IMS Based Network Stored Address Book using the XCAP Protocol

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Abstract
The IP Multimedia Subsystem (IMS) network is the next generation network that aims to integrate all traditional circuit-switched networks into one network on which services can be accessed at any time and from any place. This paper highlights how the next generation networks evolve to IMS and explains different protocols such as SIP and XCAP. One of the main advantages of IMS is that it provides an environment for rapid service creation. In order to test whether applications can be created on the IMS platform rapidly, an application is designed and implemented on the IMS platform. Using the standardized available APIs, the application that is created in order to prove that IMS allows development of new services is a network stored address book.
Theft is considered a large problem regarding cellular phones. Cellular phones are stolen or lost frequently and if a phone is stolen or lost, the user's contacts are also lost. It is difficult to retrieve the contacts' details once the phone is stolen or lost. Another problem is that if a user requires a particular contact's details and does not have the mobile phone that contains the address book at that moment it is difficult to gain access to the contacts on the user's cellular phone. This is considered a big problem since a user could require a contact's details quite urgently and would not be able to get the details. The network stored address book created helps eliminate these problems.
Key words:
IMS, NGN, SIP, XCAP

1. Introduction

There has been an immense growth in the usage of mobile voice and data usage in the world which has lead to the Next Generation Networks (NGN) [1]. The purpose of the next generation networks has been to combine two of the most successful paradigms, namely cellular networks and the Internet, thus leading to the convergence of voice and data into one multimedia network called the Internet Protocol (IP) Multimedia Subsystem (IMS) [2].

Over the past few years, the Internet has undergone a significant growth. In the beginning it was a small network linking a few research websites but now it has become a massive worldwide network. The main reason for this significant growth has been the need to provide useful services and applications for different kinds of users. The reason why the Internet is able to provide so many new services is that it uses open protocols that are available on the web for any service developer to use [3].

Cellular networks are widely used by users worldwide. The services that are provided mainly by cellular networks are telephone calls and messaging services. Cellular networks provide coverage virtually everywhere. Some cellular networks also provide roaming capabilities which allow users to access cellular services even when they are abroad. Cellular networks can easily connect to the Internet and provide the services that the Internet provides but IMS is still required. This is because IMS provides more Quality of Service (QoS), charging capabilities, and allows integration of different services. Another feature that the IMS has is that its aim is to not only provide new services but to provide all services that the Internet provides, current and future at any time and at any location [3]. IMS allows the user to be present in a particular network and be accessible at any time in any other network [4]. Thus, the aim of the IMS network is to combine traditionally separated services such as voice and messaging into one system therefore offering a richer experience to the user as the user can now have access to all services on one platform [5].

IMS[6] is defined by the Third Generation Partnership Project (3GPP) [7] "as a network that provides support for multimedia services (for example voice or video) based on packet switching with QoS and Authentication, Authorization and Accounting (AAA) provisioning" [2]. This new paradigm links IP based mobile networks. IMS terminals are always-on and always-connected application devices. Applications are no longer isolated entities that exchange information only with the user interface. IMS enables applications in mobile devices to establish peer-to-peer connections [8].

The IMS is a Service Delivery Platform (SDP) [9] which aims to achieve network convergence. IMS has added functionalities such as user authentication, user database, session control and billing and these functionalities only have to be implemented once. Therefore in order to add a new service, the only thing required is either to update software or to add an application server, and then to perform the necessary network integration [10]. This

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process increases productivity and overall effectiveness as well as demands for new services. There are many different types of communication services that are supported by IMS. Some of these services are instant messaging, push-to-talk cellular walkie-talkie services, videoconferencing, and video on demand [11].

2. Next Generation Networks and their evolution to IMS

According to [12], A Next Generation Network (NGN) is defined as "a packet based network that provides telecommunication services and makes use of multiple broadband QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies." IMS is considered an NGN and in order to understand IMS, it is important to understand the targets of NGN.

The first target of NGN is to be able to use the service anywhere and at anytime. The second target is to be able to have personalized mobile communications. In order to provide personalized mobile communication, mobile NGNs must provide flexible bit rates and local and wide area coverage both outdoors and indoors. They should also support computing devices' location and situation in an intelligent way [13]. The main difference between an NGN and a traditional telecommunications network is that the latter consists of separate vertically integrated application-specific networks while the former consists of a single network that is capable of carrying all different types of services [12].

The whole purpose of evolution of networks is to be able to provide new services in an enhanced way. These services are evolving from current voice and data bearing services to high bit-rate IP-based services. In order to provide such services, Second Generation (2G) networks first upgraded to Second and a Half Generation(2.5G) networks and then to Third Generation (3G) networks. The most common types of 2G networks are Global System for Mobile communication (GSM), Interim Standard 136(IS-136), Interim Standard 95(IS-95) and Personal Digital Cellular (PDC) technologies. These then evolved to 2.5G systems which are commonly known as General Packet Radio Service (GPRS) and Code Division Multiple Access (CDMA) 2000. One of the most common types of 3G technology is Universal Mobile Telecommunications System (UMTS). In order for GSM to evolve to UMTS, it first evolved to GPRS and then to UMTS [13].

GPRS is a better choice than GSM because it provides more effective mobile data capabilities. It provides a rate of up to 115 Kbytes per second (kbps). Therefore GSM upgraded to GPRS. After that, 3G networks such as UMTS were introduced where the GSM/GPRS network was enhanced and supplemented with a new air interface. This new air interface is defined as a 3G radio part. The 3G technologies provide high capacities and bit rates thus enabling true multimedia services such as watching movie previews over a mobile device [13].

In order to provide multimedia services, it is necessary to be able to have multiple sessions over one physical channel. This capability is only possible with Packet Switched (PS) networks not with Circuit Switched (CS) networks. PS networks utilize their capacity more efficiently as compared to traditional CS networks because they share available physical transmission capacity for several sessions either for one user or among all users [13]. Future mobile communication networks are now evolving to an all-IP architecture from the traditional circuit-switched type of networks and therefore the PS domain is used [2]. In order to mix real-time and non-real time services in one physical channel, the service, control and transport functions must be separated. This allows a more flexible and easier introduction of new features. In order to do this successfully, voice and data networks should be converged into one network and the protocol chosen for this is the IP protocol [13].

The PS domain allows the network to gain IP access to the internet. This allows for faster access to the internet as well as more available bandwidth [2]. The IP protocol is used in two different ways; one is in the horizontal direction where it allows communication to occur between user and user/host and the other is in the vertical direction where it provides session control, QoS and billing facilities. The IP protocol allows distributed functionality, open platforms, network intelligence packet based radio access and mediation technologies.

Once Session Initiation Protocol (SIP) [14] has been added to the all IP network, the network becomes known as IMS. SIP is added so that signaling and control tasks can be separated from end-to-end user information exchange and this allows users to manage several multimedia real-time and non-real time sessions simultaneously. Figure 1 [13] illustrates the development of the IMS network from other networks over time.

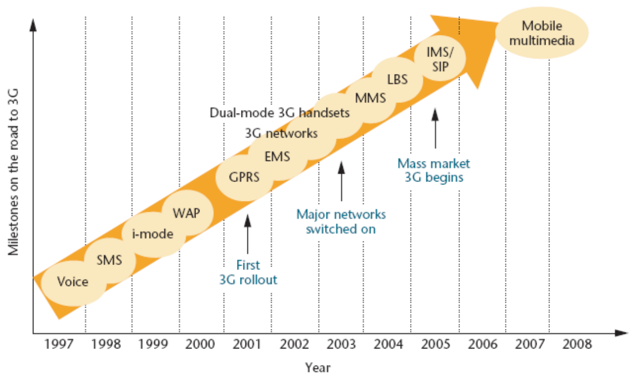

Figure 1: Evolution to IMS from different networks

3. Why IMS is a Good Platform for Service Creation

IMS provides service providers with one common platform that helps with the provisioning and management of a wide range of services. In order for IMS to be a success, the services that are based on the platform have to appeal to the users. In order to make IMS services more appealing as compared to other platforms, IMS enables services to be integrated horizontally by the service developers. The reason for this is that horizontal service integration produces faster service development times than the traditional vertical service integration. This is because in the case of horizontal service integration, all functionality required by a particular service can be provided by a stand-alone module. Another advantage of horizontal service integration is that if there is a common function that is used by many services such as user authentication, the function can be reused by several services. Due to this advantage, service developers do not have to re-implement these functions for each new service that is created on the IMS platform. Therefore, service providers can focus more on implementing functions that are related specifically to the service instead of re-implementing functions. Some of the functions that are quite common among IMS services are capability negotiation, authentication, service invocation, addressing, routing, group management, presence, provisioning, session establishment, and charging [13].
The IMS platform has been described to be a good choice because services can be created very easily on this platform. There is also reduction in redundancy and support for seamless application mobility [15].

4. SIP and XCAP protocols

4.1 SIP

Session Initiation Protocol (SIP) is the core protocol that is chosen by the 3GPP [7] to perform signaling tasks in the IMS [2]. SIP is an application-layer control protocol that is used for creating, modifying and terminating sessions with one or more participants. These sessions include Internet telephone calls, multimedia distribution, and multimedia conferences. SIP is standardized by the Internet Engineering Task Force (IETF) [16]. SIP is used mainly in telephony but its usage has been extended to other applications such as instant messaging and presence [17]. Previously in the CS based system, each telephone had the same set of capabilities in order to work whereas in the new Internet-based system that uses SIP, a phone can be attached by a user anywhere on the Internet and at anytime. The phone can also have a large range of functionalities and support different applications such as instant messaging, games, shared applications and text editors [18].
The basis of SIP user mobility is registrations. The way that SIP works is that users have to first register their current locations with the network. The network then uses this registration information to route incoming session requests to the registered users [18]. SIP helps with two problems while establishing real-time communication sessions. Firstly, SIP helps two parties that want to communicate to find each other [17]. This is based on the offer/answer model which is a two-way session description exchange between two SIP users. Using the offer/answer model all the information required to establish a session between the two users is exchanged [18]. Figure 2 [17] illustrates how the session is established between the two users. Secondly, SIP allows the parties to negotiate the session. This means that the parties can then decide how they want to communicate. Figure 3 [17] illustrates how the session is negotiated between the two users.

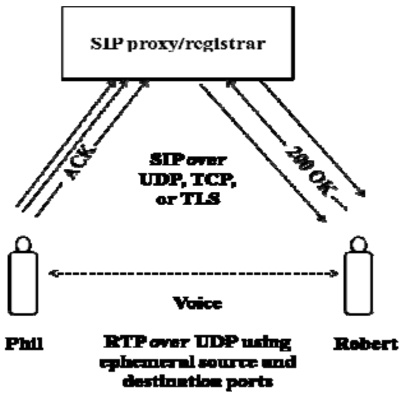

Figure 2: Session Establishment

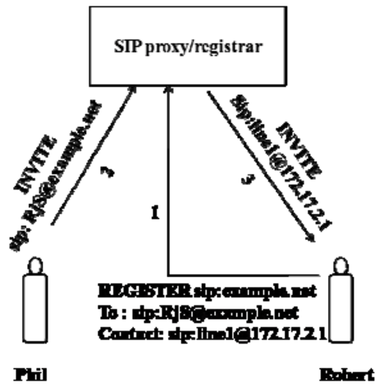

Figure 3: Session Negotiation

SIP is a text based protocol that is transaction oriented. Its messages have a lot of similarity in the syntax that is used with Hyper Text Transfer Protocol (HTTP) messages but the protocol behavior is quite different [17]. There are different methods that SIP uses and these methods are described in table 1 [18]. The first six methods are described as the basic SIP specification whereas the rest of the methods are extensions to SIP.

Table 1: SIP methods

Method	Description
INVITE	Session setup
ACK	Acknowledgement of final response to INVITE
BYE	Session termination
CANCEL	Pending Session cancellation
REGISTRATION	Registration of a user's URI
OPTIONS	Query of options and capabilities
INFO	Mid-call signaling transport
PRACK	Provisional response acknowledgement
UPDATE	Update session information
REFER	Transfer user to a URI
SUBSCRIBE	Request notification of an event
NOTIFY	Transport of subscribed event notification
MESSAGE	Transport of an instant message body
PUBLISH	Upload presence state to a server

SIP has a registration function that is very similar to the registration function in cellular phones. A user sends a proxy server to the Uniform Resource Identifier (URI) from which it wishes to receive calls in a registration message. This is performed by the SIP REGISTER method. Registration is a very important method for SIP. In order to use SIP's functionalities, the user has to always register the SIP phone with the registrar server by sending the server a REGISTER message [18].
The main reason for the discussion of SIP is that SIP is used by the address book in order for the client to communicate with the IMS core. SIP also performs signaling functions in the IMS network.

4.2 XCAP
XML Configuration Access Protocol (XCAP) [19] is a protocol that allows a user to upload information in the form of Extensible Markup Language (XML) documents to an XCAP server. This uploaded information is provided to application servers that use this information to satisfy user's requests. XCAP provides a user with a way to upload, modify or delete XML documents that are stored in a server such as users in a presence list, contacts in an address book, authorization policies or a list of users participating in a conference. XCAP is not responsible for controlling the user interface.
XCAP is encoded using XML code and it is a set of conventions that explains the work process with a remotely stored XML document. The transport protocol that XCAP uses in order to upload information and read the information that is set by the users is HTTP. The information is represented using XML [3].
The network stored address book is based on transmitting XML documents and for that it requires the XCAP protocol. Therefore it is important to understand how the XCAP protocol works. More detailed information about the XCAP protocol can be found in [19].

5. Proposed Network stored address book Design

5.1 Architecture
The Network stored address book has been created as an extension of the University of Cape Town (UCT) IMS client version 1.0.8. The architecture is integrated into the UCT SDP sandbox. Figure 4 [20] illustrates the UCT SDP Sandbox architecture.

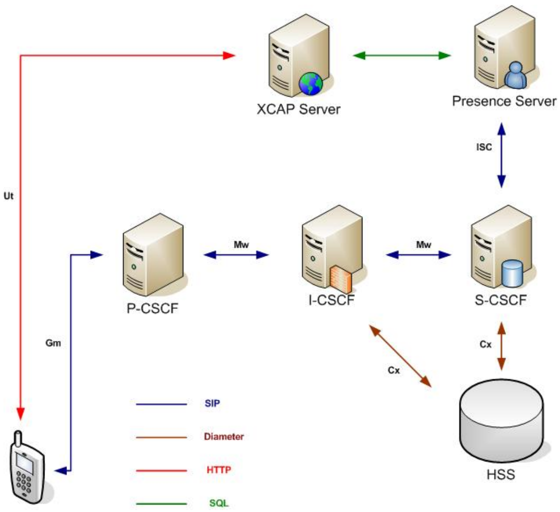

Figure 4: UCT SDP Sandbox

The network stored address book was implemented on the application layer of the IMS network. The IMS client is the terminal that is used by the client in order to access the services provided by the IMS network which in this case is the network stored address book. The XCAP server is where the address book is stored.

5.2 Client Implementation
The UCT IMS client is extended in order to include the network stored address book. The IMS client is the terminal at which the user can access services. The client has a GUI created in Glade on the Linux Ubuntu 7.04 platform. The backend programming is done in the C programming language. The user uses the client terminal

to access the address book. The user can add, delete, modify or retrieve addresses from the address book. Sorting and scrolling functionalities have also been implemented in order to provide user friendliness so that the user can find details of a particular contact with more ease. A detailed implementation with screenshots of the interface has been provided below.

The first change that has been made to the UCT IMS client is that an address book tab has been added to the UCT IMS client which allows the user to access the network stored address book service. This is illustrated in figure 5.

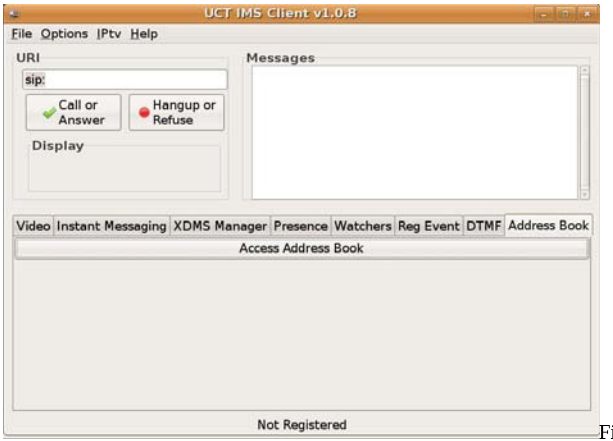

Figure 5: UCT IMS Client extended to include Network Stored Address Book

When the address book GUI is opened, a few options have been implemented for the user. The user has the option to either create a new address book or to open an existing address book. The user can either retrieve an existing address book from the local workstation or from the XCAP server. These options are shown in figure 6.

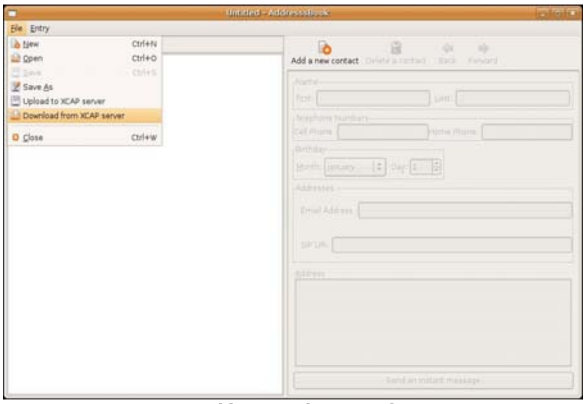

Figure 6: Address Book GUI with options

If the user selects the option of retrieving the address book from the XCAP server, the window illustrated in figure 7 appears. The user is asked to enter the AUID for the address book. Every time the user wants to download the address book, they are asked for the AUID. This ensures security because the address book can only be downloaded if the AUID is known.

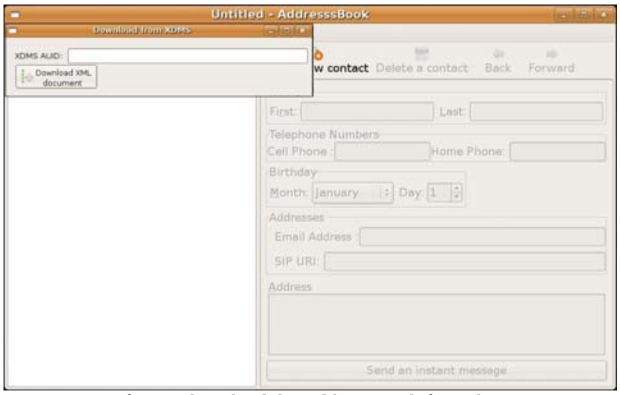

Figure 7: Interface to download the Address Book from the XCAP Server

Once the user has selected an option, they can either just view the address book or add a new contact to the address book. The user can scroll through the address book using the back and forward icons and view the details of the contacts. Using the delete button, the user can delete a selected contact. A complete implemented address book is shown in figure 8.

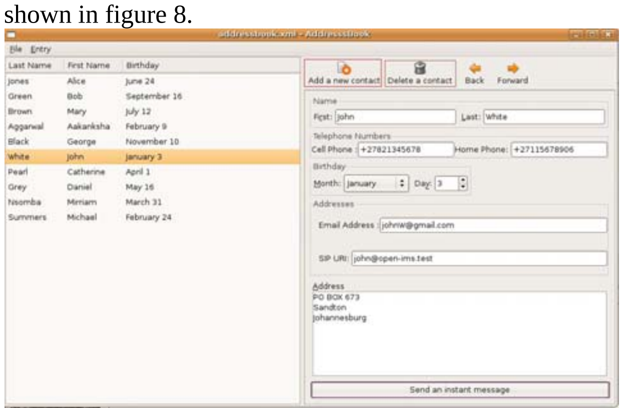

Figure 8: Screenshot of the implemented Address Book with data

The user can upload the address book to the XCAP server. The address book is saved in xml format. In order to save the address book in xml format, xml manipulating techniques have been implemented. The AUID is asked every time the user wants to upload the document for security purposes. The interface implemented in order to perform the upload function is illustrated in figure 9.

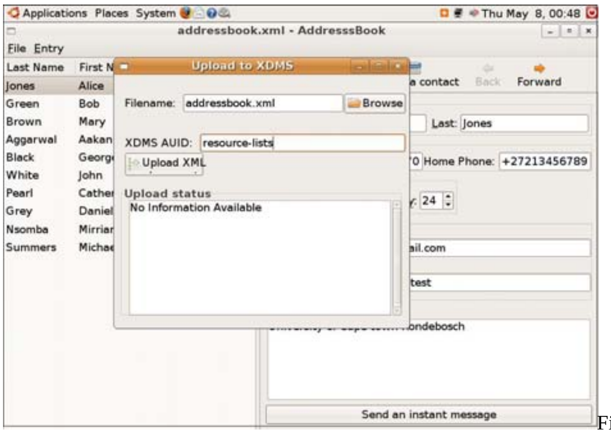

Figure 9: Interface to upload the Address Book to the XCAP Server

6. Performance Evaluation

This section of the paper presents the results that were obtained after evaluating the performance of the network stored address book. After the network stored address book was implemented, it was tested to ensure that it performed all functionalities such as adding a contact, deleting a contact, and modification of a contact. Tests were also performed in order to ensure that the address book was able to be uploaded and downloaded from the XCAP server

6.1 Results

Each of the different scenarios in the address book was tested several times to ensure that they worked with 100% efficiency. The tests were done in steps. Firstly, the address book was created and contacts were added to the address book. Screenshot of a fully implemented address book has been shown in figure 8. The results for the addition of contacts were confirmed by opening the xml document and checking whether a new contact and its details were added to the document. Once the address book was ready, it was saved and uploaded to the XCAP server.

. In order to confirm that the address book was uploaded to the server, messages that were communicated between the client and the server were captured by a program called Wireshark. Wireshark analyses protocols for the Linux environment. It examines data from a live environment and allows capturing of such data.

The PUT method is an XCAP method that is used when a file is uploaded to the XCAP server. The client sends the server a PUT message requesting the server to allow the client to upload the document to the server. Then a 100 Continue message is sent by the server to the client. The 100 Continue message is used to inform the client that the server has received the first part of the request and has not rejected it. This means that the client should continue with its request and send the remainder of the request. The client then starts sending data to the server. The server then sends a 401 Unauthorized message. This is a challenge that the server sends to the client asking for authentication details. Once the client receives the challenge, it sends the AUID, username and password to the server. Once the details have been authenticated, the server sends back a 100 Continue message to the client asking it to send the document. The client then sends the document to the server and the server responds with a 200 OK message indicating that the document has been received thus proving that the address book has been uploaded to the server successfully.

A graph has been captured by Wireshark to show the amount of time taken to upload the document onto the server. The graph is illustrated in figure 10.

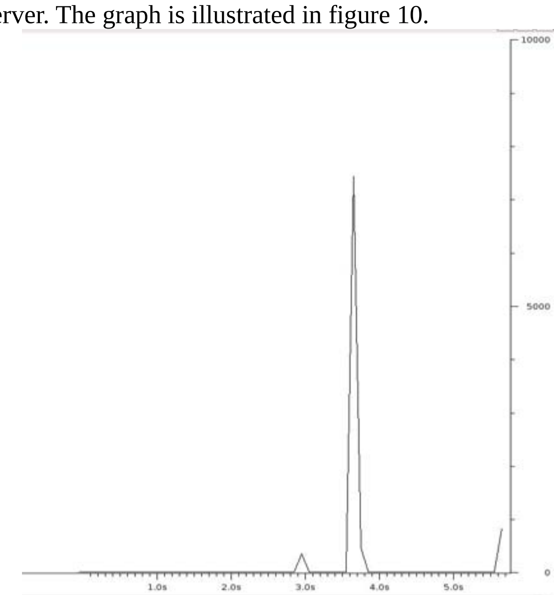

Figure 10: Graph depicting time taken to upload address book to server

In the graph in figure 10, the x-axis shows the time taken in seconds for the transmission of bytes and the y-axis shows the number of bytes transmitted. The long triangular peak in the graph shows the data transmitted. According to the graph in figure 10, about 7800 bytes have been transmitted to the XCAP server in about 0.30 seconds. The address book thus can be uploaded to the server within a reasonable amount of time.

The address book was then downloaded from the server to prove that the download function worked. This also proved that the address book was uploaded to the server.

The GET method is an XCAP method that is used when a file is downloaded from the XCAP server. The client sends a GET command to the server requesting for the document. The server then sends a 401 Unauthorized message. This is a challenge that the server sends to the client asking for authentication details. Once the client receives the challenge, it sends the AUID, username and password to the server. Once the details have been authenticated, the client can retrieve the document from the server. Once the client has retrieved the entire document, it sends a 200 OK message to the server indicating that the document has been received successfully.

A graph has been captured by Wireshark to show the amount of time taken to download the document from the server. The graph is illustrated in figure 11.

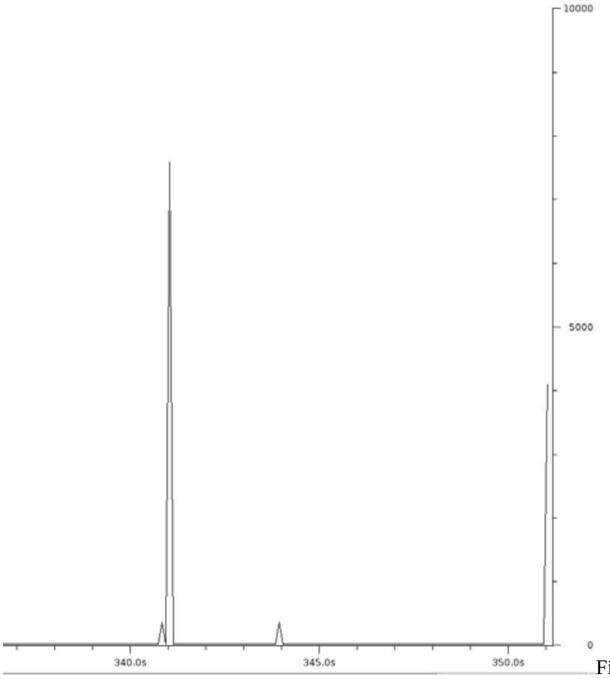

Figure 11: Graph depicting time taken to download Address Book from Server

In the graph in figure 11, the x-axis shows the time taken in seconds for the retrieval of the document in bytes and the y-axis shows the number of bytes retrieved. The long triangular peak in the graph shows the data received. According to the graph in figure 34, about 7800 bytes have been received from the XCAP server in about 0.30 seconds. The address book thus can be downloaded from the server within a reasonable amount of time.

6.2 Current UCT IMS client versus the Modified UCT IMS client

The current UCT IMS client was assessed in terms of convenience and personalization and it was realized that it was not very convenient to use it because different services that used the same principles were accessed from different places. Therefore the user had to repeat the same procedure again. For instance, two services that have been created on the UCT IMS client are instant messaging and presence. For both of them, SIP addresses are required. Currently, in order to use any of the two services, the user has to type in the SIP address every time which is not very user friendly. Also, for the presence service, a maximum of ten buddies can be added. All these different services can be integrated with the network stored address book. Instead of creating a separate buddy list with a maximum of only ten buddies, the address book can be used as a buddy list. Instead of the user using different interfaces for accessing instant message services and call services, the user can use the address book to access all these services. Therefore the network stored address book interface is a more user friendly and personalized interface.

7. Conclusion

This research investigated whether rapid service creation and integration of different services was possible on the IMS platform. In order to prove that services can be created on the IMS platform, the application that was chosen to be created was a network stored address book. The network stored address book can be used as an interface to integrate all other services such as instant messaging and call services. Due to time constraints, the actual integration of services was not implemented but was illustrated in order to show the user how the integration would work.

The network stored address book was integrated into the UCT SDP Sandbox. The application was tested after the implementation process to ensure that it performed all of its functionality up to standard. The testing phase proved that the network stored address book performed its functionality up to standard and therefore it was concluded that rapid service creation was possible on the IMS platform.

8. Recommendations and Future Work

This paper demonstrated the development of a network stored address book. An extension of this work would be to include integration of other services into the architecture. For instance, instant messaging, voice calling and presence services could be incorporated into the system. This would help the user access all the services from one interface instead of accessing from different interfaces.

Another recommendation for future work would be to implement the client on the actual mobile phone and connect it to the server so that a real life situation can be tested. The user can try and upload the address book to the XCAP server from the mobile phone and try downloading it back onto the mobile phone.

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References

[1] J.C. Crimi, "Next Generation Network (NGN) Services," http://www.mobilein.com/NGN_Svcs_WP.pdf, April 2004
[2] F.G. Marquez, M. G. Rodriquez, T.R. Valladares, T.D. Miguel and L.A. Galindo, "Interworking of IP Multimedia Core Networks between 3GPP and WLAN," IEEE Wireless Commun, vol 12, issue 3, pp.58-65, June 2005.
[3] G.Camarillo and M.A. Garcia-Martin, The 3G IP Multimedia Subsystem (IMS): Merging the Internet and the Cellular Worlds 2nd ed., John Wiley & Sons, Ltd, 2006.
[4] Nokia Siemens, "Presence-The flexible approach-higher data efficiency in your mobile network," Information and communication mobile networks, pp. 1-2, 2003.
[5] Nokia Siemens, "IMS/SIP Frequently Asked Questions," Siemens AG, pp. 1-7, 2005.
[6] Wikipedia: "IP Multimedia Subsystem" [http://www.en.wikipedia.org/wiki/IP_Multimedia_Subsystem, 2008
[7] 3GPP http://www.3gpp.org/, 2008
[8] M. Poikselka, G. Mayer, H. Khartabil, and A. Niemi, The IMS Multimedia Concepts and Services in the Mobile Domain 2nd ed., John Wiley & Sons, Ltd, 2004.
[9] C.J. Pavlovski, "Service Delivery Platforms in Practice," IEEE Communications, vol 45, issue 3, pp. 114-121, March 2007.
[10] Nokia Siemens, "Fixed Mobile Convergence – Bringing together the worlds of fixed and communications," May 2006.
[11] D.Geer, "Building converged networks with IMS technology," Computer, vol 38, Issue 11, pp. 14-16, November 2005.
[12] K.Knightson, N. Morita, and T.Towle, "NGN Architecture: Generic Principles, Functional Architecture, and Implementation," IEEE Communications Magazine, vol 43, issue 10, pp. 49-56, October 2005.
[13] J.F.Huber, "Mobile Next-Generation Networks," IEEE Computer Society, vol 11, issue 1, pp. 72-83, March 2004.
[14] J.Rosenberg et al, "SIP: Session Initiation Protocol" RFC 3261, Internet Engineering Task Force, June 2002 http://www.ietf.org/rfc/rfc3261.txt
[15] 3GPP, "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS); Stage 2," TS 23.228 version 8.1.0 Release 8, June 2007.
[16] IETF http://www.ietf.org/
[17] R.Sparks, "Q focus: session initiation protocol: SIP: basics and beyond," ATM Queue, vol. 5, no. 2, pp. 22-33, March 2007.
[18] H. Sinnreich and A.B. Johnston, Internet Communications using SIP, Wiley Publishing, Inc., 2006.
[19] J. Rosenberg, "The Extensible Markup Language (XML) Configuration Access Protocol (XCAP)," RFC 4825, Internet Engineering Task Force, May 2007 http://www.ietf.org/rfc/rfc4825.html
[20] D.Waiting, "On Privacy and Prevention of Unsolicited Sessions in the 3GP IP Multimedia Subsystem," COE Seminar, August 2007
[21] http//coe.uct.ac.za/downloads/Coe_Seminar_2007/CoE%20Seminar_26_2/D%20Waiting%20-%20%20Prevention_of_Unsolicited_Sessions_in_the_3GPP_IMS Industry Seminar).ppt

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