

# Towards Business Model and Technical Platform for the Service Oriented Context-Aware Mobile Virtual Communities

Pravin Pawar<sup>1</sup>, Julien Subercaze<sup>2</sup>, Pierre Maret<sup>2</sup>, Bert-Jan van Beijnum<sup>1</sup>, Dimitri Konstantas<sup>3</sup>

<sup>1</sup>Architecture and Services for Networked Applications Group

Department of Computer Science  
University of Twente, The Netherlands.  
{p.pawar, Beijnum}@utwente.nl

<sup>2</sup>Institut National des Sciences Appliquées de Lyon,  
Lyon, France

{pierre.maret, julien.subercaze}@liris.cnrs.fr

<sup>3</sup>Advanced Systems Group, Centre Universitaire d'Informatique  
University of Geneva, Switzerland.

dimitri.konstantas@cui.unige.ch

**Abstract:** *Owing to the recent technical advances in the computing and mobile communications domain, the world of online virtual communities is experiencing a phenomenal growth and ever-increasing popularity. However, the focus of existing virtual communities is centered on a particular product or social interaction and the role of mobile devices is restricted to exchange a limited amount of contents. Herewith we envisage that the upcoming virtual communities will exploit the potential of social interaction and context information to offer personalized services to its members and mobile devices will play a significant role in this process. As a step towards this direction, in this paper we propose a business model for the mobile virtual communities in which the mobile device takes on the role of a content producer and content consumer. Though there are a number of research issues which need to be addressed to realize such virtual communities, in this paper we focus on the service requirements, architecture and open source software implementation of a technical platform for the content producer and consumer mobile devices. The next phase of the technical platform is aimed at using context information of the community members for enhancing social interaction, services and product offering aspects. We present a case study of the proposed business model in the mobile healthcare domain.*

## 1. INTRODUCTION

A virtual community is a technology-supported cyberspace, centered upon communication and interaction of participants, resulting in a social relationship being built up [1]. The world of online virtual communities is experiencing a phenomenal growth and ever-increasing popularity by capitalizing on the ubiquitous Internet connectivity and the contemporary technologies such as weblogs, social bookmarking, wikis, podcasts, RSS feeds, peer-to-peer computing, social software, web application programming interfaces (APIs), and online web services all of which comprise Web2.0 [2]. Complimentary to these technologies and due to the recent advances in the

mobile hardware, software and communication technologies, the world has seen the rise of mobile virtual communities where the members use mobile devices to participate in the virtual community [3].

The existing day virtual communities are particularly *social networking oriented* (e.g. mySpace), *product oriented* (e.g. BMW-forum) and *consumer services oriented* (e.g. eBay). A typical social networking community platform consists of a number of functions including those for creating/updating community member profiles and interactions between these members using online text/audio/video chatting, messaging, picture/video sharing, and interactive animations. In addition to a subset of these functions, the product oriented community platform supports functions for displaying product information, product FAQs, and purchasing and selling products. Similarly, a consumer services oriented platform includes functions for services listing, pricing, seller–consumer negotiations, services and sellers ratings and payment management. In principle, these communities are decoupled from each other depending on their focus. We believe that context-awareness would enable us to design and develop a virtual community which cleverly combines the social interaction and commercial functions to provide enhance social interaction aspects, offer personalized services and products to its members.

In existing virtual communities, mobile devices play the role of a *content consumer* to access the services available in the fixed network. For example, the hybrid community environment proposed in [4] is composed of a web-based part (the platform and member profiles) which can be managed from the fixed computer and a mobile part of the community is focused on communication via a mobile device. However, recently the role of mobile devices is evolving from the content consumer to *content producer* [5]. The information obtained from the contents produced (e.g. user preferences and profile, user generated content) by these mobile devices could be of possible use to other members of the community. Moreover, the user context information (e.g. real-time location information, user agenda) obtained from these devices is important to realize the context-awareness and personalization aspects of the virtual community.

It has been observed that a concrete business model is necessary to financially sustain the virtual community [6]. Firstly, in this paper, we outline the business model for the mobile virtual communities in which the mobile devices assume a content producer role along with the content consumer role. Another feature of the proposed business model is that the community platform provides the necessary context-aware matchmaking functions based on community member's profile, interactions and the context information (e.g. location) of these members for recommending the relevant sub-communities, products, services and displaying community support content (e.g. advertisements).

To realize the virtual community based on the proposed business model, along-with the technical challenges, a number of issues such as legal issues, social issues, user generated content copyrights, user interface, security and

trust concerns need to be addressed. In this paper we limit our focus to the architecture of the virtual community and participating mobile devices based on the principles of *Service Oriented Architecture* (SOA) [7] and the services implementation for the content exchange on the mobile devices. We also motivate our choices for the community platform and mobile services implementation, provide the current implementation status and analyze a case study in the mobile health domain.

Section 2 of the paper discusses the related work in this area. Section 3 presents the proposed business model. Section 4 elicits the service requirements for the virtual community technical platform and presents the high level architecture. Section 5 is on the implementation of the case study in the m-health domain. Section 6 summarizes the work and discusses the future work.

## **2. RELATED WORK**

The roots of the present day virtual communities in the cyberspace could be attributed to the rise of e-mail in 1960s. Further, the virtual communities flourished from the use of online media like electronic mailing lists, blogs, chat rooms and Internet forums for the knowledge exchange. The existing virtual communities broadly fall into the *commercial* and *non-commercial communities* [8]. Further analysis in [8] classifies the virtual communities along two dimensions: *profit* and *non-profit*, *company* and *non-company*. A comprehensive state of the art of virtual communities is reported in [1] where the existing research on virtual communities is classified into basic research, technology development, functions derived and adoption, implementation and outcome assessment and institutionalization. A number of directions for the future work are recommended in [9] as follows: 1) The Meta-analysis of research in the virtual community; 2) Impact of Informatics to support communication in virtual community; 3) Knowledge transfer in virtual community; 4) A review on technology-supported relationship; 5) User Interface Design of virtual community to differentiate from online information services and 6) Longitudinal Study on technology adoption in virtual community.

A thorough synthesis of current research trends of the mobile virtual communities is reported in [3]. The work reported in [3] groups current research interests in the mobile virtual communities into *technology-centered interest*, *user-centered interest* and *business-centered interest* and analyses inter-dependence between them. The technology-centered aspects include the issues in the platform design, development framework, mobile network bandwidth limits and intelligent agents. The user-centered interest consists of the aspects such as user interface, behavior, personalization, privacy, data security and trust while the business-centered aspects are marketing, investment and business models.

Leimister et.al. [6] claim that for the virtual community to be successful, a business model should consider external factors such as technical and legal conditions as well as market and competition conditions. To motivate this claim,

[6] analyses two case studies of the successful virtual communities using the proposed business model framework. As referred in [4], a business model helps to understand the fundamental components of an existing or future business activity. The business model proposed in [4], handles the social and commercial aspects of the virtual community. The community platform is established and promoted by the product and service providers (sellers) who are interested to sell their services to the individuals (buyers) in the community. Based on the information such as preferences and buddy list provided by the buyers, the sellers provide personalized services to the buyers. In terms of the mobile aspect, the hybrid community in [4] is asynchronous i.e. the members broadcast their messages to the buddy list and people react whenever it is convenient for them. The proposed business model in [4] is applied in a *mobile community online reservation system* in the leisure services domain. The business model proposed in this paper is an extension of the business model proposed in [4]. This extension is mainly in terms of the role of mobile users as service and data providers and context-aware mechanism for enhancing social interaction, services and product offering aspects.

To exploit the advantage of mobility in the scenarios such as traffic jam, [9] propose an innovative collaboration model based on the concepts of *spots*. *Action spot* is the place of interest to the community while *member spot* is the place of the community member. Since an action spot could develop dynamically (e.g. traffic jam), a community member informs the other members about the location of the action spot using the mobile device. This collaborative model has earlier been used in [10] to develop a community for the public transport awareness system. To expand the virtual communities from the fixed computers to the mobile devices, [11] propose a wireless and mobile application known as *MOOsburg++*. In combination with the positioning systems, *MOOsburg++* could enable scenarios such as reminders when a member reaches a pre-configured location.

The distinguishing aspects of our work as compared to the related work are as follows: 1) The proposed business model considers the situations where the mobile device acts as a content and service provider; 2) The community platform uses the context information of the community members to recommend them relevant sub-communities, products, services and community support content; 3) SOA based approach for the architecture and implementation where the members use their mobile devices for offering commercial services and the content exchange.

### **3. A BUSINESS MODEL FOR MOBILE VIRTUAL COMMUNITIES**

The most frequently cited definition<sup>1</sup> of a business model is that by Timmer [12] and it is as follows: 1) An architecture for the product, services and information flows, including a description of the various business actors and their roles; 2) a description of the potential benefits for the various business actors and their roles; 3) a description of the sources of revenues. This section explains the elements of the proposed business model based on

---

<sup>1</sup> 690 citations according to Google Scholar on January 08, 2008.

this definition. However, before going into the details, we would like to clarify the scope of the terms *product*, *service*, *content*, *information* and *sub-community* referred in the business model herewith.

The distinction between the product and service is very fuzzy. For example, the Merriam-Webster Online Dictionary defines product as *something (as a service) that is marketed or sold as a commodity*. The meaning of the product and service often associated with the context in which they are used. Herewith we consider that both, the product and service are sellable i.e. for the use of the product or service, their consumer needs to pay a certain amount of money to their providers. We also consider that the product is *tangible, could be owned, countable* and *manufactured* while service is *intangible, could not be owned, tailor-made, leveled* (e.g. best) and *could be subscribed*. In this paper, the content is data in the form of text, files (e.g. images), and real-time streams. *Information* is a result of certain operations on the *content*. The *sub-community* is a community formed inside the main community and it could be based around a particular product and service. Thus, in principle, a community is comprised of of all the distinct members in the sub-communities.

## **A. Business Actors**

In the proposed business model, we define the following three primary types of the actors: *consumers*, *providers* and *the community platform operator*. The consumers and providers could be fixed as well as mobile. The providers are further sub-divided into the *commercial service provider*, *commercial product provider*, *social contents provider*, *community support provider* and *Internet Service Provider (ISP)*. The consumers are sub-divided into the *commercial service consumer*, *commercial product consumer* and *social services consumer*. The *community platform operator* provides the necessary infrastructure and functionalities for the interactions between the consumers and providers.

In this paper, since we emphasize the role of mobile users as the *provider of the services, product* and *contents* as well as *the consumer of services and products*. We present herewith two examples to justify this role. For the additional example of this concept, we refer to the case study in the Section 6.

*Mobile user as a commercial service consumer:* The mobile user takes a picture of the book barcode and the barcode picture (or barcode number) is sent to the commercial product information service provider who sends the information about the product to the user.

*Mobile user as a commercial service provider:* The mobile user uses his mobile device to monitor the Quality of Service (QoS) information of the wireless network she is connected to and sends this information to the QoS map service provider [13] which will analyze the information received from multiple mobile devices to generate a QoS map showing the QoS characteristics and available networks at a particular location and time.

ISP provides the Internet connectivity so that the other actors could interact with each other. Since their role is limited only to provide connectivity, we don't consider ISP further in this business model. Figure 1 shows the business model depicting the consumers, providers, community platform operator, and ISP along with the knowledge and money flow within these actors. The following subsection explains the role of the community platform in details.

## **Community Platform Operator**

The community platform operator provides an infrastructure and facilities to build the social relationships and facilitate content and financial transactions between the providers and consumers. The community platform allows the commercial service (product) providers to list and offer their services (products) to the consumers. The *social interaction service* within the community platform provides the necessary facilities to build social relationship between the consumers and providers. For example, the service (product) providers advertise their services (products) to the potential consumers and these consumers could rate these providers and recommend them to the other members using social interaction services. The community platform is also a single point of contact for the revenue exchange between the service (product) providers and their consumers.

One of the features provided by the community platform operator is the *context-aware matchmaking function* which makes use of the context information (e.g. location) of the providers and consumers to recommend them services and products based on their context. E.g. if there are multiple mobile service providers offering an ambulance service, the patient requesting the ambulance is offered the nearest ambulance service. Using the context information of the mobile consumers is also helpful for offering contents (e.g. advertisements) provided by the *community support provider*.

## **B. Product, Service and Content Flows**

We define the following three types of interaction modes for the content exchange between the actors in the proposed business model:

*Publish*: The interaction mode *Publish* is used by the *commercial service provider*, *commercial product provider*, *social contents provider* and the *community support provider* to publish offered services, products, social content and support content (e.g. advertisements) respectively. The community platform provides necessary facilities (e.g. services, product and advertisements listing in the appropriate sub-community and social content display in the member profile) to publish this information.

*Request-Reply*: The *Request-Reply* mode is used by the consumer actors and the community platform to interact with the providers. Thus the community platform essentially serves as a *mediator* between them. The *mediation*

service for the commercial aspects offered by the community platform operator facilitates the interaction between these consumers and providers. This service processes and forwards the requests from the consumers to the providers and the reply from the providers is processed and relayed back to the consumers. The processing part at the mediation service is mainly for generating revenue for the community platform (described in the sub-section 3.D herewith). The social services consumer uses the request-reply interaction mode to request social contents and information published by the community members using the social interaction services.

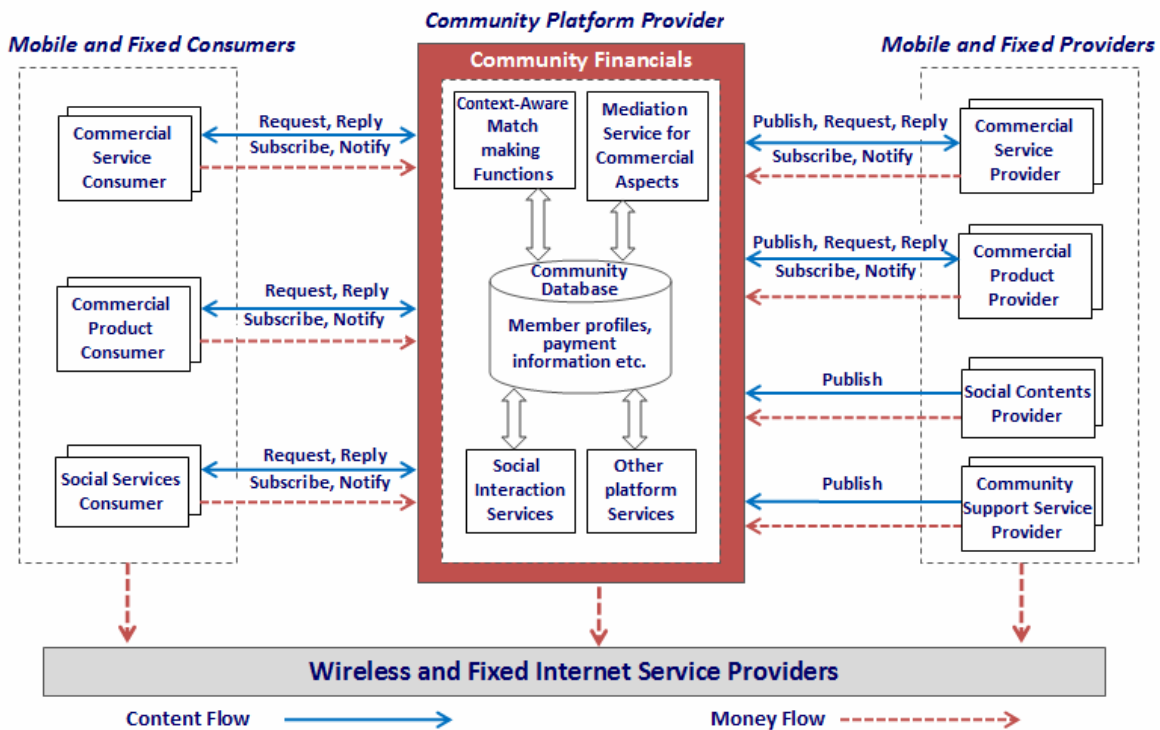


Fig. 1: Business Model for Nomadic Virtual Knowledge Communities

*Subscribe-Notify:* The interaction mode *Subscribe-Notify* is similar to the Request-Reply mode. However, additionally this mode lets the consumer subscribe to certain information and receive the updated information on its change. E.g. A social services consumer subscribes to the social interaction service to be notified when a certain member comes online. The commercial product consumer could subscribe to the additional products being listed by a particular commercial product provider.

### C. Description of the Potential Benefits

The proposed business model is beneficial to all of its stakeholders because of a number of factors listed as follows:

*Consideration of mobility:* The consideration of the mobility of both, the consumers and the providers results in the provisioning and utilization of the products and services anytime and anywhere. Moreover, the members of the community could access the social interaction services on their mobile devices.

*Matchmaking functions:* The matchmaking function provided by the community platform matches the interests of the community members to the services and products offered by the providers. The community platform also proposes appropriate sub-communities for their members and suggests to them to the other members for the social interaction. The context-awareness in the matchmaking function finds the best matching services to the consumer based on the consumer and provided context. The consumer also receives the community support contents based on their context; hence it is more likely to be appreciated by the consumer.

*Mediation Service for the Commercial Aspects:* The mediation service for the commercial aspects handles the commercial transactions on behalf of the consumers and alleviates them from entering the financial information multiple times.

#### ***D. Source of Revenues***

The use of virtual communities for the social interaction (e.g. dating, friend finder) has been tremendously successful by generating revenues from the membership fees as well as advertising. Similarly, the pure commercial communities (e.g. providing auction and shopping services) have been successful too by using a certain revenue sharing model. The proposed model has a potential of revenue generation from the membership fees, revenue sharing between the commercial providers and the community platform as well as revenue from the community support providers. For the detailed information on the revenue generation aspect, we refer to [6] and [14].

### **4. SERVICE REQUIREMENTS FOR THE MOBILE COMMUNITY PLATFORM**

Nowadays, SOA is a popular choice for the application development because it facilitates the development, deployment and usage of (composite) services which are well defined, loosely coupled, flexible, reusable and have implementation independent interfaces. Hence we choose to use SOA paradigm as a basis for the design of the mobile virtual community platform. To be viable, a mobile community platform based on the proposed business model has a plethora of requirements including services, user interface, and detailed matchmaking functionality. However, in this paper, we present our requirements mainly in terms of the basic services provided by the community platform and the services to be hosted on the mobile device to take on a consumer and producer role. Please note that the definition of service in this section is different from that in the business model described in the Section 3. Herewith, we consider a service to be a unit of well-defined functional behavior (in syntax and semantics) that is offered by a software entity for use by other software entities. A service could be a composite service in that it can consist of one or more constituent services [15].

#### ***A. Services Requirements at the Community Platform***

We describe here the services requirements regarding to the community platform, as depicted on the figure 2.



*Member Management Service:* The member management service provide functions such as registration of the new members, editing and managing member profiles, their roles (e.g. commercial service provider), login, and session handling.

*Directory Service:* The directory service provides functionality for the commercial service (product) providers and community support providers to list the offered services (products) and content. Thus, it basically results in the creation of yellow pages.

*Community Management Service:* This service consists of all the functionalities required to create, join, access and search sub-communities, publish, get and subscribe information in the existing sub-communities.

*Social Interaction Service:* This service handles the one-to-one, one-to-many or many-to-many interactions between the community members. This includes interaction functions such as live chat, group notifications, and subscription to the member information.

*Context-Aware Matchmaking Service:* Semantic descriptions of the member profiles combined with description logic are powerful tools to perform matchmaking [9]. The matchmaking functionality of this service is used to find potential members for the new sub-community automatically by providing the semantic description of the community. The matchmaking service is vital to support the business model described herewith. The ability to quickly capture a base of substantially interested users is very attractive for the commercial service providers and community support providers. If a community member is interested in a particular type of the service, the matchmaking service performs the final selection of the services based on context information of the members and services using the approach proposed in [15].

*Mediation Service for Commercial Aspects:* Centralizing member profiles and billing functionality simplifies the everyday life of the users. The role of the mediation service is to provide access for the members to the listed services and products through the community platform and to handle financial transactions on behalf of the members. For this purpose, the mediation service consists of a centralized billing module. The Community Platform provisions a database which stores information such as the member profiles, services and product listings and billing information. The social interaction between the community members is also stored in this database along with their profiles.

Due to the choice of SOA paradigm for the community platform design, it is possible that the services interact between themselves to achieve a composite functionality. For example, the combined use of the social interaction service, context-aware matchmaking service and mediation service lets a community member have an interaction with the commercial service provider, select the service and use the service. For more information on how to use the service composition we refer to [15].

## ***B. Services Requirements on the Mobile Devices***

The following basic services are required at the mobile device to be able to successfully make use of the community platform services:

*Content Exchange Service:* The content exchange service on the mobile device is aimed at sending the contents (e.g. text, images, and streams) generated at the mobile device to the community platform so that this content could be published in the relevant communities the user is a member of. Similarly, this service also requests/subscribes the community contents the user is interested in and sends these contents for user viewing. This service enables a mobile device to be a social content provider, social services consumer and commercial services consumer.

*Commercial Mobile Service:* The commercial mobile service enables a mobile device to be a commercial service provider. This service could make use of the content exchange service for exchanging commercial content and apart from this, the additional functionalities required to provide the hosted commercial service need to be provisioned.

*Context Information Service:* This service obtains the context information (such as location) of the mobile user and sends this information and subsequent context changes in real-time to the community platform. This information is further used by the matchmaking function.

## **5. TECHNICAL PLATFORM**

Our technology choice for implementing the services at the community platform is Web Services. Compared to other SOA technologies (e.g. Jini), Web services technology promises interoperability in terms of the service development. That means that as long as service descriptions are published using WSDL and SOAP is used for exchanging contents, the programming environment (e.g. Java, C#, PHP) in which the service is implemented.

As compared to the service provisioning in the fixed network, to develop, deploy, use and maintain a service on the mobile device, a variety of concerns need to be addressed because of the following reasons: intermittent bandwidth characteristics and high error rate of the wireless communication link, reachability and connectivity issues arising because of mobility, performance concerns as a reason of the scarce computation resources of a mobile device as compared to their counterparts in the fixed network and lack of standardized protocols. As identified in [5], there exist following three infrastructures for service provisioning on the resource constrained mobile devices. [5] refer to such service as the *Nomadic Mobile Service (NMS)*. These infrastructures are as following:

1. *Micro-Services:* *Micro-Services* is a lightweight infrastructure capable of hosting web services from the mobile devices. However, it supports only SOAP simple types (e.g. *String*, *Integer*, *Char*) to avoid the complexity in performing the extraction process of SOAP complex types on the mobile device. Due to the limited support for the content types, *Micro-Services* is not our choice for the services implementation on the mobile devices.

2. *Mobile Host*: *Mobile Host* is a prototype implementation of mobile web service provisioning and the discovery of services in a peer to peer (P2P) network on top of JXTA service discovery. Though it could be potentially used with less effort to interact with the Web Services based community platform, it does not support streaming content transfer to/from the mobile device.

3. *Mobile Service Platform (MSP)*: MSP is a proxy based middleware based on the *Jini surrogate architecture specification* and developed in Java. MSP supports streaming content delivery to/from the mobile device. In addition, it also features context-awareness by exploiting multi-homing feature of the mobile device. This feature provides the capability of selecting the network interface which offers higher bandwidth among the available network interfaces providing internet connectivity [16]. Because of these two features, MSP is our choice for the services on the mobile device. However, since the service developed using MSP is able to participate only in the Jini network; it is required to develop additional components so that they could be interoperable with the web services.

A NMS realized using MSP consists of two components: 1) An application realizing a service running on the mobile device (referred to as a *device service*); and 2) A representation of the device service in the fixed network which is referred to as a *surrogate*. The surrogate functions as a proxy for the device service and participates in the service discovery network. *Surrogate Host* is responsible for the management of surrogates. The main components of MSP include the following: 1) *MSP-Input/Output (MSP-IO)* resides on a mobile device and interacts with the device service. 2) *MSP-Interconnect* is located at the surrogate host and interacts with the surrogate. 3) *MSP-Messages* specifies the structure of messages exchanged between the device service and the surrogate. MSP uses HTTP as a data transfer protocol.

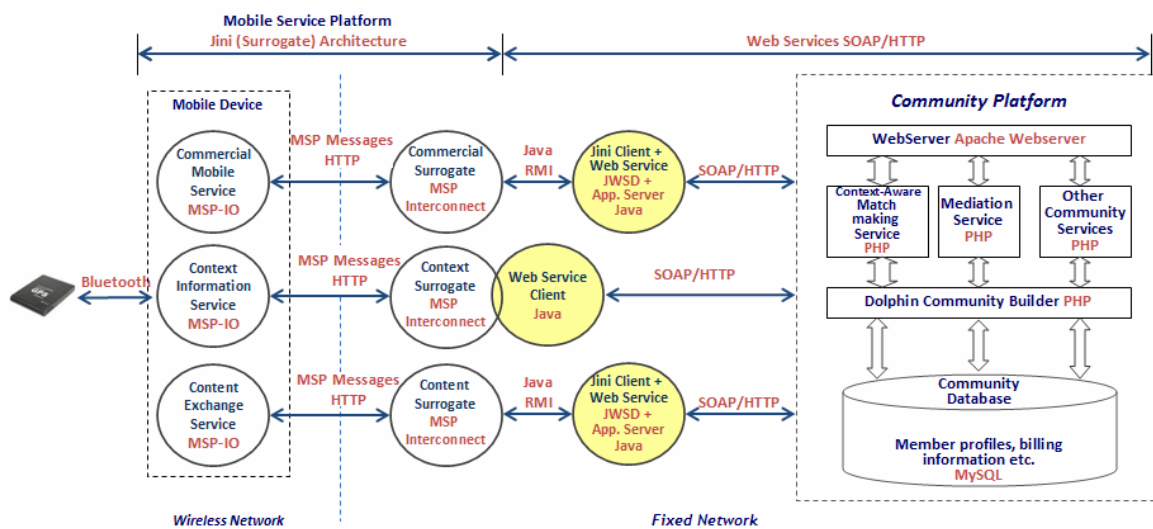


Fig. 2: High Level Overview of the Technical Platform

The architecture of the technical platform is shown in Fig. 2. The community platform is an extension of the PHP based open source community builder software called as *Dolphin* [17]. Dolphin is installed on top of *EasyPhp* [18] toolkit which provides preconfigured and easy to install/use/configure environment for running PHP programs with *Apache webserver* and *MySQL* database. On the community platform side, the web services are implemented in PHP. For the implementation, development and testing purposes, Dolphin + EasyPhp along with the newly developed PHP web services are hosted at the development server (<http://ewi217.ewi.utwente.nl/Dolphin>) at the University of Twente. The commercial mobile service, context information service and content exchange service are developed as the nomadic mobile services. For interoperability between these services and the community platform, it was required to implement adapters so that the Jini client works as a web service and the surrogate works as a web service client. For example, the Jini client of the commercial mobile service and content exchange service function as a web service for the community platform. Internal to these adapters, we use *Java Web Services Developer Pack 2.0* toolkit and *Sun Java System Application Server* [19] for web services deployment and deployment, respectively. The surrogate of the context information service is extended as a web service client so that it could send the context information to the community platform. A Jini client communicates with the Jini service using Java RMI.

## 6. CASE STUDY

For the healthcare industry, mobile applications provide an opportunity to offer better care and services to the patients and a more flexible and mobile way of communicating with the patients and caregivers [17]. The case study presented here lies in the m-health domain. Though we have not yet developed a full set of components necessary for realizing the presented case study, given our expertise in the area of context-aware service discovery [15] and mobile virtual knowledge community [22], it seems quite plausible. The entities involved in the following case study are shown in the Figure 3.

*Bob is a patient suffering from epilepsy disorder. He joins the community using his basic profile (e.g. name, address, gender, credit card info.) Alice is paramedics (mobile commercial service provider) and she also joins the community. The local health-care center creates a sub-community called as Health-Care Community (HCC). The community management service recommends Bob, Alice and other members to join HCC. Bob and Alice accept this invitation and they join HCC by updating their profile with information specific to HCC (e.g. the problem the Bob is suffering from). The Matchmaking service recommends the members to be a part of each other's social network based on their HCC centric profile (e.g. two patients suffering from the same problem). Bob, Alice and other members (social services consumer) of HCC including patients and paramedics socialize with each other for sharing their experiences.*

Meanwhile, the Health-care center (commercial service provider) announces the offering of a tele-monitoring service for the patients suffering from epilepsy. For the patient to avail this service, it is required to purchase a Body Area Network (BAN) which is compatible with their mobile devices. Various BAN manufacturers (commercial product provider) recommended by health-care center offer their BAN to the patients. Using the context-aware matchmaking service, the HCC recommends Bob a particular BAN which is compatible with his PDA. Bob (commercial product consumer) purchases the recommended BAN and subscribes (commercial service consumers) to the tele-monitoring service via the community platform.

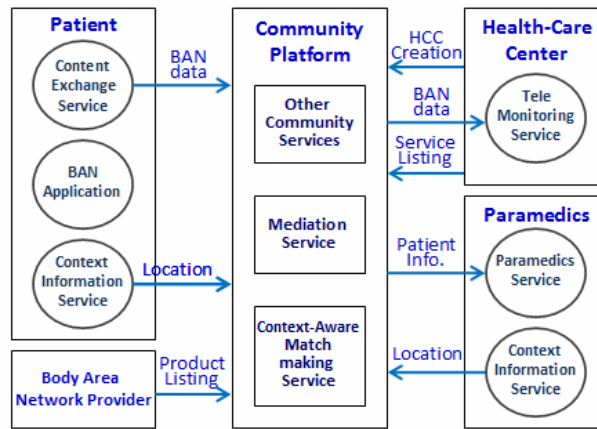


Fig. 3: Actors and services in the case study of tele-monitoring in the m-health domain

One day after Bob suffers from a sudden epileptic seizure, the tele-monitoring service requests HCC to search for the nearest paramedics. On this request, the context-aware match-making service searches for the nearest paramedics service based on Bob's and paramedics' current location. Fortunately, Alice is the nearest paramedics to Bob. HCC invokes Alice's paramedics service on behalf of Bob so that Alice knows about the critical condition of Bob and reaches the patient for providing emergency medical assistance.

In principle, these functionalities could be provided by a specialized application for the remote patient tele-monitoring [21]. However, the advantages of using the mobile virtual community approach is that it leverages the benefits of the social interaction to create a trusted relationship within the patients, paramedics, BAN developers and the health-care center. In addition, it provides a wide and competitive choice of products and services to the patients, a platform for the paramedics to exploit their skills and an opportunity to make money for all the product and service providers.

## 7. SUMMARY AND FUTURE WORK

In this work, we propose a business model for the mobile virtual communities whereas apart from the role of content and service consumer, the mobile devices also take on a role of the content and service provider. We have

chosen *Service Oriented Architecture* (SOA) paradigm for the design of the technical platform based on the proposed business model. Though there are a number of research issues which need to be addressed to fully implement the virtual community based on the proposed business model, herewith we focus on the service requirements, architecture and implementation of a technical platform for the content producer and consumer mobile devices. The proposed virtual community model and the technical platform are also aimed at using context information of the community members for enhancing social interaction, service and product utilization aspects. We have assessed the feasibility of the proposed business model and technical platform in a tele-monitoring application case study. The existing implementation uses open source software and extends them for the services on the mobile devices and the community platform.

In the second phase of the implementation, we will focus on the detailed specifications and internal working of the context-aware matchmaking service and how it uses member profiles, social interactions and other context information for achieving expected functionality. For that purpose we plan to use our experience gained in the development of mobile virtual knowledge community in [22]. The third phase is the implementation of the presented case study and validation of the mobile virtual community concept in the m-health domain.

## **ACKNOWLEDGMENT**

This work is supported by Mobility International region of Rhone Alps (MIRA), France, Dutch Freeband Awareness project (under grant BSIK5902390) and Amigo project (IST-004182, partially funded by the European Commission).

## **REFERENCES**

- [1] Lee F.S.L.; Vogel D.; Limayem, M, *Virtual community informatics: what we know and what we need to know*, Hawaii International Conference On System Sciences, Hawaii,, January 2002.
- [2] Web 2.0 [[http://en.wikipedia.org/wiki/Web\\_2.0](http://en.wikipedia.org/wiki/Web_2.0)]
- [3] El Morr C., Kawash J., *Mobile Virtual Communities: Current Trends and Future Perspectives*, International Journal of Web Based Communities, Vol. 3, No 4, pp. 386-403, 2007.
- [4] Schubert P., Felix J., *Hampe: Business Models for Mobile Communities*, Hawaii International Conference On System Sciences, Hawaii, January 2005.
- [5] Pawar P., Srirama S., van Beijnum B. J., van Halteren A., *Comparative Study of Nomadic Mobile Service Provisioning Approaches*, International Conference and Exhibition on Next Generation Mobile Applications, Services and Technologies (NGMAST 2007), Cardiff, Wales, UK, September 2007.
- [6] Leimeister J., Krcmar H., *Revisiting the Virtual Community Business Model* Proceedings of the Tenth Americas Conference on Information Systems, New York, New York, August 2004.

- [7] Papazoglou M.P., Georgakopoulos D., *Service Oriented Computing*, Communications of the ACM, 46(10): p. 24-28, 2003.
- [8] Klang M., Olsson, S., *Virtual Communities*, Proceedings of the 22nd Information Systems Research Seminar in Scandinavia, Keuruu, Finland, August 1999.
- [9] Kawash J., El Morr C., Itani M., *Towards Enabling Collaborative Mobile Virtual Communities*, International Journal of Web Based Communities, Vol. 3, No 4, pp. 427-447.
- [10] Kawash J., El Morr C., Charaf W., Hamza T., *Building Mobile Virtual Communities for Public Transport Awareness*, The 2nd International Conference on Mobile Technology, Applications and Systems, Guangzhou, China, 2005.
- [11] Farooq U., Isenhour P.L., Carroll J.M., and Rosson M.B. 2002. *MOOsburg++: Moving Towards a Wireless Virtual Community*, Proceedings of the 2002 International Conference on Wireless Networks, Las Vegas, 2002. ,
- [12] P. Timmer. *Business Models for Electronic Markets*. *Electronic Markets*, 8:3--8, 1998.
- [13] Wac K., van Halteren A., and Konstantas D., *QoS-predictions service: infrastructural support for proactive QoS- and context-aware mobile services*, International Workshop on Context-Aware Mobile Systems (CAMS) co-located with On The Move 2006. October-November 2006. Montpellier, France.
- [14] Rothaermel F. T., Sugiyama S., *Virtual internet communities and commercial success: individual and community-level theory grounded in the atypical case of TimeZone.com*, Journal of Management, Vol. 27, No. 3, 297-312 (2001).
- [15] Hesselman C., Tokmakoff A., Pawar P., Iacob S., *Discovery and Composition of Services for Context-Aware Systems*, IEEE European Conference on Smart Sensing and Context, Enschede, The Netherlands, October 2006.
- [16] Pawar P., van Beijnum B. J., Peddemors A., van Halteren A., *Context-Aware Middleware Support for the Nomadic Mobile Services on Multi-homed Handheld Mobile Devices*, 12th IEEE Symposium on Computers and Communications (ISCC 2007), Aveiro, Portugal, July 2007.
- [17] Dolphin – Smart Community Builder – Free Software, <http://www.boonex.com/products/dolphin/>, last accessed date: 28 January, 2008.
- [18] EasyPHP: PHP – Apache – MySQL for Windows, <http://www.easyphp.org/>, last accessed date: 28 January, 2008.
- [19] Java Web Services Downloads – Java Web Services Developer Pack, <http://java.sun.com/webservices/downloads/>, last accessed date: 28 January, 2008.
- [20] Siau K., Shen Z., *Mobile Healthcare Informatics*, Medical Informatics and the Internet in Medicine, June 2006. 31(2): p. 89 - 99.
- [21] *Mobihealth – Putting Care in Motion*, <http://www.mobihealth.nl/>.
- [22] Subercaze J. Maret P., Dang M. N., Sasaki K., *Context-aware applications using personal sensors*, Proceedings of Bodynets, Firenze 2007.