MOBILE CLOUD COMPUTING

SWETHA G.R
Dept. of MCA
Sambhram Institute of Technology
Bangalore-97, INDIA
grswethagbd@rediffmail.com

PRATHIMA S
Dept. of MCA
Sambhram Institute of Technology
Bangalore-97, INDIA
prathima135@gmail.com

KALAIVANI Y.S
Dept. of MCA
SambhramInstitute of Technology
Bangalore-97, INDIA
kalaiys@rediffmail.com

***Abstract*- Mobile Cloud Computing (MCC) which combines mobile computing and cloud computing, has become one of the important element in the industry and a major discussion in the IT world since 2009. MCC integrates cloud computing into the mobile environment. In this paper, we introduce the concept of Mobile Cloud Computing (MCC), its inner workings and the various implementable architectures related to the MCC. The market of mobile recently has been evolving rapidly and cloud computing is spreading into mobile also. In cloud computing, a user lends IT resources (software, storage, server, network) as needed, uses them, get a support of real-time scalability according to service load, and pays as he goes. We discussed the architecture of MCC (Mobile cloud computing) with the different services needed by the client and the server in MCC.**

Keywords: Mobile Computing, Cloud Computing, Mobile Cloud Computing

I. INTRODUCTION

1.1 Mobile computing:

Mobile devices allow users to run powerful applications that take advantage of the growing availability of built-in sensing and better data exchange capabilities of mobile devices. Mobility has become a very popular word and rapidly increasing part in today's computing area. An incredible growth has appeared in the development of mobile devices such as, smart-phone, PDA, GPS Navigation and laptops with a variety of mobile computing, networking and security technologies.

Mobile computing is described as human-computer interaction by which a computer is expected to be transported during normal usage [1]. Mobile computing is based on a collection of three major concepts: hardware, software and communication. The concepts of hardware can be considered as mobile devices, such as smart-phone and laptop, or their mobile components. Software of mobile computing is the numerous mobile applications in the devices, such as the mobile browser, anti-virus software and games. The communication issue includes the infrastructure of mobile networks, protocols and data delivery in their use. They must be transparent to end users.

1.2 Cloud Computing

At the same time, Cloud Computing has emerged as a phenomenon that represents the way by which IT services and functions are charged for and delivered. *"Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable resources (e.g. networks, servers, storage, applications and services) that can rapidly be provisioned and released with minimal management effort or service provider interaction."*

The core technology of cloud computing is centralizing computing, services, and specific applications.

Service Models:

Software as a Service:

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:

The capability provided to the consumer is to deploy onto the cloud infrastructure, consumer created or acquired applications created using programming languages 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 application hosting environment configurations.

Infrastructure as a Service:

The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources 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, deployed applications, and possibly limited control of select networking components (e.g. host firewalls). The below figure shows a typical Cloud Service Model.

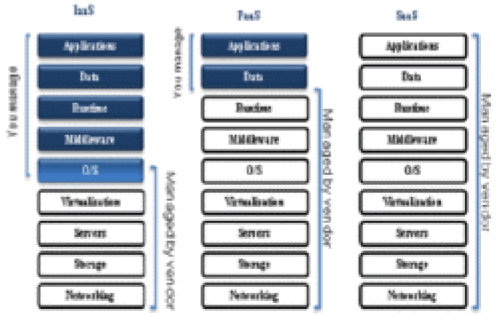

Fig 1: Cloud Service Model

Deployment Models:

Private Cloud: The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

Community Cloud: The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.
Public Cloud: The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
Hybrid Cloud: The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between Private and Hybrid cloud deployment example.

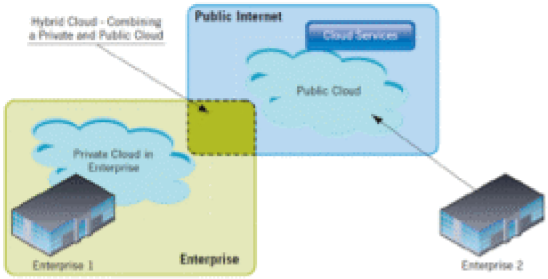

Fig 2: Public, Private and Hybrid Cloud deployment

1.3 Mobile Cloud Computing
Mobile devices can be seen as entry points and interface of cloud online services. development of cloud computing, resources in mobile cloud computing networks are virtualized and assigned in a group of numerous distributed computers

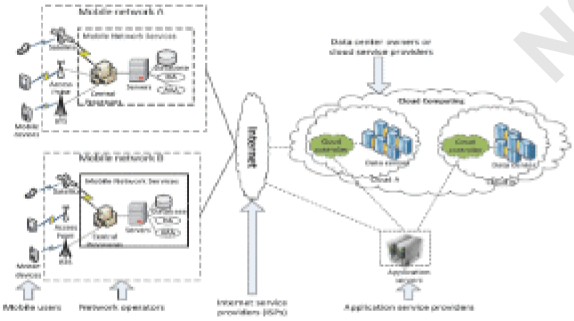

Fig 3: Architecture of Mobile Cloud Computing

rather than in traditional local computers or servers, and are provided to mobile devices such as smart-phones, portable terminal, and so on. (See Fig. 3).

From the concept of MCC, the general architecture of MCC can be shown in Fig.1. In Fig. 1, mobile devices are connected to the mobile networks via base stations (e.g., base transceiver station (BTS), access point, or satellite) that establish and control the connections (air links) and functional interfaces between the networks and mobile devices. Mobile users' requests and information (e.g., ID and location) are transmitted to the central processors that are connected to servers providing mobile network services. Here, mobile network operators can provide services to mobile users as AAA (for authentication, authorization, and accounting) based on the home agent (HA) and subscribers' data stored in databases.

After that, the subscribers' requests are delivered to a cloud through the Internet. In the cloud, cloud controllers, process the requests to provide mobile users with the corresponding cloud services.

These services are developed with the concepts of utility computing, virtualization, and service-oriented architecture (e.g., web, application, and database servers).

The details of cloud architecture could be different in different contexts. For example, four-layer architecture is explained in [2] to compare cloud computing with grid computing.
Alternatively, service-oriented architecture, called Aneka, is introduced to enable developers to build .NET applications with the supports of application programming interfaces (APIs) and multiple programming models [3].
Presents architecture for creating market-oriented clouds, and [4] proposes an architecture for web delivered business services.

Mobile Cloud Computing (MCC) data storage and the data processing happen outside of the mobile device. Mobile cloud applications move the computing power and data storage away from mobile phones and into the cloud, bringing applications and mobile computing to not just smart-phone users but a much broader range of mobile subscribers"

From the concept of MCC, the general architecture of MCC can be shown in Fig.1. In Fig. 1, mobile devices are connected to the mobile networks via base stations (e.g., base transceiver station (BTS), access point, or satellite) that establish and control the connections (air links) and functional interfaces between the networks and mobile devices. Mobile users' requests and information

Microsoft, and Moto-Blur from Motorola. Mobile users send service requests to the cloud through a web browser or desktop application.
The management component of cloud then allocates resources to the request to establish connection, while the monitoring and calculating functions of mobile cloud computing are implemented to ensure the QoS until the connection is completed. Numerous challenges and problems.

Meanwhile, various applications based on mobile cloud computing have been developed and served to users, such as Google Gmail, Maps and Navigation systems for Mobile, Voice Search, and some applications on an Android platform, Mobile-Me from Apple, Live Mesh from Microsoft, and Moto-Blur from Motorola. Mobile users send service requests to the cloud through a web browser or desktop application. The management component of cloud then allocates resources to the request to establish connection, while the monitoring and calculating functions of mobile cloud computing are implemented to ensure the QoS until the connection is completed. Numerous challenges and problems. In short, the core of such challenges and problems is just how to combine the two technologies seamlessly to overcome the disadvantages of limited resources and computing ability in mobile devices in order to access cloud computing with high efficiency like traditional PCs and Servers.

II. HOW MOBILE CLOUD COMPUTING WORKS?

Cloud Server

This is the server-side part of the infrastructure that is located in the 'Cloud'. The system provides mobile-oriented features like data synchronization, real-time push, and the mobile rpc server. The Cloud
Server provides a Java based Developer API to expose your data services

Mobile Bean

Mobile Bean is a managed Mobile Component which carries the state of domain object that it represents on the Cloud. It is propagated from the Cloud Server to the mobile device via its corresponding "Channel" on server.

Mobile MVC Framework

This is a thick client MVC (Model-View-Controller) framework. It is based on a Rich Internet Application design principle.

Mobile Service Bean

A Mobile Service Bean exposes some coarse- grained business a process to the on-device Mobile App. It provides a very simple Request/response based on synchronous invocation mechanism.

Mobile Data Framework

The Mobile Data Framework provides Cloud data-oriented services like data synchronization, real-time push notifications, and the simple RPC (Remote Procedure Call) mechanism.

a) Mobile Service

Mobile Service facilitates making RPC (Remote Procedure Call) invocations from device to the server side *'Mobile Service Bean'* components.

Typical services needed by mobile cloud Client:

a) Sync

It supports various synchronization modes such as way sync, one way server sync, one way device sync, slow sync, and boot sync.

b) Push

Push service is the service that manages state updates being sent as notifications from the Cloud Server, so that client can get new notifications from the cloud server.

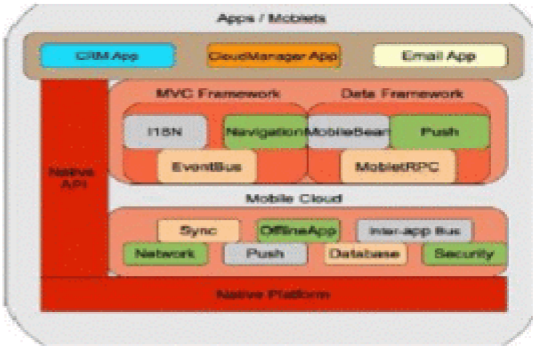

Fig 4: Architecture of Mobile Cloud Client

c) Offline-App

Its carries the management capabilities to create coordination between the low-level services like Sync and Push. It decides which mode of synchronization is the best for the current runtime App. It carries the smartness to track the type of data being pushed along with which it is installed App on the device needs the notification. The App developer does not have to write any special code to receive the notifications. The moment the data channel for the App is established, all synchronizations and push notifications are automatically handled by Offline-App service.

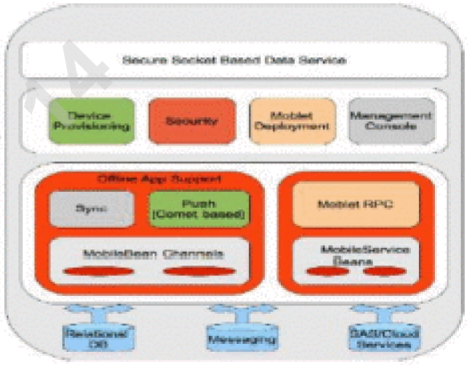

Fig 5: Architecture of Mobile Cloud Server

d) Mobile RPC

Mobile RPC facilitates making synchronous RPC (Remote Procedure Call) invocations from the device to server side using 'Mobile Service Bean' components

e) Network

Network service establishes a network connection with the Cloud Server. It manages the communication channel needed to receive Push notifications from server. This is a very low-level service and an App developer never has to deal with using directly.

f) Database

Database service manages local data storage details for the Apps. Depending on the Platform it uses corresponding storage facilities. It provides thread safe concurrent access to all Apps. Just like the Network service, it's a low-level service used by Mobile Data Framework components.

g) Inter-App Bus

Inter-App Bus service provides low-level coordination/communication between the suite of Apps/Mob lets installed on device.

Typical servers needed by a mobile cloud server

This is a software stack that is installed on the server side. It provides the following services to Mobile

Apps: Sync, Push, Secure Socket-Based Data Service, Mobile PC, Security, and Management Console.

a) Sync

It provides a plug-in framework to mobilize the backend data. It uses the concept of a data "Channel" which mobilizes the data in the form of "Mobile Bean" instances.

b)Push

Push service monitors the data "Channels" for updates. The moment updates are detected, corresponding Comet based notifications are sent back to the same device. If the device is out of coverage or disconnected for some reason, it waits in a queue, and it delivers the push the moment the device connects back to the network.

c*) Secure Socket-Based Data Service*

Secure Socket-Based Data Service is a high performance socket server based on the Java NIO (New input output language package). It provides both, a plain socket server, and a SSL-based socket server, depending on security requirements of the Apps

d*) Mobile RPC*

Mobile RPC service on the server-side provides a Remote Procedure Call framework for invoking coarse grained business services of App.

e) Security

Security component provides authentication and authorization services to make sure mobile devices connecting to the Cloud Server are in fact allowed to access the system. After the device is registered, it is challenged for proper credentials when device itself needs to be activated. Once the device is activated, all Cloud requests are properly authenticated/authorized for going forward.

f) Management Console

The console provides user and device provisioning different functionalities.

III. Advantages of Mobile Cloud Computing:

In the following, we describe how the cloud can be used to overcome obstacles in mobile computing, thereby pointing out advantages of MCC.

1. Extending battery lifetime:

Several solutions have been proposed to enhance the CPU performance [5], to manage the disk and screen in an intelligent manner [6], to reduce power consumption. However, these solutions require changes Computation offloading technique is proposed with the objective to migrate the large computations and complex processing from resource-limited devices (i.e., mobile devices) to resourceful machines (i.e., servers in clouds). This avoids taking a long application execution time on mobile devices which results in large amount of power consumption.

2. *Improving data storage capacity and processing power:*

Storage capacity is also a constraint for mobile devices. MCC is developed to enable mobile users to store/access the large data on the cloud through wireless networks. Example: Image Exchange which utilizes the large storage space in clouds for mobile users [7]. This mobile photo sharing service enables mobile users to upload images to the clouds immediately after capturing. Users may access all images from any devices. With cloud, the users can save considerable amount of energy and storage space on their mobile devices since all images are sent and processed on the clouds.

3. Dynamic provisioning:

Dynamic on-demand provisioning of resources on a fine-grained, self-service basis is a flexible way for service providers and mobile users to run their applications without advanced reservation of resources.

4. Ease of Integration:

Multiple services from different service providers can be integrated easily through the cloud and the Internet to meet the users' demands.

5. Scalability:

The deployment of mobile applications can be performed and scaled to meet the unpredictable user demands due to flexible resource provisioning. Service providers can easily add and expand an application and service without or with little constraint on the resource usage.

IV. APPLICATIONS OF MOBILE CLOUD COMPUTING

Mobile applications gain increasing share in a global mobile market. Various mobile applications have taken the advantages of MCC. In this section, some typical MCC applications are introduced.

1. Mobile Commerce

Mobile commerce (m-commerce) is a business model for commerce using mobile devices. The m-commerce applications generally fulfill some tasks that require mobility (e.g., mobile transactions and payments, mobile messaging, and mobile ticketing).

2. Mobile Learning

Mobile learning (m-learning) is designed based on electronic learning (e-learning) and mobility.
However, traditional m-learning applications have limitations in terms of high cost of devices and network, low network transmission rate, and limited educational resources [8]. Cloud-based m-learning applications are introduced to solve these limitations. For example, utilizing a cloud with the large storage capacity and powerful processing ability, the applications provide learners with much richer services in terms of data (information) size, faster processing speed, and longer battery life.

3. Mobile Healthcare

The purpose of applying MCC in medical applications is to minimize the limitations of traditional medical treatment (e.g., small physical storage, security and privacy, and medical errors [9]. Mobile healthcare (m-healthcare) provides mobile users with convenient helps to access resources (e.g., patient health records) easily and quickly. Besides, m-healthcare offers hospitals and healthcare organizations a variety of on-demand services on clouds rather than owning standalone applications on local servers.

4. Mobile Gaming

Mobile game (m-game) is a potential market generating revenues for service providers. M-game can

completely offload game engine requiring large computing resource (e.g., graphic rendering) to the server in the cloud, and gamers only interact with the screen interface on their devices.

5. Other Practical Applications

A cloud becomes a useful tool to help mobile users share photos and video clips efficiently and tag their friends in popular social networks as Twitter and Face book. Me-Log [10] is an MCC application that enables mobile users to share real-time experience (e.g., travel, shopping, and event) over clouds through an automatic blogging. The mobile users (e.g., travelers) are supported by several cloud services such as guiding their trip, showing maps, recording itinerary, and storing images and video.

V. CONCLUSION

Mobile cloud computing is one of mobile technology trends in the future since it combines the advantages of both mobile computing and cloud computing, thereby providing optimal services for mobile users. In this paper we have given an overview of Mobile Cloud Computing that includes architecture, benefits, and applications.

FUTURE WORK

Considering the importance of Mobile Cloud Computing from this discussion, we would like to explore further architectures that are possible. Adequate security measures have to be incorporated to support the low processing ability at the client-side.

Further, we would like to test the feasibility of extrapolating concepts from cloud computing in the domain of large-scale computers to the realm of mobile world.

VI. REFERENCES

[1] (2009, Sept) Mobile cloud computing subscribers to total nearly one billion by 2014.[Online].Available: http://www.abiresearch.com/press/1484

[2] I. Foster, Y. Zhao, I. Raicu, and S. Lu, "Cloud Computing and Grid Computing 360-Degree Compared," in Proceedings of Workshop on Grid Computing Environments (GCE), pp. 1

[3] Hoang T. Dinh, Chonho Lee, Dusit Niyato, and Ping Wang, "A survey of Mobile Cloud Computing: Architecture, Applications and Approaches", Wireless Communications and Mobile Computing, 2011

[4] R. Buyya, C. Yeo and S. Venugopal, "Market-oriented cloud computing: Vision, hype, and reality for delivering IT services as computing utilities," in10th IEEE International Conference on High Performance Computing and Communications, (HPCC '08), Pages 5–13, 2008

[5] E. Vartiainen, and K. V. -V. Mattila, "User experience of mobile photo sharing in the cloud," in Proceedings of the 9th International Conference on Mobile and Ubiquitous Multimedia (MUM), December 2010.

[6] R. Kakerow, "Low power design methodologies for mobile communication," in Proceedings of IEEE International Conference on Computer Design: VLSI in Computers and Processors, pp. 8, January 2003.

[7] J. W. Davis, "Power benchmark strategy for systems employing power management," in Proceedings of the IEEE International Symposium on Electronics and the Environment, pp. 117, August 2002.

[8] X. Chen, J. Liu*, J. Han, and H. Xu, " Primary Exploration of Mobile Learning Mode under a Cloud Computing Environment," in Proceedings of the International Conference on E-Health Networking, Digital Ecosystems and Technologies (EDT), vol. 2, pp. 484-487, June 2010.

[9] L. T. Kohn, J. M. Corrigan, and S. Donaldson, "To Err Is Human: Building a Safer Health System," NATIONAL ACADEMY PRESS Washington, 1999.

[10] L. T. Kohn, J. M. Corrigan, and S. Donaldson, "To Err Is Human: Building a Safer Health System," NATIONAL ACADEMY PRESS Washington, 1999.