What Do Elderly Desire?
A Case For Virtual Communities

Jan-Willem van 't Klooster*, Bert-Jan van Beijnum, Pravin Pawar, Klaas Sikkel, Lucas Meertens, Hermie Hermens

CTIT - Centre for Telematics and Information Technology
University of Twente
PO Box 217, 7500 AE, the Netherlands
E-mail: j.w.vantklooster@utwente.nl
* Corresponding Author

Abstract: Virtual communities have a potential to improve the community building process and care services through support for activities, participation and information needs. In this paper, we propose a mobile virtual community platform for elderly healthcare. The requirements for this platform are collected from interview sessions with clients and caregivers in a care institution, and a workshop with multiple stakeholders. We focus on the technical platform that fulfills the requirements gathered from this approach.

The platform is an elaboration of our existing mobile virtual community platform and enables tailoring through an adaptable set of mobile and platform services. Reminder services, remote monitoring, video communication and (delegated) friend and service finding are discussed and exemplified through a case study.

Keywords: Virtual Community in healthcare, Mobile Virtual Community, telemedicine, e-health, m-health.

J.W. van 't Klooster, B.J.F. van Beijnum, P. Pawar, N. Sikkel, L.O. Meertens and H.J. Hermens

1   Introduction

In the past few decades, the demographic trends in western countries are characterized by aging populations, growing life expectations, a decreasing number of healthcare professionals, increasing cost pressure on healthcare systems, and urbanization. These factors have increased workload on the services sector of *elderly care* [1]. Services in this sector include daily need services such as providing meals, washing, supplying medicine etc. Other frequently occurring tasks include ensuring the health status of the clients, providing assistance in case of emergencies (e.g. falls) and reminding about the client's agenda. However, apart from providing these basic needs, other important responsibilities of the caregivers are to enable activities and participation for elderly, including socialization, activity stimulating events such as singing or pottery, and providing a daily structure and a listening ear.

Nowadays, *information and communication technologies* (ICT) have revolutionized daily living, communication and behavior of people with applications in almost every aspect of life. ICT is effectively used for socialization by means of virtual communities. A *virtual community* (VC) is an electronically supported social network: it can be seen as a group of people who have regular social interaction, independent of time and space, because of a common interest such as a problem, task, or feeling exchange [2,3]. Virtual communities are in use in various domains including computer supported collaborative work (CSCW), sport associations, contact between teenagers, and healthcare. The goal of a VC is support interaction between members.
ICT in healthcare is also referred to as *electronic Health* (e-Health) [6]. E-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies.

Virtual communities in e-Health provide a good means to support various processes in the elderly care sector. First of all, it supports the social interaction between the caretakers and (informal) caregivers. Synchronous and asynchronous communication can be supported to clients and (in)formal caregivers. Certain functions such as match-making in our existing e-Health virtual community platform [4] allows for suggestions of people and services. When security issues are addressed properly, VCs allows for exchange of public and private information between involved parties and services. Reminder and agenda services can be moderated by and tailored to community members to increase socialization. Using these services, a community can for instance give personalized medicine reminders, if connected to medicine registration. When mobility is supported as in our case, ambulant telemonitoring services can be integrated for vital sign monitoring and for feedback purposes.

In summary, virtual communities have the potential to improve the community building process and care services through support for activities, participation and information needs. This helps to solve lack of information and helps to improve quality of the healthcare service. The contribution of this paper is to present results of a multi-disciplinary approach to develop virtual communities for elderly care, incorporating client/caregiver interviews and multi-stakeholder input. The paper discusses requirements to be supported by the virtual community, gathered from these activities. Based on these findings and earlier experience in virtual communities in the healthcare domain, we describe the technical platform that fulfils these requirements for the elderly healthcare domain. Our target domain consists of elderly of 60 years and older, with varying levels of care needs, living independent or in open accommodations. In this paper, we focus on the requirements for the technical platform rather than on the user interface.

The remainder of this paper is structured as follows. Section 2 discusses related work. In Section 3, the methods that were used for requirements gathering are explained. In Section 4, results of the interviews are discussed. Section 5 gives an illustrative case study in which the envisioned system is used. Section 6 presents the proposed mobile virtual community platform and services. Finally in Section 7, a conclusion and future work are presented.

2   Related Work

The application of ICT in healthcare is often referred to as telemedicine or electronic health (e-health). Telemedicine is referred to as providing medicine over geographical or time distance, and can be used for applications such as health discussion & maintenance, alleviation, cure and prevention of diseases. On the other hand, e-health can be considered more broadly as an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology [6].

ICT-innovations like VCs have become very popular (e.g. Facebook). VCs provide people not only with information, but also with emotional support and a place to share their personal experience [2]. Vcs are also studied for healthcare purposes. In healthcare, virtual communities can be divided into four types: i) communities for healthcare professionals only, ii) for patients / informal caregivers only, iii) combinations of them, and iv) general public communities [7]. Members of a VC can of course be a member of multiple communities or other VCs according to their preferences. It is however suggested that a single community has a clear focus [5,8,9].

Several scientific trials have been performed, but there is no solid scientific evidence of the advantages of VCs. One reason of this lack of evidence is that most of these trials are combined with quite complex interventions. Promising is the fact that no negative findings have been recorded either [7].

VCs allow people to meet new friends, though a common interest alone is often not enough to form the basis of new friendships. Especially those who tend to have little cohesion with the community they frequent, stay only for short periods of time and visit less often. Posters on forum-based communities have a more intense connection with the community and are more likely to enrich their social network by means of a VC [10-12].

Maloney-Krichmar and Preece [9] have reported on an in depth investigation on sociability, usability and dynamics of the Kneeboard online community. They observed 3 factors that impact the success of a VC: robustness, a narrowly focused purpose and the social context of the community (specifically the mix of stable long-term members and newcomers).

SeniorenWeb [13] is a VC for elderly. It provides members with mail groups, interesting links for elderly and activities such as group meetings and courses. TeleCARE was a European project, (Camarinha-Matos 2002) focussing on tele-supervision and tele-assistance infrastructure. Older projects (Wellman 1996, Furlong 1989) supported information finding, and socialization through chatboxes.

What does telemedicine offer? The combination of ICT and medicine offers new ways to deliver health maintenance and disease prevention, alleviation and cure, which were not possible before ICT was available. Especially with the advent of mobile communications, ICT allows health support anywhere, anytime. With respect to VCs for healthcare, ICT state of art enables development of health support and socialization, beyond chatting and information providing. In this paper we describe how this can be realized, involving end-users and scenarios.

3   Methods for Requirements Gathering

This section discusses the research methods and techniques adopted for the elicitation of the requirements. Thereto, an overview is discussed first followed by a further detailing. Our requirements gathering process combines elements of scenario based user need analysis, interviewing techniques guided by a holistic health model constructed from International Classification of Diseases (ICD), the International Classification of Functioning, Disabilities and Health (ICF), and their relationship as defined by so called *core sets* [16-18]. Section 3.1 gives an overview of the process steps taken. Section 3.2 discusses the health model. Section 3.3 details the interview design and Section 3.4 discusses the scenario based user need analysis.

3.1 Overview

The process that we followed is shown in Figure 1. The boxes show the activities; the arrows denote the information used for those activities. A health model and breakdown concepts were used for interviews with clients and care professionals. Analysis of the interviews was used for scenario development purposes, both directly and involving a stakeholder workshop. The scenarios consequently imposed requirements on the mobile virtual community. Hereafter details of each of the steps are given.
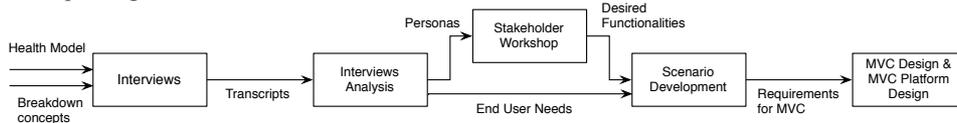

Figure 1. Steps taken to gather requirements for the virtual community.

3.2 Health Model

The interviews are the starting point of the requirements elicitation. In order to structure and guide the interviews, relevant health related issues need to be identifiable. To prepare, execute and analyze the interviews we adopted a comprehensive holistic health model.

The WHO has defined a holistic ontology for health, called the International Classification for Functioning, Disability and Health (ICF) [17]. This ontology of health is a bio-psycho-social model of health, that can be used for many different purposes, among these the assessment of the health condition of man. The ICF defines the health condition as a composition of four components: body structure, body function, activity and participation. Each component comprises a set of categories.

Example categories are: S4: *structure of the cardiovascular, immunological and respiratory systems* and D3: *communication*. Categories may be organized in a hierarchy of subcategories, for example: S4 includes amongst others the subcategories s410 - *structure of the cardiovasculair system* and s420 - *structure of the immune system*. D3 includes amongst others *Communicating - receiving* (d310-d329) and *Communicating - producing (d330-d349)*.

The ICF components are influenced by contextual factors, which can be either personal factors or environmental factors. The ICF defines the relevant categories for environmental factors.

With the ICF a quantitative assessment of client's health status is possible, moreover it enables the structuring of interview sessions and the capturing of the essential client's needs and values.

Most of the clients in our target group have been diagnosed one or more chronic diseases. A taxonomy of diseases is available from the WHO's International classification of diseases [16]. The qualitative relation between a (chronic) disease and the ICF categories potentially affected by this disease are defined by a, so called, ICF Core Set [18]. Core sets have been defined for about 10 chronic diseases. The conceptual schema of the ICF, ICD and Core Set is shown in Figure 2.
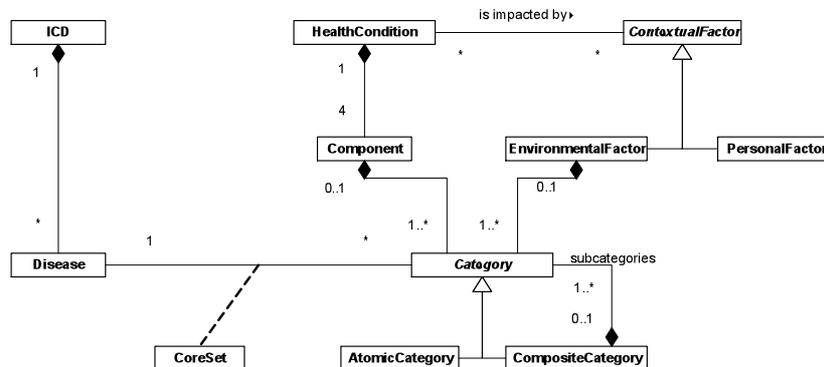

Figure 2: Comprehensive Health Model.

3.3 Interviews

Throughout 3 days, 7 clients and 4 care professionals were interviewed in the elderly care organization 'Parc Hoogveld' in Sittard, the Netherlands. The interview protocol, designed to get a broad picture of the health condition and living situation and to elicit care needs had been tried out in advance in a test interview.

The clients, aged 60 and older, had varying care needs and consumed different care services from the care organization. They were recruited on voluntary basis by this organization. Beforehand, we got information about both their health conditions and care consumption by means of examination of their personal intake assessment, for which permission was obtained.

The care professionals that were interviewed included two caregivers responsible for providing care to the interviewed clients. The third was responsible for client intakes and updates, to determine services to be provided to the clients. The fourth care professional was specialized in information management in care centers with a strong care giving background. As the 2 caregivers were interviewed after the client interviews, we were able to reflect and discuss the answers from the clients with the caregivers.

The clients were asked about their information needs, use of technology, care services from the care centre and elsewhere, related health status, and wishes for novel functionalities that could be supported by means of technology.

The caregivers were asked about their working procedures, information needs, use of technology, care services provided by the care centre and existing working practices.

The interviews were held in a semi-structured manner and were recorded and transcribed. The interview protocol was based on breakdown analysis and on the health model discussed in Section 3.2. Breakdown analysis [19] focuses on analysis of interrupted, not smoothly proceeding equipment use, technology equipment in our case. We applied elements of Grounded Theory [20,21] to analyze of the transcripts, to retrieve the concepts behind actualities. This was done by identifying codes and subsequently concepts, values and needs in the transcripts.

3.4 Scenario Based User Need Analysis

In situations where the use and purpose of a novel system are not clear a priori, usage scenarios are an appropriate technique for gathering these requirements [22,23]. As this is the case in our project, scenario-based user need analysis [24] was used to elicit functional requirements.

The interviews with end-users (clients and care professionals) were transcribed and analyzed. Based on these results, personas were created. Personas are fictional persons that serve as a vehicle to illustrate the envisioned functionality [25]. In this case they are meant to be role models of the target group of elderly. One of the created personas is not fictional, but an unaltered description of the most inspiring interviewee. A second persona was constructed, blending ideosyncratic details of different interviewees into a person with a combination of features that suited its first purpose – to serve a role model in the workshop.

The workshop centered around two multi-stakeholder focus groups with professionals from care, academia and home automation industry from different partners of the project consortium. The workshop drew up a collection of functional elements of future ICT technology use for the targeted elderly.

The interview analysis also resulted in end user needs. They are presented in Section 4.1. The end user needs, prioritized by the consortium, and the functional elements, formed the input to develop 3 scenarios. They were drafted to present the proposed novelties in a coherent story around the personas. The first persona stayed unaltered; the second persona was adapted to better suit the proposed functionalities, a third persona was invented so that all desired functionalities could be illustrated in the scenarios. Then, the project consortium validated the scenarios.

The requirements were grouped in basic (overall) requirements and requirements related to a specific function to be fulfilled. For traceability purposes, we listed from which scenario each requirement was inferred. Finally, we checked 1) whether all scenarios covered the list of desired functionalities from the workshop and 2) whether they covered the needs expressed by the clients and care professionals.

4 Results

4.1 Interview results

Table 1 summarizes the needs and values put forward by the clients resp. care professionals during the interviews. These findings were not explicitly asked for, but mentioned spontaneously by the interviewed persons. One client and one caregiver emphasized the importance of finding new friends to conduct activities with. 3 clients and 4 care professionals mentioned the importance of remembering and information on events. 6 clients and 2 caregivers recognized medication support would be useful. Almost all clients (6) used, or wanted to use, some technology for hobby, such as cellphones, multi-button remote controls, dvd players, but also computers. For instance client one said[1]:

Yes, I would like to learn how to handle a computer. I think I could do that ... from somebody, one-to-one. Not in a group, I'm not really a group person. If that would be possible...

The aspect of learning how to operate the device is important, as addressed by interviewee two:

My grandson comes then to explain to me how the operate the dvd recorder.

However not all interviewees want to use a computer, afraid that it consumes too much time learning. Interviewee two confirmed this:

My son-in-law bought a new PC, with more capacity, and wanted to dump his old one on me. But I didn't want it. If you want to learn handling a computer, that is a lot of work, and I don;t have the time to do that. I can handle the radio, the television, and the dvd recorder and that's all I need.

The use of technology indicates that the current generation independent elderly in our research accept technology, but devices that perform computing tasks should preferably not look like a computer to get high acceptation.

Five clients valued contact with family, not only for themselves but also for their relatives. Interviewee three mentioned:

For instance, my sister calls every evening at seven, and she talks for the better part of an hour. She can talk about the past, for example the business that we used to have.

Though contact with family was not addressed in 2 interviews with caregivers, the other 2 valued it as important too. 2 clients reckoned having a daily structure or aid for that is important; 2 caregivers did so as well. Almost all clients (6) valued support from and to neighbors and people in their community as important. Regarding this contact with the community, interviewee one said:

It's a fine little street here. Yesterday we went in a van and a car to the hospital, all together, and then we drink coffee together and everyone is very happy.
And in the morning I pour them a coffee. In our sitting corner, I'm usually the first to be there, and then I ask everyone "would you like a coffee?" and then I give them one. There is nothing wrong with my hands, it's only the legs that give problems.

Apparently this is valued as an important part of their daily life. Also 3 caregivers mentioned this as important for their clients. Three clients mentioned that when they would be introduced to new technologies, assistance and explanation of the usage would be important. The caregivers did not address this. Interestingly, the clients did not talk spontaneously about monitoring or being monitored, but all the caregivers addressed monitoring functions as important for the clients' safety.

---

[1] Quotes have been translated from the original interview transcripts in Dutch.

Clearly, some of the needs and values found in these interviews can be supported by means of virtual communities. For instance, we refer to earlier work [4,5,8] in which already scenarios related to monitoring for safety reasons are elaborated supported by means of virtual communities. Because of their social nature, services for finding friends, information on events, memorizing events, contact with family and contact with the community, are also good candidates for VC functionalities. Moreover, these services can be enhanced using the social graph of the member once this graph has been established.

Table 1. Values and needs important to clients and care professionals.

Value / Need	Nr. clients reported (n = 7)	Nr. prof. reported (n = 4)
Finding friends for activities	1	1
Memorizing events	3	4
Information on events	3	3
Support for medication	4	2
Technology use for hobby	6	2
Contact with family	5	2
Providing daily structure	2	2
Contact with community	6	3
Aid in technology use	3	0
Monitoring for safety	0	4

4.2 Workshop results

A project consortium workshop has been held in Enschede, the Netherlands, on 13 May 2009, to determine desired functionalities. The workshop participants (consortium members and external experts from care and ICT) discussed a range of functionalities intended for the personas. The proposed functionalities can be grouped under 3 service categories:

1. reminder and information services
2. social interaction and support services
3. remote monitoring and feedback services

Moreover, the workshop yielded an idea for an information and communication *device* that should play a central role. This device, which we call *Julie*, supports two-way (video) communication, is able to present content and (interactive) information, eventually on request. Moreover, Julie can run on various devices such as a TV, PC or smartphone.

For each of the three service categories, scenarios are developed. They contain the desired functionalities and the needs addressed by the clients. Based on the scenario about social interaction and support services, functional requirements are elicited for a virtual community platform. This motivated us to modify the design of our existing Mobile Virtual Community (MVC) Platform to fulfill the requirements imposed by this case study. Before presenting the most important requirements, we exemplify our intentions by presenting a case study based on a summary of the social interaction and support scenario.

5 Case Study

This section starts with a scenario in section 5.1 to show the proposed technology. Section 5.2 lists requirements based on the scenario, and section 5.3 briefly discusses the different communities on the platform.

5.1 Scenario

To illustrate the proposed technology, scenarios have been developed. One of them is summarized below to show possible use of the information and communication device Julie. Afterwards in Section 5.2, important requirements related to the scenario are discussed.

John Pieters is 78 years old and living alone in a care centre. He developed chronic obstructive pulmonary disease (COPD). The treatment of Mr. Pieters' disease focuses on reducing symptoms and avoiding further deterioration of his condition. Some of his medicines work for the symptoms, but physical exercise is the key treatment. The original series of exercises was explained once at the doctor's office. Since then, Mr. Pieters conducts them at his home. During the exercises, he uses a finger clip, which measures the oxygen level in his blood and his hart beat. Through the wall mounted screen Julie, he gets feedback on how long he should do each exercise, based on those measurements. Thanks to this feedback, Mr. Pieters dares to continue the exercise for longer than he would do otherwise. A COPD nurse uses the two-way video to check-up on Mr. Pieters monthly. After those check-ups, the doctor may adjust the exercise levels and medicines, based on to the acquired measures and progress of the disease. The COPD nurse also adds the next check-up to Mr. Pieters' calendar service. Reminders for the exercises, the medicine and the meetings are sent to Mr. Pieters through Julie, either at home or (when he is underway) through his mobile phone. This helps him, as his memory is getting worse.
Mr. Pieters likes Alice, one of the caregivers that regularly visit him. Alice not only helps with the housekeeping in his apartment, but also checks up on him once in a while via Julie to see ho he's doing. Julie suggests activities and new inhabitants for him to meet in the care centre. One new inhabitant turns out to be a friendly man, and Alice arranges they can have conversations through Julie. Afterwards, Mr. Pieters and the new inhabitant meet occasionally for a walk or a coffee.

5.2 Requirements imposed on MVC

A list of high-level requirements related to the MVC platform is distilled. Discussing all requirements is beyond the scope of this article; therefore an important subset is discussed below. They form a basic set of requirements for enhancements of our MVC, discussed in Section 6.

Telemedicine:
- **support for remote monitoring and feedback services;** the MVC has support for remote monitoring of vital signs and allows authorized parties to give feedback to the monitored subject;
- **presentation and storage of these data;** the monitored data should be accessible to authorized persons, both synchronously and asynchronously.
Socialization:
- **context-aware matchmaking service;** the MVC suggests and allows members of communities to get in touch with others or with services, dependent on their profile, history, location, agenda, interests, etcetera.
- **video communication;** the MVC allows for video communication between users of the service once enough trust is established.
Management:
- **content management function:** the care organization is able to perform general and content-related management functions in the MVC; such as adding and editing content, agenda items
- **trust delegate function:** the MVC allows for delegations, such as accepting or requesting connections to people or services on behalf of a user. For instance, an (informal) caregiver can be authorized to make a connection between two clients.
User-specific services:
- **service availability:** The MVC platform allows user-specific services. They are available to the user via the different screens Julie works on.

5.3 Communities distilled from scenario

From the scenario we identify multiple communities in which Mr. Pieters is involved: the community that relates to his exercises, includes Mr. Pieters, the COPD nurse, and the doctor who has access to his training data and medication record. The goal of this community is support treatment for his COPD. The second community's goal is to support Mr. Pieters' daily living. The housekeeping, his agenda and the reminder service are key services here; these services are accessible by the caregivers and partly by the COPD nurse. The third community is for socialization. Alice has delegated access to Mr. Pieters social network, as she links Mr. Pieters and the new inhabitant such that they can socialize and make appointments for activities.

6 Mobile Virtual Community Platform

How can we realize the communities described in the last section, and the services as identified by the requirements elicitation process? The existing MVC platform described in Pawar et al. [4], Beijnum et al. [5], and van 't Klooster et al. [8] does support mobile services and platform services such as telemonitoring services cq. match-making. To enable support for this case study, modifications and additions need to be made. First the internal design of the current MVC platform is presented in section 6.1. Then section 6.2 discusses the MVC Platform enhancements to support the case study.

6.1 Internal Design of the Existing MVC Platform

This section presents details on the internal design of the MVC platform. An overview of the architecture of the MVC platform is presented in Figure 3. In order to support mobility in the platform, three layers are identified:
- *Community Platform Layer (right):* The community platform layer is responsible for providing the virtual community platform services, e.g. the context-aware matchmaking service and storage.
- *Mobile Services Layer (left):* The mobile services layer is responsible for making available the MVC platform services to a mobile device and for providing services such as content exchange and context information service from the mobile device to the MVC. For example, it enables vital sign collection and delivery and context-aware reminders to the user.
- *Integration Layer (middle):* Because of the use of different technologies at the platform services layer and mobile services layer, an integration layer is used to support cooperation.
 The platform can be used by either the mobile device user via the mobile services layer, or in the home, via eg. a computer, laptop or high definition television to a more stationary user.
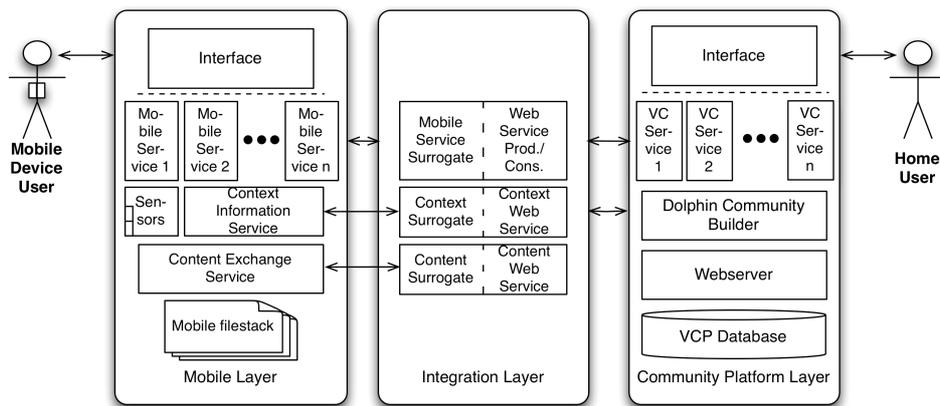

Figure 3: Layers in the Mobile Virtual Community Platform

The three layers of the MVC platform in Figure 3 are described in more detail, starting with the mobile services layer.

Mobile Services Layer

For the Mobile Services Layer, we use the existing Mobile Services Platform (MSP) [26]. An adaptable set of mobile services can run on the mobile device. Sensors, eventually placed on the user, can provide context information as well as a source for content exchange using a Body Area Network (BAN). The user may, if needed, interact with services via a graphical user interface, depending on the service evoked. If no connectivity is available, the mobile filestack is used as buffer.

The Mobile Services Platform (MSP) described by van Halteren and Pawar [26] supports patient and caregiver mobility. The Remote Patient Monitoring System built on top of MSP is capable of bridging location and time for actor interactions. Furthermore, the system comprises generic components and facilitates the design and development of telemonitoring and teletreatment case specific functionality, such as for instance case specific bio-signal processing and distribution. Case specific functionality has been developed for epileptic seizure predictions, neck pain monitoring and treatment and cardiac patient monitoring. It builds on SOA principles implemented using Jini [27] and uses the Jini Surrogate Architecture [28] for solving problems related to using mobile devices as service producers.

The Virtual Community Platform

For the VC platform, we use the Dolphin open source community builder [29]. The Community Platform is enhanced to provide loosely coupled services based on SOA approach. [30]. The services include:

- *Member Management Service:* This service includes the invited registration of new members, editing and managing member profiles, logging in, session handling etc.
- *Directory and announcement Service:* This service provides functionality for the community support providers to post news, list the offered services, and listing of events such as those leading to improvement in the psychological and physical health of the patients.
- *Alarm Service:* This service enables alarms, based on a predefined level of urgency. In case of an emergency, this service can be used to notify for example a caregiver.
- *Community Management Service:* This service consists of all the functionalities required to create, join, access and search communities, (such as those of patients with a particular type of condition), publish, get and subscribe to information in the existing communities.
- *Policy making and enforcement service:* To enforce the interactions between an actor role and a service, as well as to take into account the trust and privacy requirements in the MVC community, a set of policies need to be developed and enforced.
- *Social Interaction Service:* This service handles the *one-to-one*, *one-to-many* and *many-to-many* interactions between the MVC members. This includes interaction functions such as instant messaging, group notifications, and subscription to a particular type of content (e.g. information posted by a caregiver).
- *Context-Aware Matchmaking Service:* Semantic descriptions of the member profiles combined with description logic are powerful tools to perform matchmaking. The context-aware matchmaking functionality of this service could be used for example to recommend new members in the community, or to search for the nearest available caregiver.
- *Content Exchange Service on the Mobile Device:* This service on the patient's mobile device is aimed at sending the contents (e.g. text, images, and streams) generated at the mobile device to the community platform such that this content could be published in the community. Similarly, this service could also request/subscribe to the community content the user is interested in and present this content for user viewing.
- *Vital Sign Monitoring Service:* This service enables the monitoring of vital signs, such as blood pressure and oxygen saturation information using the MSP.
- *Context Information Service on the Mobile Device:* This service obtains context information (such as location) of the patient and sends this information and subsequent context changes in real-time to the community platform. This information could subsequently be used by the context-aware matchmaking service.

- *Community Service:* This service indexes and allows modifications on what services are available to which community.
- *Chat service:* As a sub-part of social interaction service, this service allows for instant voice, video or message chat amongst members of the MVC.

The user, e.g. an (informal) caregiver or client, can interact with these services via a web interface.

Integration Layer

The purpose of the integration layer is to integrate the MSP and with the VC Platform built using Dolphin. The integration technology adopted is Web Services. This way, we maximize the reuse of existing technologies and platforms, and focus on the integration issues, and the specific aspects that are implied by the requirements from our case study in the care domain. In the following, each of these parts will be briefly discussed.

The principles of the integration are shown in Figure 4. A Device Service Producer is made available via its associated Surrogate Service Producer. A (Jini) service consumer binds to the Surrogate Service Producer and embeds a producer based on Web Services; this web service producer publishes its service to the community platform (see Figure 3(a)). In the case of a Device Service Consumer, the Surrogate Service Consumer embeds the Web Service Consumer that binds with services provided by the community platform using SOAP over HTTP, see Figure 3.(b).
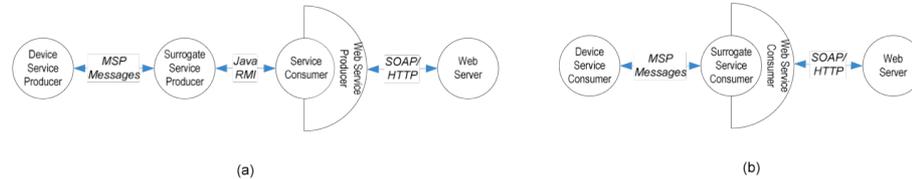

Figure 4: Service Integration: (a) integrating a device service producer; (b) integrating a device service consumer.

6.2 MVC Platform enhancements to support the case study

Having described our current MVC Platform, the questions remains: what needs to be modified to support our case study in the care domain? The remote monitoring and feedback services can be supported by means of the mobile services layer. Feedback can be given to either the stationary user or the mobile user. The presentation and storage of this data can be made available to authorized users in the community of the user. The context-aware matchmaking service has already been described; the video functionality can be supported by Dolphin, but research is ongoing with respect to usability issues.

Policies and management

The management function available in Dolphin enables control over the community, new items can also be posted by moderating members in the community. In order to improve the current facilities, policies are necessary to prescribe the access to different mobile and platform services. These *Policies* refer to the rules or constraints imposed on either the actor roles in the MVC or in the interaction with the services. In terms of the actor roles, there are specific guidelines about what an actor can do and can not do. For example, the product provider can not search for caregivers. Thus, for the interactions between a role and a service, rules could be related to *permission constraints* and *prohibition constraints*. Permission constraints refer to the prescription that a certain interaction is allowed to occur. A prohibition constraint is the opposite as it describes an interaction that must not occur at all. Specifying policies is based on the analysis of scenarios, because policies depend on the purpose and use of the MVC as well as on the roles and services that are present in the MVC.

The trust delegate issue, needed to allow (informal) caregiver to act on a client's behalf, is at the moment still in research but this is on the agenda in trial sessions in our testbed to gain experience.

In sum, we think our telemedicine-enabled MVC platform has the necessary starting characteristics to provide a platform for a functional elderly community. We have focused on the technical and architectural aspects, however there are also challenges foreseen in the interface and usability of the platform.

7   Conclusions and Future Work

To exploit the socialization benefits of the virtual community for elderly care, we proposed a mobile virtual community platform. The steps taken in the process of requirements gathering rely on the end-user input through semi-open interviews, expert inputs (workshop), consortium prioritization (which functionalities to be fulfilled) and scenario based user need analysis.
We showed that it is feasible to improve the existing implementation of our MVC platform to support specific requirements of this case study. This could be achieved by augmenting an existing platform with additional services such as remote monitoring, socialization, management and user-specific services. Further developments however require additional user validation to develop the MVC platform successfully.

We are currently working on the implementation of the proposed platform. We will validate our design with real life trials. Tests are planned to take place at our testbed in Parc Hoogveld, Sittard, the Netherlands. All the interviewees responded that they are available for future usability tests, giving us an appropriate test group size for future usability tests [31].
Furthermore, two technical aspects need to be considered closely: 1) the policies involved, including the delegate function needed to allow (informal) caregiver to act on a client's behalf; and 2) the accessibility on client information from one community to another community of this client. Both the policies and accessibility aspect are foreseen as challenges.

Acknowledgment

References

1   Broens, T., Huis in 't Veld, R., Vollenbroek-Hutten, M., Hermens, H., Halteren, A. van, & Nieuwenhuis, B. (2007). *Determinants for successful telemedicine implementations – a literature study.* Journal for Telemedicine and Telecare, Vol. 13 No. 6, pp. 303-309.

2   Rheingold, H. (1993). *The virtual community : homesteading on the electronic frontier.* Reading, Mass: Addison-Wesley Pub.

3   Eysenbach, G., Powell, J., Englesakis, M., Rizo, C., & Stern, A. (2004). *Health Related Virtual Communities and Electronic Support Groups: Systematic Review of the Effects of Online Peer to Peer Interactions.* British Medical Journal, Vol. 328, No. 7449:1166, 2004.

4   Pawar, P., Subercaze, J., Maret, P., Van Beijnum, B. J., Konstantas, D., (2008). *Towards Business Model and Technical Platform for the Service Oriented Context-Aware Mobile Virtual Communities.* IEEE 13th Symposium on Computers and Communications (ISCC'08), Marrakech, Morocco.

5   van Beijnum, B. J. F., Pawar, P., Dulawan, C., & Hermens, H. (2009). *Mobile Virtual Communities for Telemedicine: Research Challenges and Opportunities.* International Journal of Computer Science & Applications, Vol. 6 No. 2, pp. 38 - 49.

6   Eysenbach G. (2001). *What is e-health?* Journal of Medical Internet Research, Volume 18 issue 3(2) 20 June 2001.

7   Demiris, G. (2006). *The diffusion of virtual communities in health care: concepts and challenges.* Patient Education and Counseling, Vol. 62 No. 2, pp. 178-188.

8   J.W. van 't Klooster, P. Pawar, B.J.F. van Beijnum, C. Dulawan, H.J. Hermens (2010). *Perspectives on the Viable Mobile Virtual Community for Telemedicine.* Encyclopedia of E-Business Development and Management, IGI Publishing, 2010 (accepted).

9   Maloney-Krichmar, D. & Preece, J. (2005). *A multilevel analysis of sociability, usability, and community dynamics in an online health community.* ACM Transactions on Computer-Human Interaction, Vol. 12, No. 2, pp. 201-232.

10 El Morr, C. & Kawash, J. (2007). *Mobile Virtual Communities Research: A Synthesis of Current Trends and a Look at Future Perspectives.* International Journal of Web Based Communities, Vol. 3, No. 4, pp. 386-403.

11 van Uden-Kraan, C. F., C. H. C. Drossaert, et al. (2008*) Self-reported differences in empowerment between lurkers and posters in online patient support groups.* Journal of medical internet research 10, e18

12 Seniorenweb (2009). Available: www.seniorenweb.nl (Last visited 28 August 2009)

13 Camarinha-Matos, L.M. & H. Afsarmanesh H. (2002). *Design of a Virtual Community Infrastructure for*

Elderly Care. PRO-VE'02 – 3rd IFIP Working Conference on Infrastructures for Virtual Enterprises. Sesimbra, Portugal, 1-3 May 2002, #47d.

14 Wellman, B., Salaff, J., Dimitrova, D., Garton, L., Gulia, M., Haythornthwaite, C. (1996). *Computer Networks as Social Networks: Collaborative Work, Telework, and Virtual Community.* Annual Review of Sociology 1996 22, 213-238.

15 Furlong, M.S. (1989). *An electronic community for older adults: the SeniorNet network.* Journal of Communication. 39(3):145–153.

16 WHO: ICD: International statistical classification of diseases, 10th revision. Geneva, Switzerland, 2004

17 WHO: ICF: International classification of functioning, disability and health. World Health Organization Geneva, Switzerland; 2001.

18 Stucki, A., Stoll, T., Cieza, A., Weigl, M., Giardini, A., Wever, D., Kostanjsek, N., Stucki, G. (2004). ICF Core Sets for obstructive pulmonary diseases. Journal of Rehabilitation Medicine, 1651-2081, Volume 36, Issue 4, Supplement 44, 2004, 114 – 120

19 Hettinga, M. (2002). *Understanding evolutionary use of groupware.* PhD Thesis. Telematica Instituut Fundamental Research Series no. 007, p 28-29.

20 Glaser, B.G., Strauss, A.L. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Chicago, Aldine.

21 Corbin, J., Strauss, A.L. (1990). *Grounded Theory Research: Procedures, Canons, and Evaluative Criteria.* Qualitative Sociology, Vol. 13, No. 1, p. 3-21

22 Alexander, I.F., Maiden, N. (2004). *Scenarios, Stories, Use Cases Through the Systems Development Life-Cycle.* John Wiley and Sons, Chichester, UK.

23 Sutcliffe, A. (2003). *Scenario-based Requirements Engineering.* Proc. 11 International IEEE Requirements Engineering Conference, pp. 320-329.

24 Hsia, P., Samuel, J., Gao, J., Kung, D., Toyoshima, Y., & Chen, C. (1994). Formal Approach to Scenario Analysis. IEEE Software, Vol. 11, No. 2, Mar. 1994, pp. 33-41.

25 Cooper, A. (2004). *The Inmates Are Running the Asylum – Why High-Tech Products Drive Us Crazy and How to Restore the Sanity.* Sams Publishing, Indianapolis, USA.

26 van Halteren, A. and Pawar, P. (2006). Mobile Service Platform: A Middleware for Nomadic Mobile Service Provisioning. 2nd IEEE International Conference On Wireless and Mobile Computing, Networking and Communications (WiMob 2006), Montreal, Canada, June 2006.

27 Jini (2009). Jini Specifications and Archive, http://java.sun.com/products/jini/ (last visited on Augustus 28, 2009).

28 JiniSA (2009). *Jini Surrogate Architecture Specification v1.0.* https://surrogate.dev.java.net/specs.html (last visited on Augustus 28, 2009).

29 Dolphin (2008). *Dolphin Smart Community Builder.* http://www.boonex.com/products/dolphin/ (last visited on 30 January, 2009).

30 Papazoglou, M.P., & Georgakopoulos, D. (2003). Service-Oriented Computing. Communications of the ACM, Vol. 46, No. 10, pp. 25-28.

31 Nielsen, J. & Landauer, T.K. (1993). A mathematical model of the finding of usability problems. Proceedings of ACM INTERCHI'93 Conference.Amsterdam, The Netherlands, 24-29 April 1993. pp. 206-213.