A Cloud Computing Platform to Augment Mobile Phone Use in Marginalized Rural Areas

Thoba Lose and Mamello Thinyane
Telkom Centre of Excellence in ICT for Development
Department of Computer Science
University of Fort Hare, P. O. Box X1314, Alice 5700, RSA
Tel: +27 40 6022464, Fax: +27 40 6022464
Email: {tlose, mthinyane}@ufh.ac.za

Abstract: The proliferation of mobile devices and the recent developments in computing technology hold the potential of addressing the digital divide challenge, which is pertinent in Marginalized Rural Areas (MRAs). Simultaneous developments in cloud computing also provide new ways of offering innovative ICT solutions, typically in enterprise environments. Mobile Cloud Computing, which is a combination of mobile computing and cloud computing, provides ideal services to support mobile users in MRAs. In Mobile Cloud Computing, mobile devices do not need high-end resources (e.g., processing speed, storage and memory capacity) since all the data and complex computing can be offloaded to the cloud. In this research, we propose the use of Cloud Computing infrastructure to augment the use of mobile phones in Information and Communication Technology for Development (ICTD) contexts. We investigate the kinds of services the cloud can offer to improve and support the use of mobile phones. We also aim to implement a Mobile Cloud Computing Platform for use within an ICTD intervention, called Siyakhula Living Lab (SLL).

Index Terms—Mobile Computing, Cloud Computing, Mobile Cloud Computing, Information and Communication Technologies for Development, Siyakhula Living Lab

I. INTRODUCTION

Information and Communication Technology (ICT) has emerged as one of the most innovative technology areas impacting a wide range of industries, business models and social patterns. Currently, the new challenge for reducing the digital divide in developing countries is to improve access to ICT, especially through mobile phones [1, 2]. For many developing countries, phones and Internet connections have reached the general public through fixed line infrastructure. Mobile cellular technology has been the most rapidly adopted technology in history. Today, it is the most popular and widespread personal technology on the planet [3].

According to the International Telecommunications Union (ITU), developing countries have increased their share of the world’s total number of Internet users from 44% in 2006, to 62% in 2011. With 5.9 billion Mobile-cellular subscriptions, global penetration reaches 87% and 79% in the developing world. “Mobile broadband subscriptions have grown 45% annually over the last four years and today there are twice as many mobile broadband as fixed broadband subscriptions [4].” There is currently no indication of the mobile phone usage trend slowing down in developing countries. As mobile phones converge and provide banking, education, health, agriculture and entertainment services, it is difficult to anticipate or predict their future use trajectory.

Cloud Computing (CC) technology enables individuals and businesses around the world to connect to data, information and computing resources anywhere and anytime: reducing cost, increasing storage, automating systems, and decoupling service delivery from underlying technology. It enables developing countries, with limited IT resources, to participate in the global knowledge economy on an equal footing with developed nations, through accessing IT resources in the cloud [3, 5]. The main concept behind CC is providing services; namely, Software as a service, Platform as a service and Infrastructure as a service. The combination of CC, wireless communication infrastructure, portable computing devices, location-based services, and mobile web computing has laid the foundation for a novel computing model, called Mobile Cloud Computing (MCC), which allows users an online access to unlimited computing power and storage space, taking CC features to the mobile domain [5].

The current mobile device market in third world countries consists of a plethora of phones. While it is true that smartphones will grow in percentage and feature phones will become more sophisticated in time, there is no indication that these lower-end phones, which are prevalent in the developing world, are going away anytime soon [6]. The feature phones and lower-end phones are anticipated to be the main driver behind the MCC trend. Not only is there a larger number of people using feature phones in the world, there are also more web developers capable of building mobile web applications [6].

In this research, we view MCC as a potential technology to augment mobile phone use in marginalized rural areas. Mobile cloud applications offload the computing 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 users.

II. RELATED WORK

A number of cloud based mechanisms have been suggested to improve the capacity and reliability of mobile devices. Marinelli introduces Hyrax, a MCC client that allows mobile devices to use CC platforms [7]. Hyrax allows applications to conveniently use data and execute computing jobs on smartphone networks and heterogeneous networks of phones and servers. Research has been focused primarily on the implementation and evaluation of MCC infrastructure based on MapReduce [7]. The problem with this mechanism is that it only supports Android based mobile devices.

Giurgiu et al. [8] use the cloud as the container for mobile applications. Applications are pre-processed based on the current context of the user, so only the bundles that can run on the local device and minimize the communication overhead with the cloud are offloaded to the mobile device from the cloud. They focus on partition policies to support the execution of application on mobile devices, and do not tackle any other MCC related issue.

Huerta-Canepa and Dongman envision a way to overcome the problem of cost and availability of the cloud by creating a virtual CC platform using mobile phones [9]. This mechanism imitates a traditional cloud provider using mobile devices in the vicinity of users. They argue that due to the ubiquity of mobile phones and the enhancement in their capabilities this idea is feasible. The problem with this mechanism is that it assumes the nearby nodes are in stable mode, meaning that they will remain on the same area or follow the same pattern as if riding on a bus to some destination.

III. OBJECTIVES AND METHODOLOGY

In this research we propose that: ***Cloud Computing can be implemented in an efficient and scalable manner to augment the use of mobile phones in rural/marginalized communities.*** This statement will be validated through the development of an efficient and scalable MCC Platform for ICTD contexts (e.g. SLL). This will entail investigating how to utilize CC technologies to facilitate one of the grand visions of modern IT: anytime, anywhere computing. We aim to identify and develop services that will leverage the plethora of phones that exist in marginalized communities – services such as cloud storage, cloud-based VoIP services, and cloud-based messaging services. The MCC platform will be developed using one or a combination of the following emerging cloud software environments and existing platforms: ownCloud, Eucalyptus, OpenNebula, OpenStack, OpenMobster, Twilio API, Open Cloud Computing Interface (OCCI), and Cloud Data Management Interface (CDMI). When evaluating the system we will take into consideration various important aspects of MCC systems. These include computational and communication requirements, mobile network impact, energy considerations, information security, system reliability and application usability.

IV. THE GENERAL MCC ARCHITECTURE

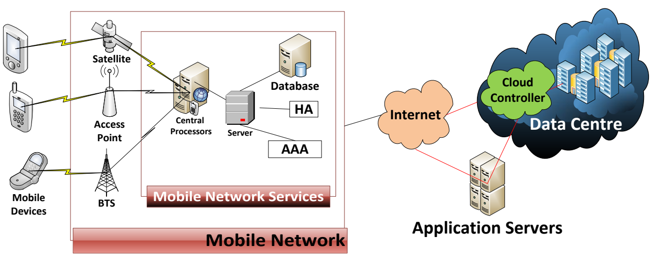

Figure 1: The General MCC Architecture (adapted from 10)

The general architecture of MCC, as proposed by Hoang et al. [10] is shown in the figure above. Mobile devices are connected to the mobile networks via base stations that establish and control the connections and functional interfaces between the networks and mobile devices. Mobile users' requests and information 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 authentication, authorization, and accounting (AAA) 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 [10].

V. CONCLUSION

In this paper, we have introduced CC and also examined existing solutions for MCC. The evolution of mobile applications enabled via CC technology for use in developing countries clearly unfolds a much greater opportunity for developing countries to participate in the global knowledge economy on an equal footing with developed nations. ICTD clouds will greatly enhance and bring dramatic improvements to existing development efforts. In this research, we see CC as a promising technology with interesting implications that can offer many benefits for mobile devices in marginalized rural communities.

VI. ACKNOWLEGEMENTS

This work is undertaken within the Telkom Centre of Excellence in ICT for Development. Financial support from the National Research Fund (NRF), Technology and Human Resources for Industry Programme (THRIP), Telkom SA, Tellabs, Saab Grintek Technologies and Easttel is hereby acknowledged.

VII. REFERENCES:

[1] Yang. Z, (2011), "*Looking Beyond Utility Model – Disruptive Cloud Computing for Future ICT4D Research*", International Conference on Computer Communication and Management.

[2] Taher. A.S, Tsuji. M, (2011), "*The Development of ICT for Envisioning Cloud Computing and Innovation in South Asia*.", International Journal of Innovation in the Digital Economy.

[3] Goundar. S, (2010), "*Cloud computing: Opportunities and issues for developing countries*", DiploFoundation.

[4] ITU, (2011), "*ICT Facts and Figures; the World in 2011*." [Online] Available: http://www.itu.int/ITU-D/ict/facts/2011/material/ICTFactsFigures2011.pdf

[5] Bajad. R. A, Srivastava. M and Sinha. A, (2012), "*Survey on Mobile Cloud Computing*", International journal of Engineering Sciences and Emerging Technologies.

[6] Mallikharjuna. N. R, Sasidhar. C and Satyendra. K. V, (2011), "*Cloud Computing Through Mobile-Learning*"

[7] E. Marinelli, (2009), "*Hyrax: Cloud Computing on Mobile Devices using MapReduce*," Master Thesis Draft, Computer Science Dept. CMU,

[8] Giurgiu. I, Riva. O, Juric. D, Krivulev. I and Alonso. G, (2009), "*Calling the Cloud: A Look at Cloud Mobile Convergence*", International Symposium on Ubiquitous Virtual Reality, vol.0.

[9] Huerta-Canepa. G and Dongman. L, (2010), "*A Virtual Cloud Computing Provider for Mobile Devices*". ACM Workshop on Mobile Cloud Computing and Services: Social Networks and Beyond.

[10] Hoang. D.T, Lee. C, Niyato. D and Wang. P, (2010), "*A Survey of Mobile Cloud Computing: Architecture, Applications and Approaches*". Wireless Communications and Mobile Computing, Wiley.

Thoba Lose obtained his B.Sc. Honours (Computer Science) in 2011 from the University of Fort Hare and is presently studying towards his Master of Science degree at the same institution. His research interests include Internet Services and End User Applications, ICTD and Cloud Computing.