A short overview for the cognition of the Internet of Things

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Abstract

In my articles I would like to provide a short general overview for the Internet of Things. It is one of the most commonly used terms of today, yet only a few have specific knowledge of the topic. Starting with the creation of the term, then standardizing it, and lastly filling it with contents. I introduce the complexity of IoT and the three different approaches. In the second part of the article I present the areas of its use preferred in Hungary, showing what an enormous role does IoT already play in our lives (e.g. building automation, safety technology, infrastructural services, transportation, eHealth, environmental protection, agricultural IT and consumer electronics).

Keywords: IoT, Internet of Things, overview

1. Introduction

The Internet of Things (IoT) is not a new term and also one of the most commonly used terms of today. However, for a lot of people it is still an inconceivable thing, and they do not know what it means exactly. What is the IoT about?

2. History of IoT

It is exactly as difficult to formulate as it seems. The term itself originates from 1999, but only in conjunction with barcode, QR-code, appliances accomplished with the help of RFID, and the identification of people. The creator of the term is Kevin Ashton. His notion was that with the help of this technology we could remove the burden of boring data recording tasks from the users' backs and leave them to the machines [1]. By storing all of the recorded data on the internet everything would be traceable and countable. It would be easy to check the date of production of a product, the next and already completed maintenance tasks, but we could also learn if the food is fresh, its expiration date, ad if it has been re-labeled.

Ideas were followed by actions, and the MIT established a research laboratory under the name of Auto-ID. With the participation of many noted universities and research institutes Auto-ID labs, an international research network was founded. This cooperation resulted in the founding of EPCglobal network in 2003, which was established for creating and standardizing the Electronic Product Code (EPC). The essence of the EPC in a few words is that every object has a completely unique EPC code, so they can be easily identified, and they can communicate with each other and also with the information systems. The goal was achieved in almost two years. The ITU (International Telecommunication Union) reported the achievement in 2005 in "ITU Internet report 2005: Internet of Things". [2]

3. Complexity

Now, that we are somewhat acquainted with the history of IoT, we did not get much closer to its meaning. Let's try to take it apart and try it that way!

After the publication of the ITU report researchers and companies started to work on the realization of these technologies, but different goals resulted in different notions. Very soon the sole standard was split into multiple approaches. In 2010 Luigi Atzori, Antonio Iera, and Giacomo Morabito's publication divided it into three big approaches: the object-oriented, the network-oriented, and the semantics-oriented. [3]

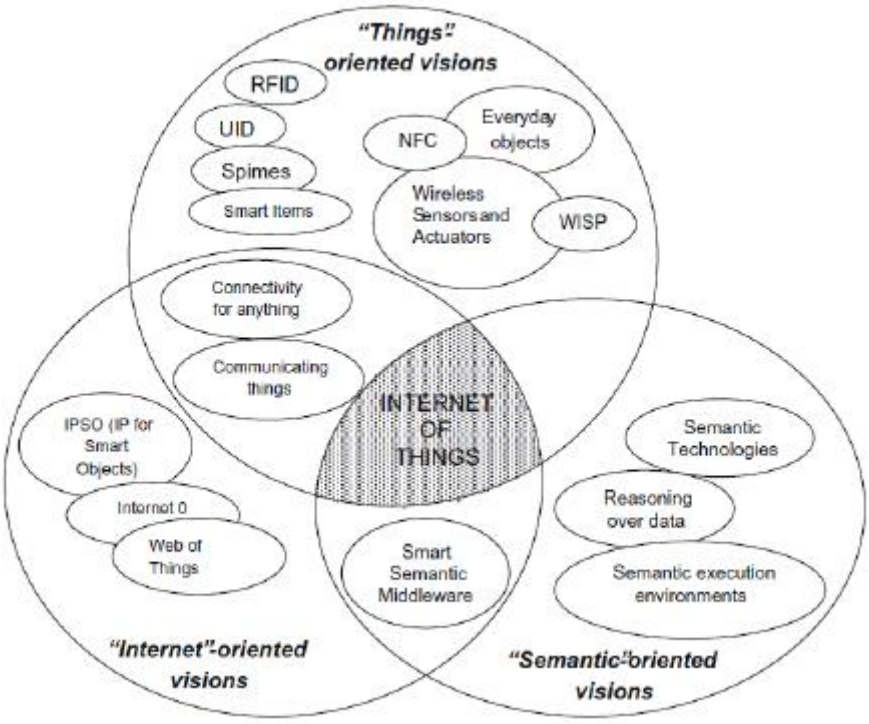


Figure 1: The convergence of different approaches [3]

Of these three, the object-oriented approach was the most developed, which is not surprising, because the concept of electronic product code is closely linked to it.

The second approach mentioned by the article was the network-oriented, from which the Web of Thing is the most commonly known. According to this theory every object should have an inbuilt computer connected to the internet. The third approach is the semantics-oriented, which emphasizes the conversion of the huge amount of data generated every day to information. Returning to the original thought, that instead of people, machines should record and process data. We may already hear an inner voice saying: Big Data.

4. Definition

In fact, we still did not make much progress. Let's try another common method, let's see what others have to say about IoT:

- According to the creator of the term: "The Internet of Things is can change the world, just like the internet did. Or maybe even more. [1]"

- According to the ITU: „It provides a worldwide infrastructure for the information society, which makes the use of advanced services possible between connected appliances (physical and virtual), with the help of already existing and developing interoperable information and communication

technologies. [4]”

- According to the publication which the subdivision was based on: “Objects have identity and virtual personality in an intelligent space, they use intelligent interfaces to reach and communicate with their environment and users.” [3]

- According to Wikipedia: “The Internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data.” [5]

- According to IEEE: “The Internet of Things is a network that connects the individually identifiable “things” with the internet. The “things” have a sensor/operating part and they have the ability of programmability. Because of the individual identifiability and sensory the information is useful, the “thing” can collect and the “thing’s” condition can change anywhere, anytime, to anything.” [6]

Now it is getting clear that we are talking about networked things, electronic devices that collect data and communicate with each other and the user on an internet-based network. They have identity, meaning they can be individually identified. This way the data they collect can be identified in both time and space. The appliances are “intelligent”, they are programmable, they have interfaces and sensors, and they can operate independently so they are some sort of computer. Their network extends to the whole world, they form a global system, and it has the possibility of changing the world in it, just like the interned did.

Perhaps we cannot get any closer to the term. If it was possible, probably somebody would already have put it into words before me.

5. Preferred areas of IoT in Hungary

Now that I roughly defined what IoT is, we should get clear about its role in our lives. It plays a much bigger part than we would think. We already went beyond that level we could see in the first season of The Big Bang Theory, when they switch a lamp on and off from China, Szechuan, and remote control a lamp with RC models from Austin and Tel Aviv “because they can”!

According to the study (Coordinated development of IoT and its dissemination in Hungary) published by the IVSZ (Society of IT, Telecommunication and Electronic enterprises) in May 2015 the preferred areas of the use of IoT are the following [7]:

5. 1. Automation of buildings

Domotics is the overall term for the automation, control and administration systems of buildings. The term itself was made by the connection of the Latin word domus (house) and informatics. It is also called home automation.

Figure 2: Possibilities of automation in a family house.
Source: http://domotika.com.mx/wp-content/uploads/2015/08/home.png

In this area the key is the coordinated operation of the automation system. It is not enough to build efficient cooling, heating and lighting systems in, they also have to be coordinated so they can work as a unity. This is where the IoT gains ground. If the standardized automation of buildings reach a critical level it opens new possibilities for providers. After the optimization of houses as island-like networks come system-level developments, but whole countries can be organized into one WAN platform.

The locally collected but centrally stored and analyzed data provides useful experiences for other industries. The system can also be used to prevent natural or industrial disasters by recognizing the data patterns in time.

5.2. Safety systems

Thanks to the high sensitivity sensors recording physical, chemical and biometrical parameters broad spectrum supervision is possible. With the help of high-definition cameras and fast data connection an efficient video surveillance system can be built also in areas without accessible wired infrastructure. In these areas apart from fixed sensors it is possible to use moving sensors, fixed to drones for example. Apart from security systems security system appliances used in areas of access

control, identification, intrusion protection, and detection of foreign objects can also bring significant changes to the home and industrial segment.

5.3. Infrastructure service, energy sufficiency

Right now this does not mean IaS from cloud based computing, but the surveillance of utilities. From the perspective of providers monitoring given network sections, analyzing consumer habits, the effect of the weather and other conditions on consumption and the quality of service can be a tangible result of using the IoT. From the consumers' perspective it is mainly a comfort service, not having to check on the meters then read and report its position, the appliances do these things by themselves. The harbingers of this technology are the smart meters already in use. [8]

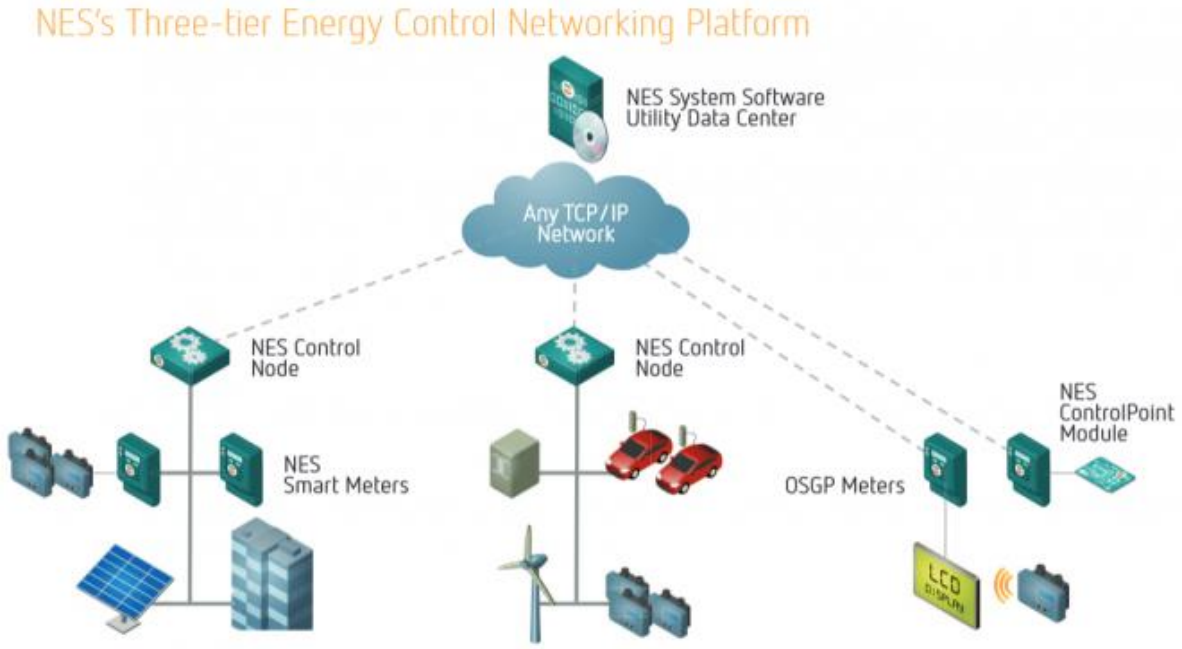


Figure 3 : Infrastructure services monitored trough a network

Source: http://snt.hu/wp-content/uploads/2015/03/NES_System_Software1-660x370.png

5.4. Traffic

Vehicles and road components communicating with each other mean a new perspective for the development of traffic and its safety. Traffic management improves, the permeability of roads grows, and the operational efficiency of vehicles improves. From the perspective of the passengers the comfort of travel increases, the adaptive system of the vehicle accommodates to the driver and the passengers. Safety can also be improved this way. A bus or a train can make individual decisions by collecting and analyzing data by itself, it can calculate the braking force and stopping distance based on fullness and GVW (gross vehicle weight). It can provide information about its arrival time based

on traffic data. A functional example for the smart traffic – smart city concept is BKK's Futár project.

5.5. eHealth

Figure 4: Elements of the eHealth system

Source: http://www.ehealthireland.ie/infographic.png

The medical use of mobile technology, telemedicine services combines the tools of IT and mobile communication with the methods and appliances used in medicine. In the near future it can radically change the daily practice of prevention, diagnostics and therapy. Home measurement can reduce the workload of the doctors, providing a calmer environment for the patients. Constant monitoring provides a more detailed and accurate picture of the condition of patients. Constant data connection shortens the waiting time until an incidental intervention, and central databases provide a more accurate diagnosis. The can give an automatic alert for doctors on duty. A patient's case history would also be more easily accessible for the attending physician. Trough the high-speed connection, they can hold a video consultation with a specialist.

5.6. Environment protection

At first glance it may be not clear, but the possibility of utilization is there. Pollution is one of the

biggest problems of today's society. Here it is very important to collect data from the biggest possible area as accurately as possible. IoT may be able to provide a solution for us.

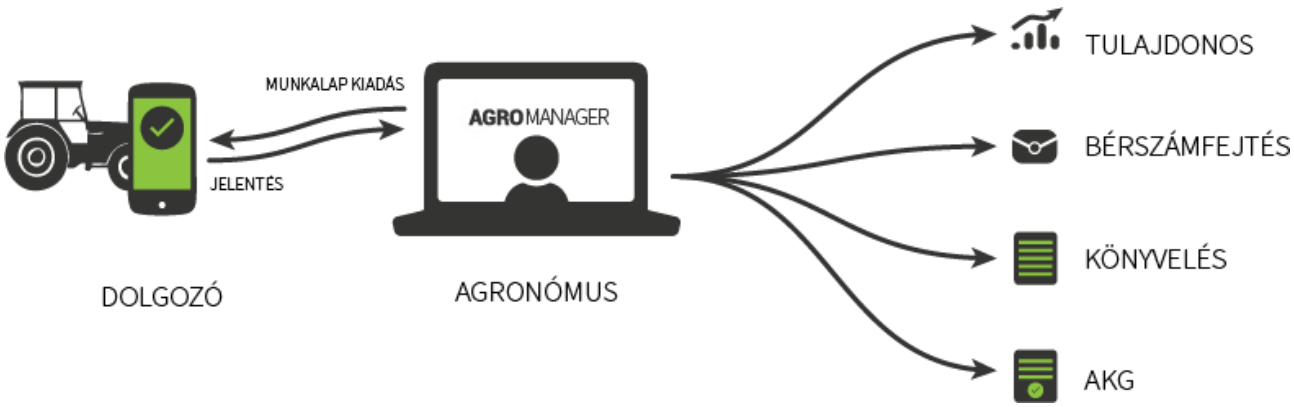
So far the size of the sensors and meters and therefore their price (larger material requirements) has been a problem. However, the development of technology and the miniaturization of sensors and network appliances led to the reduction of chips' prices, making it possible to create mass data collection networks. We can access more accurate information about environment in both urban and rural areas. Instead of the current meters with only a few test points for weather and air pollution, machines could be installed in large numbers to provide highly detailed information about pollution, temperature and dust. This information could be used in the areas of traffic, traffic control, and also in eHealth, in alarm systems. The key words are cheap and many, but small independent sensors.

5.7. Agricultural Informatics

Livestock breeding and crop production have been mechanized and automated for a long time now. This is a good base for introducing IoT solutions.

A good example is BovControll (https://www.bovcontrol.com/), which collects data about the animals with a smart collar equipped with Bluetooth connection and uses the information to provide predictions about the cows. Or when they analyze pigs based on pre-stored sound samples thus identifying the sick animals. In crop production up-to-date GIS information and weather prediction are needed. Where further development can be expected is soil analysis: monitoring and controlling nutrient levels and moisture and automated production.

Figure 5: Data flow of an agricultural informatics system



Source: http://agroinformatika.hu/img/process.png

Earthworks and the control of agricultural machines are also partly digitalized, tractors, sowing and harvesting machines are working based on a GPS sensor, many times without human intervention.

However, the real advantage is not local, enterprise-level use (just like domatics), but the creation of global systems. The resources needed for harvest could be reallocated, or determining tasks depending on weather conditions could be optimized. In the long run, cultivation suggestions can be made based on the condition of the soil.

5.8. Consumer electronics

Last but not least, the connected devices. Today the PC and the telephone serve as a junction; accessories are connected to and synchronized with them. These accessories are smart watches, odometers, e-book readers, cameras, navigation devices, photo frames, televisions, home network media players and online car systems. These devices must be easily operable and they must have a maintenance-free network connection, thereby being able to access online background services from anywhere.

Linear content service is losing its significance day by day; the Y and Z generation are characterized by constant online presence. Content consumption is accommodating to this, they want to learn about news and events right when they happen. They also choose on-demand services for relaxation, thus entertainment contents will increasingly rely on cloud-based services. The difference between this and the IoT services listed so far is that in consumer electronics the data traffic between the devices is significant, which means a different requisitioning for both devices and the network.

6. Conclusion(?)

We can see now that the IoT have already seeped into our everyday lives, and maybe invisibly, but it surrounds us. Day by day new technologies appear on the market and and conquer new areas of our lives. All this does not happen smoothly. What kind of technical difficulties may appear? To only name a few from the ever-growing list:

How to identify this many devices at the same time? In theory EPC was created for this purpose, but the internet is currently using IP addresses. The currently widespread IPv4 is already overwrought, the IPv6 intending to replace it has a seemingly limitless address pool. So which one would be adequate: EPC or IPv6?

How to move data between this many devices in a given time? IoT devices usually don’t move a lot of data, because the devices are not high-capacity, but the sum data traffic can be significant because of their abundance. Not to mention cloud-based services. Are today’s wireless technologies capable of forwarding this much data?

How to store this much data? Cloud-based service can be a solution for this. But whoever stored the

data, the storage device has to be made by somebody, and somebody has to operate it. Can the industry keep pace with the increasing need for data storage? Maybe there will be a technological breakthrough and storage will be places on atomic levels? [9]

Who and how should process the data? Not only the quantity, but the diversity, different speed of arrival and authentic of the data is also an issue. Bi Data can be a solution for this. But who will give an answer to the questions of Big Data?

And if it is not me, who stores my data, but an outside partner (provider): who can access it and with what kind of permission? This is not only a technological, but also a legal issue.

In conclusion, better if we get in touch with the idea and prepare for handling these problems!

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