RESEARCH ARTICLE OPEN ACCESS

A Survey Report on Internet of Things Applications

Sapandeep Kaur [1], Ikvinderpal Singh [2]
Department of Computer Science & Applications [1]
SR Govt. College
PG Department of Computer Science & Applications [2]
TSGGS Khalsa College
Amritsar -India

ABSTRACT

This paper addresses the Internet of Things. The Internet of Things continues to affirm its important position in the context of Information and Communication Technologies and the development of society. Identification and tracking technologies, wired and wireless sensor and actuator networks, enhanced communication protocols (shared with the Next Generation Internet), and distributed intelligence for smart objects are just the most relevant. As one can easily imagine, any serious contribution to the advance of the Internet of Things must necessarily be the result of synergetic activities conducted in different fields of knowledge, such as telecommunications, informatics, electronics and social science. In such a complex scenario, this survey is directed to those who want to approach this complex discipline and contribute to its development. Different visions of this Internet of Things paradigm are reported and enabling technologies reviewed.

Keywords:- Internet of Things; Pervasive computing; RFID systems

I. INTRODUCTION

Internet of Things (IoT) is a concept that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals. The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. In this survey the research and development challenges to create a smart world are enormous. A world where the real, digital and the virtual are converging to create smart environments that make energy, transport, cities and many other areas more intelligent. The goal of the Internet of Things is to enable things to be connected anytime, anyplace, with anything and anyone ideally using any path/network and any service. Internet of Things is a new revolution of the Internet. The basic idea of this concept is the pervasive presence around us of a variety of things or objects – such as Radio-Frequency IDentification (RFID) tags, sensors, actuators, mobile phones, etc. – which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals [1].

Objects make themselves recognizable and they obtain intelligence by making or enabling context related decisions thanks to the fact that they can communicate information about themselves. They can access information that has been aggregated by other things, or they can be components of complex services. This transformation is concomitant with the emergence of cloud computing capabilities and the transition of the Internet towards IPv6 with an almost unlimited addressing capacity.

Unquestionably, the main strength of the IoT idea is the high impact it will have on several aspects of everyday-life and behavior of potential users. From the point of view of a private user, the most obvious effects of the IoT introduction will be visible in both working and domestic fields.

New types of applications can involve the electric vehicle and the smart house, in which appliances and services that provide notifications, security, energy-saving, automation, telecommunication, computers and entertainment are integrated into a single ecosystem with a shared user interface. Obviously, not everything will be in place straight away. Developing the technology in Europe right now—demonstrating, testing and deploying products—it will be much nearer to implementing smart environments by 2020. In the future computation, storage and communication services will be highly pervasive and distributed: people, smart objects, machines, platforms and the surrounding space (e.g., with wireless/wired sensors, M2M devices, RFID tags, etc.) will create a highly decentralized common pool of resources (up to the very edge of the "network") interconnected by a dynamic network of networks. The "communication language" will be based on interoperable protocols, operating in heterogeneous environments and platforms. IoT in this context is a generic term and all objects can play an active role thanks to their connection to the Internet by creating smart environments, where the role of the Internet has changed. This powerful communication tool is providing access to information, media and services, through wired and wireless broadband connections [2].

The Internet of Things makes use of synergies that are generated by the convergence of Consumer, Business and Industrial Internet. The convergence creates the open, global network connecting people, data, and things. This convergence leverages the cloud to connect intelligent things that sense and transmit a broad array of data, helping creating services that would not be obvious without this level of connectivity and analytical intelligence. The use of platforms is being driven by transformative technologies such as cloud, things, and mobile. The cloud enables a global infrastructure to generate new services, allowing anyone to create content and applications for global users. Networks of things connect things globally and maintain their identity online [3]. Mobile allows connection to this global infrastructure anytime, anywhere. The result is a globally accessible network of things, users, and consumers, who are available to create businesses, contribute content, generate and purchase new services.

II. OBJECTIVE

With the Internet of Things the communication is extended via Internet to all the things that surround us. The Internet of Things is much more than M2M communication, wireless sensor networks, 2G/3G/4G, RFID, etc [4]. These are considered as being the enabling technologies that make "Internet of Things" applications possible.

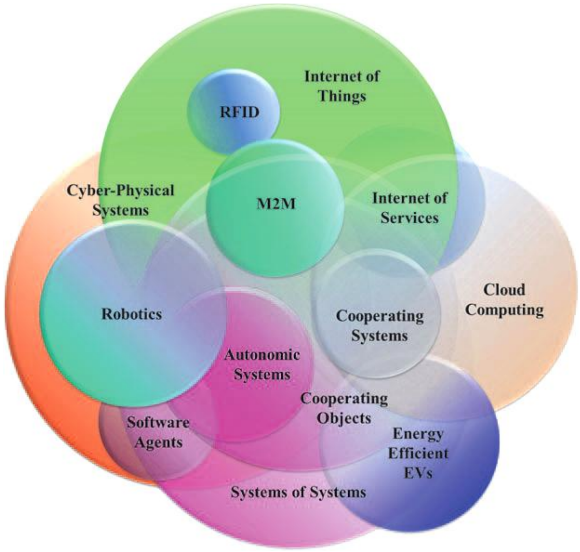

Fig.1 Technology Convergence

Several industrial, standardization and research bodies are currently involved in the activity of development of solutions to fulfill the highlighted technological requirements. This survey gives a picture of the current state of the art on the IoT. More specifically, it:

- provides the readers with a description of the different visions of the Internet of Things paradigm coming from different scientific communities;
- reviews the enabling technologies and illustrates which are the major benefits of spread of this paradigm in everyday-life;
- offers an analysis of the major research issues the scientific community still has to face.

The main objective is to give the reader the opportunity of understanding what has been done (protocols, algorithms, proposed solutions) and what still remains to be addressed, as well as which are the enabling factors of this evolutionary process and what are its weaknesses and risk factors.

III. IoT APPLICATIONS

It is impossible to envisage all potential IoT applications having in mind the development of technology and the diverse needs of potential users. In the following sections, we present several applications, which are important. These applications are described, and the research challenges are identified. Many are the domains and the environments in which new applications would likely improve the quality of our lives: at home, while travelling, when sick, at work, when jogging and at the gym, just to cite a few. These environments are now equipped with objects with only primitive intelligence, most of times without any communication capabilities. Giving these objects the possibilities to communicate with each other and to elaborate the information perceived from the surroundings imply having different environments where a very wide range of applications can be deployed. In the following subsections we provide a review of the short-medium term applications for each of these categories and a range of futuristic applications [2, 5].

These can be grouped into the following domains:

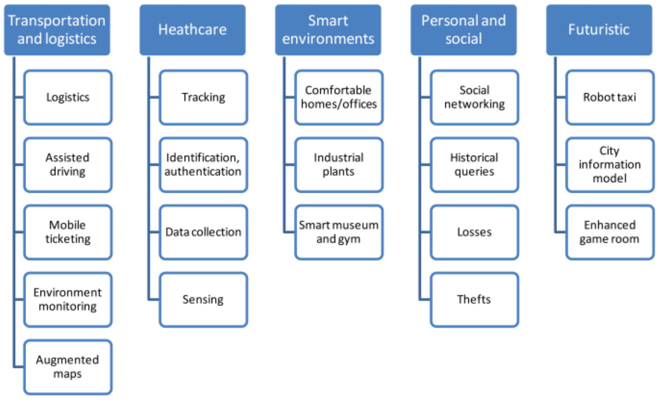

Fig. 2. Applications domains and relevant major scenarios

A. Transportation and logistics domain

Advanced cars, trains, buses as well as bicycles along with roads and/or rails are becoming more instrumented with sensors, actuators, and processing power. Roads themselves and transported goods are also equipped with tags and sensors that send important information to traffic control sites and transportation vehicles to better route the traffic, help in the management of the depots, provide the tourist with appropriate transportation information, and monitor the status of the transported goods.

The main applications in the transportation and logistics domain are:

1) Logistics: Real-time information processing technology based on RFID and NFC can realize real-time monitoring of almost every link of the supply chain, ranging from commodity design, raw material purchasing, production, transportation, storage, distribution and sale of semi-products and products, returns' processing and after-sales service [6, 7]. Additionally, real-time access to the ERP program helps the shop assistants to better inform customers about availability of products and give them more product information in general [8].

2) Assisted driving: Cars, trains, and buses along with the roads and the rails equipped with sensors, actuators and processing power may provide important information to the driver and/or passengers of a car to allow better navigation and safety.

3) Mobile ticketing: Posters or panels providing information (description, costs, and schedule) about transportation services can be equipped with an NFC tag, a visual marker, and a numeric identifier. The user can then get information about several categories of options from the web by either hovering his mobile phone over the NFC tag, or pointing the mobile phone to the visual markers. The mobile phone automatically gets information from the associated web services (stations, numbers of passengers, costs, available seats and type of services) and allows the user to buy the related tickets [9].

4) Monitoring environmental parameters: Perishable goods such as fruits, fresh-cut produce, meat, and dairy products are vital parts of our nutrition. From the production to the consumption sites thousands of kilometers or even more are covered and during the transportation the conservation status (temperature, humidity, shock) need to be monitored to avoid uncertainty in quality levels for distribution decisions. Pervasive computing and sensor technologies offer great potential for improving the efficiency of the food supply chain [10, 11].

5) Augmented maps: Touristic maps can be equipped with tags that allow NFC-equipped phones to browse it and automatically call web services providing information about hotels, restaurants, monuments and events related to the area of interest for the user [12].

B. Healthcare domain

Many are the benefits provided by the IoT technologies to the healthcare domain and the resulting applications can be grouped mostly into: tracking of objects and people (staff and patients), identification and authentication of people, automatic data collection and sensing [2, 13].

The main applications in the Healthcare domain are:

1) Tracking: Tracking is the function aimed at the identification of a person or object in motion. This includes both real-time position tracking, such as the case of patient-flow monitoring to improve workflow in hospitals, and tracking of motion through choke points, such as access to designated areas.

2) Identification and authentication: It includes patient identification to reduce incidents harmful to patients (such as wrong drug/dose/time/procedure), comprehensive and current electronic medical record maintenance (both in the in- and out-patient settings), and infant identification in hospitals to prevent mismatching. In relation to staff, identification and authentication is most frequently used to grant access and to improve employee morale by addressing patient safety issues.

3) Data collection: Automatic data collection and transfer is mostly aimed at reducing form processing time, process automation (including data entry and collection errors), automated care and procedure auditing, and medical inventory management. This function also relates to integrating RFID technology with other health information and clinical application technologies within a facility and with potential expansions of such networks across providers and locations.

4) Sensing: Sensor devices enable function centered on patients, and in particular on diagnosing patient conditions, providing real-time information on patient health indicators [14].

C. Smart environments domain

A smart environment is that making its ‘‘employment” easy and comfortable thanks to the intelligence of contained objects, be it an office, a home, an industrial plant, or a leisure environment.

The main applications in the smart environments domain are:

1) Comfortable homes and offices: Sensors and actuators distributed in houses and offices can make our life more comfortable in several aspects: rooms heating can be adapted to our preferences and to the weather; the room lighting can change according to the time of the day; domestic incidents can be avoided with appropriate monitoring and alarm systems; and energy can be saved by automatically switching off the electrical equipments when not needed [15].

2) Industrial plants: Smart environments also help in improving the automation in industrial plants with a massive deployment of RFID tags associated to the production parts. In a generic scenario, as production parts reach the processing point, the tag is read by the RFID reader. An event is generated by the reader with all the necessary data, such as the RFID number, and stored on the network. The machine/robot gets notified by this event (as it has subscribed to the service) and picks up the production part. By matching data from the enterprise system and the RFID tag, it knows how to further process the part [16].

3) Smart museum and gym: In the museum, for instance, expositions in the building may evoke various historical periods (Egyptian period or ice age) with widely diverging climate conditions. The building adjusts locally to these conditions while also taking into account outdoor conditions. In the gym, the personal trainer can upload the exercise profile into the training machine for each trainee, who is then automatically recognized by the machine through the RFID tag.

D. Personal and social domain

The applications falling in this domain are those that enable the user to interact with other people to maintain and build social relationships. Indeed, things may automatically trigger the transmission of messages to friends to allow them to know what we are doing or what we have done in the past, such as moving from/to our house/office, travelling, meeting some common mates or playing soccer [17].

The main applications in the Personal and social domains are:

1) Social networking: This application is related to the automatic update of information about our social activities in social networking web portals, such as Twitter and Plazes. We may think of RFIDs that generate events about people and places to give users real-time updates in their social networks, which are then gathered and uploaded in social networking websites.

2) Historical queries: Historical queries about objects and events data let users study trends in their activities over time. This can be extremely useful for applications that support long term activities such as business projects and collaborations.

3) Losses: A search engine for things is a tool that helps in finding objects that we don’t remember where have been left. The simplest web-based RFID application is a search engine for things that lets users view the last recorded location for their tagged objects or search for a particular object’s location.

4) Thefts: An application similar to the previous one may allow the user to know if some objects are moved from a restricted area (the owner house or office), which would indicate that the object is being stolen. In this case, the event has to be notified immediately to the owner and/or to the security guards. For example, the application can send an SMS to the users when the stolen objects leave the building without any authorization (such as a laptop, a wallet or an ornament).

E. Futuristic applications domain

The applications described in the previous sections are realistic as they either have been already deployed or can be implemented in a short/medium period since the required technologies are already available. Apart from these, we may envision many other applications, which we herein define futuristic since these rely on some (communications, sensing, material and/or industrial processes) technologies that either are still to come or whose implementation is still too complex.

The main applications in the Futuristic applications domains are:

1) Robot taxi: In future cities, robot taxis swarm together, moving in flocks, providing service where it is needed in a timely and efficient manner. The robot taxis respond to real-time traffic movements of the city, and are calibrated to reduce congestion at bottlenecks in the city and to service pick-up areas that are most frequently used. With or without a human driver, they weave in and out of traffic at optimum speeds, avoiding accidents through proximity sensors, which repel them magnetically from other objects on the road. They can be hailed from the side of the street by pointing a mobile phone at them or by using hand gestures. The user's location is automatically tracked via GPS and enables users to request a taxi to be at a certain location at a particular time by just pointing it out on a detailed map [2, 18].

2) City information model: The idea of a City Information Model (CIM) is based on the concept that the status and performance of each buildings and urban fabrics – such as pedestrian walkways, cycle paths and heavier infrastructure like sewers, rail lines, and bus corridors – are continuously monitored by the city government operates and made available to third parties via a series of APIs, even though some information is confidential. Accordingly, nothing can be built legally unless it is compatible with CIM. The facilities management services communicate with each other and the CIM, sharing energy in the most cost-effective and resource-efficient fashion.

3) Enhanced game room: The enhanced game rooms as well as the players are equipped with a variety of devices to sense location, movement, acceleration, humidity, temperature, noise, voice, visual information, heart rate and blood pressure. The room uses this information to measure excitement and energy levels so that to control the game activity according to status of the player.

IV. CONCLUSION

The Internet has changed drastically the way we live, moving interactions between people at a virtual level in several contexts spanning from the professional life to social relationships. The IoT has the potential to add a new dimension to this process by enabling communications with and among smart objects, thus leading to the vision of ''anytime, anywhere, any media, anything'' communications. In this paper, we have surveyed the most important aspects of the IoT with emphasis on what is being done and what are the issues that require further research. Indeed, current technologies make the IoT concept feasible but do not fit well with the scalability and efficiency requirements they will face. We believe that, given the interest shown by industries in the IoT applications, in the next years addressing such issues will be a powerful driving factor for networking and communication research in both industrial and academic laboratories.

REFERENCES

[1] D. Giusto, A. Iera, G. Morabito, L. Atzori (Eds.), The Internet of Things, Springer, 2010. ISBN: 978-1-4419-1673-0.

[2] https://cs.uwaterloo.ca/~brecht/courses/854-Emerging -2014 /readings/iot/iot-survey.pdf

[3] J-S. Lee, B. Hoh, "Sell your experiences: a market mechanism based incentive for participatory sensing", *2010 IEEE International Conference on Pervasive Computing and Communications (PerCom)*, pp. 60–68, March 29, 2010–April 2, 2010.

[4] M.Weiser, "The Computer for the 21st Century," *Scientific Am.*, Sept., 1991, pp. 94–104; reprinted in *IEEE Pervasive Computing*, Jan.–Mar. 2002, pp. 19–25."

[5] K. Ashton, "That 'Internet of Things' Thing", online at http://www.rfidjournal.com/ article/view/4986, June 2009

[6] R. Yuan, L. Shumin, Y. Baogang, Value Chain Oriented RFID System Framework and Enterprise Application, Science Press, Beijing, 2007.

[7] METRO Group Future Store Initiative, <http://www.futurestore.org/>.

[8] S. Karpischek, F. Michahelles, F. Resatsch, E. Fleisch, Mobile sales assistant – an NFC-based product information system for retailers, in: Proceedings of the First International Workshop on Near Field Communications 2009, Hagenberg, Austria, February 2009.

[9] G. Broll, E. Rukzio, M. Paolucci, M. Wagner, A. Schmidt, H. Hussmann, PERCI: pervasive service interaction with the internet of things, IEEE Internet Computing 13 (6) (2009) 74–81.

[10] A. Ilic, T. Staake, E. Fleisch, Using sensor information to reduce the carbon footprint of perishable goods, IEEE Pervasive Computing 8 (1) (2009) 22–29.

[11] A. Dada, F. Thiesse, Sensor applications in the supply chain: the example of quality-based issuing of perishables, in: Proceedings of Internet of Things 2008, Zurich, Switzerland, May 2008.

[12] D. Reilly, M. Welsman-Dinelle, C. Bate, K. Inkpen, Just point and click? Using handhelds to interact with paper maps, in: Proceedings of ACM MobileHCI'05, University of Salzburg, Austria, September 2005.

[13] A.M. Vilamovska, E. Hattziandreu, R. Schindler, C. Van Oranje, H. De Vries, J. Krapelse, RFID Application in Healthcare – Scoping and Identifying

Areas for RFID Deployment in Healthcare Delivery, RAND Europe, February 2009.

[14] D. Niyato, E. Hossain, S. Camorlinga, Remote patient monitoring service using heterogeneous wireless access networks: architecture and optimization, IEEE Journal on Selected Areas in Communications 27 (4) (2009) 412–423.

[15] C. Buckl, S. Sommer, A. Scholz, A. Knoll, A. Kemper, J. Heuer, A. Schmitt, Services to the field: an approach for resource constrained sensor/actor networks, in: Proceedings of WAINA'09, Bradford, United Kingdom, May 2009.

[16] P. Spiess, S. Karnouskos, D. Guinard, D. Savio, O. Baecker, L. Souza, V. Trifa, SOA-based integration of the internet of things in enterprise services, in: Proceedings of IEEE ICWS 2009, Los Angeles, Ca, USA, July 2009.

[17] E. Welbourne, L. Battle, G. Cole, K. Gould, K. Rector, S. Raymer, M. Balazinska, G. Borriello, Building the internet of things using RFID: the RFID ecosystem experience, IEEE Internet Computing 13 (3) (2009) 48–55.

[18] SENSEI FP7 Project, Scenario Portfolio, User and Context Requirements, Deliverable 1.1, <http://www.sensei-project.eu/>.