A survey of IoT: Architecture, Applications and Future Vision

Styliani Chatziefthymiou and Sotirios K. Goudos
Radiocommunications Laboratory, Department of Physics,
Aristotle University of Thessaloniki, Thessaloniki, 54124, Greece
schatzie@physics.auth.gr, sgoudo@physics.auth.gr

***Abstract*— Nowadays, one of the main objectives of Internet is its own development, so it can provide the potential of ultimate communication, not only among human beings but also the communication between humans and devices, as well as among devices (M2M), without the need of human interference. We enter an era, where Internet is everything, specifically, Internet of Things (IoT). Every object will have a unique identifier and will be able to locate itself and connect to the Internet. Radio Frequency Identification techniques will be the base of IoT. In this paper, the meaning of IoT is defined, its architecture is analyzed, and its development structure in connection with cloud computing and its services to users is reported. Then, there is an example of IoT in a smart city. Lastly, after the tenth application of IoT technology we conclude that this technology is still in a primary stage of development and we report its deficiencies, risks and improvement potential.**

***Index Terms*— IoT, RFID, M2M, cloud computing, smart city**

I. INTRODUCTION

Until today the vast majority of Internet connections worldwide are devices that are used directly by humans, such as computers and cell phones. The major form of communication between two human beings has been transformed into communication between humans and devices and ultimately communication among devices. We are entering a new era of ubiquity; we are entering in the IoT era, in which any device has access to a network, anytime, anywhere, for anybody [1].

So, an object apart from its physical entity will incorporate an electronic device; a computer that will process data and will support wireless communication [2]; Internet access, achieving connection between the physical and the world of data [3].

In order to fully understand the IoT term, one of the most recent definitions, according to the Cluster of EU research projects of IoT is the following, [2] IoT is defined as:

"The things that actively participate in the operation, the information, and social processes, where all these can interact, communicate with each other and the environment, through data exchange, that is traced in the environment, while they react autonomously towards real/ natural incidents in the world and affect it, executing the processes that activate the actions and the development of services with or without direct human intervention."

II. ARCHITECTURE

In this chapter we will describe the development structure patterns of IoT, as it is shown in figure 1, the objects of our daily life will be equipped with micro-controllers, transmitters for digital communication[4], [5], and appropriate protocol stacks [6], such as WiFi, Bluetooth, ZigBee, RFID, Z-wave, cellular etc. As a result, these protocols contribute in the communication with each other and with users [1].

The basic entities that are included in this structure are

i. Application areas, detector devices [5]
ii. Reader/ middleware gateway [5]
iii. a suited communication network [7]
iv. web server [7]
v. cloud platforms [8]
vi. final user [2], [8]

The process is developed as follows:

i. The objects of interest can be sensorized [7].When the interaction with objects is based on Radio Frequency Identification objects are equipped with a proper tag(using contactless interactions ,RFID, ZigBee etc),[9], [10].
ii. In case of RFID, the reader reads from a small distance the EPC. The RFID reader functions as a gateway to the internet. In other similar cases of protocols as internet gateway function the sensor gate zigbee and middleware gate, wifi router. The middleware gateway is able to receive the data and forwards them to the next level.
iii. Interaction between the user and the available network. (WiFi, 3G-GPRS etc.) [7] , [11]
iv. Connection to the worldwide web, in order to send all the detectable data to a cloud software platform.
v. Connection to cloud platforms in order to store huge ammount of data that are produced and in order to be analyzed [2].

vi. So that they can be send to the final users (in laptops, tablets, smart phones, pc etc.)

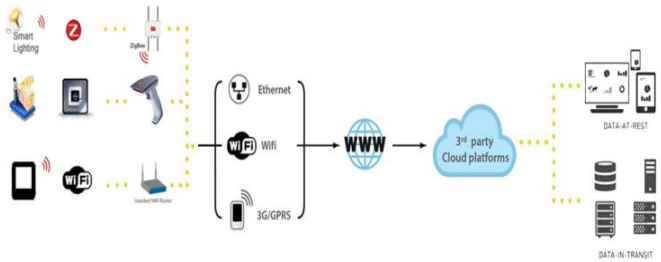

Fig. 1. Architectural model [12], [13].

III. IoT APPLICATION IN A SMART CITY

The technology of IoT will promote the development of applications that manage enormous quantity and variety of data which come from objects and then provide new services to citizens, businesses and public bodies. Figure 2 shows an image of heterogeneous scope of IoT, which can be divided mainly into the following categories: transportation and logistics, healthcare, smart environments, personal and social sector [5], estimate that as regarding future applications will be extended in additional domains such as robotic taxi, Model city information and enhanced games room.

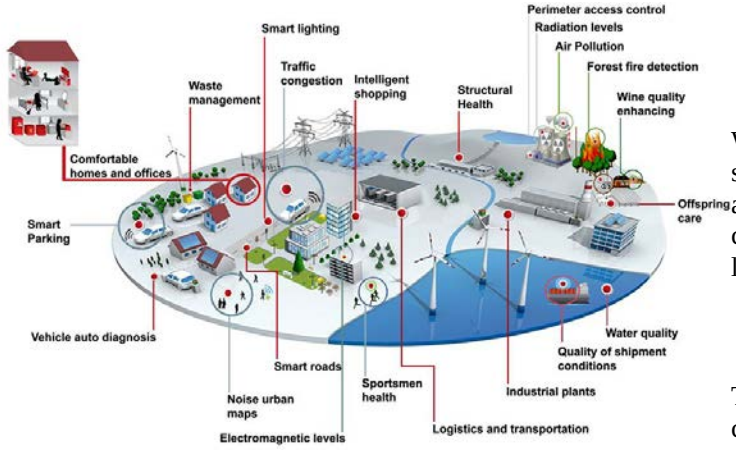

Fig. 2. Virtual representation of IoT in smart city [4], [5], [14], [15].

IV. DISCUSSION- OPEN ISSUES

The IoT is currently in progress, but there are many issues to be solved. Whereas a number of technologies that are used today make the IoT apllication possible, a large research effort is still needed. The most important issues can be seperated in two groups: Initially, the standardization of technologies and their integration in a complete framework and the second one in the problems regrading security and private life protection.

Many advices regarding the development and standardization of the IoT example that come from the research community are mentioned. However, without the development of comprehensible and detectable standards, the spreading of IoT will not achieve a worldwide development. So the need for cooperation among various organizations will be necessary.

As long as there is suspicion and as long as there is no trust that the IoT will not cause serious threat to the protection of private life, there cannot be common acceptance of IoT by the public. Therefore securing private life should play a crucial role in the IoT architecture. Moreover, approaching the security and safety of private life just from the aspect of technique is not enough. Apart from technology, the regulation, marketing and social-ethic issues must be investigated. Figure 3 depicts the aspects that must be taken into account regarding security and private life. [1], [13], [3], [15].

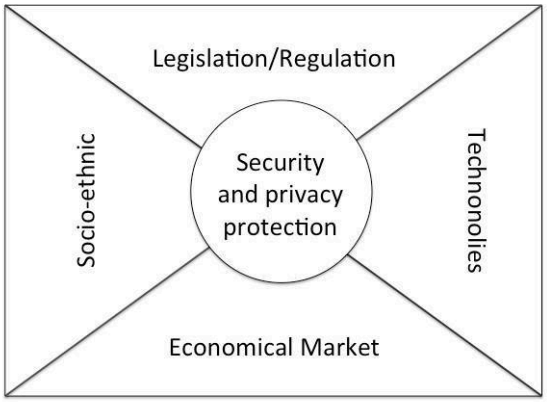

Fig. 3. The aspects of security and protection of private life [1].

We believe that in the next years- when the difficulties will be surpassed- the interest that shown by the industries in IoT applications, will be a boosting factor for networking and communication research, in the industrial and academic laboratories.

V. CONCLUSION

Thus, from all the above, the contribution of our research could be useful in the literature especially in the field of IoT area, because provide a fulfill scheme concerning the application of IoT. The forces behind the development of Internet of Things, technology push forces and technology pull forces, see in the IoT a vast new market for the deployment of current and future information and communication technologies (ICT), that will help both the communication of devices.

Furthermore, by enabling easy access and interaction with a wide variety of devices such as, for instance, home appliances, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT will foster the development of a number of applications that make use of the potentially enormous amount and variety of data generated by such

objects to provide new services to citizens, companies, and public administrations. So the development of the IoT is a key interest, which will not only improve the lives of consumers, but also the domain of industry and society.

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