IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 07 | January 2016
ISSN (online): 2349-784X

The Evolution of Internet of Things (IoT) and its Impact on Existing Technology

Ratnam Dodda
P V P Siddhartha Institute of Technology, Vijayawada

Venugopal Gaddam
P V P Siddhartha Institute of Technology, Vijayawada

Dr. J. Rajendra Prasad
P V P Siddhartha Institute of Technology, Vijayawada

Dr. B. V. Subba Rao
P V P Siddhartha Institute of Technology, Vijayawada

Abstract

The Internet is an existing thing, always changing and growing. New applications and businesses are created endlessly. Besides to developing Internet, technology is changing the backdrop. Broadband connectivity is becoming cheap and omnipresent; devices are becoming more powerful and smaller with a variety of committed sensors. The abundance of more devices becoming connected is leading to a new prototype: the IoT. The IoTs is driven by an extension of the Internet through the addition of physical objects united with an ability to provide smarter services to the upbringing as more data becomes available. Various application domains like Smart Infrastructure, Healthcare, Security and Surveillance, Transportation, Retail, Industrial and Telecommunication etc., there are challenges associated with the IoTs, most explicitly in areas of trust and security, Privacy and Data Confidentiality. In this way, the things/objects are capable of recognizing events and changes in their surroundings and are acting and reacting autonomously.

Keywords: Internet-of-Things, Smart Objects, RFID, Sensors, Cloud, Security

I. INTRODUCTION

Though the term “Internet of Things” was proposed by Kevin Ashton [1, 2] in 1999, but ‘The Internet of Things’ is a concept originally coined and introduced by MIT, Auto-ID Center and intimately linked to RFID and electronic product code (EPC) [4, 3]. The IoT precisely means, “..all about physical items talking to each other..”. M2M[1] interactions and P2C[2] communications will be extended to things. Technologies that will drive the future Internet of Things: Sensor technologies including RFID, smart things, nanotechnology and miniaturization. The concept of the Internet of Things is now being influenced strongly by developments in computing and network ubiquity and developments in the next generation Internet—and considered at all levels including United Nations [5].

II. TECHNO-ALLIANCE

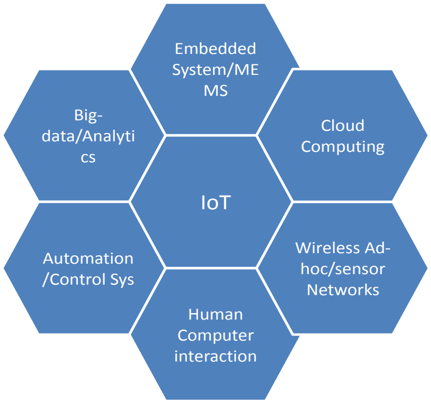

Fig. 1: Techno-Alliance relevance to IoT

A. M2M[1]-Machine to Machine, P2C[2]-Person to Computer

The explosive expansion of the Internet of things (IoT) is driving rapid demand growth for micro electro mechanical systems (MEMS) devices in the areas including asset-tracking systems, smart grids and building automation. IoT can benefit from the virtually unlimited capabilities and resources of Cloud to compensate its technological constraints (e.g., storage, processing, energy). Specifically, the Cloud can offer an effective solution to implement IoT service management and composition as well as applications that exploit the things or the data produced by them[6].

Wireless sensor networks (WSN) behave as a digital skin, providing a virtual layer where the information about the physical world can be accessed by any computational system. As a result, they are an invaluable resource for realizing the vision of the Internet of Things (IoT) [7].

Internet of things can be introduced as the concept where objects in our environment, through some new properties, become smart and begin autonomously communicating with each other and humans, through networks supported by interfaces. Opportunities for meaningful benefits to humans and the environment are many and varied so that only a small subset of examples can be mentioned here. In particular, the focus of this paper is to present the recent efforts and developments in the areas of interactive systems, with new affordances of the Internet of things and related technologies; emergence of and need for new and innovative ways in which human-computer interaction can support these [8].

B. Enabling Technologies

Radio Frequency Identification (RFID) is as follows: RFID is a technology which allows a sensor (reader) to read, from a distance, and without line of sight, a unique product identification code (EPC) associated with a tag. Smarter Environment More sophisticated embedded sensor technology can be used in order to monitor and transmit critical environmental parameters such as temperature, humidity, pressure, etc. Social sensing is an integral paradigm of the internet of things, when the objects being tracked are associated with individual people. Examples of such sensing objects include mobile phones, wearable sensors and pedometers. Such paradigms have tremendous value in enabling social networking paradigms in conjunction with sensing. Smarter devices in the future, it is envisioned that a variety of devices in our day-to-day life such as refrigerators, televisions and cars will be smarter in terms of being equipped with a variety of sensors and will also have internet connectivity in order to publish the collected data. For example, refrigerators may have smart sensors which can detect the quantities of various items and the freshness of perishable items [9].

III. CHARACTERISTICS

A. Intelligence

Both algorithms and compute together (i.e. software & hardware) provide the “intelligent spark” that makes a product experience smart. Consider Misfit Shine, a fitness tracker, compared with Nest’s intelligent thermostat. The Shine experience distributes compute tasks between a smart phone and the cloud. The Nest thermostat has more compute horsepower for the AI that makes them smart.

1) Connectivity

Connectivity in the IoT is more than slapping on a WiFi module and calling it a day. Connectivity enables network accessibility and compatibility. Accessibility is getting on a network while compatibility provides the common ability to consume and produce data. If this sounds familiar, as it is Metcalfe’s Law and it rings true for IoT.

2) Sensing

We tend to take for granted our senses and ability to understand the physical world and people around us. Sensing technologies provide us with the means to create experiences that reflect a true awareness of the physical world and the people in it. This is simply the analog input from the physical world, but it can provide the rich understanding of our complex world.

3) Expressing

Expressing enables interactivity with people and the physical world. Whether it is a smart home or a farm with smart agriculture technology, expressing provides us with a means to create products that interact intelligently with the real world. This means provide more than just rendering beautiful UIs to a screen. Expressing allows us to output into the real world and directly interact with the people and the environment.

4) Energy

Without energy, it is not possible to bring our creations to life. The problem is we are unable to create billions of things that all run on batteries. Energy harvesting, power efficiency, and charging infrastructures are necessary for a power intelligent ecosystem that we must design. Today, it is woefully inadequate and lacks the focus of many product teams [10].

5) Safety

As we gain efficiencies, novel experiences, and other benefits from the IoT, safety must not be ignored. In the case of creators and recipients of the IoT, we must design for safety. This includes the safety of our personal data and the safety of our physical well-being. Securing the endpoints, the networks, and the data moving across it means creating a security paradigm that will scale [10].

IV. BENEFITS TO HUMANITY

This principle of sharing information and building on discoveries can best be understood by examining how humans process data (see Fig. 2). From the bottom to top, the pyramid layers include data, information, knowledge, and wisdom. Data is the raw material that is processed, into information. Individual data by itself is not very useful, but volumes of it can identify trends and patterns. This and other sources of information come together to form knowledge. In simple, knowledge is information about which someone is aware of. Wisdom is then born from knowledge that is added with experience. While knowledge changes over time, wisdom is timeless, and it all begins with the acquisition of data [11].

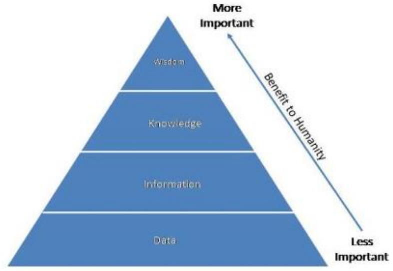

Fig. 2: How Humans Process Data

V. IOT PARADIGM

AAA Connectivity: Here AAA means AnyTime- AnyThing-AnyPlace. One of the objectives of IoT is to enable the connectivity of two objects located at two different places. We have mobile banking, tele-conferencing, etc. where services are being achieved while traveling or staying at home. The IoT infrastructure aims to connect all real world objects through conventional computing system, RFID, WSN and mobile technologies, and Internet act as the primary backbone of the communication channel. Through this collaborating and integrated approach, one would be able to get AAA required service from IoT for all applications that we may use in our daily lives [12].

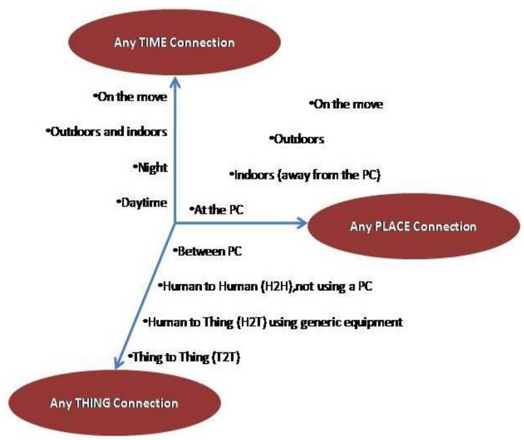

Fig. 3: IoT Paradigm

A. One Paradigm, Many Visions

In Fig. 4, the main concepts, technologies and standards are highlighted and classified with reference to the IoT vision in ordered to contribute to characterize best. They are

- Things-Oriented perspective
- Information-oriented perspective
- Semantic-oriented perspective

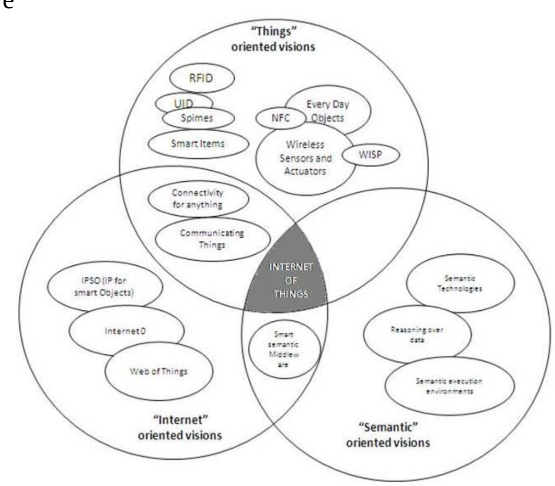

Fig. 4: Different Orientations of IoT

The reason of today apparent fuzziness around this term is a consequence of the name ‘‘Internet of Things” itself, which syntactically is composed of two terms. The first one pushes towards a network oriented vision of IoT, while the second one moves the focus on generic ‘‘objects” that are integrated into a common framework. Differences, sometimes substantial, in the IoT visions raise from the fact that stakeholders, business alliances, research and standardization bodies start approaching the issue from either an ‘‘Internet oriented” or a ‘‘Things oriented” perspective, depending on their specific interests, finalities and backgrounds. The object unique addressing and the representation and storing of the exchanged information become the most challenging issues, bringing directly to a third, ‘‘Semantic oriented”, perspective of IoT [13].

B. IoT Building Blocks

1) Sensing

As the IoT becomes more pervasive, it is important to address the architecture that makes it a reality. The IoT is feasible through the use of embedded devices, most often sensors, which communicate to, or are accessed over a network through the means of standard information exchange protocols. These sensors include RFID and other identification techniques that make everyday objects in our environment distinguishable, addressable and ultimately, measurable. It is because of these sensors that smart devices can initiate different commands based on the surrounding conditions, providing almost limitless application opportunities.

2) Connectivity

Once the embedded sensors have gathered data, they are tasked with transmitting this data to an identified destination. This transference can utilize different connectivity methodologies, depending on the requirements of the corresponding device, but most often use wired/wireless or PAN/BAN/LAN communication links. Regardless of the method used, the links will generally only need to transmit small kilobytes of data, unless higher bandwidths are required.

3) Gateways

Given the diversity of the IoT connectivity options available and the variety of devices they must support, IoT gateways serve an important function as the means of translating, disseminating and routing data to the cloud via WAN communication technology. The IoT gateways utilize cost-effective designs to enable the performance of these actions. The designs exploit an amalgamation of different components in order to create solutions to the wide-array of encountered inputs. The gateways transfer the data back as new commands to execute the input task. This input/output execution appears to the user as a real-time transaction.

4) Processing

The reliance on communication to create cohesion between the physical and the technological realms places importance on the microprocessors that enable this connection to occur. Whether these microprocessors allow objects to sense their surroundings, exchange data with other components, or interact with the cloud, their incorporation into the overall schema of the IoT is integral to the engagement of the varied systems that must cooperate with one another. Given the changing nature of the landscape, microprocessors that are low power, cost-effective and leave a smaller imprint will be those that are favored within the IoT.

5) Software

The interconnection of so many disparate components is crucial to the success of the IoT. Software deployment plays a critical role in bringing these contrasting elements together into a cohesive whole, allowing devices to relay, talk and interact with one another and the architecture around them. Middleware also plays a function within this sequence as it is needed to make certain that interactions occurring within the varying nodes happen seamlessly and reliably.

6) Power

It is observed that, with the wealth of devices, processes and actions that occur within the IoT, powering everything represents a challenge. To guarantee a smart grid that encompasses all of these elements, factors such as power generation, power transmission and power consumption must be taken into account. Sensors that are integral to the IoT need power converters that are both small and efficient and that are adapted for autonomous, low-power devices [14].

VI. CHALLENGES

Though the development of many IoT based systems are reported, there are many design challenges faced by the developers and engineers. Among many issues such as availability of internet, miniaturization, the IoT is entirely dependent on the development of Wireless Sensor Networks (WSN) and Radio Frequency Identification devices (RFID).

The wireless sensors are the extension of smart sensors with communication along with adaptation and learning capability. There are many wireless devices available around us having the different functionality. The wireless devices offer many advantages in terms of cost, flexibility, power options, ease of installation and replacement [6].

The challenges of IoT can be summarized as:

- Security issues
- Low-cost smart sensing system development
- Energy
- Computational ability
- Scalability
- Fault Tolerance

- Power Consumption
- Acceptability among the society

VII. IOT FRAMEWORK

In the case of meeting the requirements of managing massive IoT data in cloud platform, the data storage framework should deal with various types of data, which are collected from many different devices, such as RFID readers, monitors, thermometers, etc. These datas are different in data structures, volume, accessing methods, and some other aspects, as such; they can hardly be stored and accessed efficiently by a single method. Besides, the data volume may increase quite rapidly, so that the framework must be able to process the data with a high throughput [15].
The architecture of the proposed framework is shown in Fig.5.

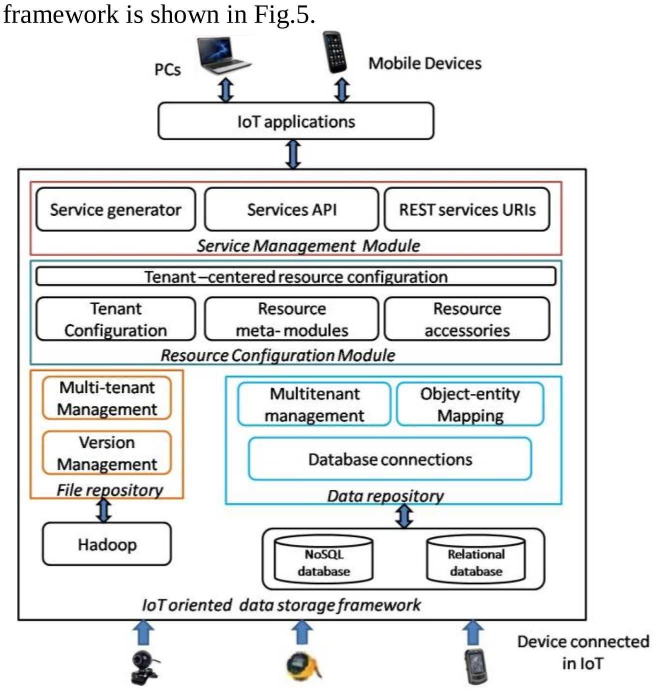

Fig. 5: Proposed Framework of IoT

The data storage framework consists of several modules.

A. File Repository:

File repository makes use of hadoop distributed file system (HDFS) to store unstructured files in a distributed environment. We also add a version manager and a multitenant manager to implement the management of the versioned model files and the isolation of tenants' data. A file processor is used to improve the file repository's ability for handling small files.

B. Database Module:

Database module combines multiple databases and uses both NoSQL database and relational database for managing structured data. This module also provides unified API and object–entity mapping for multiple databases to hide their differences in implementing and interfacing so that the development of data access modules and the application migration of databases can be simplified.

C. Service Module:

Service module is built to generate RESTful service automatically. This module extracts the metadata through configuration, then mapping to the data entities and files stored in the databases and file repository according to the extracted metadata and finally generating corresponding RESTful service.

D. Resource Configuration Module:

Resource configuration module supports static and dynamic data management in terms of predefined meta-model. Thus, data resource and related services can be configured based on tenant requirements. Furthermore, data disposing mechanism such as load balanced and isolated preferences can also be carried out.

VIII. CLOUD-BASED IOT FRAMEWORK

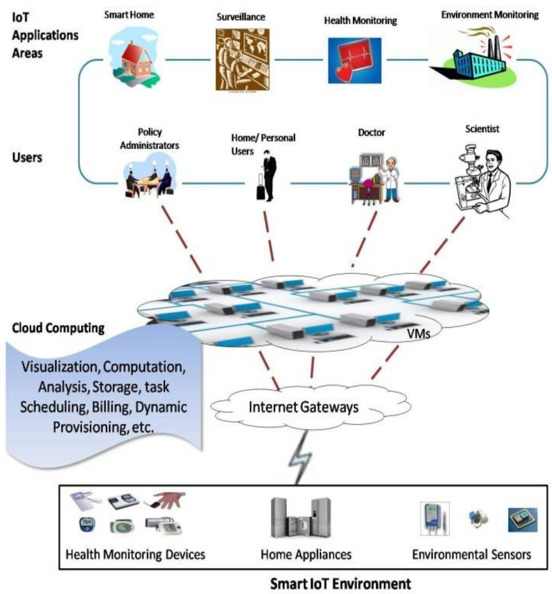

Fig. 6: IoT Cloud Centric Architecture

The sensors are set in smart IoT environments within different application areas, environmental sensors are set for environmental monitoring purposes, sensor enabled home appliances are fixed in smart home environments, and health monitoring devices are set for health monitoring purposes, etc... These sensor enabled devices from different application areas send the gathered data to the cloud where it is processed and then the reaction or feedback is sent to the concerned users through the sensors interfaces'. Such smart environments require intensive information processing which is done in the cloud rather than exhausting the miniature sensors' processors [16].

A. Security

The IoT is built on many different semiconductor technologies, including power management devices, sensors and microprocessors. Performance and security requirements vary considerably from one application to another. However, one thing is constant. Indeed, success of smart homes, connected cars and on user confidence in robust, easy-to-use, fail-safe security capabilities. The greater the volume of sensitive data we transfer over the IoT, the greater the risk of data and identity theft, device manipulation, data falsification, IP theft and even server/network manipulation.

B. Vulnerability

Every single device and sensor in the IoT represents a potential risk. How confident can an organization be that each of these devices have the controls in place to preserve the confidentiality of the data collected and the integrity of the data sent.

C. Trust and data integrity

Corporate systems will be attacked by data from all manner of connected sensors in the IoT. But how sure can an organization be that the data has not been compromised or interfered with?

D. Data Collection, Protection and Privacy

The vision for the IoT is to make our everyday lives easier and boost the efficiency and productivity of businesses and employees. The data collected will help us to make smarter decisions. But, this will also have an impact on privacy expectations. If data collected by connected devices is compromised, it will undermine trust in the IoT.

IX. APPLICATIONS OF IOT

A. Transport/Logistics

In transport logistics, IoT improves not only material flow systems but also the global positioning and automatic identification of freight. It also increases energy efficiency and thus decreases energy consumption.

B. Smart Home

Future smart homes will be conscious about what happens inside a building, mainly impacting three aspects: resource usage (water conservation and energy consumption), security and comfort. The goal is to achieve better levels of comfort while cutting overall expenditure.

C. Smart Cities

While the term smart city is still a fuzzy concept, there is a general agreement that it is an urban area which creates sustainable development and high quality of life. Giffinger et al.'s model elucidates the characteristics of a smart city, encompassing economy, people, governance, mobility, environment and living.

D. Smart Factory

In a global supply chain, companies will be able to track all of their products by means of radio frequency identification (RFID) tags. As a consequence, companies will reduce their operating expenses (OPEX) and improve their productivity due to tighter integration with enterprise resource planning (ERP) and other systems.

E. Retail

IoT realizes both customer needs and business needs: price comparison of a product; looking for other products of the same quality at lower prices; with shop promotions, giving information not only to customers but also to shops and businessmen. Having this information in real time helps enterprises to improve their business and to satisfy customer needs.

F. E-Health

Control and prevention are the two main goals of future health care. Already today, people have the option of being tracked and monitored by specialists even if the patients and specialists are not in the same place. Tracing peoples' health history is another aspect that makes IoT-assisted e-health very versatile [17].

X. CONCLUSION

In this paper, the technology, security and applications of IoT are discussed. By all odds, IoT's scope shows magnificent prospective in real-world applications. The main objective of the paper is to state that much exploration will take place in each and every aspect of our life. The security of the communication at this global level and privacy of the people and "things" involved is one of the most vital requirements of IoT.

REFERENCES

[1] Kevin, A.: That 'Internet of Things' thing, in the real world things matter more than ideas. RFID J. (22 June 2009). Accessed 10 Nov 2013
[2] http://en.wikipedia.org/wiki/Internet_of_Things. Accessed 10 Nov 2013
[3] Analyst Geoff Johnson interviewed by Sue Bushell in Computerworld, on 24 July 2000 (M-commerce key to ubiquitous internet)
[4] http://ec.europa.eu/information_society/policy/rfid/events/past/Info18022009/index_en.htm. Accessed 10 Nov 2013
[5] Internet of Things: Challenges and Opportunities by S. C. Mukhopadhyay and N. K. Suryadevara.
[6] On the Integration of Cloud Computing and Internet of Things by Alessio Botta, Walter de Donato, Valerio Persico, Antonio Pescap.
[7] Wireless Sensor Networks and the Internet of Things: Do We Need a Complete Integration by Cristina Alcaraz, Pablo Najera, Javier Lopez, Rodrigo Roman.
[8] Internet of Things (IoT) and Human Computer Interaction by Olja Rastic-Dulborough.
[9] The Internet Of Things: A Survey From The Data-Centric Perspective by Charu C. Aggarwal.
[10] Internet of Things: Six Key Characteristics by Carlos Elena-Lenz.
[11] The Internet of Things How the Next Evolution of the Internet Is Changing Everything by Dave Evans.
[12] Internet of Things – A Paradigm Shift of Future Internet Applications by Sarita Agrawal, Manik Lal Das .
[13] The Internet of Things: A survey by Luigi Atzori , Antonio Iera , Giacomo Morabito .
[14] The Building Blocks of the Internet of Things by Chaney Ho, President – Advantech Co., Ltd.
[15] An IoT-Oriented Data Storage Framework in Cloud Computing Platform by Lihong Jiang, Li Da Xu, Senior Member, IEEE, Hongming Cai, Zuhai Jiang, Fenglin Bu, and Boyi Xu.
[16] A Framework of Adaptive Interaction Support in Cloud-Based Internet of Things (IoT) Environment by Noura Alhakbani, Mohammed Mehedi Hassan, M. Anwar Hossain, and Mohammed Alnuem.
[17] Introduction to the Internet of Things by Thorsten Kramp, Rob van Kranenburg, and Sebastian Lange.
[18] IoT-A, Internet of Things – Architecture http://www.iot-a.eu
[19] IoT-i, Internet of Things Imitative, http://www.iot-i.eu
[20] IPSO Alliance, IP for Smart Objects
[21] ISO/IEC JTC 1/SC 6 Telecommunications and information exchange between systems
[22] ISO/IEC JTC 1/SC 31 Automatic identification and data capture techniques
[23] ITU-T IoT-GSI, Internet of Things Global Standards Initiative
[24] ITU-T JCA-IoT, Joint Coordination Activity on Internet of Things
[25] ITU-T Study Group 2 Operational aspects of service provision and telecommunications management
[26] ITU-T Study Group 11 Signaling requirements, protocols and test specifications

[27] ITU-T Study Group 13 Future networks including mobile and NGN
[28] ITU-T Study Group 16 Multimedia coding, systems and applications
[29] ITU-T Study Group 17 Security
[30] K. Johnson, "Machine-to-Machine: Reinventing Embedded Devices for Smart Services,"http://www.intel.com/content/dam/doc/technology-brief/ m2m-reinventing-devices-for-smart-services.pdf
[31] A. M. Kelly, "Telecom Milestone: More Cellphone-Only Than Landline-Only Households," Mediamark Research Inc., Sept 2007.
[32] G. Lawton, "Machine-to-machine technology gears up for growth," Computer , vol.37, no.9, pp. 12- 15, Sept. 2004
[33] T. Pering, Y. Agarwal, R. Gupta, and R. Want,"Coolspots: reducing the power consumption of wireless mobile devices with multiple radio interfaces," in Proc. Of ACM Mobile Systems, Applications and Services, pp. 220–232, 2006.
[34] Public Polls from EE5158 students, National Taiwan University, Sept. 2011.
[35] A. Sample and J. R. Smith, "Experimental results with two wireless power transfer systems," Proceedings of the 4th international conference on Radio and wireless symposium, pp. 16-18, Jan. 2009.
[36] J. Santa, A.F. Gomez-Skarmeta, "Sharing Context-Aware Road and Safety Information," Pervasive Computing, IEEE , vol.8, no.3, pp.58-65, July-Sept. 2009
[37] J. Sen, "Internet of Things-A Standardization Perspective," July 2010,www.gisfi.org/wg_documents/GISFI_IoT_2010062.pdf
[38] SENSEI, Integrating the Physical with the Digital World of the Network of the Future, http://www.sensei-project.eu/
[39] J. O. Smith, "The Coming of Age of M2M Standards," Connected World Conference, Keynote presentation, 2010.
[40] R. Staszewski, T. Jung, R. B. Staszewski, K. Muhammad, D. Leipold, T. Murphy, S. Sabin, J. Wallberg, S. Larson, M. Entezari, J. Fresquez, S. Dondershine, and S. Syed, "Software Assisted Digital RF Processor for Single-Chip GSM Radio in 90 nm CMOS," IEEE Custom Integrated Circuits Conference, 2006.
[41] TIA TR-50, Telecommunications Industry Association Smart Device Communications Standards Committee uniteChannel, "The simple truth about LTE," http://youtu.be/asxYJw7wlHE