RFID, ENERGY, AND INTERNET OF THINGS

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Abstract

Digital Enterprise is the free flow of real-time information to be exchanged between suppliers and consumers. RFID transforms the energy into data, and it is suggested as an enabling technology of the Internet of Things. Industries, Hospitals, Homes use the fieldbus systems to exchange data. Powerline communication extends the space enabling the wider interoperability and the remote management of energy-consuming appliances. We present a view linking real world processes with the digital ones using RFID and energy. We present an use case on near miss in healthcare.

Keywords: RFID, fieldbus, energy efficiency, internet of things, nursing.

1. Introduction

Digital Enterprise might be seen as the free flow of real-time information exchanged between suppliers and consumers: digital demand, digital service, and digital money. The process of enterprise digitization starts exploiting the always-on broadband (internet) connections, deregulation, the rise of merchant plants, and ubiquitous trading. The Digital Enterprise resource-related facet might be compared with Digital Money and will have probably similar implications.

We can ubiquitously manage on-line bank accounts, digital meters, industrial automation equipment, intelligent home, tele-medicine and whatsoever. We can use ubiquitous credit cards. We can do real-time de-materialized stock trading. Digital money and digital investments has granted to industry leaders some lower costs and higher margins, but also the intimate access to customers. Digital Enterprise works in a similar way, fully automatically, in the background, and will be invisible to the user, but Digital Enterprise Systems will be able to manage the digital objects worldwide.

Internet of Things (IOT hereafter) is a new vision of the future technological ubiquity in ubiquitous computing and communication era radically transforming the society, corporate, communities, and personal spheres. Early forms of ubiquitous information and communication networks are represented by the widespread use of mobile phones, little gadgets becoming an integral and intimate part of everyday life for many millions of people. Second step is the embedding of short-range mobile transceivers into a wide array of additional devices/appliances, enabling new forms of communication between People and Things (P2T), and between Things themselves (T2T). A new dimension has been added to the world of Information and Communication Technologies (ICT): from anytime (day/night), anywhere (nearby PC, somewhere else indoor, outdoor, while moving) connectivity for anyone, to anything, e.g. between PCs, Human to Human (H2H), Human to Thing (H2T), and Thing to Thing (T2T). Multiple connections creates an entirely new dynamic network of networks – an Internet of Things, which is based on solid technological advances and visions of network ubiquity, computing, communications, and dynamic technical innovation in a number of domains, ranging from wireless sensors to nanotechnology.

To connect everyday objects and devices to large databases and IOT, a simple cost-effective system of thing's identification is essential: data about "things" become collectable, processable and transformable into knowledge. Radio-Frequency Identification (RFID) offers this functionality. Data or knowledge collection benefit from the capability to detect changes in the physical status of things (event detection) by the mean of advanced sensing technology. Embedded intelligence can further enhance the power of the IOT by devolving information and knowledge processing capabilities to the edges of the network. Advances in miniaturization and nanotechnology downscale things: smaller and smaller smart objects will have the ability to interact and connect. A combination of all above-mentioned developments makes the Internet of Things, connecting the world's objects in both a sensory and an intelligent manner with the digital representation of physical objects. The IOT becomes the mapping from the real world to the digital one.

The powerline communication and fieldbus enabled systems transforms the electrical energy distributions networks into the valuable components of the IOT, where the embedded chips grant the identification capability. Like digital money, Digital Enterprise depends on communications.

2. Discussion

On the Fig. 1 the scheme of the typical RFID reader is presented. RFID tag is a smart device equipped with an electronic chip and a smart antenna. RFID reader interacts with the tag and sends a signal to someone for further elaboration.

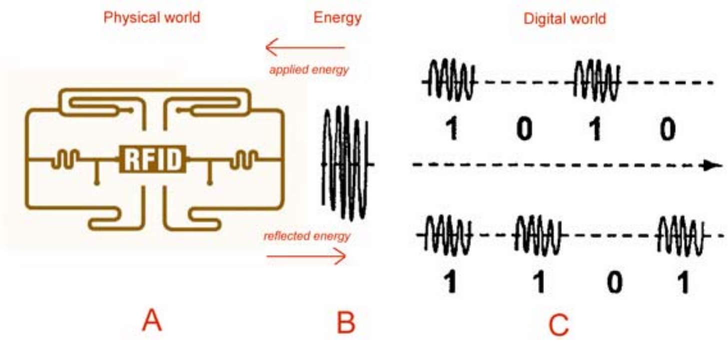

Fig. 1. RFID transformation.

RFID-enabled system [1] will interpret the data and take some decisions. Let us now analyze the picture form a new point a view. RFID tag is a physical object, applied to a real world item in order to identify and track it electronically. Radio Science and related Technology, represented by tag, makes the physical object an energy consumer, because RFID technology uses energy alimented active tags, or some energy is applied to the passive tags in order to ask them to activate the sending of data. The quantity of energy scavenged might be very small, but the concept is extremely clear: **any item** becomes the energy consumer. This is important because of the implications not yet accounted: the energy-less physical objects become energy consumers. Physical objects are being introduced into the Digital World, and also into the Digital Energy world. RFID technology becomes the transforming function able to map physical objects into the digital world by the simple injection. Several implications are generated by this very simple assertion: we have now the digital representation of a real world object, the digital clone of it, a second life indeed. On the Fig. 1 we can see the energy-less physical world member identified by tag (A), some analogue energy going from the real world power plants and some reflected energy (B), and the digital signal (C), ready to be consumed by the digital world.

The above-said transforming might be used to project **physical objects** vs. the Internet of Things. Let us go on with observations. On the Fig. 2 there is an example of a real world living organism (A) made identifiable by the tag (B), becoming a digital object of the Internet of Things (C) and a consumer of the energy business: a **digital thing** hereafter.

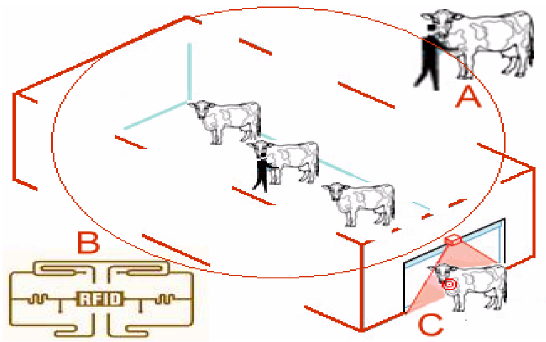

Fig. 2. Object mapping

On the Fig. 3 we analyze the representation of one geographically-distributed process, and the possible split into several businesses: the industry producing goods (A), the transport business (B), the value-added service industry (C), a nested small business (D), a possible subcontracting (E), the distribution/delivery chain (F), and any external business (G). We can perceive the possibility to map processes into the digital world and to organize the interoperable business, and the chance to transform **any process**, which is a non-physical object, into an energy consumer. This transformation maps non-physical objects into digital things as well.

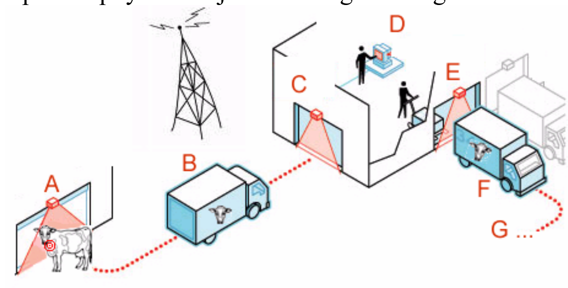

Fig. 3. Process mapping

There are different interaction forms: human interacting with the real world objects, human interacting with the digital world objects using PC or something else, human interacting with the real world process, human interacting with the digitized process etc. Radio science and technology innovate [2] interactions between PC and similar devices used to manage the real world and the ubiquitous digital one around.

Further step vs. the Internet of Thing is possible, but additional enabling technologies are needed to arrive to the vision represented on Fig. 4.

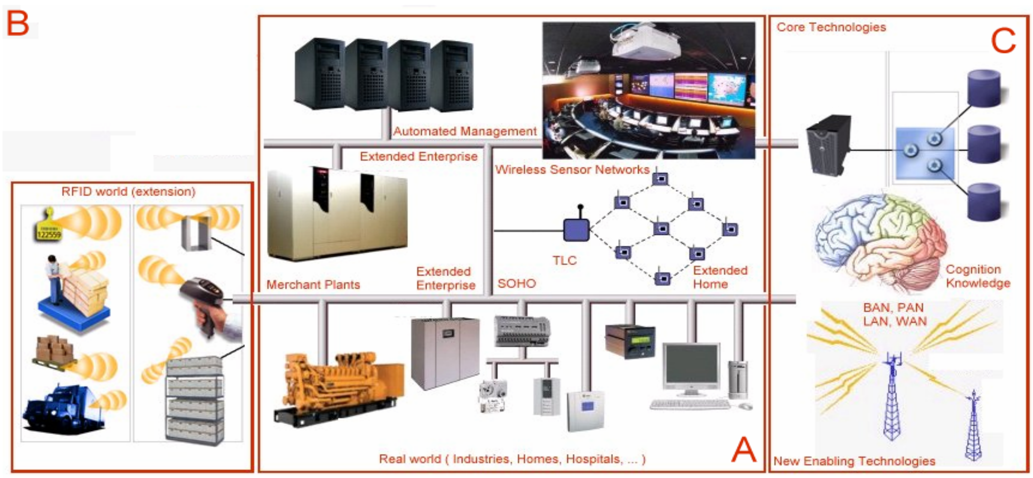

Fig. 4. Internet of Things

The "traditional" ubiquitous world is represented by the component (A) including industries, extended and de-localized enterprises, ubiquitous workers, domotic homes, energy utilities [3], TLC, services, and all other realities. The extension of the above-mentioned reality by new enabling and emergent technologies is represented by the component (C), including the formalization of cognitive processes, machine-reasoning, semantic web, automated decision support, and whatsoever. This is the wireless extension worldwide enabling the future human-less scenario, in which the automated intelligence might govern things: physical objects and non-physical entities (processes), parts of the real world or of the digital one. The (B) component shows the missing element, making possible such scenario, which might be the RFID, a part of the Radio Science and the Technology, transforming real life members into digital things, ready to enter into the Internet of Things.

3. Use Case

The stay of the bon marrow transplanted patient in the hospital between the chemio- therapy and the sufficient recovery of the functionality of the immune system is the period associated with several serous risks in terms of the possible infectious disease. The nursing is undertaken in a strongly controlled isolated environment with the full control of the sterility value chain [4]. The room where the patient stay is typically separated from the rest of the Department with two doors, and the atmosphere is controlled separately. The nurses and other healthcare professionals having the access to the patient's room should undertake accurate measures ensuring the absence of pathologic agents which might be introduced in such an environment. For instance a sink is typically placed between two doors to allow to wash hands and to apply the new sterile gloves. The process might be formalized transforming the tacit knowledge owned by professionals dealing with the above-mentioned problem into the implicit one, placed into the knowledge repository and controlled by the machine-reasoning (computerised brain) in order to detect the near miss situations and to manage the situation in the most efficient way.

The business issue is the risk (to introduce the pathologic agents inside) management and the healthcare professional's support by the proactive help, e.g. the near miss detection and the real-time help offer. The scientific challenges are: (a) human-human interaction to support by automation, (b) directional process-related context understanding, (c) automated reasoning and decision taking. The ICT support in bone marrow transplant nursing might be represented by the introduction of some sensor **devices** to detect the risk characterizing **conditions** and the knowledge engine running encoded **rules (descriptions)** aimed on the **situation** triggering to undertake the proactive **action**: to advert the human actor, not acting on behalf.

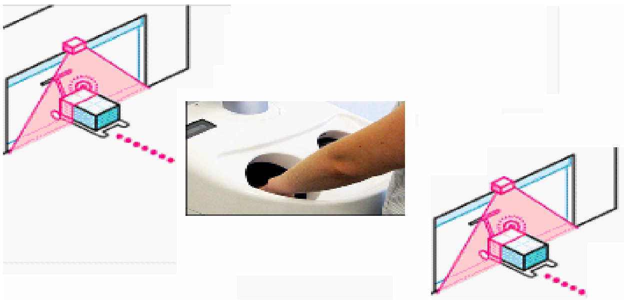

Fig. 5. Wash hands process fulfilment.

4. Conclusions

We have outlined a possible way to map real life objects on the Internet of Things. We have examined the role of Radio Science and the contribution of the enabling technology in the transition from the modern ICT world vs. the Internet of Things. We have analyzed an example of real life healthcare service from the process point of view pointing the need of the combined use of the RFID, ubiquitous technology and machine reasoning. We have outlined the transformation of the objects and processes into energy consumers and stated the imminent Digital Energy world.

We will continue to use the PC in order to interact with the Internet of Things, but more options are possible using the world-wide automation and border-less extended cooperation, for instance those offered by the combined use of the knowledge and cognitive technologies, and those enabling the transition, where RFID holds the promise of networking the physical world and tightly integrating it with computing systems.

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