Future Directions of Converged Services in the Web Session Mobility Scenarios

Michael Adeyeye (*Member, IEEE*)
Department of Information Technology
Cape Peninsula University of Technology, South Africa.
adeyeyem@cput.ac.za

***Abstract*—The future directions of converged services in the Web session mobility scenarios are presented in this paper. The architecture used in the work is a composite system that is made up of a SIP integrated web client and a Converged (SIP and HTTP) Application Server. It uses SIP to migrate web sessions between two web clients. The work evolved overtime to a framework for developing converged services over the Internet like the Google Wave. An evaluation of this work with the Google Wave is discussed in this paper. In addition, recommendations on how to improve the work are discussed. Lastly, the paper points at research areas and models requiring SIP, HTTP and XML that could later be explored.**

***Index Terms*—Google Wave, Open API, Web client, Service Convergence**

I. Introduction

Convergence means different things to different people and is taking place across numerous areas; examples are network convergence, service-convergence and device convergence. Network layer convergence is taking place in networks with focus on technology convergence. While application layer convergence is taking place in the provision of telecoms, the Internet and entertainment services, device layer convergence is taking place in hardware and software manufacturing, which has resulted into new handsets and computer equipments. There are three main technology trends that are influencing the future of the communications industry. They are IP based networks, the growth of Web 2.0, and the advancement of devices [1], and the three trends have sequentially led to network convergence, service convergence and device convergence. The interplay of the trends will determine the kind of services that will be available in the future. These services are however envisaged to be converged services. Owing to this technological evolution, communications service providers (CSPs) may soon no longer be the primary market drivers of communications services but increasingly drift towards a role of mediator and change-enabler [2].

The first major changes taking place in the communications industry can be seen in the variety of network technlogies. These changes are faster network speeds or broadband access, introduction of mobility and development of IP-based architectures. The second major changes taking place in the communications industry can be noticed in the developments in Web 2.0. The developments have enabled Telco Service Providers to expose their services, telco-ICT enablers to bring together numerous applications and people to produce and consume composite services. The combinations of potential new services are nearly limitless. The third major changes taking place in the communications industry are in advancement in devices, which has allowed customers to fully benefit from converged offerings.

Future Internet requires innovative concepts for networking and service evolution. Openness, self-organization, self-adaptation, improved flexibility and hiding management and operation complexities to users and operators are features expected in the future Internet [3]. With the convergence of the Internet, Broadcasting and Telecommunications, there are

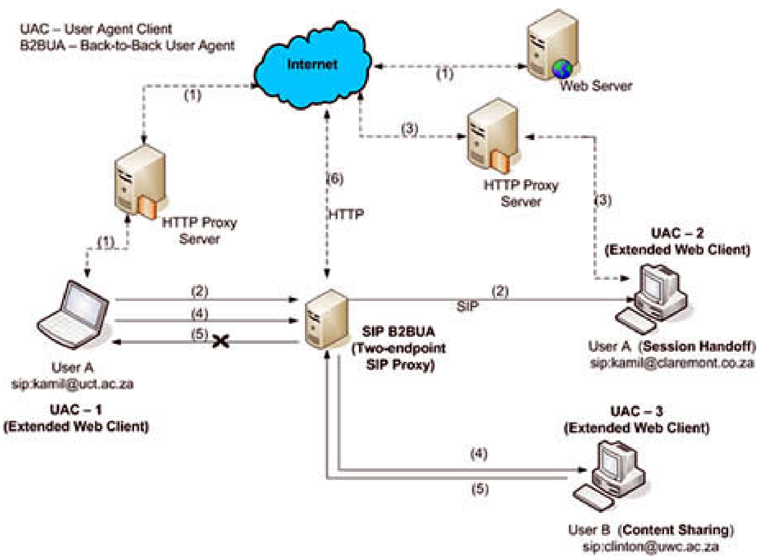

Figure 1. The Hybrid-based Architectural Scheme

many technological possibilities and business models. The future of the Web, as anticipated, can only be achieved where the best of Internet protocols and technologies - XMPP/SIP, HTTP and XML are used. Researchers and industry experts have provided frameworks and service delivery platforms for converged services provision by leveraging these protocols. This paper presents technical contributions of a SIP-based hybrid architecture that leverages SIP, HTTP and XML to provide converged services. In addition, it highlights the future industry research directions and future academic research efforts that could help improve the work. This paper also

978-1-61284-993-5/11/$26.00 ©2011 IEEE

discusses the comparisons of the work with the web and telephony application development tool called the Google Wave.

II. A SIP-Based Hybrid Architecture for Converged Services in the Web Session Mobility Scenarios: Technical Contributions

A distributed hybrid-based architecture shown in Figure 1 was proposed and implemented for content sharing and session handoff between two web browsers. Content sharing is defined as the ability to simultaneously view the same Web page on two browsers at the same time, by typically transferring only the Web page Universal Resource Locator (URL); session transfer is defined as the ability to move the whole Web session, including not only the Web page URL, but also all needed session data (cookies, hidden form elements and rewritten URL). The architecture is a composite system that is made of heterogeneous elements - an extended web client and an application-based SIP proxy; hence, it is called a hybrid-based architecture. The interaction in Figure 1 is between extended web browsers, enhanced with SIP capabilities, and acting as SIP UACs and a two-endpoint SIP proxy that coordinates browser-to-browser interactions. SIP proxy enforces (via SIP, solid arrows in Figure 1) web session blocking or forwarding by using standard SIP user identities and access policies declared by the users.

The increasing request for converged multimedia services has motivated relevant standardization efforts, such as the Session Initiation Protocol (SIP) to support session control, mobility, and interoperability in all-IP next generation wireless networks. Notwithstanding the central role of SIP in novel converged multimedia, the potential of SIP-based service composition for the development of new classes of Web 2.0 services able to interoperate with existing HTTP-based services is still widely unexplored. As a result, the specific contributions of this work, a novel SIP-based application in the web session mobility scenarios, are highlighted below.

First, a novel service, referred to as content sharing and session handoff between web browsers, has been provided [4]. This implementation has provided a fast and efficient way of referring someone else to the same web page currently viewed by the referrer rather than the slow way of copying, pasting and sending the URL in a chat session or an email. While [6], [7] broke the IETF RFC 2616 and 2965 specifications in their implementations, this work has provided a way of transferring a stateful web session from one PC to another that does not break the specifications.

Second, integrating a SIP stack into a web browser offers the advantage of extending a web browser to act as a SIP client [4]. In this case, web browsers can now act as SIP clients thereby setting up multimedia session between two or more users. Most notably, web browsers now have unique SIP addresses to interact with one another like PCs, which have unique Media Access Control (MAC) or IP addresses.

Lastly, a plethora of control services that prevent abuse of the content sharing and session handoff service were introduced [5]. The web browser extension, developed in this work, co-ordinates with the novel SIP-based Converged Application Server, which was also developed in this work, to enable session mobility and prevent abuse of its services.

Currently, there is no agreement on what the future Internet technology will look like. It is however obvious that the online experience can only be improved when there are additional protocols that HTTP could interact with. This work, through its services, has just shown one of the ways of improving the online experience.

While other related works were for experimental purposes (and mostly explored session handoff) [6], [7], [8], this is a reference system for converged application development, which could be easily deployed for general use. The converged services here – Web session blocking and forwarding, content sharing, session handoff and session tracking, to mention a few - require HTTP and SIP to work. This is a new social network service for sharing URLs, moving web sessions and providing a multimedia service among peers. Services in the proxy are called control services because they prevent abuse of the client services. Results showed that the services are feasible; they could be provisioned at a minimal cost and do not necessarily need high performance PCs. Figure 2 shows the message exchange between two PCs or Web clients. The architecture proposed and used here is a hybrid-based architecture that requires extending a Web browser and implementing a proxy server. The interaction could be between Web browsers running on PCs or smart devices and it transverses the proxy, which co-ordinates the interaction. The interaction, however, varies among Web browsers, based on users' policies and the kind of service chosen by the users.

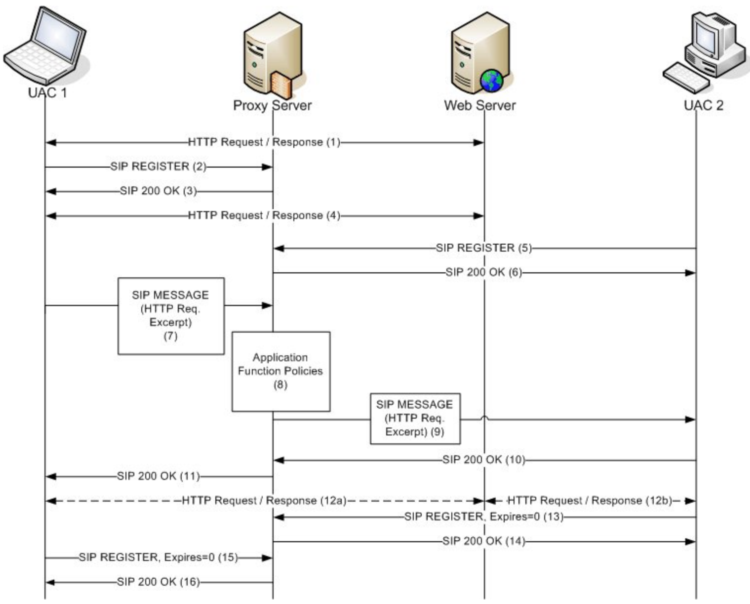

Figure 2. The Message Exchange between Web clients

III. Emerging Web 2.0 Models and Tools: The Google Wave

Table 1 shows the comparison of this work with the Google Wave. Google Wave, which is now referred to as Apache

Wave, is a new tool for communication and collaboration on the Web. It uses an open protocol [9], [10], so anyone can build their own wave system.

The Google Wave API allows developers to use and enhance Google Wave through two primary types of development, namely Extensions and Embed. The Extensions represent the server-side, while the Embed represents the client-side. The extensions (also called the Robots API) can be developed using the Java Client Library, Python Client Library, or Gadgets API, while the embed, which is embedded into a Web application, is always written in JavaScript.

Table I
COMPARISON OF GOOGLE WAVE AND TRANSFERHTTP+CAS

	Google Wave	TransferHTTP+CAS
Client Technologies	JavaScript in HTML	XUL and JavaScript
Server Technologies	Python/Java/ Gadget	Java (HTTP/SIP Servlet)
Architecture	Server-based	Hybrid-based
Protocol	Wave (Extension to XMPP)	SIP

The Google Wave and this work (TransferHTTP+CAS) provide the same services, though over different architectures. While the Google Wave API is used to develop applications that reside on a web server, TransferHTTP APIs are used to develop applications that reside at the client end. For example, the Click-to-dial in Google wave [11] requires the server to set up a call session, while in TransferHTTP, the client sets up the call session. In Google Wave, the robot in the web server is responsible for the signalling, while in TransferHTTP, the SIP stack in the browser does the signalling.

The Google team has separated the signalling (HTTP and XMPP) in a bid to maintain the current web architecture. The Extensible Messaging and Presence Protocol (XMPP) stack [12] in the Google Wave resides at the server, and its APIs are written for third-parties to help them develop converged applications. Hence, it could be referred to as a server-based architectural framework for service creation. In this work (TransferHTTP+CAS), a SIP stack is integrated into a browser to provide similar services. It was found out that the integration of a SIP stack into a browser does not impede its performance thereby making this work a viable approach to create converged services. A hybrid-based architectural framework is created in which services could be provided by the client using the TransferHTTP APIs. In addition, a number of services could also be provided by the proxy component (CAS). These proxy services could prevent abuse of the services offered by the client. They are meant to control the interaction between the browsers. While the proxy services could be developed using the Mobicents SIP Servlets and JAIN SLEE APIs, the client services could be developed using the TransferHTTP APIs.

In summary, irrespective of the technologies or programming languages used in the Google Wave and this work (TransferHTTP+CAS), the difference between them is that the Google Wave only has a stack (an XMPP stack) in its server, thereby making it a server-based architectural framework for service creation, while TransferHTTP has a stack (a SIP stack) both in its client and proxy, thereby making it a hybrid-based architectural framework for service creation.

IV. Future Directions of this Work

A. The Industrial Research Directions

Below are the four industrial research directions that could be looked into to improve this project.

1) **Improving the HTTP Session Mobility Service**
There was a problem encountered during the test of the HTTP session mobility service. The exact web browser's state could not be reproduced when session handoff was carried out on Mashups, AJAX-based and FRAME/IFRAME-based websites. A probable solution to this problem is to capture the web browser's running state at the source UAC and reproduce at the destination UAC. This solution is highly technical but could be achieved by the developers of web browsers.
While a session-based cookie expires in a short time of inactivity, a persistent cookie could provide access to a website over a long period. An improved session management mechanism could be integrated into CAS so that a session handoff request could be held for a long time without expiring when the destination SIP address cannot be reached or a web server uses a session-based cookie. This feature could ensure that all session handoff requests do not expire for a certain period specified by the user.
2) **Extending TransferHTTP and CAS Interfaces to support Buddy list with Presence**
An address book with presence of contacts could be integrated into the web browser extension - TransferHTTP. Alternatively, CAS could be extended to provide the buddy list with presence. The integration of an address book or buddy list with presence would make it easier to retrieve the destination SIP address and could make it possible to send requests to two or more people at a time.
3) **Multi-domain Implementation**
Although the proposed architecture was implemented using a SIP server(i.e. over a single domain), it could be extended to support multiple domains or servers. That is, the implementation or deployment of this reference system could involve multiple CASs. To achieve this, the SIP application could be deployed on a Service Delivery Platform (SDP) that supports multi-domain, such as the IP Multimedia Subsystem (IMS). Testing this work in an environment like the IMS would provide more stimulating scalability results.
4) **Further Enhancement to the web browser extension**
Although SIP MESSAGE method is used in this implementation to transfer the web session data, the implementation can still support instant messaging (IM) between two UACs. To extend the extension to support IM, messages that are not wrapped in the XML format [4] for session transfer should be made to appear in a chat box UI. While this work shows interaction between web browsers running on PCs, the work could also

be extended to web browsers on mobile devices. The stream media to call service, which is based on a P2P architecture, could also be extended to a client-server architecture (i.e. a broadcast service).

In addition, the web browser extension could be extended to support full multimedia services including IP Television (IPTV) [21], [22], and Internet TV. In general, it could be extended to support features available in the IMS clients. New plug-ins/codecs could be integrated into web browsers in order to support file formats that are available in the IMS. For example, the video media type "video/3gpp" in the IMS has a file extension ".3gp" for video files.

Lastly, this project could be extended to work with other IM services, such as GTALK, AIM and Yahoo Messenger. As earlier stated that an address book could be integrated into this project, the address book could be linked to users' address books from those IM services, and a suitable gateway, such as SIP-XMPP gateway, could be provided so that the web browser extension (TransferHTTP) could work with those IM services.

B. Academic Research Efforts

The two academic research efforts that could be explored are discussed below.

1) **A SIP-based Web Services Model for Internet Telephony Services**
The web services framework is built around SOAP. Although SOAP could act as a middleware to exchange information between peers in a decentralized and distributed environment, like SIP is used in this project, SIP outperforms SOAP in terms of routing messages, ensuring reliable delivery over an unreliable transport, ensuring security of message exchange and correlation of multiple SOAP messages [23].
An Internet telephony endpoint, such as a PDA or a 3G phone, is often resource restricted. It usually has low battery life, limited processing power and constrained storage space. Integrating a web services framework into the resident SIP stack on such devices could be challenging. However, an XML parser and a small footprint SIP stack, which are loosely or tightly coupled, could enable an Internet telephony endpoint to participate in the web services model. With numerous works exploring ubiqitious access to services [24], [25], [26] and convergence between Internet telephony services and web services [**?**], [27], [28], this model could be explored.

2) **Smart Home Services via a SIP-based Web Browser**
The evolution of both mobile and home networking technologies offers opportunities for supporting the interoperation between mobile devices and devices residing in a home network. The transition to an all-IP wireless infrastructure in the mobile domain means that SIP is likely to be embedded into the next-generation mobile devices. Home networking technologies, such as Jini, UPnP and HAVi and protocols, such as Firewire, Bluetooth, X10 and IEEE 802.11, are proliferating the home networking market. OSGi [29] is one of the frameworks being defined to help manage the diversity and heterogeneity inherent in home networks. It is a Java-based framework that supports the delivery, activation and execution of services (called bundles) to home networks. It is independent of lower-level communication protocols and provides a middleware layer that can accommodate a variety of networking technologies [30]. Numerous works have already investigated the interoperability between SIP and the OSGi framework [30], [31], [32]. Although most works used a SIP-based device to control the smart home services, using a SIP-based web browser to control the services is very practicable. While the SIP endpoint in the web browser works at the control plane, the HTTP endpoint could help display the schematic diagram of the environment. A mashup service that renders, monitors and controls smart home services via a SIP-based web browser could also be explored.

V. Conclusions

While session handoff has been widely explored, content sharing and the proxy services are relatively new services in the web-browsing context that could encourage collaboration or community interaction between the Internet users. Having shown that the integration of a SIP stack into a web browser makes no significant change on the memory footprint or quality of experience, the inclusion of SIP in commercial web browsers is not only feasible, but also will offer new services to end users. SIP is an extensible protocol that is not only used in multimedia services provisioning, but also in control and automation, such as smart homes. Should Free Open Source Software (FOSS) and Open Standards be widely adopted, many more innovative solutions, like this project, would be introduced into the web browsing experience and found in this Web 2.0 era as services are rapidly converging.

References

[1] Arun Sarin, "The Future of Convergence in the Communications Industry," in: the Technology Leaders Forum, IEEE Communications Magazine, September 2007, pp. 12,14.
[2] Christian Saxtoft (2008), Convergence: User Expectations, Communications Enablers and Business Opportunities, John Wiley & Sons Ltd, England, pp. 34-37.
[3] Antonio Manzalini, "Tomorrow's Open Internet for Telco and Web Federation," in: Proceedings of the International Conference on Complex, Intelligent and Software Intensive Systems (CISIS '08), Barcelona, Spain, March 4-7, 2008, pp. 567-572.
[4] Michael Adeyeye and Neco Ventura (2010), "A SIP-based Web Client for HTTP Session Mobility and Multimedia Services," in: the Special Section on Hot Topics in Mesh Networking, the International Journal for the Computer and Telecommunications Industry, Elsevier Computer Communications (COMCOM), Volume 33, Issue 8, Pages 954-964, DOI information: 10.1016/j.comcom.2010.01.015.
[5] Michael Adeyeye, Neco Ventura and David Humphrey (2009), "Control Services for the HTTP Session Mobility Service," in: Proceedings of the 3rd IEEE Conference on New Technologies, Mobility and Security (NTMS), Cairo, Egypt, December 21-23, 2009.
[6] G. Canfora, G. Di Santo, G. Venturi, E. Zimeo and M.V. Zito, "Proxy-based Handoff of Web Sessions for User Mobility," Proceedings of the Second Annual International Conference on Mobile and Ubiquitous Systems: Networking and Services (MobiQuitous '05), 2005.

[7] Ming-Deng Hsieh, Tsan-Pin Wang, Ching-Sung Tsai and Chien-Chao Tseng,"Stateful session handoff for mobile WWW," Information Sciences, Elsevier Science Press, volume 176, 2006, pp. 1241-1265.

[8] H. Song "Browser Session Preservation and Migration," In Poster Session of WWW 2002,Hawai, USA, 7-11 May, 2002, pp. 2.

[9] The Wave Protocol, http://www.waveprotocol.org, July 5, 2009

[10] The Google Wave Project, http://wave.google.org, July 5, 2009.

[11] The Google Wave Click-to-dial, http://googlewavedev.blogspot.com/2009/06/twiliobot-bringing-phone-conversations.html, July 31, 2009.

[12] P. Saint-Andre, Ed., "Extensible Messaging and Presence Protocol (XMPP): Core," IETF RFC 3920, October 2004.

[13] R.R. Bhat and D. Tait, "JAVA APIs for Integrated Networks," in Java in Telecommunications: Solutions for Next Generation Networks, T. Jespen, (ed.), Wiley & Sons, New York, 2001, pp. 193.

[14] Sun Microsystems, JAIN SIP Release 1.0 Specification, 2001, http://www.jcp.org/aboutJava/communityprocess/final/jsr032, March 25, 2010.

[15] Web Sharing and RichDraw, http://hyperstruct.net/2007/2/24/xml-sync-islands-let-the-Web-sharing-begin, September 4, 2009.

[16] J. Schonwalder, M. Fouquet, and G.D. Rodosek, "Future Internet = Content + Services + Management," in the IEEE Communications Magazine, Vol. , 47, No. 5, July 2009.

[17] K. Krechmer, "Open Standards: A Call for Change," IEEE Communications Magazine, Vol. 47, No. 5, May 2009.

[18] The TransferHTTP Extension, http://transferhttp.mozdev.org, July 8, 2009.

[19] Gregory Bond, Eric Cheung, Ioannis Fikouras, Eric Cheung, Roman Levenshteyn, "Unified Telecom and Web Services Composition: Problem Definition and Future Directions," in: Proceedings of the IPTCOMM 2009, Atlanta, Georgia, July 7-8, 2009.

[20] Wu Chou, Xueshan Shan and J. Jenny Li, "An Architecture of Wireless Web and Dialogue System Convergence for Multimodal Service Interaction Over Converged Networks," in: Proceedings of the 27th Annual International Computer Software and Applications Conference (COMPSAC '03), Hong Kong, Sept. 30 - Oct. 3, 2003, pp. 69-74.

[21] Yang Xiao, Xiaojiang Du, Jingyuan Zhang, Fei Hu and Sghaier Guizani, "Internet Protocol Television (IPTV): The Killer Application for the Next-Generation Internet," in: the IEEE Communications Magazine, Vol. 45, No. 11, pp. 126-134, November 2007.

[22] Ignacio Mas and Viktor Berggren, "IMS-TV: An IMS-Based Architecture for Interactive, Personalized IPTV," in: the IEEE Communications Magazine, Vol. 46, No. 11, pp. 156-163, November 2008.\

[23] World Wide Web Consortium (W3C), "SOAP Version 1.2 Part 0: Primer (Second Edition)," Technical Recommendation, http://www.w3.org/TR/soap12-part0/, April 1, 2010.

[24] Pablo Cesar, Ishan Vaishnavi, Ralf Kernchen, Stefan Meissner, Cristian Hesselman, Antonietta Spedalieri, Matthieu Boussard, Dick C. A. Bulterman and Bo Gao, , "Multimedia Adaptation in Ubiquitous Environments: Benefits of Structured Multimedia Documents," in: Proceedings of the 8th ACM Symposium on Document Engineering (DocEng '08), Sao Paulo, Brazil, pp. 275-284, September 16-19, 2008.

[25] Ron Shacham and Henning Schulzrinne, "Ubiquitous Device Personalization and Use: The Next Generation of IP Multimedia Communications," in: the Journal of ACM Transactions on Multimedia Computing, Communications and Applications, Vol. 3, No. 2, Article 12, May 2007.

[26] Vijay K. Gurbani, Xian-He Sun and A. Brusilovsky, "Inhibitors for Ubiquitous Deployment of Services in the Next-Generation Network," in: the IEEE Communications Magazine, Vol. 43, No. 9, pp. 116-121, September 2005.

[27] Karim Sbata, Houda Khrouf, Sabine Zander and Monique Becker, "Converging Web and IMS Services: Stakes and Solution Proposals," in: Proceedings of the International ACM Conference on Management of Emergent Digital EcoSystems (MEDES '09), Lyon, France, October 27-30, 2009.

[28] Haruno Kataoka, Masashi Toyama, Yoshiko Sueda, Osamu Mizuno and Kenji Takahashi, "Demonstration of Web Contents Collaborative System for Call Parties," in: Proceedings of the 7th IEEE Consumer Communications and Networking Conference (IEEE CCNC '10), Las Vegas, Nevada, USA, January 9-12, 2010.

[29] Open Service Gateway Interface Specification, Release 4, http://www.osgi.org, March 24, 2010.

[30] Guiran Chang, Chuan Zhu, Ma, M.Y., Weiguo Zhu and Jingbo Zhu, "Implementing a SIP-based Device Communication Middleware for OSGi Framework with Extension to Wireless Networks " in: Proceedings of the 1st International Multi-Symposiums on Computer and Computational Sciences (IMSCCS '06), Zhejiang, China, June 20-24, 2006, pp 603 - 310.

[31] Chintada, S., Sethuramalingam, P. and Goffin, G., "Converged Services for Home Using a SIP/UPnP Software Bridge Solution ," in: Proceedings of the 5th IEEE Consumer Communications and Networking Conference (CCNC '08), Las Vegas, USA, January 10-12, 2008. pp 790 - 794.

[32] Jinhong Yang and Hyojin Park, "A Design of Open Service Access Gateway for Converged Web Service ," in: Proceedings of the 10th International Conference on Advanced Communication Technology (ICACT '08), Gangwon-Do, South Korea, February 17-20, 2008, pp 1807 - 1810.

978-1-61284-993-5/11/$26.00 ©2011 IEEE