RTC for Mobile-Learning : Current State of the Technology

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Abstract. In this paper, we introduce a new form of education – mobile learning. In oder to get an overview of this concept, the history, advantages and disadvantages of mobile learning are discussed. The challenge of implementing mobile learning introduced in this paper is to bring an interactive learning experience, namely learning community into mobile learning. As one solution for that, Real Time Collaboration (RTC) will be a main part discussed in this paper. As a widely deployed technology for RTC, XMPP and XMPP based RTC applications like presence, Instant Messaging will be introduced in the paper. In the last part of the paper will mobility issues, and relevant protocols as solution for supporting mobility be discussed.

Keywords: Mobile learning; RTC; XMPP; Instant Messaging; on-line learning community; MIP; I-TCP

1 Introduction of Mobile Learning

The original idea of mobile learning is “learning anywhere at any time”. But the requirements for mobile learning and technologies involved differ from time to time. When we are talking about mobile learning right now, it is more regarded as a subset of e-learning and distance education, which is accessing on-line learning resource with mobile devices. In the following subsections, the history, advantages and disadvantages of mobile learning will be discussed.

1.1 History

The first instance of mobile learning goes back to 1901, when Lingua-phone released a series of language lesson on wax cylinders, which is later obsoleted and replaced by recording mediums like LP record or vinyl record in 1948, cassette tapes and 8 track tape, which were popular between 1970s and 1990s, and then CD (commercially

available since October 1982), as the Technology improved [1]. Up to now, it is still a popular and common way to use CD to carry and record learning materials.

In 1968 Alan Kay and his colleagues in the Learning Research Group at Xerox Palo Alto Research Center proposed a conceptual portable educational device, which is called Dyna-book, as a book-sized computer to run dynamic simulations for learning [2].

In May 1991, Apple Classrooms of Tomorrow (ACOT) in partnership with Orange Grove Middle School of Tucson, Arizona, used mobile computers connected by wireless networks for the 'Wireless Coyote' project [3]. Universities in Europe and Asia developed and evaluated mobile learning for students. Palm corporation offered grants to universities and companies who created and tested the use of Mobile Learning on the Palm-OS platform.

In 2000s, the European Commission began to fund the major multi-national MOBIlearn and M-Learning projects. Companies, specializing in these three core areas of mobile learning were formed:

(1)Authoring and Publishing

(2)Delivery and Tracking

(3)Content Development

Conferences and trade shows were created to specifically deal with mobile learning and hand-held education, including: mlearning, WMUTE, and IADIS Mobile Learning international conference series, ICML in Jordan, Mobile Learning in Malaysia, Hand-held Learning in London, and SALT Mobile in USA.

Seeing through the History of Mobile Learning, the meaning of mobile learning and people's expectations on this term varies and increases as time went on, which is always restricted by the state of technology in the period.

Decades ago, when we talked about mobile learning, it refered to the learning materials recorded on mediums like tapes and CDs. Now-a-days, as a large number of smart mobile devices (smart mobile phones, Tablet PC) came onto the market, one has more expectations on m-learning, “Learning at any place, at any time ” will be possible.

1.2 Advances in mobile-learning

While e-learning moves education from classroom and campus to non-mobile multimedia stations, like a personal computer, as a subset of e-learning, mobile learning enjoys some advantages brought up by e-learning, such as its ability to access to a lot of information presented in a diverse way, more than just pictures and texts as will be presented by books, but also videos and audio folders etc.

With the new generation of mobile devices, mobile learning provides a much more different learning experience. Through the wireless network technology , devices are capable to access to the Internet, and mobile learning will be available no matter where the location is. And Devices are smaller and weigh less which makes them easy and comfortable to carry. Thus, the students can learning while taking a bus, subway with their mobile device at hand. In this way, the students will no longer be pressured by a strict schedule for learning.

The new trend of education enjoys so many benefits because of its mobility , Nevertheless, there are also some disadvantages. Firstly is the question whether it is possible to make meaningful and lasting connections with fellow students and professors outside a traditional classroom. When the Student – Teacher relationship no longer exists, the student can learn at any time or never, the study time will no more be under control of the teacher. This can affect the student's motivation for study. What else should be mentioned is, most mobile devices share the disadvantage of having a small screen and limited input possibilities, and the device needs to be upgraded constantly, according to the new tendencies. More problems appear on the view of developers. The variety of smart mobile products makes it a hard work to develop mobile learning applications. The developers face a decision, to which devices (smart-phone or tablet) and operating system (Apple, Android , blackberry, windows, Linux) they would target.

2 Real Time Collaboration (RTC)

As is mentioned above, m-learning enables learning out of classrooms and campus, which is also a disadvantage that it breaks the student – teacher and student- student relationship. It makes the students feeling isolated during the learning experience. And the key to a qualified education, distanced or classroom based, is not only the teaching contents, but also the teaching methods and learning environment. When we look at the traditional education, it is clear, that the interaction between students and teachers, and the interaction between the students, are necessary for a healthy and successful education. Additionally, establishing relationships with teachers and classmates helps students to create a more rewarding experience.

In order to realize interactive leaning and teaching, we introduce here on-line learning community. An online learning community (OLC) is a web-based learning environment replete with the latest digital technologies where interconnected learning participants communicate, collaboratively construct their knowledge, and share their personal experiences.

With OLC, it will make mobile learning experience like having lessons in a real classroom. Learners are not only able to access to the teaching resources, they can

also communicate with the teacher, ask questions and share ideas with other students. Mobile Learning is no longer just watching video or reading information that are uploaded longtime ago. Learners are actually participating in the teaching and having a real learning experience.

A Solution for the implementation of OLC is real-time collaboration.

2.1 Definition of RTC

Real-time collaboration uses the Internet and presence technology to communicate with co-workers as if they were in the same room, even if they are located on the other side of the world.

Our Intension is to build real-time collaboration tools to facilitate cooperative work and communication between the mobile learning users, which involves several kinds of synchronous communication tools such as Instant messaging, White-board collaboration,Voice over IP, Co-browsing, Application sharing etc.

There are protocols like SIP, RTP, XMPP, IMPP, PRIM for implementing RTC. In the following sections, we are going to introduce XMPP, which is a very popular technology and widely deployed for real time collaboration over the Internet, followed by the details of the XMPP based real-time communication like presence, instant messaging, and white-board collaboration.

2.2 XMPP

The Extensible Messaging and Presence Protocol (XMPP) is an open technology for real time communication, using the Extensible Markup Language (XML) as the base format for exchanging information. In essence, XMPP provides a way to send small pieces of XML from one entity to another in close to real time. XMPP implementations provide services (function) like channel encryption, authentication, presence, contact lists, one-to-one messaging, multi-party messaging, notifications etc. To get a quick view of the features used by all XMPP-based applications, the general architecture of XMPP systems, addressing scheme for XMPP communications and XML streaming mechanism will be discussed in the following subsections [4].

2.2.1 Architecture

Similarly, the Internet's infrastructure for instant messaging, presence, and other forms of real-time communication increasingly consists of hundreds of thousands of Jabber servers running software like ejabberd and Openfire, and millions of Jabber clients running software like Adium, Gajim, Pidgin, and Psi. And XMPP technologies use a decentralized client-server architecture similar to the architectures used for the World Wide Web and the email network, as shown in figure 2.2.1.

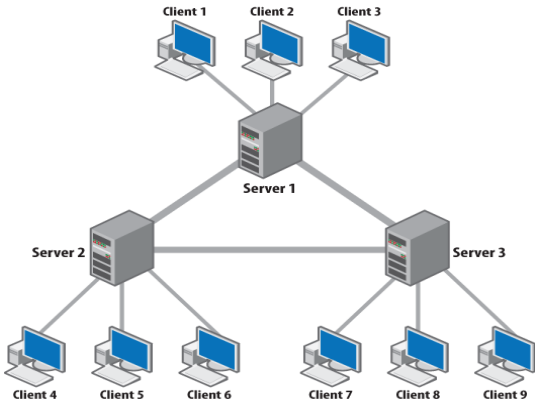

Fig. 2.2.1. XMPP decentralized client-server architecture [4]

As shown in figure 2.2.1, there is no central authoritative server, as there is with services like Windows Live Messenger or AOL Instant Messenger [5]. And Using a decentralized client-server architecture enables the intelligent separation of concerns. Which means, the client developers can focus on user experience, and the server developers can focus on reliability and scalability.

Although clients and servers are the fundamental entities on an XMPP network, other entities play a part, e.g. automated clients.

2.2.2 Address

Because XMPP communications happen on a network, every XMPP entity needs an address, called Jabber-ID (JID). XMPP relies on Domain Name System (DNS) to provide the underlying structure for addressing, instead of using raw Internet Protocol (IP) address, because it is easier to remember. In order for clients to connect and log in, they need to find the IP address of the server associated with their JID. Similarly remote servers which need to forward a message to a user also need to contact that

user's server to pass that message on. This is achieved by looking up the domain in DNS, as shown in figure 2.2.2 .

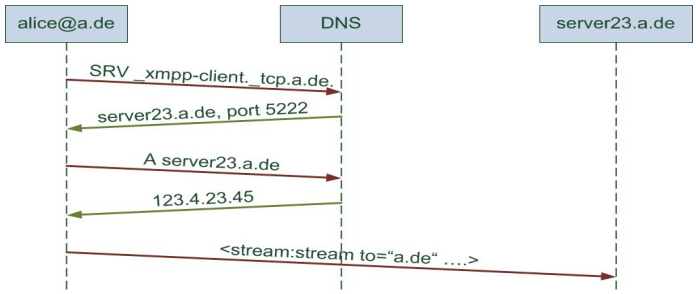

Fig. 2.2.2. looking up domain to get real IP address of the server

One Jabber-ID for users looks like email address (alice@jabber.org) which is a familiar format to people. Further more, this Format uses the complete DNS infrastructure as its address space, unlike older IM systems that used numbers or names without any domain identifier.

2.2.3 Streaming XML

When one wants to start a session with an XMPP server, long-lived TCP connection is opened and then an XML stream is negotiated to the server (the server also opens a stream in return,there is one stream in each direction). Imagine a stream as an XML document that is built up incrementally over time between your client and your server.

Once an XML stream is negotiated with the server, user can exchange three special XML snippets over the stream: <message/>, <presence/> and <iq/>. These are called XML stanzas, they are the basic units of meaning in XMPP. And unlimited number of stanzas can be sent over the stream once the XML stream is negotiated.

2.3 XMPP Use Case

In the following subsections, XMPP based implementation of presence information and instant messaging will be short discussed.

2.3.1 Presence Information

Presence is a type of application that makes it possible to locate and identify a computing device wherever it might be, as soon as the user connects to the network. Presence information can be add to any Application, to show the real-time information about a person's availability, to make the collaboration possible wherever and whenever users are on-line.

To use presence information, user client may publish a presence state to indicate its current communication status. This published state informs others that wish to contact the user of his availability and willingness to communicate.

XMPP presence typically follows a "publish-subscribe" or "observer" pattern, when an entity sends presence to its server, and its server then broadcasts that information to all of the entity's contacts who have a subscription to the entity's presence. Accessing presence information is usually bidirectional. This happens through a subscription “handshake”, as shown in Figure 2.3.1.1. If the handshake is completed successfully, the result is a bidirectional presence subscription between the two user clients.

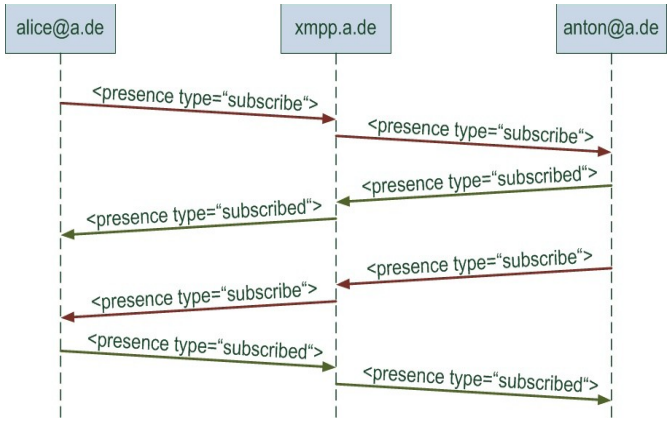

Fig. 2.3.1.1 Subscription “Handshake”

Presence information is then broadcasted only to the subscribed entities through subscription requests within subscription “Handshake”, as shown in figure 2.3.1.2. These subscription states are stored on the server in the user roster. With roster, we can not only store a flat list of contacts, but also group into various categories. More

detail of implementing presence (availability status, presence priorities, presence-based routing and access control) are in [4].

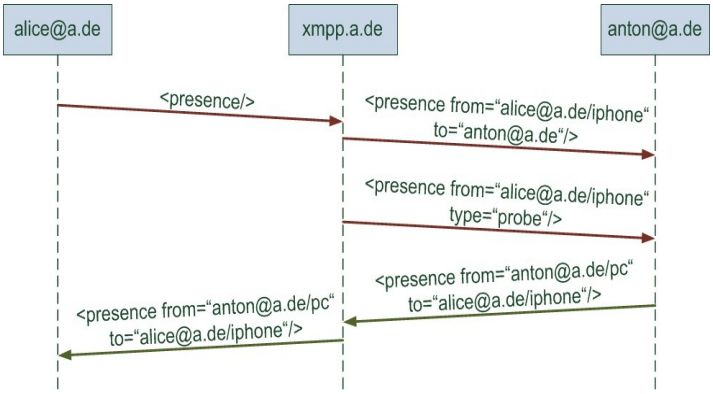

Fig. 2.3.1.2. Propagation of presence information

Making presence technologies inter-operable is a current challenge. The aim is to achieve a so-called unified communication. Many of the current IM systems, for example,it is not possible for users to exchange messages with the customers of other systems, a situation which has been compared to a long distance telephone service provider making it impossible for users to communicate with another long distance provider's customers. The problem has always been in knowing which communications mechanism is best suited to reach and get in touch with a person (phone?email?face-book?). The challenge is to make it possible for presence-enabled applications to make intelligent decisions about how to contact a person based on what the application knows about the person's availability. There are already a lot of researches done in this area, since it is not relevant to mobile learning, more details please see [9].

2.3.2 Instant messaging

As is said in wikipedia,"Instant Messaging (IM) is a type of on-line chat which offers real-time message transmission over the Internet ." And XMPP servers are optimized for handling large numbers of relatively small messages with very little latency.

In XMPP, messages are delivered using message stanza over the client-to-server, server-to-server or server-to-client XML streams.

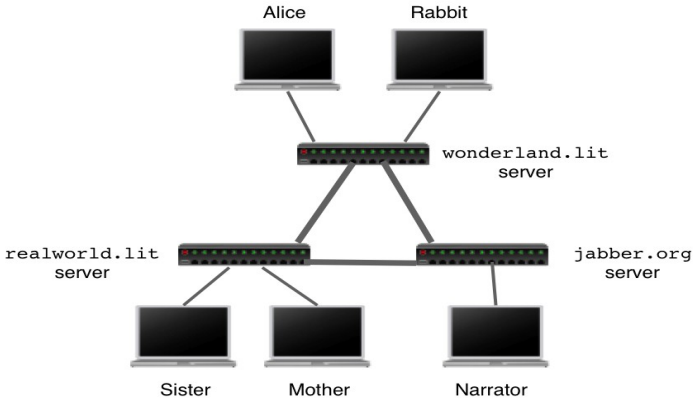

Fig. 2.3.2 Architecture of XMPP based IM

As shown in figure 2.3.2, Alice, Rabbit, sister are clients using Instant messaging applications and realworl.lit, woderland.lit jabber.org are XMPP servers. Alice sends a message from her new account on the wonderland.lit server to her sister on the realworld.lit server. Her client effectively "uploads" the message to wonderland.lit by pushing a message stanza over a client-to-server XML stream. The wonderland.lit server then stamps a "from address" on the stanza and checks the "to address" in order to see how the stanza needs to be handled. Seeing that the message stanza is bound for the realworld.lit server, the wonderland.lit server then immediately routes the message to realworld.lit over a server-to-server XML stream . Upon receiving the message stanza, the realworld.lit server checks to see whether Alice's sister is on-line; if so, the server immediately delivers the message to one or more of her on-line devices over a server-to-client XML stream. As a result, the message is delivered very quickly from Alice to her sister.

IM interactions usually take the form of chat sessions: short bursts of messages exchanged between two parties. The XMPP extension for chat state notifications provides support for chat sessions by communicating up-to-date information about the involvement of one's conversation partner in the discussion. And XHTML is used to provide user-friendly formatting, such as bold, italics, and colored text. Furthermore, vCards enable the user to find out more about people he might want to chat with, and privacy lists can prevent unwanted communication from other entities. More detail about these feature in [4].

3 RTC for mobile learning

Real time collaboration applications are based on OSI model, as shown in figure 3.1.

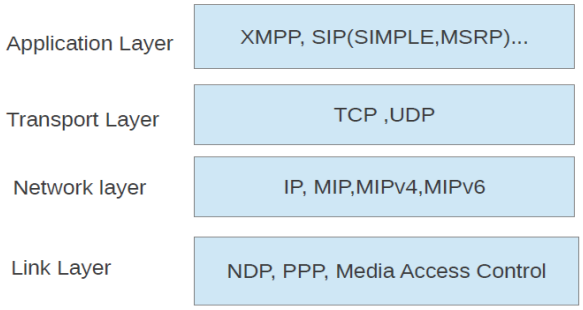

Fig. 3.1 OSI model from link layer to application layer including RTC relative protocols

In the design of RTC tools for mobile learning, we should always take the mobility issues into concern.

The mobility issues for mobile learning will differentiated into two scenarios:

(1)Learning under stable wired or wireless network. In this case, usual TCP/IP protocol will work well.

(2)Learning while moving from one Internet attachment point to another. In this case, the user requirements should be taken into concern. For nomadic use, Internet connection is terminated each time the user moves and a new connection is initiated when the user reconnected. For mobile use, user's point of attachment changes dynamically and want all connections automatically maintained despite the change.

In this capital, we are focusing on the mobile use scenario and gonging to introduce the alternative protocols to support mobility in Internet layer, Transport layer and Application layer.

3.1 Internet layer mobility - MIP

The Mobile IP (MIP) [10] uses a stable IP address assigned to mobile nodes (MN). This home address is used to allow the MN to be reachable by having a stable entry in the DNS service, and to hide the IP layer mobility from upper layers. A consequence of keeping a stable address independently of the MN's location is that all correspondent nodes try to reach the MN at that address, without knowing the actual location of the MN. Therefore, if there are packets forwarded to the home address, and the MN is not at its home network, its home agent is responsible for tunneling packets to the MN's new location [11], as shown in figure 3.1.1.

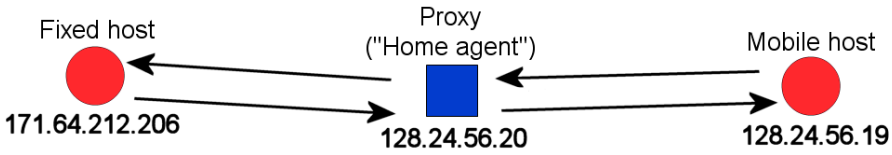

Fig. 3.1.1 Mobile IP use "Home agent"

For RTC applications, sudden changes in network connectivity and IP address can cause problems. Mobile IP was designed to support seamless and continuous Internet connectivity.

3.2 Transport layer mobility

IP based solutions to accommodate mobile hosts within existing internetworks do not address the distinctive features of wireless mobile computing. IP-based transport protocols thus suffer from poor performance when a mobile host communicates with a host on the fixed network. This is caused by frequent disruptions in network layer connectivity due to mobility and unreliable nature of the wireless link. We describe I-TCP an indirect transport layer protocol for mobile hosts. I-TCP utilizes the resources of Mobility Support Routers (MSRs) to provide transport layer communication between mobile hosts and hosts on the fixed network. As shown in figure 3.2.1.

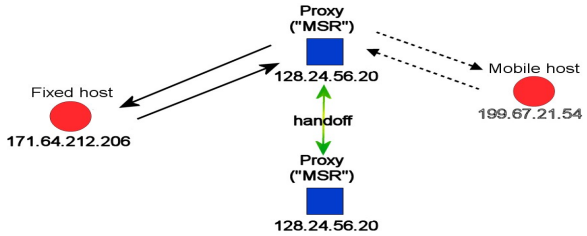

Fig. 3.2.1 I-TCP utilizes MSRs to provide transport layer communication between mobile host and fixed host

The fixed host always sends to the same IP. The MSRs coordinate amongst themselves to decide who actually handles the communication. With I-TCP, the problems related to mobility and unreliability of wireless link are handled entirely within the wireless link [12].

One alternative solution to support Transport layer Mobility will be MSOCKS architecture and TCP Splice. More information in [13].

3.3 Application layer mobility

Mobility can also be achieve in application layer using SIP. As is said in Wikipedia, the SIP (Session Initiation Protocol) is a signaling protocol, widely used for setting up and tearing down multimedia communication sessions over the Internet. It can be used in any application where session initiation is necessary.

The SIP registration mechanism is considered the application-layer equivalent of the MIP registration mechanism. However, while mobile IP binds a permanent IP address identifying a host to a temporary CoA (an address that is assigned to the MN when located in a foreign link), SIP binds a user-level identifier to a temporary IP address or host name [14]. An INVITE message is sent by a MN to its correspondent node (CN) to set up a communication session. The mechanism to provide MN mobility during an active session foresees that the MN needs to send another INVITE message to the CN to communicate the information about the new parameters of the communication session after the handover, using the same call identifier as the original call setup.

This solution has some drawbacks [15]. The second INVITE is sent end-toned, and this could lead to high delays. Moreover, the handover procedure relies on the

capability of the CN to handle this procedure, thus increasing MN processing needs. An auxiliary mechanism is necessary if the MN and CN move at the same time.

3 Discussion

The World are becoming more and more interested in the new concept of mobile learning due to the availability and rapid advancement of mobile devices such as smart phones, PDAs, Tablet PCs. The research studies presented in this paper show the advances and benefits of using mobile technology in learning, and at the same time, the current state of real-time collaboration technologies using to build an interactive learning environment, for instance, on-line learning community. This bring following features to mobile learning:

(1)Improved learning. Collaboration within on-line learning community expose people to new ideas.

(2)Sense of Commitment. Where people have a shared experience, they gain a deeper sense of commitment to the process and to the product.

(3)Learning beyond the content. Learning is more than just learning the content, it's learning how the content is applied during the interactions.

These are the motivations for this paper, why we apply RTC technology to mobile learning, and also the motivation for our future work.

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