CONTEXT-AWARE MOBILE CLOUD COMPUTING: APPLICATIONS, LIMITATIONS AND A NOVEL OF NEW SOLUTION

Rasha El Stohy, Haitham El Ghareeb, Nashaat El Khamessy

Department of Information Systems, El Mansoura University
e-mails: ratsh@hotmail.com, helghareeb@mans.edu.eg, wessasalsol@gmail.com
Egypt

Abstract: Over the past few years, Mobile Cloud Computing (MCC) has gained a remarkable interest by both research and professional community. Consequently, there have been several frameworks and pieces of models developed to support different aspects of mobile applications which have gained benefits from cloud computing resources. Meanwhile, few number of context-aware mobile cloud applications are presented before. This paper helps general readers to have a review on context-aware mobile cloud applications and its limitation. In this article; you will learn about the idea and plan for the application called "Parent". The proposed android app was implemented using Eclipse. The app has been tested and validated using real android devices. Evaluation process has proven that the proposed app offer good solution contributes in enhancing the relation between two parts-users as a parent and provider as school administration in an ICT (information communication technology) domain not focused on before.

Key words: Context-aware, Mobile cloud computing, Smartphones, Mobile applications.

1. INTRODUCTION

Mobile devices (e.g., smartphone, tablet PCs, etc.) so far are progressively turning into a key portion of human life because the handiest and convenient communication tools not restricted by time or place, yet common problems that most of those devices share and still in need to be addressed are capabilities, limitation of the devices regarding available resources such as processor power, available memory and the known energy consumption.

Accordingly, Companies are moving towards mobile clouds on-demand. Customers need the apps to allow them accessing the key applications of the companies. The employees need access from their mobile devices. In the wake of these needs,

context come to offer pertinent information and services to end user depend on his tasks, profile, or situation [1].

Several researches identify Context as set of information; this information can be used to describe the situation of an entity. An entity is a person, an object, a place or that is considered pertinent to interaction between end user and application [2].

Thus, an application or system utilizes context to offer relevant information and/or services to end user is context-aware system, this relevancy relies on the user's activity. examples of context information in mobile applications can be introduced, such as spatial information, temporal information orientation ,location, speed , acceleration, time, date from calendar and season of the year, social information - nearby friends and who accompanying you, other information like, environmental information, resources that are nearby, availability of resources, accessible devices, and hosts; cell phone screen display, battery, network, and bandwidth; blood pressure; physiological measurements, heart rate, muscle activity ,respiration rate, and tone of voice; in addition to user other activities while reading , walking, talking , running schedules and sport agendas[3, 4].

Other examples include data captured from mobile platforms within the country, traffic conditions, people nearby are and so on.

The composition of cloud computing, wireless interaction, mobile devices and user context brought up the basis for a new model, named mobile cloud computing. It gives users a remote access to infinite computational capability and memory for data storage. So, we can define “Mobile cloud computing" as an information technology concept that involves providing ubiquitous and convenient network of on-demand access to a shared pool of computing sources that may be rapidly supplied and released with minimal running fees or appeals to the company [5]. Dinh [6] mentioned in his research to mobile cloud computing as an infrastructure in which both of data container and data processing happen outside of the cell phones where computation is performed on remote servers with partial support of a cell phone’s hardware [6]. This migration process called Computation offloading which defined as a methodology enable migration process from resource-intensive computations like mobile device to the resource-rich cloud, or any server (nearby infrastructure). an applications performance can be enhanced through cloud based computation offloading, execute applications and reduces consumption of battery power, that are unable to execute due to insufficient cell phone resources [7].

A mobile cloud computing (MCC) give a helpful and fast strategy for clients to get to and get information from the cloud, this has done efficiently by using cell phones [8, 9].

In this paper, a descriptive and comparative study of MCC models that accompany with cloud computing ideas will be presented. The review of results demonstrates that present related projects cover only different subsets of the affordable mobile cloud characteristics. In this manner, a new designed model for mobile applications engaged with cloud capabilities and context-aware adoption will be also proposed.

The remainder of this paper is arranged as following: Section 2 presents an overview of MCC applications. While section 3 addresses an analysis of affordable application and thus a comparison table of existing solutions will be presented, the proposed model for called "Parent" is presented there in practical work section. Evaluation of proposed system will be focused on in section 5. Lastly, Section 6 concludes the paper and sketches some new future research work ideas.

2. OVERVIEW OF MOBILE CLOUD APPLICATIONS

Advantages of MCC have been taken from various mobile applications. In this section, some typical MCC applications are introduced.

2.1. Mobile Learning

Mobile learning (m-learning) is summarized in view of electronic learning (e-learning) and portability, for instance, utilizing a cloud the prodigious storage capacity and puissant processing capability, the applications provide learners with much richer services in terms of data (information) size, faster processing speed, and longer battery life exhibiting, combining m-learning and cloud computing offer advantages to enhance the communication quality between students and teachers. Additionally, the instructors can get the data about understudy's learning level of the course and can answer understudies' inquiries in an auspicious way, LMS implemented to provide prevalent utilizer interface utilizable in any devices including PC and mobile platforms such as Android and IOS, more about m-learning addressed in [10-14].

2.2. Mobile Healthcare

The point of applying MCC in medical intention is to minimize the constraints of traditional medical treatment (e.g., minute physical storage, medical errors, security, and privacy). Portable healthcare (m-healthcare) offers mobile users the advantages to access resources (such as patient health records) effortlessly and quickly. A limited number of MCC schemes for healthcare purpose is available include [15]:

A new system can manage and coordinates the fleet of emergency vehicles in an effective way and in shortest time after receiving calls from accidents or incidents, such system called an intelligent emergency management system.

Pervasive access to healthcare selective data permits patients and healthcare supplier to access the past and current medical information.

In the medical domain, Lin System [15] aims to implement a medical record app that can be used by patients to record, attach pictures of the affected part, make notes, and present their medical record to physicians when seeking medical support. By Show-Me System patient information can be updated instantly, stored and carried in the mobile device of the patient. All the functions and information should be operated and presented on the patient cell phone.

2.3. Mobile Gaming

Mobile game (m-game) is an electric potential business sector generating revenues for service providers. Large computing resource (e.g., graphic rendering) can be fully offload to m-game engine which requires large computing resource to the server in the cloud, in time gamers can only interact with the screen port on their devices [9].

Somaiya, Shindel and Cuervo in [16, 17, 18] mentioned in their reviews to MAUI (memory arithmetic unit and interface); where framework can empower fine-grained energy-aware offloading of mobile codes to a cloud. MAUI partitions the application codes at a runtime taking in the account system correspondence expenses and CPU utilization on the cell phone. To maximize energy savings given by network connectivity, many experiments are conducted to assess energy utilized for game applications in two cases of 3G and WIFI network. That's done as opposed to offloading all codes to the cloud for processing.

Research outcomes exhibit that MAUI not only assists in energy reduction mainly for cell phones, it was seen that energy has been saved by 27% by MAUI while the usage of video game and about 45% for chess.

2.4. Mobile Tourism

For tourism innovation, Mrs. Alshattnawi [19] built a tourist guide application, her application customizes to user preferences using J2ME and Android programming language. The system is built to be a tourist guide for Jordan, and flexible enough by allowing information changing at any time according to the desired city. For example, the system can be a tourist guide for another city by allowing GPS dimensions of the desired city from a website and correspondent information to the tourist locations, hotels, restaurants, which stored in the cloud database.

Trip Tracker [20] is an Android based application for travelers to acquire the geolocation and tag it with multimedia contents. Users create, store and view visited places and all the memories that they keep with them. Trip Tracker combines visited spots, the captured images and edited notes can be displayed on a map at the correct area where everything occurred. The developed application provides users with rich user experience by having all the information in one place, convenience in access and interactive. With the assistance of Google Maps, each place can be drawn out on the guide with all visited areas before and the taken path. Respectively, user can view location description as well.

2.5. Other Practical Applications-real time applications

To illustrate how cloud turns into a valuable tool enable mobile users while sharing photographs and video clips proficiently and tag their friends in popular social networks as Twitter and Facebook. In [21], MeLog MCC application enables cell phone users to share real-time experience (for instance travel, event, and shop-

ping) over clouds through an automatic blogging. For example travelers can be supported by several cloud services such as guiding their trip, recording itinerary, storing images and video and showing maps as well as in mobile tourism.

2.6. Mobile smart Cities

In Dianxi REAL-TIME TRAFFIC DEMO [22], most of city cell phones could be utilized to gather the contexts of location, speed and send them to the cloud. Gathered contexts will be aggregated in the cloud, and then a city real-time traffic information will be acquired.

In his experiment, one PC is used to simulate the context of vehicle ID, location, and speed. Then the context data sent to the cloud. One mobile phone runs the app to get real-time traffic information, in time there is no application server in this demo. Periodically, the Hadoop cluster executes a MapReduce job to aggregate contexts. The recent received contexts are the input data of the MapReduce job, and the output data of the MapReduce job is traffic data. In this demo, because the real-time contexts are only considered, the historical contexts are not considered.

Regarding to cities challenges in terms of crowdsourcing with data quality collection, service interoperability and data storage infrastructure, Khan et al [23] proposed a conceptual framework to address challenges regarding to cities challenges regarding crowd sourcing with information quality gathering, service interoperability and data storage infrastructure in addition to presenting cloud-based context-aware services for smart cities.

His proposed system is to build up a guide for the cloud-based and context aware services improvement for citizens in smart cities. The framework expects to build artefact including data models, process models to correspond data in view of end clients preferences, contextual models, citizen participates in data collection, cyberspace infrastructure, and service federation. Results indicated that citizens' participation improved quality of life especially in crimes and safety situations due to using this framework.

2.7. Mobile Context-aware Communication Systems

For utilizing contextual data available on the cell phone like in[20], where authors refer to ContextPhone, a platform for Symbian OS dependent smartphones using (e.g. Nokia Series 60) in which designers can create applications adjusted with the utilization of contextual such as location, surrounding Bluetooth devices, phone alarm profile, information about calls. ContextPhone must be installed on user's cell phone; its communication module empowers sharing of contextual data and supports the storage of sensed context. The data set of phones' contextual information was built from the logs of this platform and used in many studies, like which in the reality mining, authors in [24], others in [25] and [23, 26] have presented a social recommender system for context-aware mobile services. The proposed services are a location-based service such as ad, maps, route service. A case of the top class of services

the conveyance of maps improved with point of interest (POI) information. The target of these services is to utilize contextual information recovered from the client device (e.g. GPS location), in addition to user activities to help them finding products, friends, services, POIs, and management of their day, About provisioning a context-aware media recommendation framework for mobile devices, Moradeyo [27] proposed CAMR, it gives components of consequently conveying media content suggestions, based on dynamic contexts inferred from client's cell phone installed sensors. It captures and utilizes the dynamic contextual information, practically client mobile activities, which related to client contextual information preference, that's for choosing appropriate and important online media content, customizing it for particular clients in context. The proposed solution is extensible, and addresses different categories of media content domains such as movie, music, news, so forth.

Comparison of the MCC applications is presented in the Table 1.

Table 1. Comparison of Mobile Cloud Computing Applications

Application model	*Domain*	*Solution Generality*	*Technology used*	*Code complexity*	*Cloud integration*	*Context-aware provisioning*	*Dynamic adaptation*	*Network load*	*Scalability*
Pocatilu	m-learning	high	Soap,studIP LMS,PHP,Sql	low	-	high	-	low	medium
Show-ME System	m-healthcare	high	XML,,J2me	high	-	medium	low	low	medium
@Health-cloud system	m-healthcare	medium	Restful WS	Low	high	-	low	high	high
MAUI	m-games	high	.NET,CLR	medium	high	-	high	low	high
EGTS	m-tourism	low	J2me,android,HTML	medium	high	medium	low	high	medium
Dianxitraffic	Smart-cities	low	Mapreduce algorithm	Low	high	medium	high	low	low
Khan et al		low	XML	low	high	medium	high	low	high
HEP	recommendation systems	High	Java,Restful WS	medium	medium	Low	High	low	-
CAMR		medium	Restful Ws,JavaEE,Mysql	medium	-	high	-	low	medium
Biarcalona system		Medium	Google API	high	Low	medium	high	medium	medium

3. ANALYSIS ON MCC APPLICATIONS & ITS' LIMITATIONS

As Cloud computing is a revolutionary idea to support mentioned services, It has been noticed that integration of cloud and context awareness still struggling and lacks from insufficient usage in context resources including user context, such as

device calendar time,location, user profile and physical context like traffic conditions, lighting, weather and other environmental information as a source of context terms [2].

Our proposed solution promises to collaborate more than context sources in a MCC solution to enhance relation between two parts-students' parents as a mobile users and school administration as service provider in an ICT (information communication technology) domain not focused on before.

The web service of OpenWeatherMap [28] offers several API to get weather information, a specific class that handles this task has been created. Furthermore, the application can automatically push alarm in case of bad weather situations, snap of android alarming code illustrated below:

```
StringUrl ="http://api.openweathermap.org/data/2.5/weather?q=cairo";
client.get(Url, new AsyncHttpResponseHandler()
tem=Double.parseDouble(_ReturnedFromWeather.main.temp)-273.15;
if(tem<15||tem>30)
{if(tem<15){
mesg="Take Care : It's coldest today : ";
}
if(tem>30)
{
mesg="Take Care : It's hot today : ";
```

4. PRACTICAL WORK

For enhancing relation between two parts as mentioned above, an interview with sample of parents and administration staff took place to discuss participates ' needs, we collect their ideas regarding what they want to be delivered, the school administration ideas were also conducted, in this interview about 80 persons participated, 60 of them are presented as students' parents. All of participants were aged between 23 and 50 years old, we investigated their requests toward receiving real time notification particularly an alarm one while their kids are preparing for new school day.

Consequently, Parent system has been proposed. Fig. 1 depicts the basic architecture of the proposed System. Parent is a mobile notification system; the system was designed with three major components.

An android client application, cloud server application and remote Web service. Fig. 2 gives an overview of system implementation. In order to store parent personalization data, an SQL database instance was deployed remotely in the cloud on the Azure portal, where parents email, mobile phone and school name, location were offloaded remotely at the cloud.

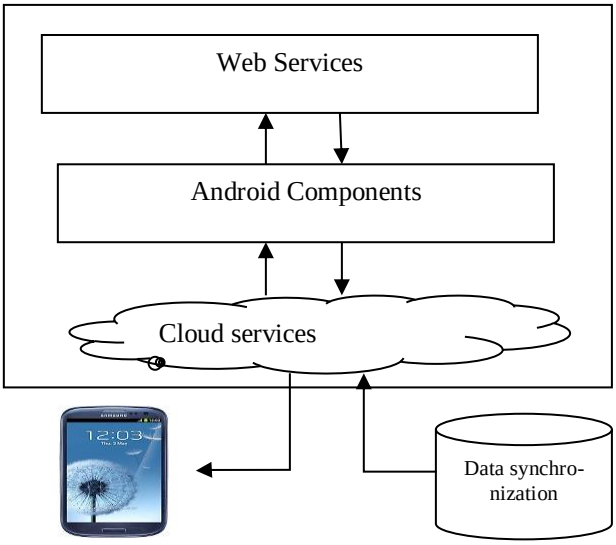

Figure 1. Parent system architecture

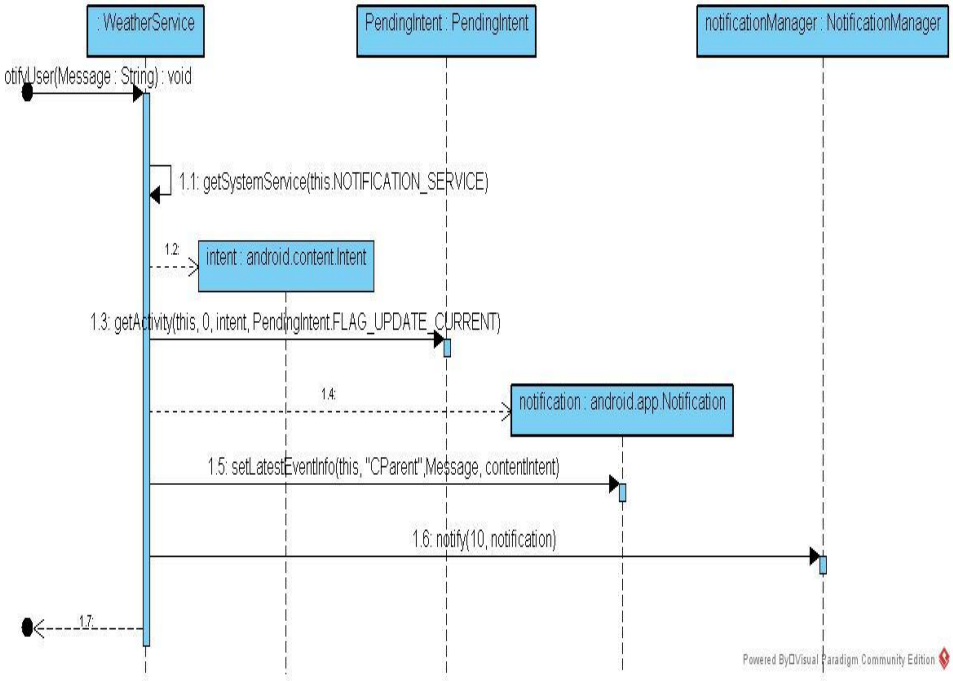

Figure 2. Weather Service Sequence Diagram

At our client android application, the application utilized context-aware information in the form of time, location and metrological data, additionally; it utilized context-aware information from the cloud-integrated backend server. To develop the client application, an android service class extend android service has been utilized to connect with the Openweather API, as a web service provider.

5. EVALUATION AND RESULTS

In this part an application for Android push notification service has been developed and tested on real Samsung Galaxy S3 device as depicted in fig. 3, 4. The testing set up is based on one PC with 1.4 GHz and 3 GB of RAM used to build the android client application and database model.

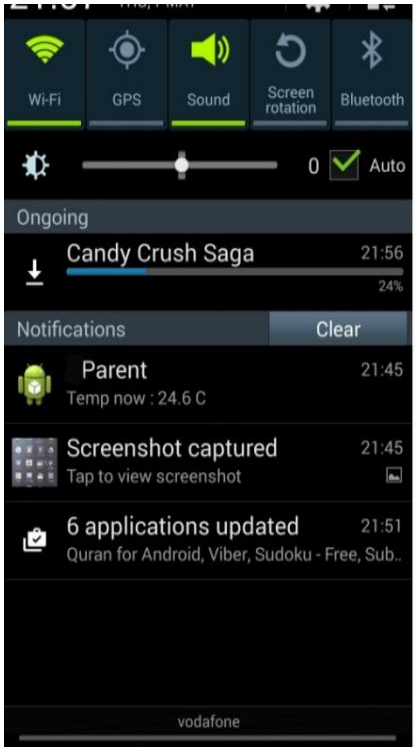

Figure 3. Parent weather notification screenshot

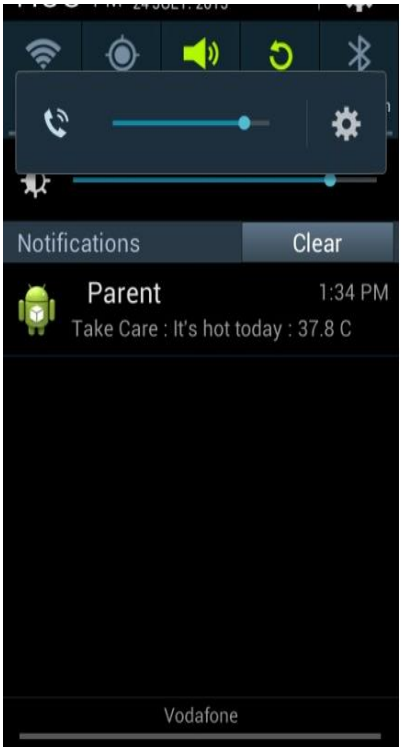

Figure 4. Parent alarm notification screens

The main tasks of this machine were to access data storage in the cloud server with high scalability and minimal traffic consumption for use in poorly developed Internet network countries, thus, Microsoft azure [29] has been selected as a suitable

cloud provider with adequate "pay as you go" model. Openweathermap API provides free metrological data returned back in RSS format.

Same sample participated in interview phase has joined in testing phase using their android phones, after two testing weeks, a questionnaire checked people's opinion and tried to spot trends.

All participants had previous knowledge of mobile phones and mobile communication, but had not previously used the type of application employed in this test, questionnaire statements shown in table 2.

Table 2. Questionnaire Statements

No	***Statement***
1	The app don't consume my device resources (battery, CPU)
2	Pushed messages time accurate & appropriate.
3	User needs is considered in suggested services.
4	This mobile service is helpful and I satisfy in using it

After deep analysis from staff and parents feedback, it's found that experiment results exposed positive facts about app performance, overall impression is depicted in Fig. 5, highlighting majority of users trends, we found that notifications are light messages and don't consume a lot from their time and device resources, pushed messages time accurate and appropriate as well, most of participants feel comfort towards using this mobile app.

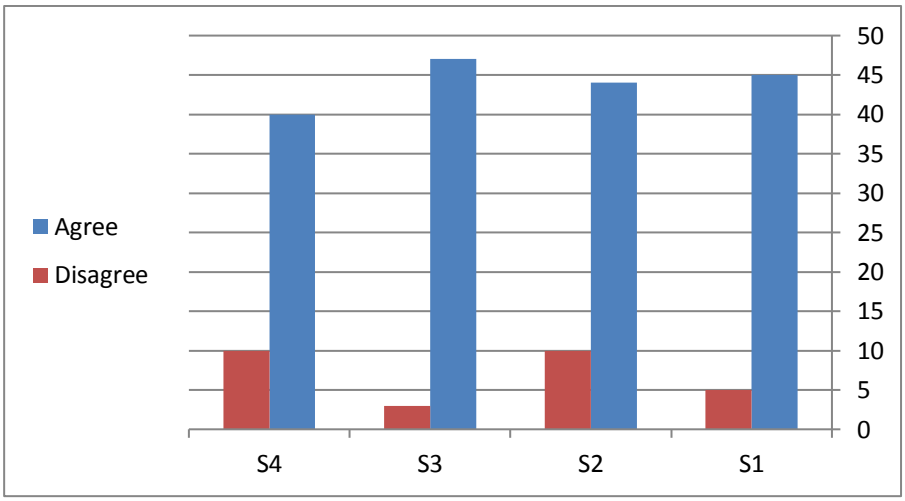

Figure 5. Parent app questionnaire feedback

6. CONCLUSION

This paper presents the most related context-aware mobile cloud applications and frameworks have been investigated. Discuss & compare recent frameworks and models in order to gain some ideas leads in proposing a new innovative MCC application serve multidimensional purposes and benefits from new mobile cloud techniques.

The presented MCC solution considered the highly recommendation of MCC generality, which is extremely relevant in recent years, to cover easy reuse of platform components, gaining benefits from offloading techniques to cloud based resources to minimize network load, resources consumption including device battery consumption, memoryusage ,CPU utilization, and support unlimited scalability.

To assess proposed android system, Parent app has been implemented in java language using Eclipse which has the ability of extensibility and allow the reuse of Android components with medium complexity code to broadcast notifications from web services, Parent app designed to support working in low bandwidth, with full cloud computing integration , context-aware provisioning and high adaptation with device situation, Parent app tested on real device, the evaluation process imposed comfort feeling for using Parent app from user perspective. The research opens up future work to evaluate the extension of the android components including device calendar, sensors usage and integration with other cloud capabilities, perhaps some analytics should also be used in order to measure the app's performance, profitability of the push services rather than other mobile platforms push techniques can be studied.

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Information about the authors:

Eng. Rasha el Stohy – is a PhD researcher at faculty of Computers and Information, De apartment of Information Systems, she works as lecturer assistance and interested in mobile computing, mobile learning, mobile services, cloud computing, environmental technologies management information systems.

Dr. Haitham el Ghareeb – working as a lecturer at Faculty of computers and information, Department of Information Systems, He is interested in e-learning, enterprise architecture, information architecture, and software architecture, especially in Service-Oriented Architecture (SOA), Business Process Management (BPM), Business Process Management Systems (BPMS), Information Storage and Management, Virtualization, Cloud Computing, Big Data.

Prof. Nashaat el Khamesy– working as a professor at Sadat Academy for Management Sciences, Department of Information Systems, He did his Ph.D. in Software Engineering at Ohio, USA, he is interested in computer distributed systems & Networks, Database management systems and Operating systems.

Manuscript received on 08 February 2017

Revised paper received on 13 April 2017