Humanizing the Internet of Things
Toward a Human-centered Internet-and-web of Things

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Abstract: This paper envisions how the Internet of Things (IoT) complements the Internet of People to build a human-centered Internet-and-Web of Things. The Internet of Things should go beyond the Machine-to-Machine paradigm and must include people in its foundation, resulting in a "Humanized Internet of Things (H-IoT)". Starting from a relevant work of Fiske, this paper defines how the Human-centred Internet of Things can embed the Fiske patterns in this particular domain. An analysis of some of existing IoT platforms and projects is also presented with the aim to analyse how real implementations are in the same direction of such social patterns.

1 INTRODUCTION

Today the *Internet of Things (IoT)* is one of the main topics of discussion in the ICT world; it can be defined as the interconnection of uniquely identifiable embedded computing devices within the existing Internet network. The IoT evolved to a convergence of multiple technologies, ranging from many different fields of application such as industrial, health, Smart Grid and Smart Cities in general covering the Machine-to-Machine (M2M) paradigm. Until nowadays the main effort was to create applications and platforms hardware oriented, to improve devices connection and communication, giving little importance to aspects related to the user-experience, privacy and security policies. In other words, giving little importance to the human side of the Internet (of Things).

The aim of this work is to investigate an alternative point of view that includes people in the IoT loop to give a more human perspective to the technology.

2 RELATED WORKS

Several works stressed the need for the IoT to go beyond a pure Machine-to-Machine (M2M) paradigm, in order to also include people. First steps toward this aim have been connecting things in a sort of extended social networks, the so called "Social Internet of Things", but it was originally a concept where things were capable of establishing social relationships with other objects and autonomously with respect to humans (Atzori et al., 2014). About this topic, other works focused in using supernetwork theories (Cheng et al., 2014) to model relationships between humans, things and services, resulting in proposing models to create a social network involving humans and things but with a user experience and human interaction to improve and further test. First fusion of traditional social networks with data coming from sensors remarked a potential, strict correlation between that world and the IoT (Schmid and Srivastava, 2007); where other works (Guinard, Fischer and Trifa, 2010) and platforms (Paraimpu, 2015) not only extended this paradigm of socializing things and produced data through Facebook or Twitter, but also envisioned the possibility to share these things with people in a social circle and to use them for their personal aims. That vision of a social IoT could be seen as a declination of the *Sharing Economy* and *Collaborative Consumption* (Botsman and Rogers, 2010) paradigms (Pintus, Carboni and Piras, 2011).

3 HUMANIZING THE INTERNET AND THE WEB OF THINGS

In earlier IoT research, its related definitions, scientific papers and scenarios remarked the

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property of a new way to automate daily processes involving "things" with a little or no human intervention at all.

Nowadays, on the other hand, we believe that the IoT deeply involves people interaction with things and devices, at least in every day scenarios, like training, health, home appliances automation and so on.

As stated in an interesting work (Wilson, 2014), in a human-friendly IoT vision, involved things *need to talk to other things we use*, be *conspicuous* and *attractive* and *go beyond remote controlling* them.

These assumptions are a good starting point and we state that a *Humanized Internet of Things (H-IoT)* includes the "classic definition" of IoT (basically M2M-focused) plus the Social Internet of Things (S-IoT) and the Internet of People (IoP), going toward the concept of the Internet and the WWW as an extraordinary means enabling interactions between communicating entities: smart things and people, the physical world and the digital one.

There is plenty of scientific literature about technology in IoT, while in this paper we focus on human and organizational perspective. On the other hand, despite we believe that a user-centered design of IoT applications should be taken into consideration to complete the H-IoT concept, in this paper we do not face Human-Computer Interaction aspects, which are accurately analyzed in (Koreshoff, Leong, and Robertson, 2013).

3.1 The Social Internet of Things and the Internet of People

In this paper we define a new domain for social interactions pattern as introduced by Fiske (Fiske, 1992). In his relevant psychological work, Fiske identified four common forms or models of sociality that people use in their relations. Each model is distinct in the rules and values of how people interact. These patterns are: *Communal Sharing (CS), Authority Ranking (AR), Equality Matching (EM) and Market Pricing (MP).*

Figure 1 shows how Fiske's model can be mapped to the social aspects of a H-IoT, remarking the main features of each pattern and how them relate to equivalent ones in our specific domain.

A deep analysis of Fiske's forms goes beyond the aims of this work; they are applicable to many domains, but what we want to shape here is if and how they can be shifted and projected toward our idea of a H-IoT, stressing where these model of sociality can naturally include Things and People.

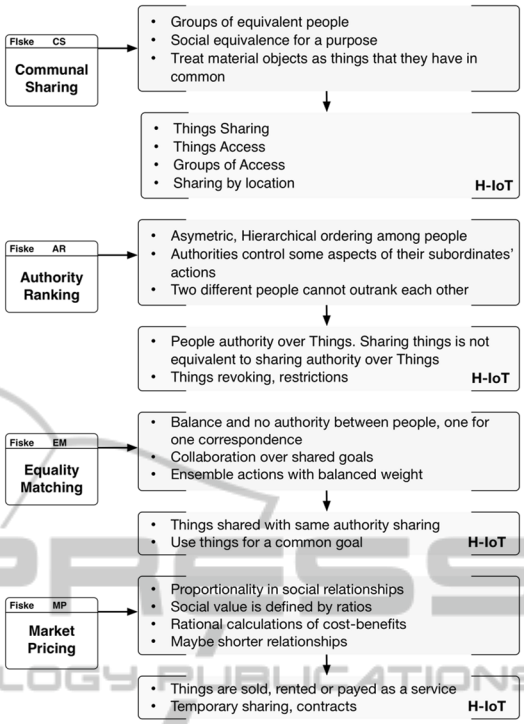

Figure 1: Fiske's Four Elementary Forms of sociality projected to a Humanized Internet of Things.

In our view, a social H-IoT exposes all the elementary forms of sociality between people but it adds a new layer: *Things over the Internet/Web*. People interact with things and devices; people use Fiske's similar patterns to establish social actions and group goals with other people through things. In this domain, Fiske's *Communal Sharing* is adapted to a totally trusted sharing of things, where a person let all persons in the community to use his/her smart things, such permission is not revocable in principle and the other persons have the same level of control of the owner because of mutual trust. So, for example, a person could share its connected smart-TV with his/her friends and family members because of the strict level of trust; or he/she can create groups of social equivalence in sharing home things; for example, some devices can be used only by family members, whereas others also by hosts.

In the domain of the IoT, the *Authority Ranking* pattern is built around an authority, maybe hierarchical: things and related Internet resources can be shared but not the authority over them. Things owners can set restrictions and/or revoke the social interaction between a thing and another person. Thus, most of the authority is in the hand of a single actor while the others have least-authority.

Again, in this IoT domain, the Fiske's *Equality*

Matching form is adapted to shape a collaboration of people sharing smart things for a specific goal. For example, adopting a weighted one for one correspondence people could use environmental data observed by shared sensors to build together a new distributed application for pollution alerts in a city, with no authority over these relations and with a good balance between benefits and contributions.

Finally, adapting the Fiske's *Market Pricing* pattern requires a transaction-based model over exchanges and things sharing, providing a definition of rational cost-benefits calculation over things usage; For example, we can think about it as smart devices renting, or an IoT platform sold as-a-Service, where also contracts and specific terms-of-service could rule this type of relationship.

A H-IoT tool should expose one or more of these features, theoretically tracing an equivalent form of natural social relationship patterns between people.

A good definition of IoP we like can be found in (Vermesan et al., n.d), where the IoP is defined as *the interconnects growing population of users while promoting their continuous empowerment, preserving their control over their online activities and sustaining free exchanges of ideas*. The IoP also provides means to facilitate everyday people's life, communities and organizations, allowing at the same time the creation of any type of business and breaking the barriers between an information producer and an information consumer (the emergence of *prosumers*).

Another definition of IoP is proposed in (Hernández-Muñoz et al., 2011) and it is envisaged as *people becoming part of ubiquitous intelligent networks having the potential to seamlessly connect, interact and exchange information about themselves and their social context and environment*.

The IoP and the S-IoT are strictly related in overtaking the original M2M-related definitions of the IoT: adopting a H-IoT people interconnect, interact, socialize, create, communicate, make and become prosumers (both producers and consumers) through the Internet/Web of connected things and people, implicitly using the IoT equivalent of the Fiske's four elementary forms of sociality. That's the new era of the Internet: a Humanized Internet (of Things).

But, to go toward a real H-IoT it is mandatory to take into consideration how the four H-IoT patterns can be managed. From a technical point of view, using some form of digital contract or policy could shape the patterns. The policies should be flexible enough to cover the four aspects described above and, of course, they involve a balance between identities and privacy, authorities and trust, rules and permissions.

3.2 Implementing the Social Patterns in the H-IoT Domain

This section addresses some more detailed descriptions of the Internet of Things domain as a new one in the Fiske classification. For each social pattern the issues and possible high-level technical solutions are broadly described. In the next sections some existing Internet platforms for smart Things are then evaluated against these features.

3.2.1 Communal Sharing

In this pattern the level of trust is the highest as the smart things are in principle controllable and shareable by everyone in the community. Building a community of trusted peers is then the point to face here, and the balance between disclosing the identities of peers and keeping their privacy is important, too. Given the level of control on the smart things, this management is similar to the sharing of credential among a group of sys admin in a computer system. In such a case there exists at least one authority over the community, which knows the identities of each peer, but inside the community the hierarchy is flat and every participant is equally entitled to manage the resources. The community manager is commonly a trusted entity with a known identity. The community manager is not required in cases like a community is spontaneously formed by means of contextual fact. For example, people and device inside a given place forms a "community" because their mere presence is a proof of trust in that context.

3.2.2 Authority Ranking

In this pattern a person with a particular authority (e.g., ownership) shares things with other people but he/she doesn't share the authority over them. Thus, the set of defined rules in resulting digital environments development must ensure that authority can not be changed by people down on the established hierarchy; for example, by people who are not owners of a shared thing. Authority must have the choice to change policies, too. In this case, social circles or groups are formed because people follow an acknowledged leader: identified by social influence, value of shared things and resources, level of influence in a specific community or by technical skills.

3.2.3 Equality Matching

To extend this pattern to the domain of the Internet of Things we could start from the definition in the domains of work and contribution in (Fiske, 1992). The idea is that every peer contributes in a balanced way eventually to reach common goals. As example we could imagine a use case in which an actor contributes with a temperature sensor, while another with a noise sensor, and a third one contributes developing a software application that elaborates data from the sensors and provides new information with value for the local environment. The three actors are not establishing a hierarchy but they are pursuing a common goal where each one is equally contributing and equally getting some benefits. When speaking of Internet-related resources, the point is how to measure the "equality" of each contributor in order to keep the balance among peers. What if one of the contributions is quantitatively much bigger or much lower than the others? To manage the above points a distributing approval process could be deployed. In other words the individual feeling that some of the other contributions are unfair should be able to choose either to withdraw the group or to promote an action to ban the participant who are not providing enough value by starting a remote voting.

3.2.4 Market Pricing

This pattern is based on the existing infrastructure of a market. Products pages, shopping carts and back-office processes are the key elements of this pattern in order to serve orders from the purchase to the final delivery. In the field of the Internet of Things it should be defined what is finally sold. At one end there are manufactures that sell physical objects, in other words they sell the smart things and then publish on an app store like Apple Store or Google play some free-apps. Often, the real value is not in the hardware but in the software, even if this is given for free. As example, we mention the case of iRig™, a special purpose cable which allows to add real time effects to an electric guitar. The valuable part is the software, which is given for free from the App store, but the revenues come from cables shipping. At the opposite end, there are markets, which do not sell the physical stuff, but sell some form of digital asset for one or more hardware platform. Glue.things is an example of this concept. In this platform users can register their smart objects, design applications and event management processes, and finally share and trade their applications in a dedicated market.

3.3 Comparison of Existing IoT Web Tools and Platforms

To analyse the impact of the Fiske's model and to discover its application, we seek the four patterns in a number of tools and platforms already available on the Web. Here follows a short analysis of major platforms. The analysis is aimed at classify if a platform is more inclined to one or more Fiske patterns as we have previously informally defined for the domain of IoT.

IFTTT (If This Than That) (IFTTT, 2015) is a Web platform that allows users to automatize tasks on the Internet. For instance, the user can define a rule (called "recipe") to manage an event coming from one device and under a given condition to perform an action on another system (a device or a web service). Its main advantages are easiness of use, recipe sharing between users and a large set of available services/devices.

In IFTTT it is not possible to share things, so a Communal Sharing seems not applicable, however it is possible to share recipes as templates to define personalized actions for a specific goal, thus recipes goes toward an incomplete Equality Matching pattern because only goals are shared but not things as means to fulfil them.

Paraimpu (Paraimpu, 2015) provides a personal workspace where users can register devices providing a basic level of virtualization. An integrated transformation engine allows composing things managing their heterogeneity. It has a good balance between simplicity of use and flexibility, social-ability and things sharing (Pintus, Carboni and Piras, 2012). Paraimpu partially supports the Communal Sharing pattern because it is not possible to create fine-grained social circles; however, when things are shared as "public" they are available to use to all the people belonging to a person's social circle. Paraimpu implements the Fiske's Authority Ranking model: authority over things is enforced and cannot be changed by people whose not own a particular thing. The platform enables Equality Matching pattern because people can share things and data with other users to build "cooperative" applications to fulfil a particular shared goal.

Xively (Xively, 2015) provides a platform, services and support needed to create and manage connected products and services on the IoT. It provides a basic workspace and it's more developer-oriented than the other tools, thanks to a good, consistent, set of libraries. The set of available tools are really oriented toward a company-to-product-to-customer model, so things sharing and related patterns could

be applied in an intra-company environment, where people belonging to a company (in this case: the social circle) use Fiske patterns to reach a particular goal, that is: to produce and to sell products. Equality Matching can be not directly implemented through provided API and credentials.

SocIoTal (SocIoTal, 2015) aims to design and provide key enablers for a reliable, secure and trusted IoT environment. It will enable the creation of a socially aware citizen-centric Internet of Things by encouraging people to contribute with their IoT devices and information flows.

By providing communities with secure and trusted tools that increase user confidence in IoT environment, SocIoTal will enable their transition to smart neighbourhood, communities and cities.

SocIoTal supports Communal Sharing pattern because each person has a number of different trust zones or communities. A trust zone represents a group of people or objects that can access the resources in the community. Participants can decide at any time to leave the community revoking any previous access to the other participants.

SocIoTal presents also a form of Authority Ranking model: information sharing and data access have the primary role to limit and control the access to data or resources.

This platform also enables the Equality Matching pattern. That's because the entire project is finalized to share things, create a community of trust and reach a common result. An example of this pattern is represented by the description of the project use cases like "Car Pooling" (N. Gligoric et al., 2014).

Glue.things (Glue.things, 2015) is a Platform-as-a-Service (PaaS) designed for applications and services for the Internet of Everything. It sells some form of digital assets for one or more hardware platforms. In this platform users can register their physical smart objects and connect them with other virtual objects, can design apps and event management processes, and finally share and trade their apps in a dedicated market.

There is a smart objects marketplace that gives to the user the chance to distribute and share the output data of his/her devices and his/her applications with the community. This market provides flexible revenue models, which clearly focus on the means of your target groups. Glue.things supports Fiske's Market Pricing pattern allowing enterprises and innovators to introduce new Internet of Things enabled services and apps in a short time and with limited upfront investment.

The platform also partially supports Communal Sharing pattern, sharing smart objects data and apps to the developer community through the marketplace. There is no implementation of the Equality Matching because people cannot share, contributing in balanced way, smart objects to reach a common goal.

Authority Ranking pattern is partially implemented because people can share apps and data selling it through the market and sharing the authority over them.

The following Table 1 summarize the comparison between the selected tools/platforms described and if they match the four patterns of Fiske in the H-IoT:

Table 1: Comparison of some existing Web tools and platforms with respect to the envisioned H-IoT properties.

	CS	AR	EM	MP
IFTTT	No	No	Partially	No
Paraimpu	Partially	Yes	Yes	No
Xively	Partially	Yes	Not directly	No
SocIoTal	Yes	Yes	Yes	No
Glue.things	Partially	Partially	No	Yes

The indications on the Table could suggest which one of these common IoT platforms to date is more ready for the H-IoT than the others.

4 FUTURE WORKS AND CONCLUSIONS

In this paper we describe a socially-centered model where Internet of Things applications are be confined to Machine-to-Machine technology issues. In this respect, people and sociality patterns are a key factor for the emergence of a *Humanized Internet of Things (H-IoT)*.

These considerations led us to examine not only a user-centered design, which is not covered in this paper, but also to dissect an implementation of the common basic patterns of human sociality defined by Fiske in his famous work. We have extended Fiske work introducing the IoT domain as a new one in the Fiske classification. For each social pattern, the issues and possible high-level technical solutions are broadly described together with some suggestions about their implementation in a real IoT application or platform.

Fiske's model projection to the IoT domain is interesting because all processes involving people sociality could build a conceptual framework to better envision and design the IoT of the future.

Trying to find an actual implementation of Fiske's models toward a real H-IoT guided us to a basic set of lesson learned and recommendations

about open issues in IoT platforms. Then, we examined some of the existing platforms, checking their adherence to the envisioned H-IoT model and, as remarked, none of them fully support the four transposed Fiske patterns, maybe due to specific business models or market targets. Anyway, some of them seem very promising toward a better H-IoT adherence. Future works will refine the explored H-IoT concepts to provide a full conceptual framework and recommendation to build socially-aware and Fiske-complete systems.

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REFERENCES

L. Atzori, D. Carboni, A. Iera, Jul 2014. “Smart things in the social loop: Paradigms, technologies, and potentials” in Ad Hoc Networks, 2014, Vol 18, pp. 121-132, doi:10.1016/j.adhoc.2013.03.012.

C. Cheng, C. Zhang, X. Qiu, Y.Ji, Feb. 2014. “The Social Web of Things (SWoT)- Structuring an Integrated Social Network for Human, Things and Services” in Journal of Computers, Vol 9, No 2 (2014), pp. 345-352, doi:10.4304/jcp.9.2.345-352.

T. Schmid and M. B. Srivastava, Nov. 2007. “Exploiting Social Networks for Sensor Data Sharing with SenseShare,” CENS 5th Annual Research Review.

D. Guinard, M. Fischer, and V. Trifa, Mar. 2010. Sharing using social networks in a composable web of things. In Proc. of the First IEEE International Workshop on the Web of Things (WOT2010), Mannheim, Germany.

R. Botsman and R. Rogers, 2010. “What’s Mine Is Yours: How Collaborative Consumption is Changing the Way We Live: The Rise of Collaborative Consumption”, Harperbusiness.

A. Pintus, D. Carboni, A. Piras 2011. "The anatomy of a large scale social web for internet enabled objects", Proceedings of the Second International Workshop on Web of Things ACM WoT '11 pages 6:1–6:6 New York, NY USA.

H. James Wilson, “Make the Internet of Things more Human-Friendly”, Oct. 2014. Harvard Business Review, Blog. Available from: http://blogs.hbr.org/2014/10/make-the-internet-of-things-more-human-friendly/.

T.L. Koreshoff, T.W. Leong, T. Robertson, 2013. “Approaching a Human-Centred Internet of Things”, OZCHI’13, November 25–29, Adelaide, SA, Australia.

A. P. Fiske, 1992. "The four elementary forms of sociality: framework for a unified theory of social relations", Psychological Review, vol. 99.

O. Vermesan, P. Friess, P. Guillemin, S. Gusmeroli, H. Sundmaeker, A. Bassi, I. S. Jubert, M. Mazura, M. Harrison, M. Eisenhauer, P. Doody, “Internet of Things Strategic Research Roadmap”, Available from: http://www.internet-of-things-research.eu/documents.htm.

J. M. Hernández-Muñoz, J. B. Vercher, L. Muñoz, J. A. Galache, M. Presser, L. A. Hernández Gómez, J. Pettersson, 2011. “Smart Cities at the Forefront of the Future Internet” Future Internet Assembly 2011: Achievements and Technological Promises; Lecture Notes in Computer Science Volume 6656, pp 447-462.

A Pintus, D Carboni, A Piras, Apr. 2012. “Paraimpu: a platform for a social web of things.” Proceedings of the 21st international conference companion on World Wide Web. Lyon, France.

N. Gligoric, S. Krco, I. Elicegui, C. López, L. Sánchez, M. Nati, R. Van Kranenburg, M. V. Moreno, D. Carboni, March 2014. SocIoTal: Creating a Citizen-Centric Internet of Things, 4th International Conference on Information Society and Technology (ICIST 2014), 9-13.

Paraimpu, a social tool to allow people to connect, compose and share Things. Available from: https://www.paraimpu.com. [27 January 2015].

Glue.things. Available from: http://www.gluethings.com. [27 January 2015].

IFTTT, web-tool to connect services and things with the statement “if this then that”. Available from: https://ifttt.com. [27 January 2015].

Xively, IoT platform as a service for the IoT. Available from: https://xively.com. [27 January 2015].

SocIoTal, an EU FP7 funded STREP project, “A reliable, smart and secure Internet of Things for Smart Cities” Available from: http://sociotal.eu. [27 January 2015].