A Social Network Specialized for the Elderly Meets the Social Internet of Things

Vittorio Miori
Institute of Science and Technologies of Information (ISTI)
National Research Council of Italy (CNR)
Pisa, Italy
vittorio.miori@isti.cnr.it

Dario Russo
Institute of Science and Technologies of Information (ISTI)
National Research Council of Italy (CNR)
Pisa, Italy
dario.russo@isti.cnr.it

Abstract—The average age of the world's population is increasing, and life expectancy is predicted to rise by another 10 years by 2050. The growing number of older adults is placing ever-greater demands on public health systems, with consequent increases in related care costs. Information and communications technology (ICT) can make an important contribution to reducing such costs through the support afforded by integrated healthcare services in elderly homecare.

The SOCIALIZE AAL project aims to create a new Social Internet of Things framework able to simplify the ways elderly people can gain access to dedicated services while living in a technology-served environment. This paper describes SocializeNet, the software core of the project. SocializeNet provides for interoperability among the various services developed with enabling technologies for the Internet of Things following W3C recommended standards, thereby creating a true social network specialized for the elderly. Moreover, the paper focuses attention on the services through which intelligent "objects" are able to interoperate without human intervention.

Index Terms—SIoT, IoT, Interoperability, SOA, SOCIALIZE, AAL, Domotics, E-Health, Elderly, Social Network

I. Introduction

Given the current demographic dynamics, the ageing population will soon become one of the most demanding big societal challenges that developed countries will face [1]. Over the last 150 years, life expectancy has risen by 50 years and over the last half century alone, it has become three years longer every decade.

Hand in hand with aging, it is probable that disability and dependence will rise for the elderly, as will the incidence of age-related illnesses and the need for medication [2]. The majority of the ageing population experiences progressive deterioration of their health from 50-80 years old. This 30-year interval of aging with deteriorating health is thus a critical aspect to take into consider.

As a result of such ongoing socio-demographic changes, which are having an enormous impact on healthcare, the economy and society in general, there is an ever-increasing need to sustain the quality of life of our elderly population. We need to move beyond the current treatment-oriented approach and undertake a new direction which accepts mass active longevity as a fact, and a new goal, of modern life and a driving force of development.

EU countries face many challenges related to the aging of its population, which is placing substantial strain on publicly-funded healthcare [3] and long-term and income support programs for older people. One of the aims of providing care for the elderly and disabled is to help them live normal, independent lives, which includes living in their own homes as long as possible.

According to the *Internet of Things* (*IoT*) paradigm, objects become "intelligent": they can be localized and they can acquire, process and exchange data. *Smart Home & Building* applications are particularly crucial to the *IoT* scenario, as they are the link between the individual (citizen, consumer) and the overlying layers implementing the *IoT* paradigm (*Smart City, Smart Grid*) [4].

Moreover, in the near future, more and more devices and services will be capable of sending and receiving data automatically via the Internet. This new scenario involves new developments with enormous potential, for example, in business markets. The *IoT* will enable connecting market participants and sectors that previously had no business dealings with one another. This will generate new products and services, which will in turn lead to the creation of new business models as well. In such a scenario, companies must get used to the idea of sitting down and cooperating at a "virtual table". Web-based platforms can create the basis for partners to extend or supplement what they offer in completely new ways. However, the *IoT* is not just a distant vision of the future - it's already here and is having an impact on more than just technological developments.

It allows us to share information directly with each other and the cloud, making it possible to collect, record and analyze new data streams faster and more accurately than ever. The *IoT* exploits advanced sensors collecting real-time data and that can even detect health problems by monitoring behavioral trends in homes. Family members and emergency services can then access the collected data and be alerted automatically. This will grant the elderly more independence and autonomy and thereby allow them to lead a high-quality social life.

In this regard, a new paradigm related to integrating *Social Networking* concepts into *IoT* solutions is emerging: the *Social Internet of Things* (*SIoT*) [5] [6]. The *SIoT* is defined as an *IoT* where things have the capacity to establish social relationships with other objects, independently of human intervention. In this

way, a social network of objects is created. Adoption of the *SIoT* paradigm presents several advantages: (i) the resulting structure of the social network of things can be shaped as required to guarantee network navigability, so as to effectively perform the discovery of objects and services and guarantee scalability as in human social networks; (ii) a level of trustworthiness can be established to leverage the degree of interaction among things that are 'friends'; (iii) models designed to study social networks can be reused to address *IoT* related issues (intrinsically related to extensive networks of interconnected objects) [7].

The key guiding principle behind the *SOCIALIZE* project is the goal of creating a complete technological *SIoT* solution which effectively fulfills the general objectives of the third call of the *EU - AAL programme*. By exploiting the *SIoT* paradigm with a decidedly operative approach, the *SOCIALIZE* project will simplify the ways the elderly can access dedicated services. The project focuses particular attention on elderly people (between the ages of 55 to 80) with a basic or previously consolidated knowledge of Information Technologies, that is, they already use electronic devices, access Internet services and have at least basic computer skills acquired during work experiences or in carrying out everyday tasks. Clearly, the target group must moreover live in a technology-served environment. This population segment is destined to become more and more numerous over the coming decades, when today's 40 year-olds, most of whom have more than a basic knowledge of Information Technologies and the use of electronic devices, will have aged. These people (i.e., "primary" end users) will be quite familiar with how to access Internet services and are likely to live in technology-served environments. As its second objective, the *SOCIALIZE* project will offer the means for healthcare organizations offering services to the elderly to integrate such services into the envisaged system (i.e., "secondary" end users).

II. Related works

The most interesting results relevant to the project have been obtained by applying the *IoT* paradigm to home automation, or 'domotic' devices.

Tin-Yu Wu et al. [8] has proposed an auto-configuration mechanism that implements three functions: (i) assisting the information appliance in acquiring a regular domain name without manual configuration; (ii) providing a session initialization protocol, uniform resource identifier and auto-configuration, and seeing to device registration; (iii) initiating communications between devices in order to manage the residential gateway and configure the user management system interface. To these ends, a software application must be executed during device system boot to add different embedded routines.

The first paper that heads in the direction of *SIoT* was written by Holmquist et al. [9]. The paper discusses how qualitative relations and more selective connections can be established between smart artifacts, and how users can retain control over artifact interconnection. To illustrate the results of their research, the authors implemented small embedded devices called Smart-Its Friends.

More recently, Nazzi et al [10] have introduced the theoretical concept of Embodied Microblogging. This represents a personal, group blogging technique that enables users to announce their everyday activities within local communities, thereby helping senior citizens to share and make their day-to-day activities noticeable and create more openings for social interactions in their local communities.

Kranz et al. [11] investigate the potential of combining social and technical networks to collaboratively provide services to both human users and technical systems. The authors illustrate the objects' ability to interconnect, not only amongst themselves, but also with the human beings. The paper reports on a use case of a distributed sensor-actor environment in which both humans and technical systems form a socio-technical network.

Mendes et al. [12] raise some discussion about the technology required to ensure efficient interaction between the physical, social and virtual worlds by extending the Internet through interconnected objects. They have developed a data-centric architecture based on IP-driven opportunistic networking able to make useful data available to people when and where they really need it, thereby enhancing their social and environmental awareness.

Ding et al. [13] propose a platform to cluster the Internet, the Internet of Things and social networks together. The aim of such a clustered platform is to track and summarize human society in order to analyze the behaviors of objects and people as data.

Guinard et al. [14] propose an ecosystem of real-world devices that can be reused and recombined to create new ad-hoc applications. The proposed platform enables people to share their Web-enabled devices so that others can use them. Data are then published on existing social networks to enable owners to leverage the social structures in place for sharing smart things with others.

III. Socialize project

The *SOCIALIZE* (*Service Oriented Assisted Living Infrastructure)* project will develop a *SIoT* hardware / software platform able to put and keep elderly users in close touch with the community in which they live, and thereby promote social interaction and proactive involvement in the democratic development of their own community through the use of new technologies implemented in the community members' day-to-day setting. The technology will be accessible through different channels and in different geographical locations.

The software architecture of the *SOCIALIZE* project includes three broad areas: (i) a *service-oriented* software application to supply network services; (ii) a set of user interfaces and access devices (with a particular focus on mobile devices) to optimize the experience of using the services available on the network for first level end-users (i.e., the elderly); (iii) some software tools for caregiver organizations to

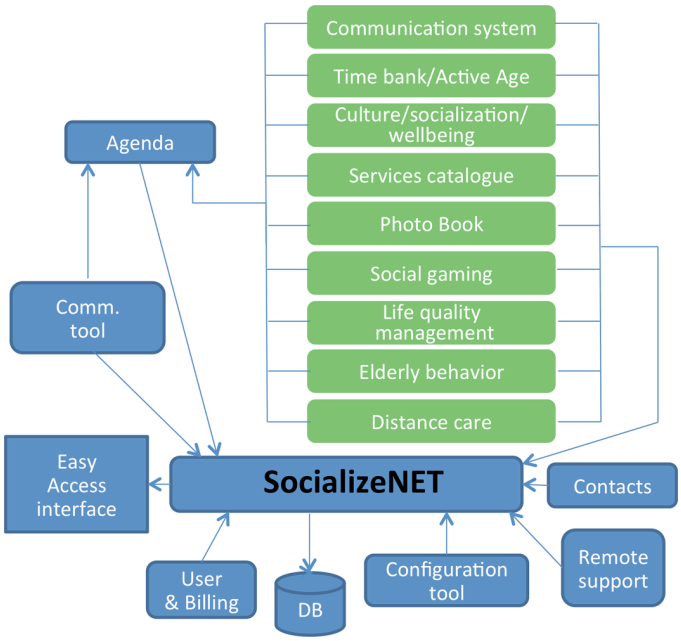

Fig. 1. SOCIALIZE architecture

implement their services, which will enable configuring and personalizing them according to needs.

The services supplied by the project (figure 1) constitute a social network specialized for the elderly population. They are divided in two categories: (i) cross services: *Agenda*, *Remote support*, *User & billing*, *Configuration tool, DB, Easy access interface, Communication tool, Contacts*; (ii) social services: *Communication system*, *Culture/socialization/wellbeing*, *Time bank/Active Age*, *Services catalogue*, *Photo book*, *Social gaming*, *Life quality management*, *Elderly behavior analysis*, *Distance care*.

IV. SocializeNet

SocializeNet represents the core of the platform. It is an interoperability software application able to interface all implemented social networking services and hence enable them to share information in technologically heterogeneous environments (figure 2). The framework addresses such aspects to achieve a true "*social network of intelligent objects"*. In fact, the platform actually establishes a social relationship among objects that can then collaborate to provide for common *IoT* applications.

SocializeNet exploits *standard W3C-recommended Web technologies*. It exposes services using *Web Services*, *SOA* and *XML* technologies. The advantage to using *W3C standard* solutions is that they ensure that the developed applications are fully compatible with other standards-based software and are not tied to any particular software system, programming language or computer architecture.

SocializeNet defines a standard *XML*-based language, called *SocializeML*, which represents a sort of universal language to abstract heterogeneous systems and services in order to describe the functions, data types, messages and models of the interactions and communications between framework entities. In this way, using this high-level descriptive language, cooperation among services and devices can be attained by providing a single, univocal way for all network components to communicate and share data. In particular, device interoperability is provided for by the *Elderly behavior service*. This consists of a set of sub-modules that work as gateways to deal with specific domotic systems purposely installed within homes (figure 2).

SocializeML consists of two main formalisms: (i) *SocializeService*, which defines objects and their functions. In particular, it describes the characteristics of a device/service, its location, and the processes by which it interacts with other *SocializeServices*; (ii) *SocializeMessage,* which formally describes events, commands and responses.

The *elderly behavior* is a significant example of the social networking services implemented within the homes of the elderly users. It allows them to live and work in an environment where they feel "protected" and "safe" through the awareness that alarms will be activated automatically to alert operators, doctors or family, in the event of any health emergencies .

For this purpose, the elderly occupants are monitored within highly automated 'domotic' environments, consistent with the *SIoT* paradigm, where devices are intelligent "objects" able to interoperate without human intervention for predictive purposes.

The service analyzes users' habits within home equipped with smart devices. Occupants merely go about their normal routines inside their homes, conducting life as usual. Domotic devices inside the environment collect data about the elderly person's habits, which will be analyzed afterwards.

Figure 3 shows a diagram illustrating how the elderly can interact with the domotic environment using objects such as actuators, while at the same time being monitored by sensors.

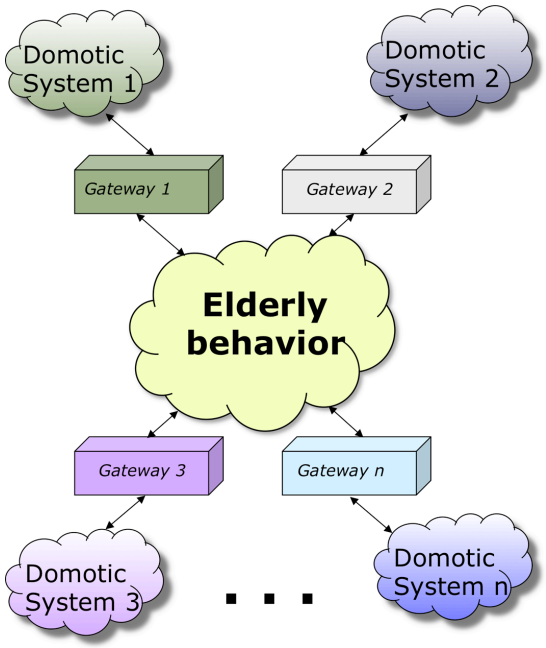

Fig. 2. Elderly behavior service

User interaction with the environment can come about in three different ways: (i) indirect interaction, when the user acts using a tablet, smartphone or web interface; (ii) unaware device interaction, when the user activates the devices without explicit interaction (e.g., a *PIR* - Passive InfraRed sensor device); (iii) direct device interaction, when the elderly acts by directly touching a device (e.g., activating a switch). The data collected is then processed using specialized algorithms in order for the system to learn the users' habits by accumulating 'experience' on normal day-to-day activities, and thereby become able to recognize 'abnormal' health situations.

Two types of communication tools are provided by this social network: (i) a private messaging tool, which is an internal email system, integrated within the traditional one, whereby users can send private messages to each other; (ii) the public messaging tool with thematic areas dedicated to the elderly.

In both cases the messages can be generated and sent automatically without human intervention as a result of specific events occurring within the various services. The information transmitted may come from devices or from objects within the social network services (e.g. health alarm messages and parameters generated by the *Elderly behavior analysis*, are automatically sent to *Remote Support* or *Distance Care*).

Of course, the messaging system can also be used directly by the elderly. Figure 4 illustrates the functionalities of the private messaging system. Users can receive messages from other *Social Network* users in their inboxes. Users can view the list of received messages and decide to remove, trash, recover, archive, or unarchive them. Moreover, they can view a 'friends list' and can decide to remove or add some, or mark some as spammers.

Figure 5 shows users can interact using the public messaging system. They can create a thread about a topic and reply to posts created by others. They can mark threads with an 'interest' tag, or signal 'agreement' with another user's post, as well as revoke such tags.

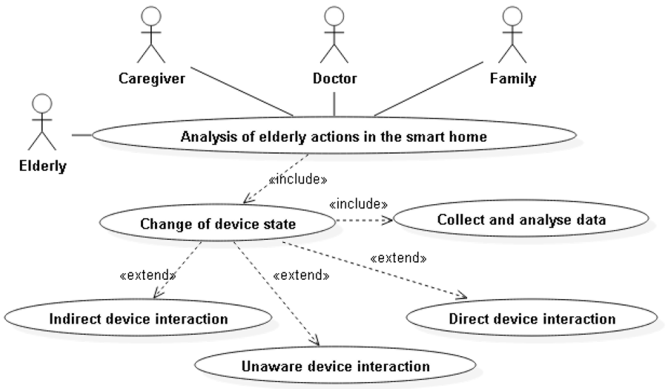

Fig. 3. Elderly behavior analysis service

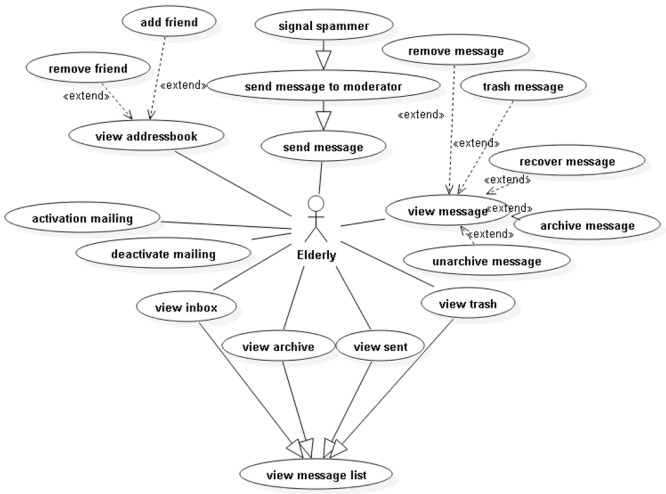

Fig. 4. SOCIALIZE private messaging system

They can upload links, multimedia content and pinpoint locations on maps. The number of *interest* and *agreement* tags enables the system to automatically highlight the most interesting threads and posts.

V. Conclusions

This paper has focused on integrating *social networking* concepts into the *Internet of Things*, which has given rise to the so-called *Social Internet of Things* (*SIoT*) paradigm. We have applied this new paradigm to an *AAL programme* European project proposing innovative solutions to support and improve the quality of life of the elderly through the application of ICT instruments.

Enabling the application of *SIoT* has been discussed in detail, though it should be stressed that the work done so far just represents a starting point for a new *IoT* vision, whereby *Social Networking* becomes a means to connect not only humans to each other, but also things to humans (and other things).

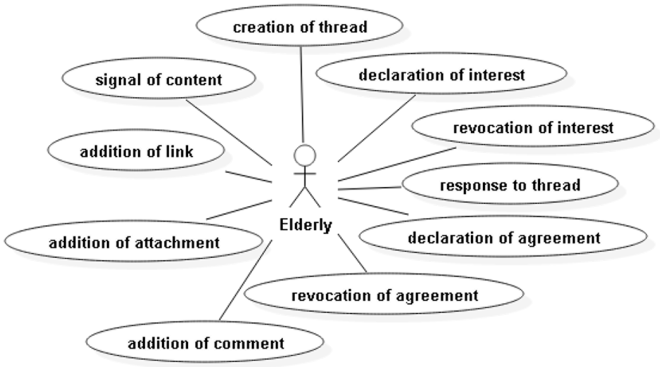

Fig. 5. SOCIALIZE public messaging system

ACKNOWLEDGMENT

The SOCIALIZE project has been financed by the European Commission through the Ambient Assisted Living Joint Programme (AAL JP).

It is being conducted by an international consortium made up of: IRIS Consortium S.r.l. (project coordinator) – Italy; Italian National Research Council (ISTI-CNR) – Italy; Fondazione Politecnico di Milano – Italy; Consorzio Nazionale Idee in Rete - Italy; Spring Techno GmbH & Co KG – Germany; Asociación de Investigación de la Industria Textil - Spain; Embedded Technologies Innovation Center s. coop. – Spain; SUPSI TTHF - Telecom Telemetry and High Frequency – Switzerland; and Casa Santa Lucia - Switzerland.

REFERENCES

[1] A. Börsch-Supan, M. Brandt, C. Hunkler and T. Kneip "Data resource profile: the Survey of Health, Ageing and Retirement in Europe (SHARE)." International Journal of Epidemiology (2013) *doi: 10.1093/ije/dyt088*

[2] A. Hofman, D. E. Grobbee, P. T. V. M. De Jong and F. A. Van den Ouweland "Determinants of disease and disability in the elderly: the Rotterdam Elderly Study." European journal of epidemiology 7.4 (1991): 403-422.

[3] J.E. Fast, D.L. Williamson, N.C. Keating "The hidden costs of informal elder care." Journal of Family and Economic Issues 20.3 (1999): 301-326.

[4] J. Gubbi, R. Buyya, S. Marusic and M. Palaniswami, Internet of Things (IoT): A vision, architectural elements, and future directions, Future Generation Computer Systems, Volume 29, Issue 7, September 2013, Pages 1645-1660, ISSN 0167-739X, http://dx.doi.org/10.1016/j.future.2013.01.010.

[5] L. Atzori, A Iera, G Morabito, M Nitti, "The social internet of things (siot)–when social networks meet the internet of things: Concept, architecture and network characterization", Computer Networks 56 (16), 3594-3608, 2012

[6] L. Atzori, Luigi, A. Iera and G. Morabito. "From "smart objects" to "social objects": The next evolutionary step of the internet of things." Communications Magazine, IEEE 52.1 (2014): 97-105

[7] V. Miori, and D. Russo, Domotic Evolution towards the IoT, Advanced Information Networking and Applications Workshops (WAINA), 2014 28th International Conference on, pp.809,814, 13-16 May 2014 doi: 10.1109/WAINA.2014.128

[8] T.Y. Wu, C.C. Hsu, and H.C. Chao, "IPv6 Home Network Domain Name Auto-configuration for Intelligent Appliances", IEEE Transactions on Consumer Electronics, Vol. 50, No. 2, pp. 491-497, May 2004.

[9] L.E. Holmquist, F. Mattern, B. Schiele, P. Alahutha, M. Beigl, H.Gallersen, Smart-its friends: a technique for users to easily establish connections between smart artefacts, in: Proc. of ACM UbiComp'01, September–October 2001.

[10] E. Nazzi, T. Sokoler, Walky for embodied microblogging: sharing mundane activities through augmented everyday objects, in: Proc. Of the 13th International Conference on Human–Computer Interaction with Mobile Devices and Services, MobileHCI, September 2011.IEEE Communication Letters 15 (4) (2011) 461–463

[11] M. Kranz, Luis Roalter, F. Michahelles, Things that twitter: social networks and the Internet of things, in: Proc. of the Pervasive 2010, the Citizen Internet of Things 2010 workshop CIoT 2010: What Can the Internet of Things Do for the Citizen? May 2010.

[12] P. Mendes, Social-Driven Internet of Connected Objects, in: Proc. of the Interconnecting Smart Objects with the Internet Workshop, March 2011.

[13] Ding, P. Shi, B. Liu, The Clustering of Internet Internet of Things and Social Network, in: Proc. of the 3rd International Symposium on Knowledge Acquisition and Modeling, October 2010.

[14] D. Guinard,; M. Mueller and J. Pasquier-Rocha, Giving RFID a REST: Building a Web-Enabled EPCIS, Internet of Things (IOT), 2010 , vol., no., pp.1,8, Nov. 29 2010-Dec. 1 2010, doi: 10.1109/IOT.2010.5678447