Internet of Future Enabling Social Network of Things

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Abstract. Advances in the areas of embedded systems, computing, and networking are leading to an infrastructure composed of millions of heterogeneous devices and services. These devices will not simply convey information but process it in transit, connect peer to peer, and form advanced collaborations. This “Internet of Things” infrastructure must have the interoperability of solution at the communication level, as well as at the service level, has to be ensured across various platforms [1].In this paper we investigate on the potential of combining social and technical networks to collaboratively provide services to both human users and technical systems supported by the Internet of Future (IoF). In the Internet of Things (IoT), things talk and exchange information to realize the vision of future pervasive computing environments. The common physical and social space emerges by the objects’ ability to interconnect, not only amongst themselves, but also with the human beings living and working in them. This paper intends to present an architecture and its application.

Keywords: internet of future, pervasive systems and computing, social networks, Internet of Things, ubiquitous communtication.

1 Introduction

Social networks are one of the most discussed topic in any kind of media. Many believe that the subject began with the advent of Facebook [2] and its creator Mark Zuckerberg. But the subject matter and his own records since1954 when J. A. Barnes began using the term systematically to show the patterns of ties, incorporating the concepts traditionally used either by society or by social scientists, well-defined groups (e.g., tribes, families) and social categories (e.g.: gender, ethnic group) .

The "social need" or the necessity to provide event information that we are active or alive, causes, according to a survey [3], 60% of Brazilian Internet interviewed users spend time on the Internet on social networks. Facebook reached the mark of 28 million Brazilian users and 753 million of global users [4].

This social interaction could also integrate elements of our surroundings, which we nominated as things. This would make the elements of everyday life, like our car or house, in members of our social network. It is possible to imagine our car as a virtual entity in our social network, “blogging” a bad humor declaration because its oil needs to be changed.

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This concept is possible if we consider the emerging Internet of Things. There are a great pool of products and things that are able to inform their status and also its functionality. As example, we have already washing machines twittering when it has done its job or if there is any kind of problem.

The Internet of Things (IoT) is a technological phenomenon originating from innovative developments concepts in information and communication technology associated with, ubiquitous communication, pervasive computing and ambient intelligence[5].

These concepts have a strong impact on the development the IoT. Ubiquitous communication means general ability of objects to communicate (anywhere anytime); pervasive computing means the enhancement of objects with processing power (the environment around becomes the computer); ambient intelligence means objects capability to register changes in the environment and thus actively interact in a typically internal network. Objects that fulfill these requirements are smart objects.

The IoT is defined as the smart objects ability to communicate among each other building networks of things, building the Internet of Things. But it is necessary to address scalability and interoperability requirements of a future IoT. Hence it is particularly important to understand the complete IoT domain model.

This paper aims to demonstrate architecture based on internet of future to fit the concept of IoT, social networks and human interaction. The paper is structured as follows. In Sec. 2, is presented a social networks overview. We introduce, in sec. 3, the discussion about Internet of Future. In sec. 4, we present the conceptual reference model and architecture for IoT based on IoT-A [13]. In Sec. 5 our motivation and idea for combined social networks and IoT is described. We conclude the paper by summarizing the contributions and limitations from the social networks and IoT architecture association and give an outlook on future research in Sec. 6.

2 Social Networks Concepts and Terminologies

To better understand how social networks (SNs) can be integrated with the physical world we need to understand the services provided by current social network platforms. The primary services are as follows: Identity and authorization services; APIs to access and manipulate the social network graph and publish and receive updates; container facilities for hosting third party applications.

All social networks store identity information about their users. This typically includes profile information, privacy settings, and connections with family, friends, colleagues or followers. SNs store content such as messages to each other, updates (e.g. to their “wall” or “tweets”), photos, videos, events, fan pages and other objects. All social networks support authentication to prove user identity. In some cases third party sites can use a SN authentication service as an identity provider. In the structure of SNs, social actors are characterized more by their relationships than by their attributes (gender, age, social class). These relationships have a variable density and some actors can occupy more central positions than others. In the market there are several tools available for development and social networking intersection. But one of the most interesting is Google's OpenSocial [18] [19].

OpenSocial is a set of APIs for building social applications that run on the web. OpenSocial's goal is to make more apps available to more users, by providing a common API that can be used in many different contexts. Developers can create applications, using standard JavaScript and HTML, that run on social websites that have implemented the OpenSocial APIs. These websites, known as OpenSocial containers, allow developers to access their social information; in return they receive a large suite of applications for their users.

The OpenSocial APIs expose methods for accessing information about people, their friends, and their data, within the context of a container. This means that when running an application on Orkut, we will be interacting with your Orkut friends, while running the same application on MySpace lets you interact with your MySpace friends. In figure 1 shows an example to see how to connect the OpenSocial APIs to an application layer.

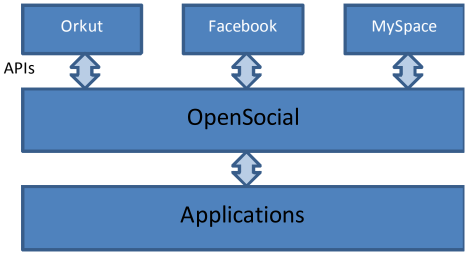

Fig. 1. Social Network connecting application

3 Internet of Future and Associations

The Internet, as we know, connects people, data and services, was conceived about 40 years ago. Since then has constantly evolved in transformation [7]. According to O'REILLY [8], was observed a sea transition from the "information sharing", known as Web 1.0, to the model of "contribution"- known as Web 2.0. For example, the users (people) in Web 2.0 can generate content across networks social. In the coming years, we have the expectation of a transition to a new collaborative model, called Web 3.0. In this model people, machines and objects can collaborate.

We can call this new environment as the Internet of the Future (IoF). In this environment, software solutions must adapt to the needs of their users, within the open, decentralized and dynamic without losing scalability and performance.

According to Papadimitrou [10], the IoF will support four key pillars, as well as physical infrastructure network: Through the Internet and people (Internet By and For People); Internet Content and Knowledge (Internet and Knowledge of Contents); IoT (Internet of Things); IoS (Internet of Services).

The term "Internet By and For the People" refers to the fact that the Internet of Future seeks to meet the growing demand from its main users, e.g., people. It will consolidate the collaborative model of Web 2.0, eliminating current barriers between suppliers and consumers of information.

The term "Internet Content and Knowledge" refers to the dissemination of local and global knowledge, through the generation of content that can be read or processed by people and mostly by machines. On the Web 3.0 generation, storage and process are made by machines. They use semantic annotations on all content generated. Machines or/and people will allow the exploration of a large volume of data, transforming it into useful information to the end user.

4 IoT Abstraction and Architecture Reference Model

According with the European Future Internet Portal [12], IoT has to ensure the interoperability of solutions at the communication level across various platforms. This motivates the creation of a reference model to IoT domain in order to promote a common understanding and businesses that want to create their own compliant IoT solutions. It also should be supported by a reference architecture that describes essential building blocks defining security, privacy, performance, and similar needs. Interfaces should be standardized and best practices (in terms of functionality and information) usage need to be provided.

The IoT-A project [13] is an architectural reference model for the interoperability of IoT systems, outlining principles and guidelines for technical design of its protocols, interfaces, and algorithms. This architectural reference model promotes a common understanding of the IoT domain as a top-level description and will be used to the basis architecture of this work. This model starts with a discourse that identifies abstract quality concepts that have to be taken into account for the realization of IoT systems. The domain model addresses to the discussion about heterogeneity, interoperability, scalability, manageability, mobility, security, reliability and ways to guarantee evolution.

The information model specifies the data semantics of the domain model and the communication model addresses high level communication paradigms pertinent to the IoT domain.

To add electronic devices to an IoT architecture and give them "life", we must carefully control and set all the requirements to transform them in a virtual entity (VE). But to do that, at first, is necessary to set all device connectivity and the communication, adjust the service orchestration and prepare the application layer to the interface with the world.

The associated middleware is still an open issue for complex, heterogeneous, distributed sensor-actor systems in the field of pervasive computing. The IoT-A presents [12][13] a poll of protocols, and techniques where is possible to detail the communication and interactions machine to machine (M2M). But the focus of this document is to present the reference architecture to the proposed problem.

In figure 2 we have the functional requirements of the reference architecture described in seven functionality groups as follow:

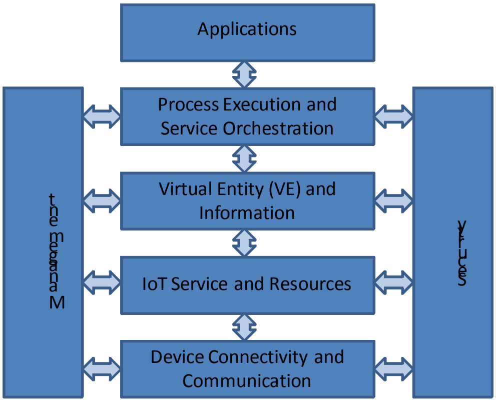

Fig. 2. Detailed view view of the IoT reference architecture [1]

- Applications – describes the functionalities provided by applications built on the top of the architecture.
- Process Execution and service orchestration – organizes the IoT resources. It is common to use APIs which works with the application layer.
- Virtual entity (VE) and information - organize the information exchanged by the physical entities, transforming in services all the output that those entities are plugged on.
- IoT service and resource – in this group is possible to manage all the IoT service resolution, understand and access its history and set the controls to manage the device.
- Device connectivity and communication – provides a set of methods and primitives for device connectivity and communication. It is possible to trace the device and associate its tag. This group also has a communication trigger and a unified communication layer to guarantee the device input/output.
- Management – all the groups above must have an external intervention which includes QoS, rules and device sets.
- Security – is one of the critical issues from the proposed architecture. There are a great heterogeneity of communication technologies, including security protocols and solutions. To guarantee the security of the device and user it must be addressed the problem by separation of high heterogeneity and demanding constraints from the more homogeneous domain. It includes authority sets (certification, authentication, and trust).

5 IoT Internet of Future to Enable the IoT Social Network

The Internet of future has its principle based on three macro dimensions. One of this dimensions is the Functional dimension which describes a static internet with unstructured information or web services working into two ways of requesting information with a defined protocol. The other is the Social dimension which includes service communities and on line communities characterizing the Web 2.0. Finally we have the Semantic dimension with machines processing information including an intelligent service discovery with interoperation. Indeed it leads to the Web 3.0 principle [20].

Simple mechanisms like OpenSocial, people can co-operate in building online communities around services. Simultaneously, such services could interoperate with one another to offer more sophisticated functionalities to the users in a largely automated way.

In a future vision, services will be combined in increasingly complex mash-ups that offer functions to support users both at home and work, helping them to perform their daily activities, transforming de devices in entities capable to interact at the social network layer.

By incorporating human interaction and cooperation into a comprehensive fashion, tasks such as service ranking and mediation, that would otherwise be computationally expensive or even infeasible, can be addressed.

When we connect both architectures, IoT to the SN OpenSocial architecture, we assembly a new architecture. The architecture presented in figure 3 unifies provides the abstraction for the Social Network of Things (SNoT)

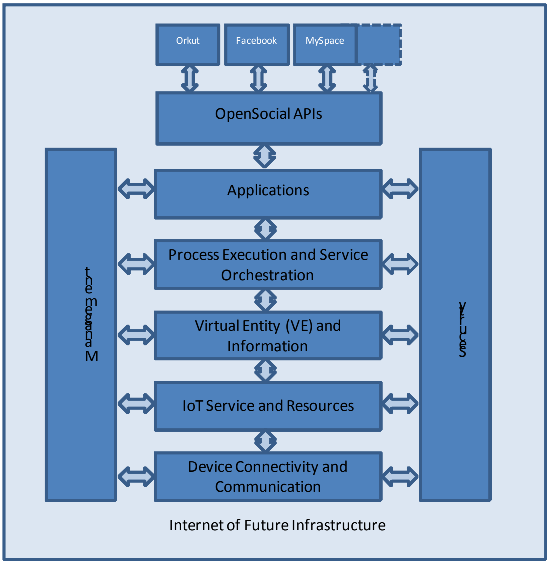

Fig. 3. SNoT Architecture

SNoT architecture must provide a stronger convergence of the real world with SNs will enable new applications and opportunities for social interaction between places and their owners, end users and the devices they control. For this to occur, stronger integration and continued convergence of the real world into SNs is necessary. However, to fully unify these worlds, there are several challenges that need to be addressed.

5.1 How the SNoT Works

Figure 4 depicts the relationship between services, resources, and devices and shows several deployment options. Network-based resources are not shown, as they can be regarded as being hidden behind cloud-based services.

We need to look at how things will interact with the online social world. How will a broad set of devices and objects ranging from passive objects like books or products on a shelf to sensors, actuators and home appliances both identify themselves and interact with SNs.

Extending SN APIs and Models for the SNoT. Second we need to consider how social network applications and the SN itself manifest things and objects in their APIs and data models to enable strong integration.

As we show in chapter II, Open Social is a set of APIs for building social applications on the web. It is an open specification with reference implementations available allowing anyone to create not only applications but also their own social network containers. Using these open APIs social application developers can write applications that "live" within any Open Social container. This allows Open Social containers to supply only the capabilities that their users need while maintaining compatibility with others at the same compliance level. Social API Server specification defines the services that a social site must provide for remote applications such as people, groups, activities, application data, albums, content and others.

In particular, while places and user location have begun to manifest themselves within on line social networks, is not clear how things or objects should manifest themselves in the on-line world.

On SNoT architecture, all the devices were embedded into a VE and they are controlled by the process execution and service orchestration. This control is generally made by APIs which works directly with the application layer.

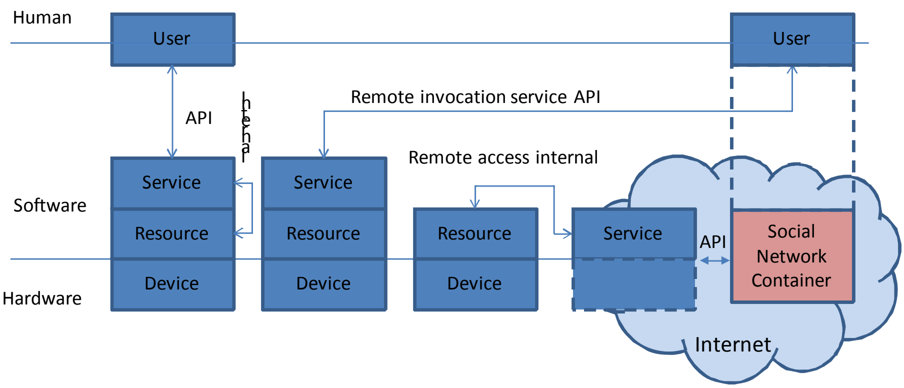

Fig. 4. SNoT working

We should consider how users interact on line with SNs that include places and things to how the real world exposes the on line social connections.

5.2 Applications Based on SNoT

Give "life" with social interaction and interoperability for a device is a concept still very advanced. But we can take advantage of the proposed architecture for various applications like e-health IoT, smart home, environment control, smart factory, among others.

A practical application extensively researched is e-health area. It is possible to have a social network composed by a doctor, nurse / medical assistant and patients, as shown in Figure 5. We could think of a community of patients with "problems" or interests, or even a direct doctor-patient relationship.

Inside the community, the patients can interact with each other about drug information and diagnoses. We can include a virtual community composed by virtual entities with the data from the medical devices or elements of health control (glucose meters, blood pressure analyzers).

In this direct relationship, the operating proceeding is executed by the technologies of IoT. The control signals can be transmitted through the Internet and it is the equipments' responsibility in IoT to connect the health and the Internet. As the result, the commands of the controller can be sent to the equipments through the Internet and IoT.

If there is any problem with one individual, automatically the IoT can send information to the other individuals from the community, thus a near neighborhood can help or give de correct assistance to the patient.

Since there is a spreading mechanism in the social network, other individuals in the community can get this information from the recommend information. This e-health interaction shows a typical application based on the SNoT. Social network can spread the related information through the relations in it. Obviously all the character of security and private can be set and managed to not expose particular information.

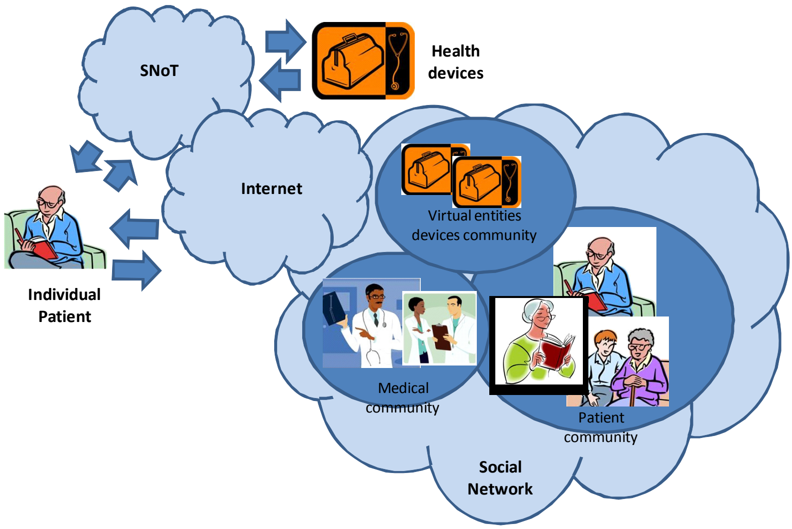

Fig. 5. SNoT E-health application

6 Conclusion and Future Work

As said before, the IoT supports different kinds of intelligent applications about devices, smart homes and etc. It can also feedback signals from different applications and provide the real time factors for real time decisions. With the information from social network, different people can be distributed into many groups with similar characteristics including the electronic devices [21].

Although many technologies and system providers label their solutions as Internet of Things technologies, in reality form a disjoint intra-nets of things. Furthermore, the existing solutions do not address the scalability requirements of a future IoT [22], both in terms of communication between and the manageability of devices. Additionally, many of these solutions area based on inappropriate models of governance and fundamentally neglect privacy and security in their design. The SNoT must address the integration between virtual and real world with the interoperability of solutions at the communication level, as well as at the service level, has to be ensured across various platforms with security, privacy and performance as show on the chapter II.

For future work, it is possible to include fuzzy logic or incertitude at the proposed SNoT to make not only the human brains as the major “component” for dealing with complexity. In the Internet of Things, objects will be duly identified (in most cases it will be either serialized or unique) and will be capable to act as autonomous media, either directly for those having active IDs with embedded software code, or indirectly throughout the network and application layers. This could potentially spread, over the existing Internet, new independent actors, capable to react and to influence the whole system.

Also at a public service level, the automatic collection of environmental data from connected sensors supports the creation of a "smart grid" — providing more accurate and timely information with which to make better decisions that optimize resource use, minimize environmental impact, improve safety and security, and provide a host of services that deliver beneficial impacts on the community as a whole at local, urban, national and even global levels. In many cases, merely making the data accessible and available (usually via a cloud-based service and published API) will spawn a wide range of additional value, creating services and opportunities within the broader community.

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