scalability and stability, are opting for this model. Hybrid clouds provide benefits of both private and public cloud, in that it allows companies to store and transmit sensitive information on the private cloud, while enjoying the cost benefits of a public cloud. Of course, these advantages come at a cost that is great than using a public cloud, but relatively less than that of a private cloud. By far, hybrid cloud architectures are most complex and require complex management and technology integration challenges.

Hybrid clouds provide benefits of both private and public cloud.

Other deployment models are as follows:

- Distributed cloud, in which are devices that are located at different geographic locations while still being connected to a single network.
- Intercloud is an interconnected "cloud of clouds" concept that focuses on direct interoperability between public cloud service providers.
- Multicloud is the use of multiple cloud computing services as part of a single heterogeneous architecture, thereby reducing reliance on single vendors. This increases flexibility and provides redundancy, in case of failure.

Fig 4: Location, Access & Control



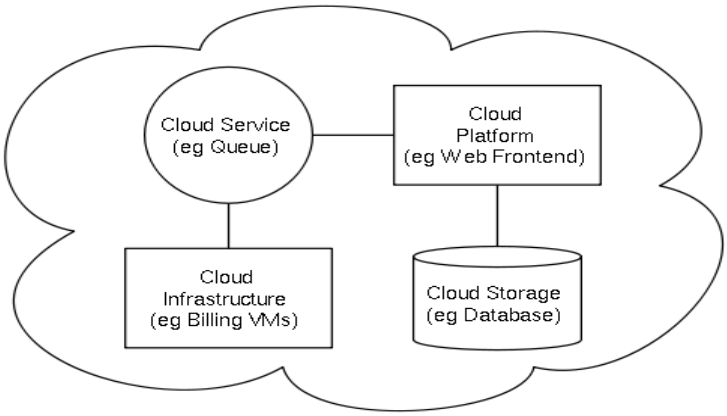
Source: elementsolutions.com

The client infrastructure consists of interfaces and applications that are required to access the cloud computing platforms.

Components and architecture

Cloud computing architecture has many cloud components that are loosely coupled. The client infrastructure is connected via the internet to the various cloud components, such as the infrastructure, virtual machines, runtime environment, storage, security, management, services, deployment models, servers and application. The client infrastructure consists of interfaces and applications (eg. web browser) that are required to access the cloud computing platforms. The cloud service provider is responsible to provide built-in security mechanism, traffic control and protocols, and ensure that connected devices communicate with each other seamlessly. Any update of hardware or software in the cloud is also rests with the CSP.

Fig 5: Cloud computing basic infrastructure



Source: giftians.com

Like in the case of utility, cloud computing is a metered pay-per-use model.

The technologies behind cloud computing platforms are as follows[2]:

Virtualization
This is a technique that allows sharing of a single instance of an application or resource among multiple organizations or clients, and is done by assigning a logical name to a physical resource, and providing access to it when demanded. This offers virtual isolation to each client, which means clients have the independence to customize an application as if they each have their own instance running.

Service-oriented architecture (SOA)
SOA helps use applications as a service for other applications irrespective of vendor type, product or technology. This ensures exchange of data between applications of different vendors, without need for additional programming.

Grid computing
Cloud computing resources may be varied and geographically dispersed, but are connected with each other to achieve a common objective. Grid computing breaks down complex tasks into smaller pieces that are distributed to the various processing units across the grid.

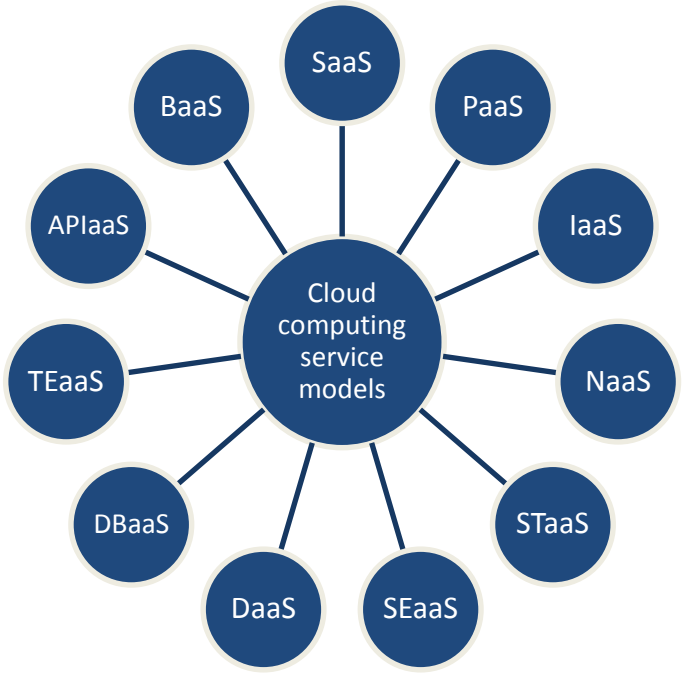
The three main service models in cloud computing are: SaaS, PaaS, and IaaS.

Utility computing
Like in the case of utility, cloud computing is a metered pay-per-use model. Resources are available on demand, as and when needed, and are charged based on usage.

Service Models
Outline the cloud computing services that can be provided to the customer ("as-a-Service") in a pay-per-use model. The three main service models in cloud computing are: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). Other supplementary service models are as follows: Network-as-a-Service (NaaS), Storage-as-a-Service (STaaS), Security-as-a-Service (SEaaS), Data-as-a-Service (DaaS), Database-as-a-Service (DBaaS), Test Environment-as-a-Service (TEaaS), API-as-a-Service (APIaaS), and Backend-as-a-Service (BaaS).

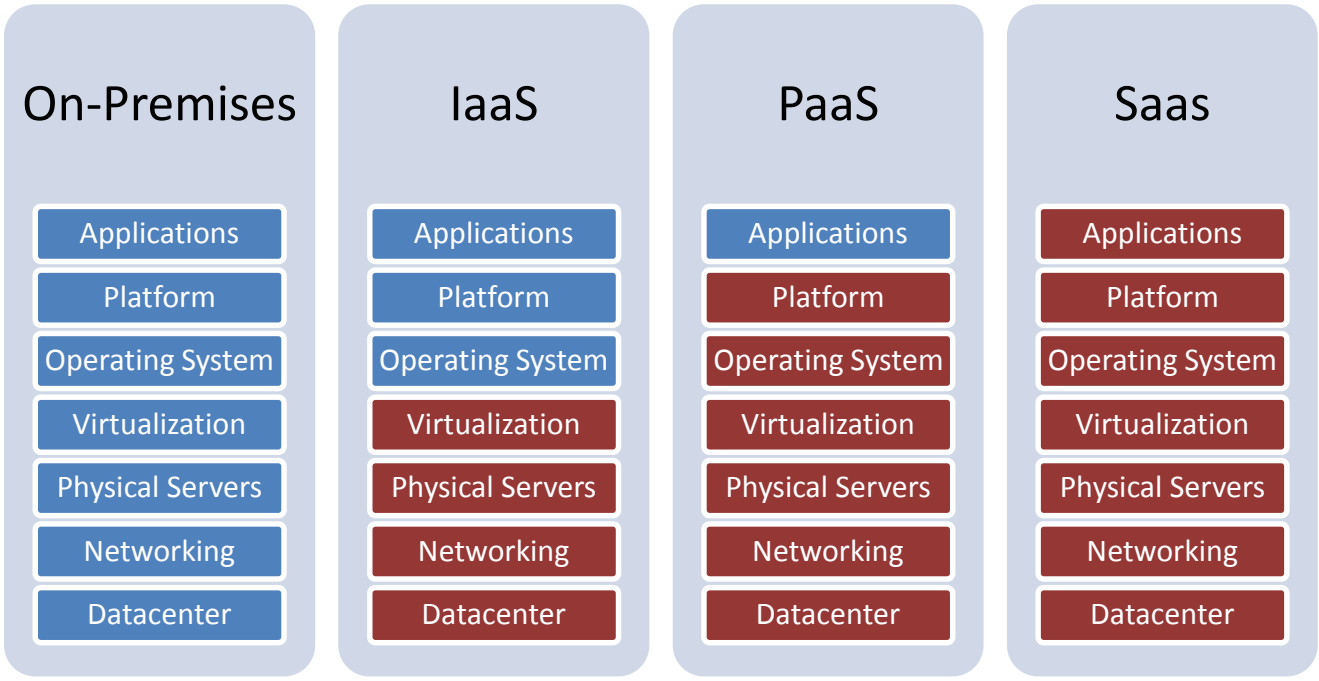
[2] Tutorialspoint

Fig 6: Cloud computing service models



Source: Various sources, Markaz research

Fig 7: Three major service models



Source: sajojacob.com

SaaS provides software applications as a service, available on demand to end users.

In the above graphic representation, the red boxes are managed by the cloud service providers (CSPs), while the blue boxes are managed by the clients. This clearly highlights the benefits of cloud computing, under different service models, over having one's own on-premise equipments and applications.

Software-as-a-Service (SaaS)

This service model provides software applications as a service that is available on demand to end users (on-demand-software). The software is hosted on a cloud,

maintained by the cloud service provider (CSP), and is accessible via the internet. The service is billed on a pay-as-you-go basis, and the license to the software may be subscription based or usage based. Upgrade or downgrade of software happens automatically, as the situation requires, and multiple users can share a single installation. The benefits of using SaaS include little or no requirement for customer side software installation, which means little upfront costs for software license. The customer can have a single license for multiple computers that are running at different locations, and the data storage is centralized at the CSP. This could also be a disadvantage as it may lead to unauthorized access of data. Some of the well-known SaaS providers are Abiquo, Oracle on demand, Akamai, Salesforce.com, and Deskaway.

The biggest disadvantage of using PaaS is the vendor lock-in.

Platform-as-a-Service (PaaS)

PaaS providers offer a computing platform that typically include operating system, programming language execution environment, database, and web server. They may also offer development and deployment tools for applications. Application developers can log on to the cloud providers' websites and use the built-in application programming interface (APIs), to develop and run their software solutions, without the cost and complexity of buying and managing the underlying hardware and software layers. App developers need not bother themselves with administrative overheads, as it is the responsibility of the CSPs, and need not purchase the underlying hardware, servers, power and data storage. The CSPs maintain and upgrade software versions and patch installations, as necessary, and provide built-in security, scalability, and web service interfaces. The biggest disadvantage of using PaaS is the vendor lock-in, due to difference in software languages used in implementation of platform among the vendors. This makes portability between PaaS clouds difficult. Microsoft Azure, Google Apps Engine, OpenStack, OS33, OrangeScape are some well-known PaaS providers.

IaaS provides access to fundamental resources such as physical and virtual machines.

Infrastructure-as-a-Service (IaaS)

The most basic cloud computing model, IaaS provides access to fundamental resources such as physical and virtual machines. All these resources are accessed by the end user through server virtualization. IaaS clouds often offer additional resources such as a virtual-machine disk image library, raw block storage, and file or object storage, firewalls, load balancers, IP addresses, virtual local area networks (VLANs), and software bundles[3]. IaaS allows CSPs to locate infrastructure over the internet in a cost-effective manner, and allows consumers full control of the computing resources through administrative access to virtual machines. All the IaaS resources are made available to consumers on rent, and the clients pay based on the length of time a resource is used. Amazon web services, AT&T, Eucalyptus systems, HP, Joyent, Rackspace, Verizon are the top IaaS providers in the world.

NaaS offers secure access to network infrastructure, and optimizes resource allocation.

Network-as-a-Service (IaaS)

Of the other as-a-service model, NaaS is the most widely used. NaaS offers secure access to network infrastructure, and makes it possible to deploy custom routing protocols using virtualized network infrastructure. It optimizes resource allocation by considering the network and computing resource as a unified entity. The NaaS provider manages the network resources, and provides network services as a utility, in a pay-per-use model. The client logs in via a web portal, customizes the network

[3] IaaS Cloud Concepts, Amies, Alex; Sluiman, Harm; Tong, Qiang Guo; Liu, Guo Ning (July 2012)

route that he requires, and pays for the capacity used. This provides the customer independence, and logically isolates customer traffic. VPNs, Bandwidth-on-Demand (BoD), Mobile Virtual Network Operators (MVNOs) are some of the service models that are available under NaaS. Fujitsu and Aryaka are examples of NaaS providers.

Companies from most sectors, even those with sensitive data, can benefit from deployment of available cloud models.

Clients

Any computer hardware and / or software that provide an interface to the cloud and rely on cloud computing for delivery of services, for majority of their applications can be categorized as cloud clients. For example, a client organization that accesses its applications via a cloud service provider, instead of its local servers or other storage machines. Cloud clients use web browsers to interact with the cloud, while others use specific client software, such as virtual desktop, e-mail etc. that are supported by the cloud applications.

The following is the list of well-known GCC companies from varied sectors that are cloud service users: Gulf Air, Air Arabia, Burjeel Hospital, Rak Insurance, Dubai National Insurance & Reinsurance, American College of Dubai, Khimji Ramdas, ETG, and Better Homes. From the range of clients in the example, encompassing diverse sectors, it can be seen that companies from most sectors, even those with sensitive data, can benefit from deployment of available cloud models. This enables cloud computing clients to concentrate on their core competencies, rather than worry about their computing infrastructure, or expenditure on the same.

PCCS's Jabel Ali Data Centre (JADC) in Dubai is the largest data centre campus in the Middle East.

Cloud computing companies in the GCC

Pacific Controls Cloud Services (PCCS)

A fully owned subsidiary of Pacific Control Systems LLC, PCCS partnered with Etisalat to deliver Data Centre Infrastructure Services and Cloud Services to customers globally. PCCS offers private, public and government sector customers end-to-end cloud computing services, including private and hybrid clouds, and infrastructure-as-a-service (IaaS). The company's Jabel Ali Data Centre (JADC) in Dubai is the largest data centre campus in the Middle East that is Uptime Tier III certified and is currently under consideration for the USGBC LEED (Leadership in Energy and Environmental Design), Gold rating.

Gulf Infotech

Gulf Infotech is an Oman-based Google Enterprise partner for the MENA region, and a cloud solution provider that focuses on creating applications for Google cloud based solutions. The company has invested in a product development company CloudCodes, which is headquartered in India and develops cloud based products for Google Apps. Gulf Infotech has over 125 customers and manages more than 25,000 users across Middle East.

MEEZA
A Qatar Foundation joint venture that was established to provide essential IT support to Qatar's development process in close alignment with Qatar National Vision 2030, MEEZA has become Qatar's leading IT solutions and services provider.

The company offers data centre services, infrastructure services, application services, and cloud services, via a private, public or hybrid cloud. Some of its clients include Masraf Al Rayan, Msheireb Properties, Sidra and Qatar Ministry of Environment.

Multiple clients can share a cloud, and its underlying infrastructure.

Characteristics

On-demand service

Clients can access cloud computing services and resources on-demand, and pay for these services on the basis of usage. These services are available round the clock, from any location and require only a web browser to access the cloud architecture. This implies that data stored in the cloud or applications that are available in the cloud can be accessed 24/7, via any client device. Cloud services have an 100 per cent uptime.

Resource pooling

Resources are re-allocated to other clients when not in use, and the clients are charged based on their usage.

Multiple clients can share a cloud, and its underlying infrastructure, viz a viz the hardware, storage, database, security etc. All clients access the cloud services using the same hardware, such as networks and servers, and do not have to invest in specific hardware of their own.

Scalability

The cloud components can be upgraded or downgraded, as required. Cloud service providers monitor the resources and, depending on need or client necessity, can change or upgrade components or software, when needed. This not only reduces costs of upgrading software or components, but shares the cost among the various clients, as per their usage. So any upgrade is now available at a fraction of what it would've cost otherwise, without any interruption in service.

Cloud computing model converts capital expenditure to operational expenditure.

Agility

Cloud resources can be re-provisioned based on client usage. Resources are re-allocated to other clients when not in use, and the clients are charged based on their usage. This is similar to usage of network bandwidth in mobile communications, where the bandwidth is shared by all the users, and re-allocated to others after use.

Cost efficiency

Cloud computing model converts capital expenditure to operational expenditure, thereby benefitting the clients. This reduces barriers to entry for SMEs in particular, as infrastructure is provided by a third party and does not require purchase. The payment for services depends on usage, and firms can decide upon the how to allocate their time and resources more efficiently. Resource pooling, scalability and agility transform into cost savings for organizations, and ensures that capital is allocated to their primary businesses, rather than on IT infrastructure upkeep and maintenance.

Applications

Testing and Development
Traditionally, testing and development requires significant manpower and time to install and configure a platform. With cloud computing, both physical and virtualized resources that could be tailored to our needs are readily available, which saves a lot of time and effort.

A cloud can offer file storage that is accessible anywhere, anytime using a web interface.

Big data analytics
One of the big attractions of cloud computing is its ability to process vast amounts of structured and unstructured data, and extract valuable information for businesses.

File storage
A cloud can offer file storage that is accessible anywhere, anytime using a web interface, for eg. DropBox. Organizations pay for the amount of storage that they actually use without having to worry about everyday maintenance of storage infrastructure.

Disaster recovery
Another benefit of cloud computing is the cost effectiveness of disaster recovery. With infrastructure located at different physical locations, cloud computing provides faster recovery at a lower cost, compared to a traditional high-cost disaster recovery site with fixed assets and rigid procedures.

Backup
Traditionally a complex and time-consuming operation, backing up data via the cloud is both automatic and secure. The data can be sent to any location, and can be accessed, as and when required.

Another benefit of cloud computing is the cost effectiveness of disaster recovery.

Table 2: Cloud Characteristics and Applications: Summary

Characteristics	
On-Demand Service	Computing resources and services on-demand, available 24/7
Resource pooling	Computing infrastructure and resources shared by multiple clients
Scalability	Cloud components and software upgraded / downgraded as required
Agility	Cloud resources reprovisioned based on usage
Cost efficiency	No initial operating expenditure. Expense based on usage

Applications	
Test and development	Physical and virtualized resources can be tailored to our needs, and requires a fraction of time and effort
Big data analytics	Can process vast amounts of structured and unstructured data, and extract valuable information
File storage	Can access data and applications anywhere at anytime
Disaster recovery	Computing infrastructure at third party sites, ensures faster disaster recovery
Back up	Backing up data via the cloud is both automatic and secure.

Source: Tutorialspoint.com, south.cattelcom.com

Challenges

Security and Data Privacy

The biggest concern in cloud computing is hosting confidential data with cloud service providers, as it increases risk of misuse. The recent widespread hacking of Apple iCloud accounts serves to reinforce the security and data privacy risks of cloud computing (Refer Appendix B). Issues can be overcome by employing encryption, security hardware and security applications. Organizations have to ensure that cloud providers are regularly updating their service security with the evolving threats to data and information in cyberspace. The provider also needs to understand the organization's privacy and security needs, especially if specific regulations are applicable to the entity.

Recent widespread hacking of Apple iCloud accounts reinforces the security and data privacy risks.

Portability

Applications should be vendor independent, and if a user wishes to migrate to another vendor's cloud services, this transition should occur smoothly. In reality, it is not possible as each cloud provider uses different standard language for their platforms.

Interoperability

Issues arise when application from one platform needs to be able to incorporate services from another platform. Although this can be made possible using web services, it is very complex to write them.

It is difficult and expensive for customers to switch from one cloud service provider (CSP) to another.

Computing performance

The cloud network requires high network bandwidth for intensive data applications, resulting in high cost. If such applications are used in a network with lower bandwidth, performance is compromised.

Reliability and availability

Many businesses are dependent on third party cloud services, which must be both reliable and robust to perform all tasks optimally.

Lock-in

It is difficult and expensive for customers to switch from one cloud service provider (CSP) to another, which disadvantages them. If incase there is downtime or the network crashes at the third party, the customer faces losses.

Isolation failure

In a cloud set-up an isolation mechanism separates the storage, memory and routing between the different customers. If this should experience a failure, information could be routed to parties that shouldn't have access to it.

Management interface compromise

In the case of a public cloud, management interfaces of a customer are accessible through the internet, as there are no security firewalls, unlike a private cloud.

Insecure or incomplete data deletion

Sometimes sensitive data that have been deleted may still be available elsewhere in the network. This could occur if there are extra copies of the data stored elsewhere, which cannot be accessed by the customer.

The Road Ahead

With most new software being built for cloud, it is estimated that by 2016 over a quarter of all applications will be available on the cloud. As cloud computing continues to become popular, many software developers will make applications for the cloud. As more companies offer cloud services, increased competition will drive innovation for better products and services. According to Gartner, 50 per cent of organizations will have hybrid clouds by 2017, as a mixture of on- and off-premise offers both cost efficiency and data security.

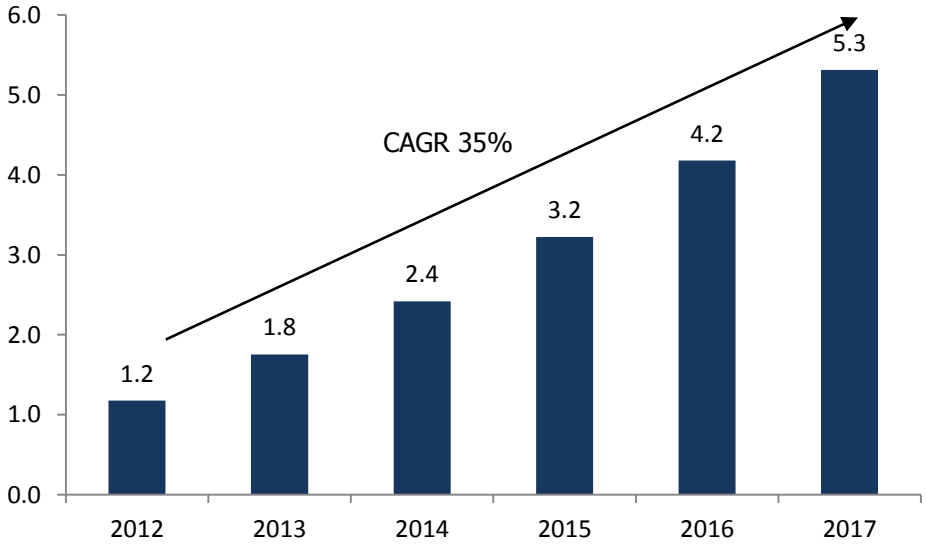
Cisco predicts that the global cloud traffic will increase from 1.2zettabytes in 2012 to 5.3zettabytes in 2017.

The cloud market is expected to grow across the world. In its third annual Global Cloud Index report, released in late 2013, Cisco predicts that the global cloud traffic will increase from 1.2zettabytes in 2012 to 5.3zettabytes in 2017, a CAGR of 35 per cent or close to a 4.5 fold increase (One zettabyte is the equivalent of trillion gigabytes). Cloud workloads would grow at 30 per cent CAGR during the same period, from 32million in 2012 to 119million in 2017.

The overall data center traffic is predicted to grow to 7.7zettabytes, of which 17 per cent will be fueled by end users accessing clouds for web surfing, video streaming, collaboration and connected devices.

Fig 8: Global cloud traffic growth in zettabytes, 2012-17

In the MENA region, Gartner predicts that from 2013 through 2017, USD 3.8 billion will be spent on cloud services.



Source: Cisco

While in the MENA region, Gartner predicts that from 2013 through 2017, USD 3.8 billion will be spent on cloud services, of which USD1.1 billion will be spent on business process as a service (BPaaS). Cloud services in the MENA region will show strong growth across market segments through to 2017. SaaS is expected to grow from USD 97million in 2013 to USD 253million in 2017. IaaS is expected to grow from USD 60million in 2013 to USD 138million in 2017. IT spending on public cloud services in the region is expected to reach USD 1.1billion in 2017.[4]

Revenue for data centers in the Gulf market is expected to grow at a CAGR of 20 per cent, and is expected to be worth USD 706.3million by 2018.

[4] Gartner

Appendix A: Cloud Computing Statistics

Table 1: Cloud traffic growth by region in exabytes, 2012-17

Region	2012	2013	2014	2015	2016	2017	CAGR
Asia Pacific	319	505	736	1,042	1,415	1,876	43%
Central and Eastern Europe	69	101	140	191	253	325	36%
Latin America	77	117	159	203	249	298	31%
Middle East and Africa	17	31	51	77	112	157	57%
North America	469	691	933	1,211	1,526	1,886	32%
Western Europe	225	311	400	501	623	770	28%

Source: Cisco

Table 2: Cloud workloads by region in millions, 2012-17

Region	2012	2013	2014	2015	2016	2017	CAGR
Asia Pacific	6.8	10.1	14.5	20	28	37	40%
Central and Eastern Europe	1.4	1.9	2.5	3.3	4.2	5.2	31%
Latin America	1.5	2.1	2.8	3.5	4.2	4.9	28%
Middle East and Africa	0.4	0.7	1.1	1.6	2.2	2.9	45%
North America	15.2	21.1	27.7	34	41	48	26%
Western Europe	7	9.8	12.5	15.1	17.8	20.8	24%

Source: Cisco

Table 3: Fixed Networks Cloud prepared countries: Consumer & Business, 2012

Country	Avg. DL (kbps)	Median DL (kbps)	Avg. UL (kbps)	Median UL (kbps)	Avg. Latency (ms)	Median Latency (ms)
United Arab Emirates	11,483	7,648	5,227	972	50	1
China	7,062	4,678	4,045	1,003	53	31
Canada	12,717	9,489	2,239	932	53	25
United States	13,154	10,840	3,617	1,866	60	33
United Kingdom	16,513	9,927	3,395	1,125	52	34

Source: Cisco, DL = download, UL = upload

Table 4: Fixed Networks Cloud emerging countries: Consumer & Business, 2012

Country	Avg. DL (kbps)	Median DL (kbps)	Avg. UL (kbps)	Median UL (kbps)	Avg. Latency (ms)	Median Latency (ms)
India	1,877	1,214	1,270	511	111	69
Bahrain	2,632	1,693	887	496	109	70
Oman	3,104	2,057	779	497	108	58
Qatar	4,198	2,090	1,684	516	88	48
Saudi Arabia	4,914	3,148	1,209	540	95	6
Kuwait	5,555	3,346	2,869	867	91	47

Source: Cisco, DL = download, UL = upload

Table 5: Mobile Networks Cloud prepared countries: Consumer & Business, 2012

Country	Avg. DL (kbps)	Median DL (kbps)	Avg. UL (kbps)	Median UL (kbps)	Avg. Latency (ms)	Median Latency (ms)
United Arab Emirates	12,385	8,168	5,844	1264	95	33
Canada	11,849	8,948	3,974	1,558	102	49

Source: Cisco, DL = download, UL = upload

Table 6: Mobile Networks Cloud emerging countries: Consumer & Business, 2012

Country	Avg. DL (kbps)	Median DL (kbps)	Avg. UL (kbps)	Median UL (kbps)	Avg. Latency (ms)	Median Latency (ms)
India	1,731	587	1,191	356	270	129
China	4,548	2,589	2,368	691	179	77
United States	9,952	8,272	4,245	2,077	115	58
United Kingdom	11,341	6,815	3,662	1,297	87	48
Bahrain	3,073	1,564	1,072	493	154	77
Oman	2,889	1,550	1,163	491	218	81
Qatar	6,656	2,111	2,847	879	165	67
Saudi Arabia	5,496	2,722	2,027	624	170	86
Kuwait	9,065	5,009	3,272	1,822	103	38

Source: Cisco, DL = download, UL = upload

Appendix B: Hacking of Apple iCloud accounts

iCloud is a cloud storage and cloud computing service from Apple Inc. that was launched on October 12, 2011. As of July 2013, the service had 320 million users. The service allows users to store data on remote computer servers that could be downloaded to multiple iOS- and Microsoft Windows-based devices. It also acts as a data syncing center for email, contacts, calendars, bookmarks, notes, reminders (to-do lists), iWork documents, photos and other data. The service also allows users to wirelessly back up their iOS devices to iCloud instead of manually doing so using iTunes. iCloud data is stored encrypted on Apple servers, but Apple maintains a master key that can decrypt it, if requested by government agencies.

In August 2014, it was revealed that hackers had used brute-force hacking techniques to find a user's Apple ID and password, and access their data from the iCloud. Many accounts of well-known celebrities were hacked into, and their stolen data was subsequently spread across the internet. Experts had highlighted that well-known celebrities could be vulnerable to attacks if their passwords or security question answers could be guessed from articles written about them.

Apple has since confirmed that some of its users' accounts were broken into, but has reportedly denied any breach of its security systems. The company has stated that data theft had occurred by deduction of log-in credentials of the various victims, and issued the following statement:

"After more than 40 hours of investigation, we have discovered that certain accounts were compromised by a very targeted attack on user names, passwords and security questions, a practice that has become all too common on the internet. None of the cases we have investigated has resulted from any breach in any of Apple's systems including iCloud or Find my iPhone. We are continuing to work with law enforcement to help identify the criminals involved."

Apple is advocating users to activate a two-stage authentication that's designed to prevent anyone from accessing or using your account, even if they know your password. The company is presently working with law enforcement agencies to investigate the issue further.

Disclaimer

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