MOBILE CLOUD COMPUTING: CURRENT DEVELOPMENT AND RESEARCH CHALLENGES

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Abstract

Mobile cloud computing has been introduced to be a powerful technology for mobile services by combining mobile computing and cloud computing technology. Though, a direct integration of two technologies can overcome a many of hurdles related to the performance, flexibility, security, and dynamic management discussed in mobile computing. Mobile cloud computing can address these problems by executing mobile applications on resource providers external to the mobile device. However, to make this vision a reality is far from being achieved and opens many new research questions. In addition, the collaboration between a mobile device and a cloud server poses complex performance issues associated with synchronization of data, network condition, security etc. In this work, we study advances in cloud computing, and discuss the benefits of using cloud services for mobile environment.

Keywords - Cloud Computing, mobile services.

1 INTRODUCTION

Mobility has become increasingly important for users of computing technology by its portability and remote connectivity; also mobile devices allow users to run powerful application that take advantage of better data exchange capabilities of mobile devices. As a result, mobile applications seamlessly integrate with real-time data and web applications such as social networking and mobile commerce [1],[2].

Therefore the rapid progress of mobile computing (MC) [3] becomes a powerful trend in the development of IT technology as well as commerce and industry fields. However, the mobile devices are facing many challenges in their resources (e.g., battery life, storage, and bandwidth) and communications (e.g., mobility, privacy of data and security) [4]. The limited resources significantly impede the improvement of service qualities. Since the Internet became popular, a mobile device might overcome the constraints by offloading portions of application workload onto a server machine via the network to save execution time and conserve energy [5]. Recently, cloud computing has changed software infrastructures and business models of Internet services with technologies to provide and manage abundant resources of computation and data storage over the network at relatively low amortized operation costs [6]. Cloud computing has emerged as the natural evolution and integration of advances in several fields including utility computing, distributed computing, grid computing, web services, and service oriented architecture [7]. The value and originality of cloud computing comes from packaging and offering resources in an economical, scalable and flexible manner that is affordable and attractive to IT customers and technology investors.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/she goes [8].

In the other hand mobile devices used in the mobile environment include personnel information and enable to provide the environment that collects a variety of context-aware information, that why

context-aware reasoning technique has been studied to provide a suitable service for user by using user' context and personal profile information in mobile environment[9].

The rest of this paper is organized as follows. Section II we describe what is mobile cloud computing, in section III current developments and research challenges, section IV we discuss future work and conclusion.

2 MOBILE CLOUD COMPUTING

There are several existing definitions of mobile cloud computing, and different research alludes to different concepts of the 'mobile cloud':

1.The definition proposed by D.kovachev, Y.Cao and R.Klamma is :« Mobile cloud computing is a model for transparent elastic augmentation of mobile device capabilities via ubiquitous wireless access to cloud storage and computing resources, with context-aware dynamic adjusting of offloading in respect to change in operating conditions, while preserving available sensing and interactivity capabilities of mobile devices »[10].

2.The Mobile Cloud Computing Forum defines MCC as follows [11]:"Mobile Cloud Computing at its simplest, refers to an infrastructure where both the 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 smartphone users but a much broader range of mobile subscribers".

3.Aepona [12] describes MCC as a new paradigm for mobile applications whereby the data processing and storage are moved from the mobile device to powerful and centralized computing platforms located in clouds. These centralized applications are then accessed over the wireless connection based on a thin native client or web browser on the mobile devices. And in (Open Gardens, 2010) is expressed as « the availability of cloud computing services in mobile ecosystem » and refers to an infrastructure where both the data storage and the processing happen outside of the mobile device from which an application is launched[13].

MCC (mobile mobile computing) can illustrated as merging mobile computing and cloud computing technologies to improve the use of mobile services in an interoperable environment.

2.1 Architecture

In Figure 1, an overview is presented of the simple architecture of Mobile cloud computing. The architecture is composed by components, namely, Mobile Terminal can be laptops, PDA, Smartphone, and so on, which connects with a hotspot or base station by 3G, WIFI…., Authentification server, Platform Cloud computing, Application server and Data center. At first the terminal sent a request to Authentication, the request include the user's information, like terminal number, login and password; application information, like the item number of application, name of application, type of platform that application belongs to, the application authorization number, and so on. Then, if this is your fist time to login in, the authentification server use this configuration information to deploy the virtual machine, if not, your personal application duplicate information will invoke from personal storage cloud, then continue the applications. When the connection is linked, the VNC server deployed in the Mobile Emulator will works, sending the request of display to mobile terminal continuously.

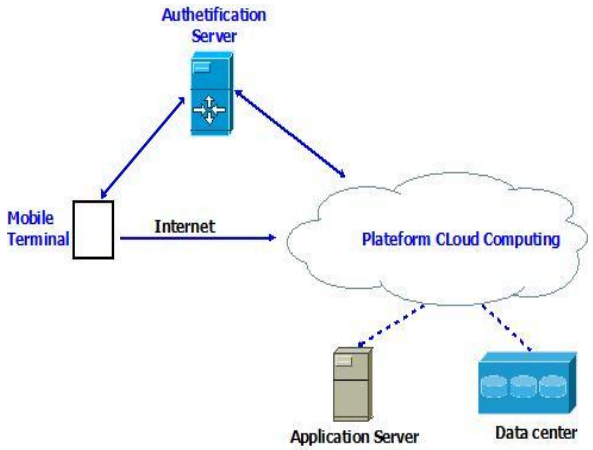

Figure 1.Mobile Cloud Computing (MCC) architecture

The most essential services include in mobile cloud client [14]:

- Sync: This service synchronizes all state changes made to the mobile or its applications back with the Cloud Server.
- Push: It manages any state updates being sent as a notification from the cloud server. This improves the user's experience as it does not require the user to proactively check for new information.
- OfflineApp: It is a service which carries the management capabilities to create smart coordination between low level services like Sync and Push. It frees the programmer from the burden of writing code to actually perform synchronization as it is this service which decides synchronization management and mechanism which is best for the current state. The moment the data channel for any mobile application is established, all synchronizations and push notifications are automatically handled by OfflineApp service.
- Network: It manages the communication channel needed to receive Push notifications from the server. It carries the ability to establish proper connections automatically. It is a very low-level service and it shields any low level connection establishment, security protocol details by providing a high level interfacing framework.
- Database: It manages the local data storage for the mobile applications. Depending on the platform it uses the corresponding storage facilities. It must support storage among the various mobile applications and must ensure thread safe concurrent access. Just like Network service it is also a low-level service.
- InterApp Bus: This service provides low-level coordination/ communication between the suite of applications installed on the device.

3 BACKGROUND RELATED WORK

3.1 Mobile Applications:

Mobile applications consist of two modes [15]:

A. Offline Applications

Most of the applications available for modern mobile devices fall into this category. They act as fat client that processes the presentation and business logic layer locally on mobile devices with data downloaded from backend systems. There is periodical synchronization between the client and backend system. A fat client is a networked application with most resources available locally, rather than distributed over a network as is the case with a thin client. Offline applications, also often called native applications, offer:

- good integration with device functionality and access to its features
- performance optimized for specific hardware and multitasking
- always available capabilities, even without network connectivity

On the other hand, the native applications have many disadvantages:

- no portability to other platforms
- complex code
- increased time to market
- a requirement for developers to learn new programming languages

B. Online Applications

An online application assumes that the connection between mobile devices and backend systems is available most of the time. Smartphones are popular due to the power and utility of their applications, but there are problems such as cross-platform issues. Here Web technologies can overcome them;

applications based on Web technology are a powerful alternative to native applications. Mobile have the potential to overcome some of the disadvantages of offline applications because they are:

- multi-platform
- directly accessible from anywhere
- knowledge of Web technologies is widespread among developers, greatly minimizing the learning curve required to start creating mobile applications

However, mobile Web applications have disadvantages:

- too much introduced latency for real-time responsiveness, (even 30 msec latency affects interactive performance [16])
- no access to device's features such as camera or motion detection
- difficulties in handling complex scenarios that require keeping communication session a over longer period of time

Therefore, mobile devices used in the mobile environment include personal information and enable to provide the environment that collects a variety of context-aware information. Users' demand on service types suitable for the individual situation has been increasing [l].Context-aware reasoning technique has been studied to provide a suitable service for user by using user' context and personal profile information in mobile environment [17-18].

There are Context-aware information modeling techniques such as key-value model, Markup scheme model, Graphical model, Object oriented model, and ontology based model which are used in the existing ubiquitous environment and Web environment. Recently ontology model has been studied lively related to Semantic Web study based on OWL(Web Ontology Language) and there is a movement to adapt ontology-based model in a variety of context-aware framework. [19]

3.2 Cloud Computing

There are various categories of Cloud Computing systems offered These include software-as-a-service (SaaS), platform-as-a-service (PaaS), and infrastructure-as-a-service (IaaS), and database-as-a-service (DBaaS).

- Infrastructure as a Service (IaaS): IaaS enables the provision of storage, hardware, servers and networking components. The client typically pays on a per-use basis. Thus, clients can save cost as the payment is only based on how much resource they really use. Infrastructure can be expanded or shrunk dynamically as needed. The examples of IaaS are Amazon EC2 (Elastic Cloud Computing) and S3 (Simple Storage Service).
- Platform as a Service (PaaS): PaaS offers an advanced integrated environment for building, testing Accepted in Wireless Communications and Mobile Computing. The examples of PaaS are Google App Engine, Microsoft Azure, and Amazon Map Reduce/Simple Storage Service.
- Software as a Service (SaaS): SaaS supports a software distribution with specific requirements. the users can access an application and information remotely via the Internet and pay only for that they use. Salesforce is one of the pioneers in providing this service model. Microsoft's Live Mesh also allows sharing files and folders across multiple devices simultaneously.
- Data Base as a Service (DBaaS): enabling IT providers to deliver database functionality as a service, Consumer-based provisioning and management of database instances using on-demand, self-service mechanisms. Instead, the database service provider takes responsibility for installing and maintaining the database, and application owners pay according to their usage. For example, Amazon Web Services provides two database services as part of its cloud offering, SimpleDB which is a NoSQL key-value store (wiki).

3.3 Mobile Cloud Computing

In mobile cloud computing, cloud services converge with Mobile Multimedia Broadcasting (MMB). Mobile cloud computing more-or-less requires an everything-as-a service concept where software, platform, and database services are really all required to be in the cloud to provide small devices with

reasonable battery-life quick access to information and the ability to manipulate large quantities of data. Additionally, the concept of offering Networking-as-a-service is added too [20].

The major challenge of mobile cloud computing comes from the characters of mobile devices and wireless networks, as well as their own restriction and limitation, and such challenge makes application designing, programming and deploying on mobile and distributed devices more complicated than on the fixed cloud devices [21].In mobile cloud computing environment, the limitations of mobile devices, quality of wireless communication, types of application, and support from cloud computing to mobile are all important factors that affect assessing from cloud computing.

The following factors are essential to delivering a "good" cloud service [7]:

- Partitioning of application functions across cloud and device
- Low network latency for faster responses
- High network bandwidth for faster data transfer between cloud and devices
- Adaptive monitoring of network conditions to optimize network and device costs

There are several other basic issues related to implementation of Mobile Cloud Computing.

Mobile cloud computing refers to an infrastructure that data storage and data processing is done outside mobile device by using cloud computing in the regardless of kinds of mobile devices. So as to secure data of individuals or enterprise, authentification technology shall be offered basically [22].

3.4 The current State of Mobile Cloud Computing

A. Mobile Platforms: Smartphone and Tablet PCs

The international telecommunication Union (UIT) stated in 2009 that the number of mobile phone subscriptions worldwide had exceeded 5 billion in 2010 and more than 8 million iPads sold this year [23] and more than 10million Samsung Galaxy S phone were sold in just 7 months[24]. According to the ITU, in 2007, 85 countries worldwide had launched 3G networks, with over 335 million mobile broadband subscribers in 2008[25].Since than 4G has been introduced with a large footprint expected in 2012 [25].Mobile cloud computing allows mobile devices, such as Smartphone, to act "as a remote display, capturing user input and rendering the display updates received from the distant server"[26]. This allows for logic or intensive applications to be utilized on-the-go.

IPads and other tablet PCs are larger versions of their Smartphone counterparts, and in some cases, aim to market at a much broader and sophisticated audience, such as educational institutions and the healthcare industry. The iPad essentially is a larger version of the iPhone, which provides longer battery-life and greater processing capabilities. It utilizes the iOS operating system. Another leading mobile operating system is Google's Android OS which, according to some, can be considered to more open and customizable than the iOS [20].

B. Mobile Commerce

Cloud Computing has proven to reduce costs for business, while mobile devices are rapidly becoming an important part of daily business life. 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). The m-commerce applications have to face various challenges (e.g., low network bandwidth, high complexity of mobile device configurations, and security). Therefore, m-commerce applications are integrated into cloud computing environment to address these issues. [27] Proposes a 3G E-commerce platform based on cloud computing. This paradigm combines the advantages of both 3G network and cloud computing to increase data processing speed and security level [28] based on PKI (public key infrastructure). The PKI mechanism uses an encryption-based access control and an over-encryption to ensure privacy of user's access to the outsourced data. In [29], a 4PL-AVE trading platform utilizes cloud computing technology to enhance the security for users and improve the customer satisfaction, customer intimacy, and cost competitiveness.

C. 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 [30], [31], [32]. 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. [33] Presents benefits of combining m-learning and cloud computing to enhance the communication quality between students and teachers. Through a web site built on Google Apps Engine, students communicate with their teachers at anytime. Also, the teachers can obtain the information about student's knowledge level of the course and can answer students' questions in a timely manner.

D. Healthcare

The healthcare industry is a prominent user of mobile cloud computing. The industry had developed applications which allow patients and doctors access to information anywhere at any time, the ability to monitor patients remotely and enhance emergency response. Due to the sensitive nature of health information, mobile cloud computing for the healthcare industry faces many challenges such as data storage, heterogeneous resources, and last but least, security [20].

4 CHALLENGE

4.1 Proposed architecture

We propose an architecture such as shown in Figure 2. The component is about to store the application data and users data. Clone is a set of agents programs on both Mobile and virtual platform, to keep the offline and online applications packages and user data in the same level of coherent. These agents put mirroring files in clone which transmits to clone virtual. In this way all kinds of applications can run on the Platform Cloud (Virtual).

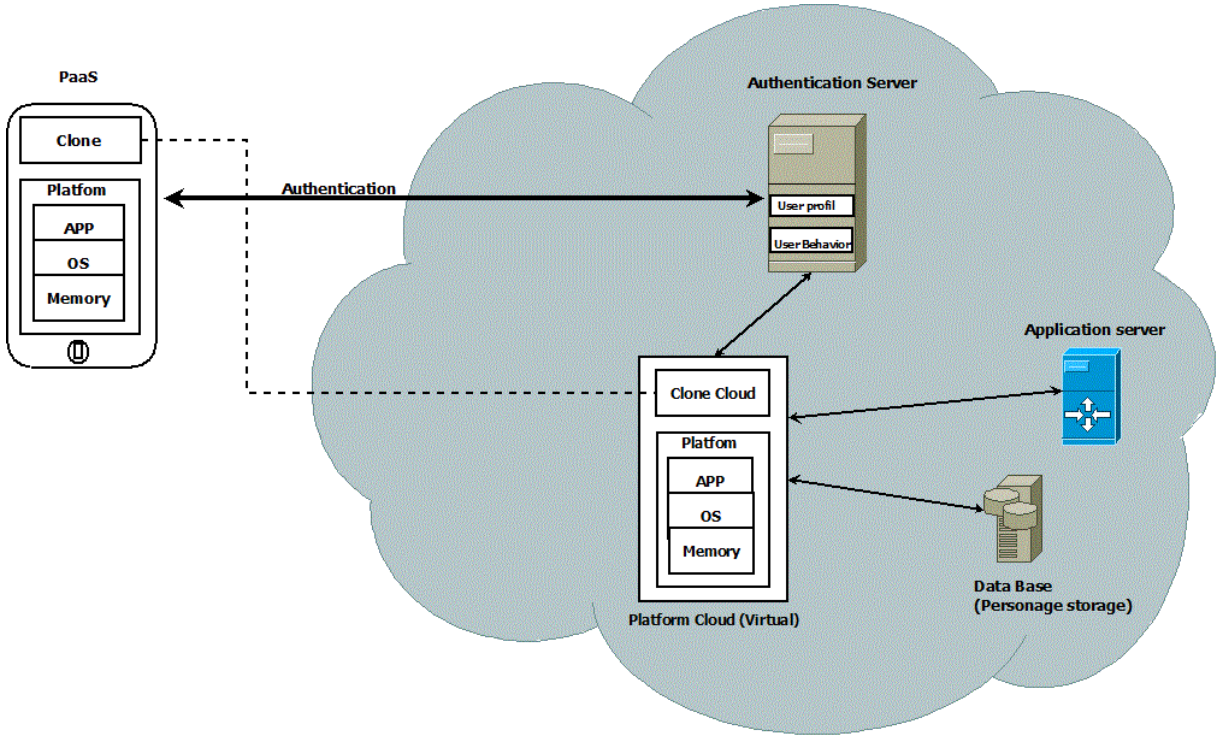

Figure 2.Clone architecture for cloud mobile device

5 CONCLUSION AND FUTURE WORK

This article has provided an overview of current mobile cloud computing. Highlighting the motivation for mobile cloud computing, we have also presented different definitions of mobile cloud computing in the literature. We have presented the approaches in which these issues have been tackled, focusing on operational level, end user level, service and application level.

As a conclusion the concept of cloud computing provides a brand new opportunity for the development of mobile applications since it will allow the mobile devices to overcome many obstacles, by combining the advantages of both mobile computing and cloud computing, thereby providing optimal services for mobile users.

As a future work we would like to develop a platform mobile cloud computing, that exploits the locally available mobile resources, while ensuring user privacy, security.The future could also explore the potential of mobile cloud computing with other areas such mobile peer-to-peer computing, dynamic Profiling, and context-awareness.

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Figures