TeleCARE Time Bank: A Virtual Community supported by Mobile Agents

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Abstract. The virtual community concept, when supported by adequate ICT and organizational infrastructures, represents a very promising approach for a new philosophy in elderly care and active aging. A mobile agents based approach to implement services to support a Time Bank virtual community in elderly care is introduced and a prototype system developed in the context of the TeleCARE project is presented.

1 Introduction

Participation in a community is an important aspect of life for most people. In fact most humans have a natural affinity for living in community. The structural process that is associated with community building is communication. Without communication there can be no action to organize social relations [1]. Today's fast emerging information and communication technologies have stimulated virtual communities to grow using the Internet.

Virtual communities can be defined [2] as being "social aggregations that emerge from the Net when people carry on public discussions long enough, with sufficient human feeling to form webs of personal relationships". A virtual community is also seen as "a community of people sharing interests, ideas, and feelings over the Internet" [3]. However, as mentioned in [4], "due the lack of a formal definition, virtual communities are casually defined as distributed online services connecting a group of people that gather to keep in touch, focused on some common interest or purpose".

An important application context for virtual communities is elderly care. Traditional approaches to care provision are based on support from either the relatives, or the elderly care centers. However, these two solutions have become increasingly insufficient due to the following reasons:

(i) Shifting the burden of responsibility onto relatives is increasingly impractical, given the fact that more and more family members have to work to secure steady incomes.
(ii) Provision of enough care centers is costly and invariably necessitates the relocation of the elderly people, often beyond their home communities.
(iii) Many elderly people preserve enough robustness to be in their homes, a situation that is often preferable to them, and as such better for their welfare.

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Due to the rapid growth of the elderly population, finding more effective ways of providing care to a growing number of elderly became a major challenge.

In this context, the IST TeleCARE project [5] was launched with the aim of designing and developing a configurable framework, based on mobile agents, focused on the establishment of virtual communities for elderly support. The underlying principle is that an integrated elderly care system consists of a number of organizations such as care centers / day centers, health care institutions, social security institutions, and involves the cooperation of a number of different human actors e.g. social care assistants, health care professionals, the elderly people, and their relatives. When supported by computer networks and adequate supporting tools, the collaboration among the care institutions may evolve towards operating as a long-term virtual organization and the various involved actors become part of a virtual community (VC). In this paper the TeleCARE Time Bank virtual community concept is presented and the developed supporting infrastructure is discussed.

2 The Time Bank Concept

The **Time Bank** concept provides a mechanism for collaborative community building / re-enforcement, i.e. a way for people to come together and help each other. The idea is quite simple: people "deposit" time they are willing to contribute to the community by giving practical help and support; in exchange they are able to "withdraw" their time when they need something done to themselves by others. One key principle here is that one hour is equal for everybody. One hour of helping out with gardening is equal to an hour of legal advice. Thus, time banks create reciprocal relationships between people and institutions, as well as between people and people, which are hard to achieve in other volunteering services.

So what can be "exchanged" in this way? From existing cases a large number of examples can be found, including: child care, breastfeeding support, children's activities, computer set-up, concrete/masonry, carpentry, plumbing, electrical repairs, cooking, meal planning, first aid classes, massage, nursing assistance, nutritional counseling, tutoring, gardening services, bedside companionship, saying prayers, hairstyling, office help, house-cleaning, translating, etc.

The **bank** is some form of organization that takes care of registering members and implementing some bookkeeping mechanisms. Most of the existing cases run in a quasi ad-hoc manner, usually associated to the city hall or any charity organization, and mainly resorting to telephone and some complementary "get together" meetings. This "institution" also requires an administrator or **broker** that acts as the driving force (catalyst) of the community.

> How does it work?
> Let's suppose you would like some help — maybe two hours' help in the garden. You contact the Time Bank and let them know what kind of help you will need, and when.
> The Time Bank administrator (or broker) checks the members' records for a "match." The administrator calls the match, then calls you back to confirm.
> At the time you need, your Time Bank friend comes by and helps in the

garden. Two hours help means two credits spent. You sign a form (cheque) for two credits. The person who helped you hands in the form to the administrator, who logs the exchange in the Time Bank's records. That person now has two credits to spend!
Some day later on, you might get a call from the Time Bank administrator asking you: would YOU like to help someone else and earn some time credits?

The Time Bank idea was originated in the USA in mid-80s by Edgar Cahn, motivated by the need not to feel useless, as he stated: "*I did not like feeling useless […] in the 1980's society was declaring a lot of people useless, the unemployed, the elderly and the young*". Then he came up with the idea "*why not reward decency and caring?*" and set up the Time Dollar movement in the United States [6]. The following principles formulated by Cahn [7] are the fundamental basis for the Time Bank:

- Assets: the real wealth of our society is its people.
- Redefining work: to include all those things that support healthy individuals and communities — the work that is not currently valued in the market economy.
- Reciprocity: we need each other.
- Social capital: humans need social networks as much as they need roads and utility lines.

Time Bank is therefore a response of the civil society trying to harmonize the social structures with working and family life [8]. This initiative turned into a "movement" that has gained rapid acceptance not only in the USA, but also in various other countries. Their main goals, as defined in [8], are the following:

- Time Banks promote that people participate actively in their daily life.
- Time Banks offer opportunities to give and receive, simultaneously. They are *spaces* where it is learned to choose services and activities that combine with the necessities and desires of the community.
- Time Banks are innovating instruments of social policy on local scale, rooted in the territory and near the people.
- Time Banks are instruments of mutual aid based on the interchange that have as change and value unit the hour of time.
- Time Banks facilitate realistic actions in current environments; do not need excellent social scenarios.

The TeleCARE Time Bank aims at applying this concept in the elderly care domain and to provide adequate ICT support tools to facilitate the establishment and operation of such communities. The aim is to provide the elderly people a way to feel useful to society, an opportunity to share their experiences with others and to have their days fulfilled. At the same time, by being integrated in such community they obtain better support for their own needs.

In fact, the current paradigms of aging as a "dependent" stage of life do no match up either with current realities of elderly people or with likely scenarios for 21st century. Aging is less and less synonymous with dependency, because not all elderly people suffer from chronic illnesses, and even persons with chronic conditions and functional limitations retain other significant capabilities [9].

The active aging concept reflects the desire and ability of many elderly people to remain engaged in (economically and socially) productive activities. Active aging means more than simply encouraging paid employment among elderly people. Our societies should foster socially important activities such as volunteering, household and child-care help, care-giving to the disabled elderly, and support for social service organizations, like the time bank concept.

The Technological Solutions. There are not many tools for supporting Time Bank activities reported in the literature. For instance, solutions found on Internet are usually focused on local or specific problems of every Time Bank, depending on its location and environment.

One of the tools for Time Bank administration is the Timekeeper [10], developed for the Time Dollars concept. This software is used by agencies of Time Dollars in USA and agencies of Time Bank in UK. It provides simple administrative services for Time Banks based on Microsoft Access 97. Nonetheless, the Timekeeper software only supports administration of Time Bank members' account. It does not provide support for virtual communities, as the concept is understood in the literature.

3 The TeleCARE Time Bank

The TeleCARE Time Bank is one of the vertical (application) services that run on top of the TeleCARE platform (Fig. 1). This platform provides an infrastructure for the implementation of distributed, Internet-based systems in elderly care [11]. The infrastructure is based on multi-agent technology (mobile and stationary agents), federated information management, and safe communications (virtual private network). The TeleCARE multi-agent system (MAS) platform is installed in each site (elderly homes, care centers, etc.) creating a flexible infrastructure that supports the idea of plug-and-play vertical services (which can be progressively added top the system).

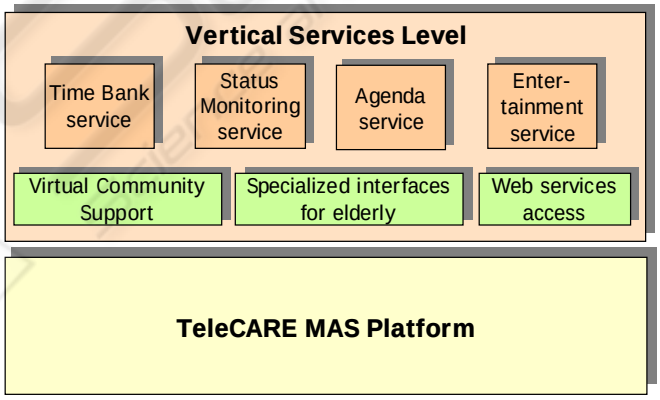

Fig. 1. The TeleCARE architecture

The TeleCARE Time Bank service supports the following macro-functionalities:

- Creation and management of the Time Bank virtual community.
- Perform the matching process between a service required by a member and the potential provider members that could accomplish it.
- Support the negotiation process between members.
- Provide member's account management and account statements.

The Time Bank is managed by a Coordinator, who is in charge of members' account, promoting active participation of members, and assisting in finding the best provider for a requested service. Participants in the TeleCARE Time Bank virtual community include: (*i*) elderly people, (*ii*) their relatives, and (*iii*) a care center (that performs the coordination role). An UML use case diagram of the main activities of the participants in the TeleCARE Time Bank is depicted in Fig. 2.

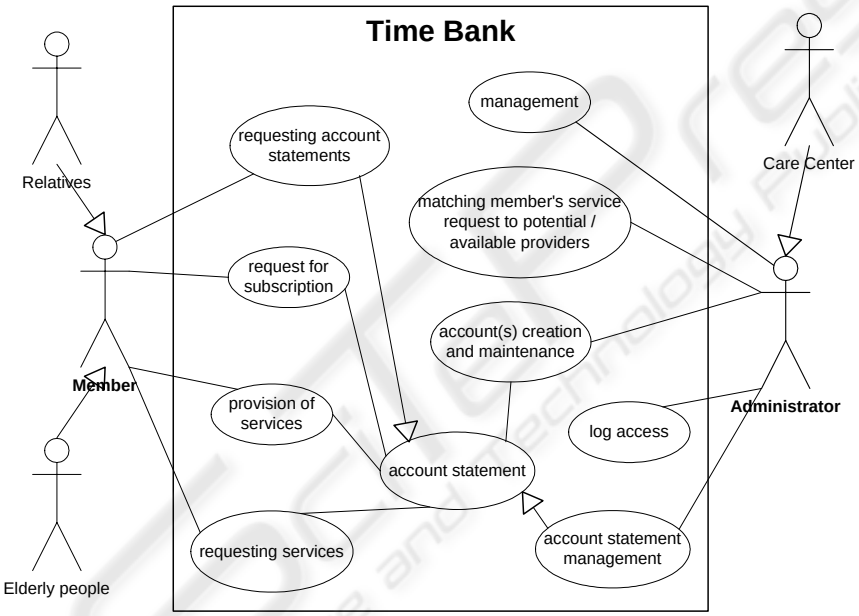

Fig. 2. UML case diagram of participants' activities of the TeleCARE Time Bank service

Typically, a transaction between members in a Time Bank includes the following main phases: service request, service performance, and confirmation of a service accomplishment. This process can be further detailed in the following steps:

A. Request a service:

a) A member, the Requester, needs a service.
b) The Requester contacts the Time Bank agency (Coordinator) for requesting the service.
c) The Coordinator matches the requested service with the available potential provider member(s).

d) The Coordinator contacts the potential provider(s).
e) The [potential] Provider receives the service requirement.
f) The [potential] Provider confirms acceptance or refusal to provide the service.
g) Once one member (the Provider) agrees to provide the requested service, the Coordinator confirms service acceptation to Requester, indicating whom the Provider is.
h) If necessary, Requester and Provider interact between them to negotiate terms and conditions for service accomplishment.

B. The service is performed…
C. Service accomplishment:

a) The Requester issues a cheque to the Provider corresponding to the received service, indicating how much time (in hours) the task took to be accomplished.
b) The cheque is "deposited" in the Time Bank agency, where
c) The Coordinator / Administrator registers the transaction, updating the account statement of both Requester and Provider members.

The Multi-Agent Architecture. In order to support this process, a number of mobile and stationary TeleCARE agents [11] are associated to Time Bank participants, as illustrated in Fig. 3. These agents run in the different TeleCARE platforms installed at every site of the Time Bank participants.

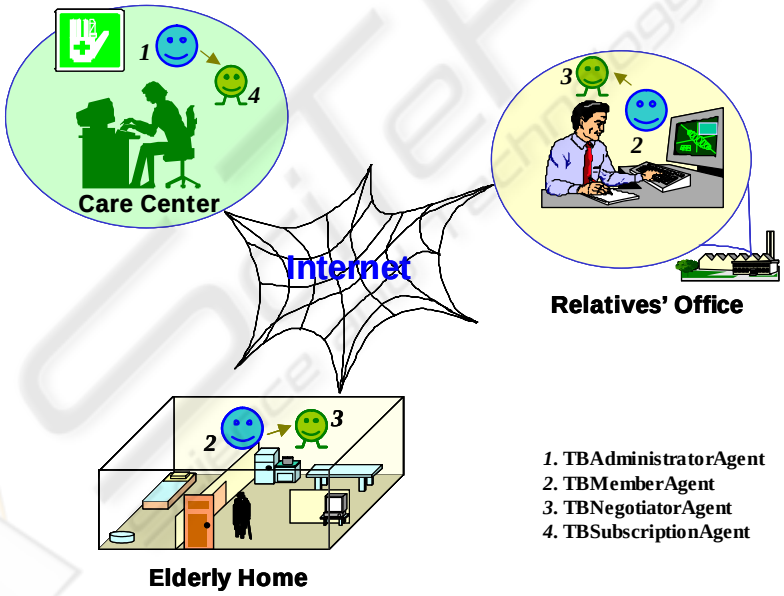

Fig. 3. The TeleCARE Time Bank MAS architecture

The **TBAdministratorAgent** is a stationary agent located at the care center and supports the following tasks:

- Time Bank creation.
- Member subscription / discard subscription facilities.
- Creation of an agent to assist the subscription process.
- Update member's credit account.
- Issue member's account statements.
- Accept service requests.
- Matching a service request to potential providers.
- Assist selection of adequate provider.
- Issue log files.
- Interface with human Time Bank administrator.
- Generation of service's accomplished key / application form.

The **TBMemberAgent** is a stationary agent that represents the members (elderly and/or their relatives) of the Time Bank. It assists members in performing the following tasks:

- Request for member subscription.
- Fill up application form for requesting a service.
- Creation of an agent for negotiation process.
- Fill up application form for service accomplished.
- Request member statement account.
- Interface with human Time Bank members.

The **TBNegotiatorAgent** is an agent created by the **TBMemberAgent** in order to execute the negotiation process whenever a member requests a service. Each time a service is requested, a **TBNegotiatorAgent** is created. This is a mobile agent that has the following characteristics:

- Capacity to migrate to other platforms (Administrator and potential provider Member(s) sites).
- Capacity of interaction with the agent **TBAdministratorAgent**, at the Administrator's site, and the **TBMemberAgent** located at the potential providers sites.

The **TBSubscriptionAgent** is a mobile agent created by **TBAdministratorAgent** when a subscription process is solicited. It has the following features:

- Capacity to migrate to other platforms (Administrator and/or Member).
- Capacity of interaction with the member who realizes a request for subscription, when the subscription is requested from Member's place.
- Capacity of interaction with the Time Bank administrator who realizes the subscription of a member, when the subscription is requested from Administrator's place.
- Fill up the application form for Time Bank subscription.

Please note that a subscription can be requested remotely (from the potential member's home) or in the care center.

The participants of the Time Bank interact with the **TBAdministratorAgent**, in case of the care center, and **TBMemberAgent**, in case of elderly people and/or their relatives, in order to realize the various tasks of the Time Bank activity. An AUML sequence diagram [12] is depicted in Fig. 4 showing some of the Time Bank agents' activities for the process of requesting a service, and notification of service accomplishment.

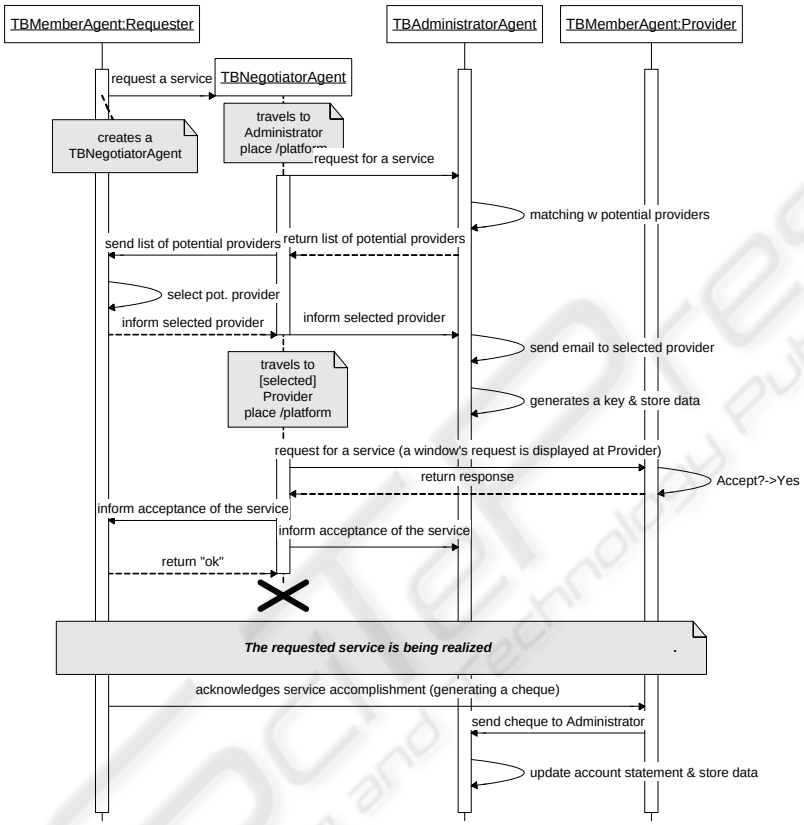

Fig. 4. Service transaction in the TeleCARE Time Bank

Taxonomy of the Services. In order to facilitate the searching of a service and the matching with the potential providers a taxonomy of services is maintained. The initial taxonomy was defined based on information provided by GRAAL, a Portuguese NGO that promotes the Time Bank concept in Portugal.

Table 1. The TeleCARE Time Bank services' taxonomy

Category	Services
A. Babyminding	A01 – Babysitting
	A02 – Taking/looking for children to the school
	A0*x* – …
B. Leisure	B01 – Bicycling (bicycle)
	B02 – Walking
	B0*x* – …
C. Housekeeping	C01 – Washing the car
	C02 – Washing dishes
	C0*x* – …
D. Animals and plants	D01 – Gardening
	D02 – Keeping animals or plants on vacation / holydays
	D03 – Helping in animals' bath (dogs, cats, etc.)
E. Bricolage (do-it-yourself)	E01 – Little domestic reparations
	E02 – Carpentry
	E03 – Electrical reparations
F. Accompany (accompanying)	F01 – Accompanying to doctor
	F02 – Talking
	F0*x* – …
G. Cooking	G01 – Cooking a special dish
	G02 – Cooking food for freezing
H. Working (workings)	H01 – Seam adjustments
	H02 – Embroidering / embellishment
	H03 – Knitting
I. Lessons	I01 – Teaching to study
	I02 – Giving explications
	I0*x* – …
J. Secretaryship	J01 – Literary corrections
	J02 – Processing texts
	J0*x* – …
K. Time Bank collaboration	K01 – Supporting bureaucratic activities
	K02 – Helping meetings' organization

The services to be offered by an operational Time Bank are specified according to the skills and necessities of its members. Therefore new categories and services can be defined (or removed) if necessary.

Time Bank Ontology. Ontologies play a key role in supporting proper interaction among the various components of this (geographically) distributed multi-agent system. The Time Bank ontologies are modeled using the Protégé [13] system and Java classes are automatically generated out of these ontologies by the DOSG tool developed by a TeleCARE partner, the University of Amsterdam. The UML diagram of the Java classes and relations corresponding to the Administrator side ontology is shown in Fig. 5.

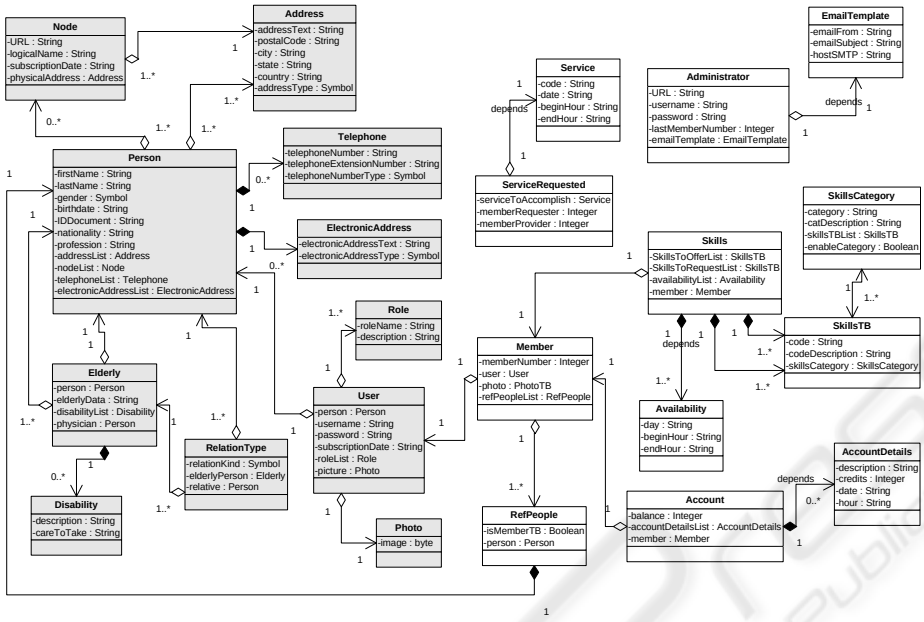

Fig. 5. The Administrator side ontology

The left side of Fig. 5 depicts the part of the ontology that is common to all vertical services running on the TeleCARE platform. The right hand side shows the Time Bank specific structures for the Administrator side. Each member of the Time Bank (*Member*) is identified by his/her personal data that is held in the common ontology; and at Administrator ontology by his/her skills (*Skills*) and availability time to realize services (*Availability*). There are also definitions of structures for members' account statement (*Account* and *AccountDetails*), services that are being realized and by whom (*ServiceRequested* and *Service*), and what services can be requested/offered (*SkillsCategory* and *SkillsTB*). The structure *Administrator* represents the Administrator entity, and the structure *EmailTemplate* is used for e-mail notifications of requested services. It is important to observe that it is mandatory for every Time Bank member to be a registered TeleCARE user. Each member must have from one to three reference people (*RefPeople*).

In Fig. 6 the Java classes and relationships corresponding to the Members side are depicted. The heart of this ontology is the member definition at *TheMember*, *TBMember* and *PhotoM*. The structures *SkillsTBM* and *SkillsAvailable* indicate the services that can be requested. The structures *SkillM* and *AvailabilityM* contain data of skills and availability time of the local member, respectively. Finally the structures *Service*, *ServiceRequested* and *ServiceToProvide* track the service accomplishment.

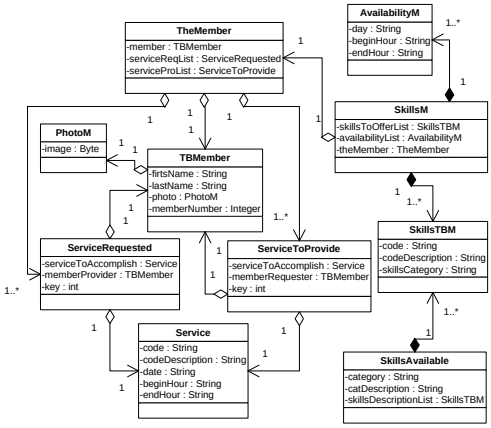

Fig. 6. The Member(s) side ontology

Implementation Aspects. The Time Bank service prototype was developed in Java, on top of the TeleCARE multi-agent platform [14] that extends AGLETS and integrates a distributed / federated information management sub-system. In Fig. 7 and Fig. 8 some of the user interfaces of the developed system are illustrated.

Fig. 7. Requesting a service

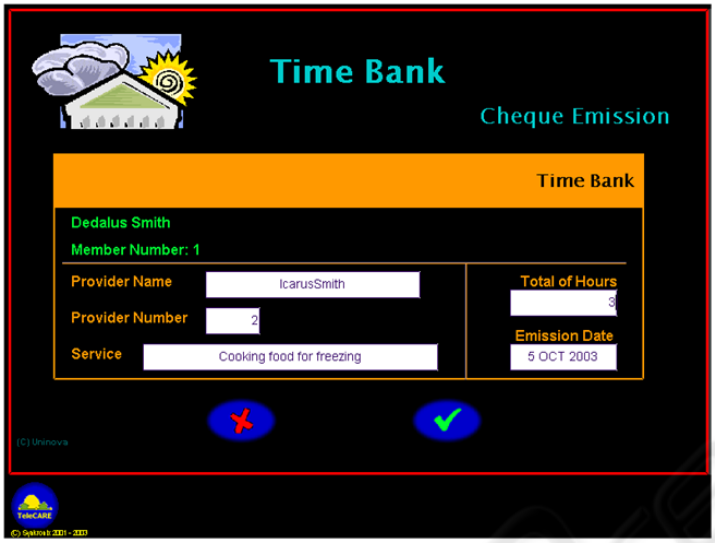

Fig. 8. Issuing a cheque after a service is accomplished

Provided functionalities can be accessed both via the TeleCARE user interfaces (running in the multi-agent platform) or via a web browser, using the component Web Services Access of the TeleCARE architecture (see Fig. 1) developed by the TeleCARE partner Skill, Consejeros de Gestión. The web interface is shown in Fig. 9.

Fig. 9. Example of the web interface to Time Bank — list of potential providers for a requested service

For the implementation of this particular service other implementation approaches (not necessarily agent-based) could have been adopted. It was however quite convenient to take advantage of the functionalities provided by the TeleCARE platform. The goal was to also have this service integrated with other services provided to the elderly care community. Thinking in terms of future developments, the use of agents and the underlying TeleCARE platform will also facilitate the development of more intelligent matching and negotiation processes.

4 Conclusions

The Time Bank mechanisms seem particularly adequate to support the "active aging" concept and represent a good example of a virtual community. It is now commonly accepted that while there is no one magic formula for successfully living a long life in a healthy manner, the concept of active aging, and remaining active and engaged in society is a critical component of maintaining a quality of life. Actively engaged older persons are more likely to remain cognitively and physically stimulated, to mature healthy interpersonal relationships and remain involved as contributing members of their societies. The integration of a Time Bank support service within an elderly care system seems thus a promising contribution to:

- Help the sense of "being involved in / part of the society" and being useful.
- Let elderly share and apply to the benefit of the community their valuable experiences.
- Facilitate the inter-generation interaction.

The mobile-agents based prototype system developed in the framework of the TeleCARE project illustrates a good set of functionalities to support such virtual communities. Nevertheless it shall be noted that the actual success of implantation of the system depends on further progress on the elderly user interfaces, namely its integration with TV sets and other home appliances, as well as the creation of a new attitude towards elderly care in the various actors and institutions involved in this domain.

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