Study of Mobile Cloud computing (MCC) and Research Challenges

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Abstract

Mobile Cloud Computing (MCC) has revolutionized the way in which mobile subscribers across the globe leverage services on the go. The mobile devices have evolved from mere devices that enabled voice calls only a few years back to smart devices that enable the user to access value added services anytime, anywhere. MCC integrates cloud computing into the mobile environment and overcomes obstacles related to performance (e.g. battery life, storage, and bandwidth), environment (e.g. heterogeneity, scalability, availability) and security (e.g. reliability and privacy).Cloud computing has now become one of the rapidly growing technologies in computer science. Cloud Computing makes its greatest impact on the IT ecosystem. It refers to the delivery of services like hardware, software, storage and infrastructure over the internet. This is called the next generation of internet. The IT organizations, businesses and other customers can take the required services and resources from cloud quickly, easily and at affordable cost (pay as u go fashion). This paper describes the basic architecture, types and models of cloud computing it also gives us a comparative study of various clouds given by different providers. The comparison is simply based upon number of factors like products, services, languages support and many other parameters of clouds.

Keywords: Mobile Cloud Computing, Advantages and disadvantages of Cloud Computing, Pros and cons of Mobile cloud computing, Types of cloud computing, MCC Open research issues, Mobile cloud components.

1. INTRODUCTION

Mobile Cloud Computing (MCC) is the state-of-the-art mobile distributed computing paradigm comprises three heterogeneous domains of mobile computing, cloud computing, and wireless networks aiming to enhance computational capabilities of resource-constrained mobile devices towards rich user experience.

MCC provides business opportunities for mobile network operators as well as cloud providers. More comprehensively MCC' can be defined as "a rich mobile computing technology that leverages unified elastic resources of varied clouds and network technologies toward unrestricted functionality, storage, and mobility to serve a multitude of mobile devices anywhere, anytime through the channel of Ethernet or Internet regardless of heterogeneous environments and platforms based on the pay-as-you-use principle." MCC realizes its vision leveraging computational augmentation approaches by which resource-constraint mobile devices can utilize computational resources of varied cloud-based resources.

In MCC, there are four types of cloud-based resources, namely distant immobile clouds, proximate immobile computing entities, proximate mobile computing entities, and hybrid (combination of the other three models). Giant clouds such as Amazon EC2 are in the distant immobile groups whereas cloudlet or surrogates are member of proximate immobile computing entities. Smartphone's, tablets, handheld devices, and wearable computing devices are part of the third group of cloud-based resources which is proximate mobile computing entities.

Mobile applications leverage this IT architecture to generate the following advantages:

- Extended battery life
- Improvement in data storage capacity and processing power
- Improved synchronization of data due to "store in one place, access from anywhere" policy
- Improved reliability and scalability
- Ease of integration

The following factors are fostering the adoption of mobile cloud computing:

- Trends and demands: customers expect the convenience of using companies' websites or application from anywhere and at anytime. Mobile devices can provide this convenience. Enterprise users require always-on access to business applications and collaborative services so that they

can increase their productivity from anywhere, even when they are on the commute.

- Improved and increased broadband coverage: 3G and 4G along with WiFi, femto-cells, fixed wireless and so on are providing better connectivity for mobile devices.
- Enabling technologies: HTML5, CSS3, hypervisor for mobile devices, cloudlets and Web 4.0 will drive adoption of mobile cloud computing.

2. AIM OF THE STUDY

The aim of this paper are :

- To know what is Cloud computing and Mobile cloud computing.
- Understand the advantages and disadvantages of Cloud computing.
- To study of Challenges and solutions of Mobile cloud computing
- Understand the pros and cons of Mobile Cloud computing
- To know the types of cloud computing
- Study of MCC Research Issues
- Understand The keys to delivering mobile cloud services
- Mobile Cloud Components

3. RELATED WORKS

Service Models:

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 a thin client interface such as a web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure with the possible exception of limited user-specific application configuration settings.

Platform as a Service (PaaS): The capability provided to the consumer is to deploy onto the cloud infrastructure consumercreated or acquired applications created using programming languages and tools supported by the provider. The consumer doesnot manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but hascontrol over the deployed applications and possibly application hosting environment configurations.

Infrastructure as a Service (IaaS): The capability provided to the consumer is to provision processing, storage, networks, andother fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can includeoperating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but hascontrol over operating systems; storage, deployed applications, and possibly limited control of select networking components(e.g. host firewalls).Belowfigure shows a typical Cloud Service Model.[1]

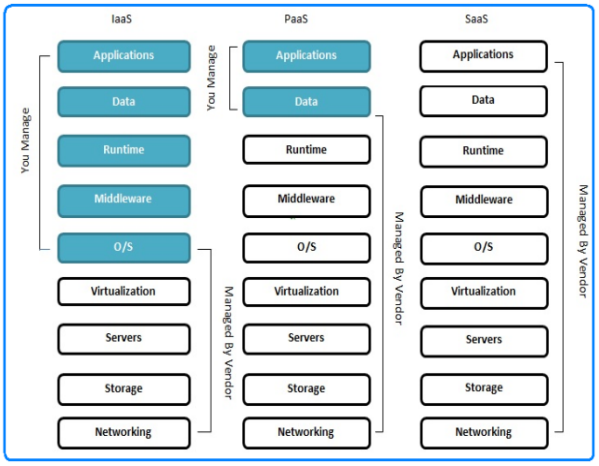

Figure 1. Services provided by cloud

Segments of Cloud computing: Application, Storage, and Connectivity. Types of Cloud computing: There are two types of cloud computing:1)On the basis of service- Infrastructure, Platform, Services, 2) On the basis of usage-Private, Public, Hybrid, Community, Special cloud. [2]

Ad-hoc Mobile Clouds: An ad-hoc computing cloud represents a group of mobile devices that serve as a cloud computing provider by exposing their computing resources to other mobile devices. This type of mobile cloud computing becomes more interesting in situations with no or weak connections to the Internet and large cloud providers. Offloading to nearby mobile devices save monetary cost, because data charging is avoided, especially favoured in roaming situations. Moreover, it allows creating computing communities in which users can collaboratively execute shared tasks.[3] The below table shows challenges and solutions of mobile cloud computing.[4]

TABLE : Challenges and Solutions of Mobile Cloud Computing

Challenges	Solutions
Limitations of mobile devices	Virtualization and Image, Task migration
Quality of communication	Bandwidth upgrading, Data delivery time reducing
Division of applications services	Elastic application division mechanism

Figure 2. Challenges and Solutions of Mobile cloud computing

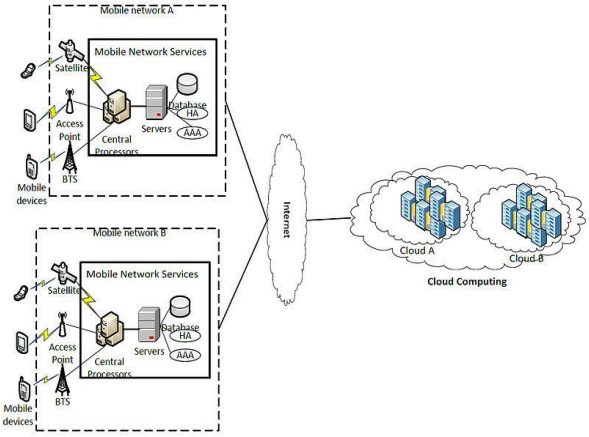

Figure 3. MCC Architecture

. CLOUD SERVICE DELIVERY MODELS

MODELS	SERVICES AVAILABLE	USED BY	WHY USE IT?	EXAMPLES
SAAS	Email,office automation,website testing,wiki,virtual desktop, blog,CRM.	Business users	To complete business tasks	Salesforce.com , Animoto , Oracle on demand, Windows Office Live
PAAS	Services, applications tests, development, integration and deployement.	Developers and deployers	Create or deploy applications and services for users	Google Application Engine, Microsoft Azure ,Coghead, Force.com,Yahoo Developer Network
IAAS	Create platforms for srvice and application test, development integration and deployment	System manager	Create platform for service and application test, development,integration and deployment	Amazon EC2 , Simple Storage Service (S3), Go-grid.

Figure 4.Cloud service delivery models

. DEPLOYMENT MODELS OF CLOUD COMPUTING

DEPLOYEMENT MODELS	DESCRIPTION	EXAMPLES
PUBLIC	Public clouds are not restricted to any particular customers or organizations. They provide services to the public all over the world without any limitations. But they are not as secure as private clouds.	• Amazon Elastic , • Google App Engine, • Blue Cloud by IBM and • Azure services Platform by Windows
PRIVATE	Private clouds provide services to the customers of the particular organizations for the sake of security and confidentiality of their personal data. The fact is that whether these private clouds are owned and controlled by customers but they are built and installed by the third parties.	• VMware • Microsoft • Amazon EC2 • Eucalyptus
HYBRID	Hybrid clouds are the combination of both public and private clouds. The organizations and other people can take benefits of both public and private cloud by using hybrid clouds. Like some of the companies set their own private clouds and they take services from it but if they need some services from public cloud also then this facility comes under hybrid clouds only.	• CTERA • Red hat open hybrid cloud

Figure 5.deploymentmodels of cloud computing [5]

SECURITY ISSUES IN CLOUD COMPUTING: Even though there is many advantage concerned in cloud computing, the organization are slow in accepting itdue to security issues associated with it. Security is one of the primary issues in cloud environment. Here thereare various security concerns given below which are applicable in cloud computing environment: VirtualizationNetwork Security, Policy and Compliance, Data location, Data integrity. [6]

Consuming web services from mobile clients: Consuming WS from a mobile client (see figure) is different compared to the standard WS scenarios, dueto the following factors.

• Mobile devices have limited resources (e.g. CPU power, screen size).

• The communications between the client and services is established through wire-less or cellularnetwork.

• Existing W.S. in the Cloud do not support mobile clients.

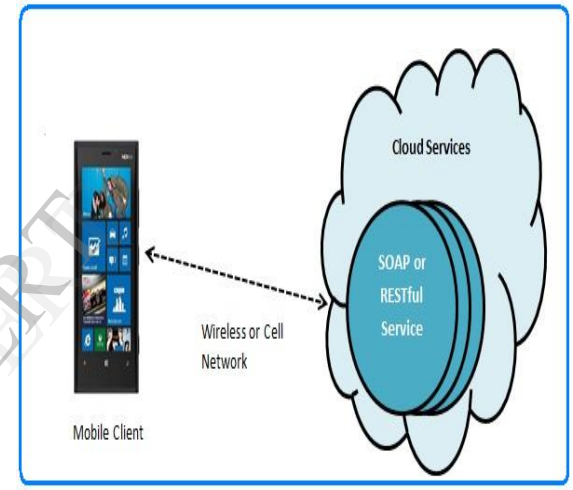

Figure 6. Consuming WS from Mobile Client

There are several challenges in the process of consuming Web Services (WS) from mobile clients. TheFollowing some are the focuses of this paper.

Challenge1. Loss of connection: The interaction between clients and service requires a steady connection.However, due to the mobility of the clients and the wireless network setup, mobile clients can betemporarily removed from the previous connected network and later may enter to another network. In Such occurrences, either service requests or responses may fail to be delivered to their destination.

Challenge2. Bandwidth/Latency: Cell networks have limited bandwidth and are often billed based on theamount of data transferred. However, even a simple SOAP message often contains a large amount of XMLdata/information, which consumes a lots of bandwidth and the transmission can cause major network-latency. In addition, the S.O.A.P. messages contain mostly XML tags that are not all necessary for the mobileclients.

Challenge3. Limited resources: Mobile clients are

"thin clients" with limited processing power. Theboundaries are essential to mobility and not just the failings of current technology. For example, a servicemash up involves parsing and combining different WS results requires a lot of computation. Thechallenges are minimizing the data processing on mobile clients and extending processing power beyondmobile clients. In addition, several mobile platforms do not include necessary libraries for S.O.A.P. WebServices. [7]

"Mobile Cloud Computing at its simplest refers to an infrastructure where both the data storage andthe data processing happen outside of the mobile device. Mobile cloud applications move the computingpower and data storage away from mobile phones and into the cloud, bringing applications and mobilecomputing to not just Smartphone's users but a much broader range of mobile subscribers".Aepona describes MCC as a new paradigm for mobile applications whereby the data processingand storage are moved from the mobile device to powerful and centralized computing platforms locatedin clouds. These centralized applications are then accessed over the wireless connection based on a thinnative client or web browser on the mobile devices. [8]

A taxonomy of mobile cloud computing : We present a taxonomy of current approaches in mobile cloudcomputing research based on issues related to Operational, Enduser and Service levels, and also in areas of Security, Contextawareness and Data management. Ourcriteria for defining the taxonomy is based on the key issuesin mobile cloud computing, and how they have been tackled inacademia. We focus on:

- Operational level issues
- End user level issues
- Service and application level issues
- Privacy, security and trust
- Context-awareness
- Data management

as the main areas.These issues at the top tier of the taxonomy are applicableto many areas, and not just mobile cloud computing. We believethese similarities would help give a comparison on how mobilecloud computing relates to other fields. Moreover, we expand eachissue to highlight the unique set of challenges in mobile cloudcomputing, and how they have been tackled in existing work. [9]

Why Cloud Computing is the Future of Mobile? Cloud computing potential doesn't begin and end with the personal computer's transformation into a thin client - the mobile platform is going to be heavily impacted by this technology as well. At least that's the analysis being put forth by ABI Research. Their recent report, Mobile Cloud Computing, is the cloud will soon become a disruptive force in the mobile world, eventually becoming the dominant way in which mobile applications operate.What does the term "mobile cloud computing" really mean? Basically, it refers to an infrastructure where both the data storage and the data processing happen outside of the mobile device. Today, no. of good ex of mobile cloud computing applications including mobile Gmail, Google Maps, and some navigation apps. However, the majority of applications today still do most of the data storage and processing on the mobile devices themselves and not in the cloud. In a few years, that could change.[10]

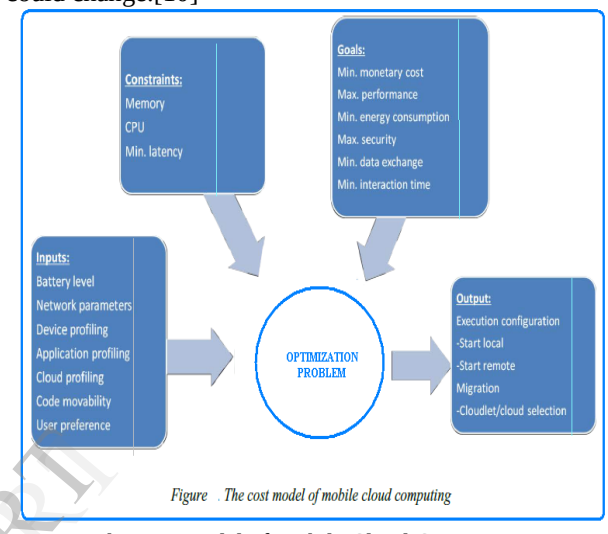

Figure7. The cost Model of Mobile Cloud Computing

Above figure shows the cost model of mobile cloud computing: inputs, outputs, Constraints and goals [11].

4. Mobile Cloud Computing – Pros and Cons

Pros

There are several advantages of using cloud computing for mobile devices, which are as mentioned below:

- **Flexibility:** One of the major advantages of mobile cloud computing is the fact that you can access your data from anywhere in the world, using a mobile device. It does not matter where you are as long as you have a mobile device that is connected to the internet, which would let you access both applications as well as data from anywhere.
- **Real time data availability:** Another advantage of mobile cloud computing is that you can get access to real time data, whenever you want and wherever you want. Given that the data and applications are managed by a third party, updating your data as well as accessing it in real time is easily possible. Moreover, it can be accessed by multiple persons simultaneously.
- **Multiple platforms:** Unlike traditional

applications, this allows for multiple platform support. In other words, whatever be the platform that you are using, you can easily access the data and applications stored in the cloud.

Cons

Where there are advantages, there are disadvantages as well. Here are some of the main disadvantages of using this technology:

- **Security**: One of the major concerns of cloud computing is with regard to security of data. Often it is seen that mobile users provide sensitive information, which if not protected, can lead to major damages.
- **Performance**: Another major concern with mobile cloud computing is with regard to its performance, which many often feel is not as good as native applications. So, checking with your service provider and understanding their track record is advisable.
- **Connectivity**: Internet connection is really important to mobile cloud computing. So, you should make sure that you have a good one before opting for these services.

Mobile cloud computing, despite the various disadvantages, is definitely the way of the future. Therefore, understanding how it will be useful for you and your business is extremely essential.

5. ADVANTAGES AND DISADVANTAGES OF CLOUD COMPUTING

a. Advantages of Cloud Computing

Cloud computing offers numerous advantages both to end users and businesses of all sizes. The obvious huge advantage is that you no more have to support the infrastructure or have the knowledge necessary to develop and maintain the infrastructure, development environment or application, as were things up until recently. The burden has been lifted and someone else is taking care of all that. Businesses are now able to focus on their core business by outsourcing all the hassle of IT infrastructure.

Let's visit some of the most important advantages of cloud computing and discuss them in more detail. Those will include both a company's and an end-user's perspective.

Cost Efficiency

This is the biggest advantage of cloud computing, achieved by the elimination of the investment in stand-alone software or servers. By leveraging cloud's capabilities, companies can save on licensing fees and at the same time eliminate overhead charges such as the cost of data storage, software updates, management etc.The cloud is in general available at much cheaper rates than traditional approaches and can significantly lower the overall IT expenses. At the same time, convenient and scalable charging models have emerged (such as one-time-payment and pay-as-you-go), making the cloud even more attractive.

If you want to get more technical and analytical, cloud computing delivers a better cash flow by eliminating the capital expense (CAPEX) associated with developing and maintaining the server infrastructure.

Convenience and continuous availability

Public clouds offer services that are available wherever the end user might be located. This approach enables easy access to information and accommodates the needs of users in different time zones and geographic locations. As a side benefit, collaboration booms since it is now easier than ever to access, view and modify shared documents and files.

Moreover, service uptime is in most cases guaranteed, providing in that way continuous availability of resources. The various cloud vendors typically use multiple servers for maximum redundancy. In case of system failure, alternative instances are automatically spawned on other machines.

Backup and Recovery

The process of backing up and recovering data is simplified since those now reside on the cloud and not on a physical device. The various cloud providers offer reliable and flexible backup/recovery solutions. In some cases, the cloud itself is used solely as a backup repository of the data located in local computers.

Cloud is environmentally friendly

The cloud is in general more efficient than the typical IT infrastructure and It takes fewer resources to compute, thus saving energy. For example, when servers are not used, the infrastructure normally scales down, freeing up resources and consuming less power. At any moment, only the resources that are truly needed are consumed by the system.

Resiliency and Redundancy

A cloud deployment is usually built on a robust architecture thus providing resiliency and redundancy to its users. The cloud offers automatic failover between hardware platforms out of the box, while disaster recovery services are also often included.

Scalability and Performance

Scalability is a built-in feature for cloud deployments. Cloud instances are deployed automatically only when needed and as a result, you pay only for the applications and data storage you need. Hand in hand, also comes elasticity, since clouds can be scaled to meet your changing IT system demands.Regarding performance, the systems utilize distributed architectures which offer excellent speed of computations. Again, it is the provider's responsibility to ensure that your services run on cutting edge machinery. Instances can be added instantly for

improved performance and customers have access to the total resources of the cloud's core hardware via their dashboards.

Quick deployment and ease of integration

A cloud system can be up and running in a very short period, making quick deployment a key benefit. On the same aspect, the introduction of a new user in the system happens instantaneously, eliminating waiting periods.

Furthermore, software integration occurs automatically and organically in cloud installations. A business is allowed to choose the services and applications that best suit their preferences, while there is minimum effort in customizing and integrating those applications.

Increased Storage Capacity

The cloud can accommodate and store much more data compared to a personal computer and in a way offers almost unlimited storage capacity. It eliminates worries about running out of storage space and at the same time It spares businesses the need to upgrade their computer hardware, further reducing the overall IT cost.

Device Diversity and Location Independence

Cloud computing services can be accessed via a plethora of electronic devices that are able to have access to the internet. These devices include not only the traditional PCs, but also smartphones, tablets etc. With the cloud, the "Bring your own device" (BYOD) policy can be easily adopted, permitting employees to bring personally owned mobile devices to their workplace.

An end-user might decide not only which device to use, but also where to access the service from. There is no limitation of place and medium. We can access our applications and data anywhere in the world, making this method very attractive to people. Cloud computing is in that way especially appealing to international companies as it offers the flexibility for its employees to access company files wherever they are.

Smaller learning curve

Cloud applications usually entail smaller learning curves since people are quietly used to them. Users find it easier to adopt them and come up to speed much faster. Main examples of this are applications like Gmail and Google Docs.

b. Disadvantages of Cloud Computing

As made clear from the above, cloud computing is a tool that offers enormous benefits to its adopters. However, being a tool, it also comes with its set of problems and inefficiencies. Let's address the most significant ones.

Security and privacy in the Cloud

Security is the biggest concern when it comes to cloud computing. By leveraging a remote cloud based infrastructure, a company essentially gives away private data and information, things that might be sensitive and confidential. It is then up to the cloud service provider to manage, protect and retain them, thus the provider's reliability is very critical. A company's existence might be put in jeopardy, so all possible alternatives should be explored before a decision. On the same note, even end users might feel uncomfortable surrendering their data to a third party.Similarly, privacy in the cloud is another huge issue. Companies and users have to trust their cloud service vendors that they will protect their data from unauthorized users. The various stories of data loss and password leakage in the media does not help to reassure some of the most concerned users.

Dependency and vendor lock-in

One of the major disadvantages of cloud computing is the implicit dependency on the provider. This is what the industry calls "vendor lock-in" since it is difficult, and sometimes impossible, to migrate from a provider once you have rolled with him. If a user wishes to switch to some other provider, then it can be really painful and cumbersome to transfer huge data from the old provider to the new one. This is another reason why you should carefully and thoroughly contemplate all options when picking a vendor.

Technical Difficulties and Downtime

Certainly the smaller business will enjoy not having to deal with the daily technical issues and will prefer handing those to an established IT company, however you should keep in mind that all systems might face dysfunctions from time to time. Outage and downtime is possible even to the best cloud service providers, as the past has shown.

Additionally, you should remember that the whole setup is dependent on internet access, thus any network or connectivity problems will render the setup useless. As a minor detail, also keep in mind that it might take several minutes for the cloud to detect a server fault and launch a new instance from an image snapshot.

Limited control and flexibility

Since the applications and services run on remote, third party virtual environments, companies and users have limited control over the function and execution of the hardware and software. Moreover, since remote software is being used, it usually lacks the features of an application running locally.

Increased Vulnerability

Related to the security and privacy mentioned before,

note that cloud based solutions are exposed on the public internet and are thus a more vulnerable target for malicious users and hackers. Nothing on the Internet is completely secured and even the biggest players suffer from serious attacks and security breaches. Due to the interdependency of the system, If there is a compromise one of the machines that data is stored, there might be a leakage of personal information to the world.

c. Cloud Computing

Cloud Computing is the use of computing resources that are delivering variety of service over an internet (WWW).

The name defines computer world can be bring into cloud and everything will be accessed from cloud servers basically.

There are many variants in cloud computing typically defined them based on service which they are going to provide in terms of hardware or software levels: Initially it is defined for PaaS later it is being implemented in different ways like below

- PaaS – Platform as a service – Hardware level service, purpose of making different platforms.
- SaaS – Software as a service – Software level service, purpose of common software
- IaaS – Infrastructure as a service – Hardware level service, purpose of hosting
- NaaS – Network as a service – Network can be utilized based on service.
- STaaS – Storage as a service – Storage will be utilized based on service.
- SECaaS – Security as a service – Security can be act as service
- DaaS – Data as a service – Data will be accessed by using service
- DBaaS – Database as a service
- TEaaS - Test environment as a service
- APIaaS - API as a service
- BaaS - Backend as a service
- IDEaaS - Integrated development environment as a service
- IPaaS - Integration platform as a service

6. Types of Cloud Computing

Cloud computing is most commonly deployed as eith private clouds, public clouds, or a combination of the two.

Private clouds are typically deployed within an organization's own internal ecosystem, often leveraging the organization's own private datacenter. Datacenters can be virtualized to create more efficient server availability, and applications can be installed on internal virtualized servers and made accessible using the organization's intranet. Private clouds typically rely on the organization having trained IT staff onsite to manage the private cloud ecosystem.

Public clouds are hosted by a third party data enter located off premise at multiple locations outside of an organization's building. Public clouds are often hosted on virtualized multi-tenancy data enters where different organizations have access to shared pooled hardware and power resources, yet can run their applications and data in secure, isolated environments. These organizations can access server availability and their software applications from these offsite third party data enters via a secure connection to their organization's location. Also, certain software companies now make their applications available as a service hosted from their own back-end servers. These services can be easily deployed by an IT administrator to clients such as notebooks, desktops and mobile devices. The software companies automatically push down updates to the clients, and as a result free up an IT administrator's time from having to manually manage the updates.

Hybrid clouds are a combination of using some services delivered via a private cloud internally and other services delivered via a public cloud externally. For example, an organization may choose to run an ERP system from their private cloud, and utilize a public cloud for offsite backup and disaster recovery purposes.

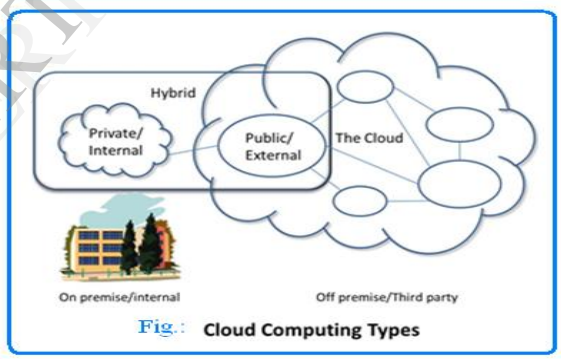

Figure 8. Cloud Computing Types

7. Cloud Computing and Smartphones

Figure 9. Cloud Computing and Smartphone's

The tech industry trends have revolved around cloud computing and Smart phone's. As Venture Capital firms rapidly invest in cloud computing and Smart phone's companies, it is important to look at how these two technologies interrelate.

Today the majority of mobile applications do most of the data storage and processing on the mobile devices themselves and not in the cloud, going forward cloud computing and Smart phone's technologies will evolve into a mobile Cloud, with mobile specific infrastructure, cloud storage, security and compliance, and applications among other things.
As users/employees spend less time on PCs and notebooks and more time on Smartphone's and tablets, to access information and perform work related functions, it is crucial for cloud service vendors to deliver cloud functionalities compatible with a number of different devices, including Smartphone's and tablets.

Mobile cloud computing has many advantages among the few listed below:

- Sharing information and applications without the need of complex and costly hardware and software as the business computations are run in the cloud.
- Enhanced features and functionality of mobile phones through new cloud applications.
- Ease of access and development since the access point to mobile cloud computing is through a browser and not a mobile operating system.
- Cheaper for cloud computing vendors to build mobile cloud applications because of economies of scale, i.e access to all Smartphone's devices, one application can be shared and accessed by many Smartphone's users.
- Broader reach, since mobile cloud applications can be accessed through a browser, the cloud computing applications can be reached by all mobile users not only Smartphone's users, as long as the mobile has access to the internet.

Some of the potential pitfalls to mobile cloud computing is the lack of internet speed and access. Also, mobile cloud computing presents challenges already inherent in PC and Notebooks such as security breaches, and viruses' attacks, and it is thus important to have identity authentication as well as controlled and secured access.
Mobile cloud computing will provide many benefits for cloud computing, mobile network operators. Among those benefits: increased reach, reduced costs, and reduced reliance on hardware and software equipments.

8. THE KEYS TO DELIVERING MOBILE CLOUD SERVICES

Given the demands of mobile cloud computing, the following factors are essential to delivering a 'good' cloud service:

- Optimal partitioning of application functions across cloud and device
- Low network latency to meet application and code offload interactivity
- High network bandwidth for faster data transfer between cloud and devices
- Adaptive monitoring of network conditions to optimize network and device costs against user-perceived performance of the cloud application.

Despite the intrinsic challenges to delivering a reliable service — the resource-poor nature of mobile devices and the relatively longer network latency and lower bandwidth of mobile broadband networks — service providers can nonetheless address these four key issues with four related strategies:

1. Network bandwidth strategy: Bring content closer to mobile broadband through regional data centers or other means.
2. Network latency strategy: Move application processor nodes to the edge of mobile broadband, and/or deploy application bandwidth optimization.
3. Battery-saving strategy: Cloning the device in the network for compute- and energy-intensive management tasks such as automatic virus scanning of mobile devices.
4. Mobile cloud application elasticity: The dynamic optimization of application delivery and execution between the device and the network.

There are various solutions to the issues of delivering guaranteed Quality of Experience (QoE) using mobile cloud computing. The technical feasibility and business viability of individual solutions will, of course, depend on the individual service provider's current network architecture, business model and commercial strategy.

9. MCC OPEN RESEARCH ISSUES

MCC is an emerging research area with significant research opportunities. Although significant research and development in MCC is available in the literature, still efforts in the following domains lacking:
Architectural issues: Reference architecture for heterogeneous MCC environment is a crucial requirement for unleashing the power of mobile computing towards unrestricted ubiquitous computing.
Energy-efficient transmission: MCC requires frequent transmissions between cloud platform and mobile devices, due to the stochastic nature of wireless networks, the transmission protocol should be carefully designed.
Context-awareness issues: Context-aware and socially-aware computing are inseparable traits of contemporary handheld computers. To achieve the vision of mobile computing among heterogeneous converged networks and computing devices, designing resource-efficient environment-aware applications is an essential need.

Live VM migration issues: Executing resource-intensive mobile application via Virtual Machine (VM) migration-based application offloading involves encapsulation of application in VM instance and migrating it to the cloud, which is a challenging task due to additional overhead of deploying and managing VM on mobile devices.

Mobile communication congestion issues: Mobile data traffic is tremendously hiking by ever increasing mobile user demands for exploiting cloud resources which impact on mobile network operators and demand future efforts to enable smooth communication between mobile and cloud endpoints.

Trust, security, and privacy issues: Trust is an essential factor for the success of the burgeoning MCC paradigm.(Source: http://en.wikipedia.org/wiki/Mobile_cloud_computing)

10.MOBILE CLOUD COMPONENTS

There are several essential elements of mobile cloud infrastructure that make it distinct from a regular computer cloud, as depicted in below Figure:

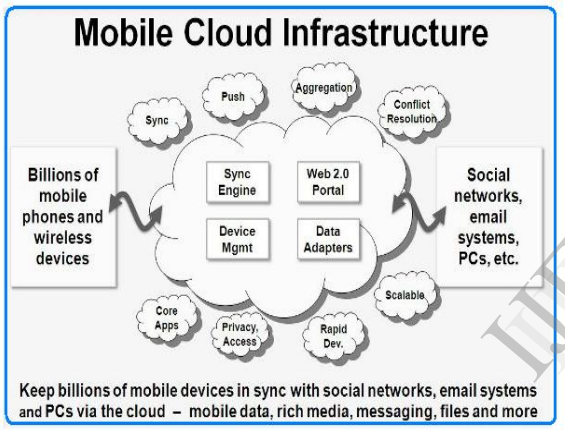

Figure 10. Mobile Cloud Infrastructure Elements

The primary purpose of a mobile cloud is to make it easy to sync mobile phones and devices with systems such as social networks, email systems, computers, and virtually any data store. The goal is to perform processing and to manage data in the cloud, to offload these functions from mobile devices. What follows is a description of the significant components and capabilities of the mobile cloud.

Sync engine: a mobile cloud should be able to sync a wide variety of data and content, between any source and device. Some people may question whether syncing is still needed in an age of broadband wireless networks. The answer is "Yes". Even with fast 4G networks, there will still be pockets of non-networked areas and times when devices are offline, and people will still want access to their data and content. Furthermore, for a good user experience, it is necessary for many apps to access local device data. For example, users do not want to wait while video buffers.

Web 2.0 portals: a second major element is a web 2.0 interface for user data and content. This provides a means to view, manage, edit and filter data and content that flows between devices and data sources. This applies to mobile data such as address books, calendars and email, as well as rich media such as photos and video.

Consider the proliferation of contacts in systems such as email, social networks, VoIP and more. People may have hundreds or thousands of contacts in multiple places, yet they typically only want a small fraction of these on their phone. A web 2.0 portal should make it easy to set up groups of users or to indicate which contacts to include from which sources.

Another example is posting photos from a phone to multiple destinations, such as social networks, photo sharing sites or personal computers. There needs to be an easy way to allow people to specify how rich media should be managed. A web 2.0 portal that provides an intuitive desktop-like user interface in a web browser, to access and manage mobile cloud data, is important.

Device management: small, portable and relatively inexpensive mobile devices are dropped, broken, lost, stolen and exchanged with greater frequency than other computing devices. This not only makes it more important to back them up, in case their data becomes lost, but it makes them more costly to support. An important aspect of a mobile cloud platform is the ability to remotely manage devices over the air, in terms of provisioning devices, performing diagnostics, updating software and settings, and remotely locking devices and erasing data for security reasons. These functions are typically found today with higher end Smartphone's such as BlackBerries and iPhones, but they are increasingly becoming expected with other types of portable devices.

Data adapters: to sync a wide range of data and content, there needs to be an easy and flexible way for mobile cloud apps to access diverse systems such as social networks, email systems, databases, customer resource management (CRM), and enterprise resource planning (ERP) applications and servers. Without this ability, it could take too long to perform even simple tasks. An important component of mobile cloud infrastructure is data adapters that provide the rapid ability to sync with common systems and to supplement this with the ability to interface with custom systems.

Beyond these core mobile cloud infrastructure components, there are several additional capabilities that are important in a mobile cloud platform, as illustrated by the smaller clouds in Figure 1.

Push notifications: when data or content is changed in one place, for example on a mobile device or online, it is important that the change automatically propagate everywhere it should, without the user initiating an update. This is the role of push notifications, which can be performed using a variety of methods, including TCP/IP, SMS and polling. Some networks and devices are only capable of supporting certain forms of push notification, so the form of push notification used needs to conform to the profile of the involved networks and devices.

Aggregation: many mobile cloud apps require aggregation, such as gathering data from multiple email systems, social networks and other systems. The mobile cloud platform should be able to intelligently source data from a variety of systems. Considerations include how often remote systems are accessed and which data is cached on the server versus stored locally or pointed to remotely.

Conflict resolution: when working with data from multiple sources, one of the most common yet perplexing challenges is reconciling differences among like data. A simple example stems from having someone's name in a mobile address book, while having a different version of their name in an email system or social network. When aggregating this information, it is easy to end up with multiple entries representing the same person.

A critical capability is detecting 'twins' by comparing attributes such as email addresses, phone numbers and other data, to determine whether these are the same person. There need to be configurable rules for determining which data should win a conflict. This may be viewed as a fairly arcane aspect of mobile cloud services, but maintaining the integrity of people's data is paramount, and a robust conflict resolution system is a must.

Core apps: many mobile cloud apps involve a common set of functions, such as syncing contact data, calendars, email, files and photos. It is important for mobile cloud infrastructure to provide common capabilities so these functions can be performed without reinventing the wheel.

Privacy and access: as user data is stored in the cloud, it is critical that data is highly secure and backed up. At the same time, there needs to be a simple way for users to specify which data to share with other people and systems.

Rapid development: there needs to be a way to rapidly build mobile cloud apps that work on a variety of mobile phones and devices. Until recently, developers either needed to build native apps for each mobile platform, which was extremely expensive and labor-intensive, or build web apps, which worked on many phones but were unattractive and clunky. There are some new initiatives that purport to provide developers with the best of both worlds: the creation of one version of a mobile app that can be widely deployed, while exhibiting many of the characteristics of native apps such as a rich user interface, local data storage, and integration with other apps on the device. Examples include the newly announced Wholesale Applications Community (WAC) initiative, technology from rhomobile, and a newly announced open source mobile web 2.0 frameworks from Funambol.

Scalability: an important aspect of mobile cloud infrastructure is the ability to support large numbers of users and, in some cases, millions or tens of millions of devices. This can be accomplished by using industry standard application servers and infrastructure, and approaches for load balancing and fault-tolerance.

11.CONCLUSIONS

MCC is a developing family of technologies that has the potential to vastly change the computing landscape. There are a variety of methods which are being used to further this trend which leverage the cloud in different ways. GPMCC has the potential to quite simply make mobile devices more powerful computing devices without altering their hardware, while ASMCC has the potential to both do that and to provide entirely new kinds of applications. While concerns and issues do trouble MCC, it is likely that many can be alleviated or countered. With luck, MCC will continue to expand and develop into a substantial and beneficial segment of the world's computational activity.

Mobile cloud computing is also beneficial for developers. Since, mobile cloud applications will let users to run application directly from the cloud, instead of installing it in their mobile phones. There will be no compatibility issues. Developers will have access to a much wider market; they can easily evade the restrictions created by mobile operating systems. Building applications for hundreds of handsets with different configurations are labor intensive and expensive. However, with mobile cloud computing, they can develop applications with less cost, as they have to develop application for only one platform (browsers). Many service providers like Verizon have already started to offer mobile cloud computing services.

Mobile cloud computing will make future mobile phones more sophisticated. It will allow users to store their data in the cloud, rather than storing it on their mobile phones. These data will be accessible to them whenever they need. It is still unclear about the future of mobile cloud computing, but all the big companies like Microsoft, Google and Apple on the trends that

will change the future of mobile. This paper we discussed pros and cons of both cloud computing and MCC. Also discusses on Challenges and solutions, components.

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