

DOI: 10.5604/01.3001.0010.4834

# DEVELOPMENT OF THE INTERNET OF THINGS IN POLAND WITH SPECIAL CONSIDERATION OF THE SOCIETY'S AWARENESS OF THE IOT

Szczepan Paszkiel<sup>1</sup>, Maciej Matusik<sup>2</sup><sup>1</sup>Opole University of Technology, Faculty of Electrical, Control & Computer Engineering, Department of Biomedical Engineering<sup>2</sup>Opole University of Technology, Faculty of Electrical, Control & Computer Engineering, Institute of Computer Engineering

**Abstract.** The article includes the description of the current development of the Internet of Things (IoT) in Poland with special consideration of the society's awareness of the IoT. In the recent years, the Internet of Things has been gaining an increasing number of supporters. The interest in this topic of many corporations from the discipline of IT and state-of-the-art technologies is especially important in this scope. The market observation in the recent years has shown that the IoT may become a widespread technology in many homes, which is why it is important to build awareness of the IoT among the Poles. The conducted survey studies were aimed at verifying the current state of the Polish society's knowledge about the IoT, which is presented in this article. The article also includes the description of possible future implementations of the IoT and characterisation of the correlation between the IoT and other rapidly developing technologies.

**Keywords:** IoT, society, Internet of Things, IT development

## ROZWÓJ INTERNETU RZECZY W POLSCE ZE SZCZEGÓLNYM UWZGLĘDNIENIEM ŚWIADOMOŚCI SPOŁECZEŃSTWA O IOT

**Streszczenie.** W artykule opisano dotychczasowy rozwój Internetu rzeczy (IoT) w Polsce ze szczególnym uwzględnieniem świadomości społeczeństwa o IoT. Internet rzeczy w okresie ostatnich lat zdobywa coraz to większe grono zwolenników. Szczególnie istotne jest w tym zakresie zainteresowanie się tą tematyką przez wiele koncernów ze świata IT oraz nowoczesnych technologii. Jak wynika z obserwacji rynku na przestrzeni kilku lat IoT może stać się powszechną technologią w wielu domach w związku z powyższym ważne jest budowanie świadomości o IoT wśród Polaków. Prowadzone badania ankietowe miały za zadanie zweryfikować obecny stan wiedzy społeczeństwa w Polsce odnośnie IoT, co przedstawiono w niniejszym artykule. W artykule opisano także możliwe implementacje w przyszłości odnośnie IoT, a także scharakteryzowano korelacje IoT z innymi technologiami dynamicznie się rozwijającymi.

**Słowa kluczowe:** IoT, społeczeństwo, Internet of Things, rozwój technologii IT

### Introduction

When using the scientific terminology and trying to define the term of the Internet of Things (IoT), after longer analyses of numerous world-class publications [10] and papers [7], the elaborated conclusion is not univocal. The vastness of knowledge and of solutions and technologies which may be deemed as correlated with the IoT terminology increases geometrically from month to month. It is therefore unrealistic to concentrate the data generated by devices in a single place without a man's interference. The concept of the Internet of Things is not therefore coherent according to various corporations and global brands, which in turn makes it unrealistic to develop a single system that collects the data, which is why it is necessary to create many correlated ecosystems by sharing the data and events.

### 1. IoT in Poland

In order to define the Internet of Things in strictly technical terms, it is necessary to consider an entire ecosystem of devices, not only a single washing machine or refrigerator, of which the server using the Dynamic Host Configuration Protocol (DHCP) has reserved the IP address in response to a request (DHCP Request). The project titled Virtualna Warszawa [10] assumes the operation of approx. 200 thousand beacons (small transmitters which constantly signal their presence [7]) as early as in 2018. This number of transmitter constitute half of the project's target. The virtual network created by them will allow the users to use the Context Internet. This type of solutions will undoubtedly bring many advantages and allow to save money and time. However, the most important algorithm from the scientific and IT point of view is the adaptive algorithm that eliminates traffic jams in a city centre. We may use the intelligent parking space service as an example. The system knows which parking spaces are vacant and which are not, which decreases the number of cars in traffic on the streets of Warsaw looking for space, which in turn translates into the reduction of exhaust fumes. Furthermore, the manager knows which spaces are occupied, but have not been paid for. It is worth noting that this type of implementation of this scale has not yet been used anywhere in the world [13]. It is however important that

the information included in the beacons will be available for anyone.

The first actual implementation and already functioning system is provided at the Warsaw Centre for Disabled Persons at ul. Generała Andersa 5 in Warsaw [10]. The application for an Android or iOS smartphone includes a virtual map of the entire office building and thanks to using the beacons, the user knows precisely in which room he currently is. The system allows downloading the identification number and assigning it to the applicant. The calculations and analyses of user behaviours and the time of residing in a specific location are executed in real-time, which enables the person waiting to receive notifications about the time until he or she is asked to enter the office in advance. The important aspect is that the entirety may be operated using voice commands.

### 2. Development of state-of-the-art technologies

Over ten years ago, the Internet of Things was basically a subject of theory [4]. The development and availability of the SMART technology, including the widespread use of smartphones, significantly accelerates the process of implementing and developing the IoT [2, 14]. In his presentation, Abhishek Kant from Telerik has listed Arduino, Raspberry Pi or Intel Galileo/Edison as the "wild west" of IoT devices. At this stage, it is simply unrealistic to use these integrated circuits in serious solutions. For business and trade solutions, reliability is the most important aspect and the first of the aforementioned does not meet this condition, which is why it may be discarded in the initial stage of the analysis [3].

One of the most important aspects to consider at the stage of designing of devices (washing machine, refrigerator, cars, etc.) is communication, and co-operation with the Internet of Things using suitable ICT media and protocols. The first personal computer is an excellent example. At the time, the personal computer of manufacturer "A" could only exchange information with a different computer of manufacturer "A" and it was impossible to exchange data with a computer manufactured by company "X". The same applies to the IoT, systems which are and will be created must be open and designed according to an

appropriate standard (global at best), so that any brand may generate, exchange and process data between one another.

In summary, state-of-art technologies and their increasing universality generate enormous quantities of data (smartphones, smart watches, cars, fitness trackers, etc.). Data without proper analysis and calculation will only be numbers and digits – a sequence of binary zeroes and ones. However, appropriate interpretation systems and algorithms enabling the processing and correct interpretation provide huge opportunities. The final objective is to develop adequate platforms and systems that would allow processing and correct exchange of the data. One thing is certain, the current progress of knowledge and technology will not decelerate and SMART CITY is the future [11].

### 3. Analysis of the awareness of IT users in Poland

In 2016, own studies were conducted on the topic of knowledge about the Internet of Things in Poland among Internet users. The sample included 200 persons. The survey sample included 47% of persons aged between 19–25, i.e. young adults. In the entire group of interviewees, 52% were male, 46% were female and 2% of the surveyed persons specified their gender as “other”. Figure no. 2 presents the answer to the question of “How do you evaluate your skills related to using the Digital World?”.

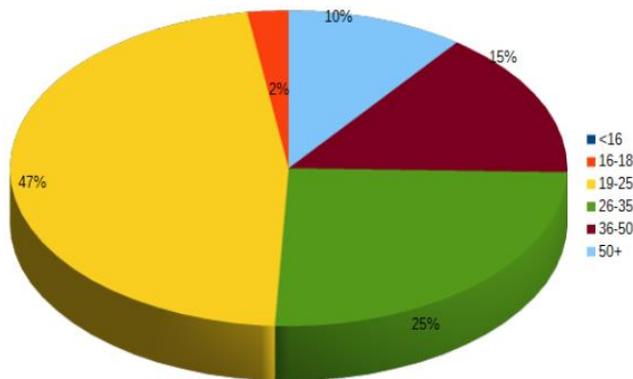


Fig. 1. Age of surveyed persons

The surveyed persons mostly have higher education, as over half of them declared in the survey – figure 3. Another criterion taken into consideration was the region in which the surveyed person resides. 58% resides in an urban area, 25% – in a rural area, while 11% of interviewees originates from a big city and only 6% resides outside of cities.

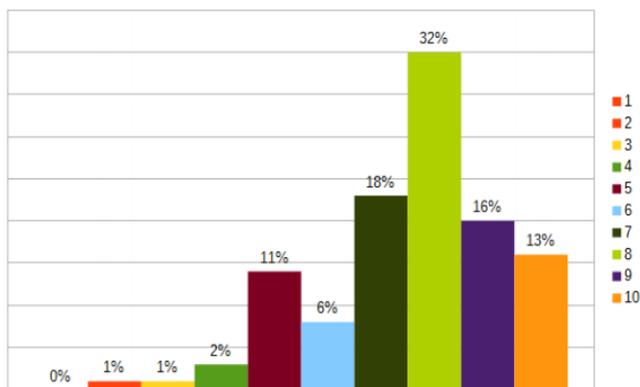


Fig. 2. Skills of the surveyed persons related to using the Digital World. Axis x: evaluation of own skills in the scale of 1-10; axis y: percentage share among the surveyed persons

One of the first questions related to the Internet of Things that the interviewees were asked was “Have you ever come across the term of Internet of Things?”. It is interesting that as much as 59% of interviewees said no and 41% had known the term. The next stage of the survey form featured the aspect of knowledge concerning the use of the Internet of Things in Poland both among persons who did not know the term and interviewees aware of the IoT. Precisely 50% interviewees stated that this type of technology may be used in Poland, 45% confirmed its use and only 5% of surveyed persons thinks that they do not use this technology in Poland. The persons who declared their knowledge about the IoT were asked a question in which they were supposed to define the term in two sentences. Most interviewees associated the Internet of Things with “Receiving and processing of data in the Internet”, “Devices have IP addresses assigned”, “Intelligent home” or “Even further integration of man with technologies”. The survey shows that basically all interviewees limited their perception of the Internet of Things to the household.

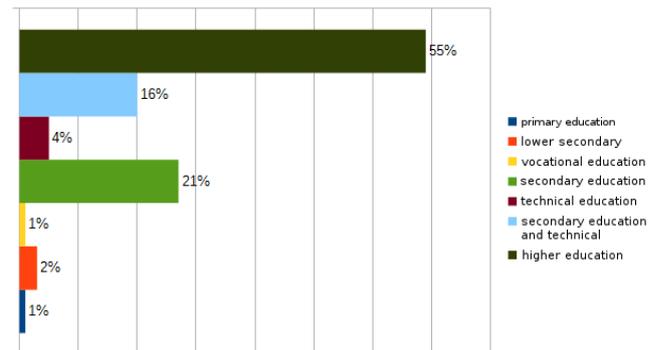


Fig. 3. Education of surveyed persons. Axis x: percentage of surveyed persons; axis y: level of education

The last task for the survey participants was to link the terms that executed the communication of the Internet of Things. Figure 4 presents a fragment of a multiple check box filled out by the interviewee. Figure 5 presents the responses of the surveyed persons to the last question – “Link terms that execute the communication of the Internet of Things”.

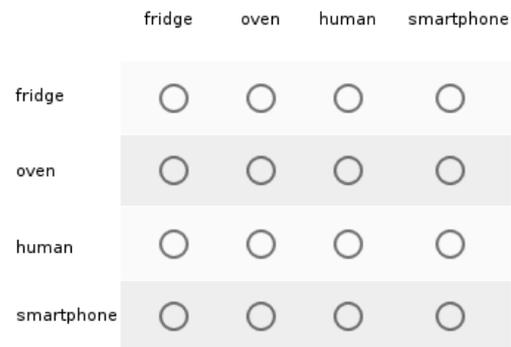


Fig. 4. Survey form fragment

It is interesting that the interviewees most often linked the specified terms with the “human”, which is an erroneous concept. The definition itself states that the Internet of Things is the internet of objects/devices. The most often linkage turned out to be the human-smartphone linkage, while none of the interviewees has linked the electronic fitness tracker with the electronic fitness tracker or a bulb with the electronic fitness tracker.

The summary of this part of the survey shows that the Polish user more or less knows what the Internet of Things is, however when considering more in-depth questions, his or her knowledge leaves a lot to be desired.

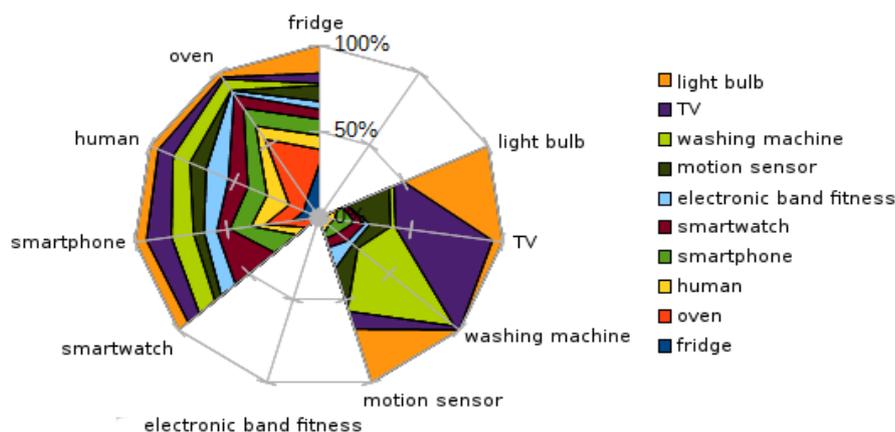


Fig. 5. Social awareness concerning the terms that fulfil the concept of IoT

#### 4. Future implementations

As shown by the prior content of the paper, it is rare, but in the case of the Internet of Things, such companies as IBM [6], Intel [9] and other significant companies in the technology market state unanimously that the IoT is the future. This part of the paper will deal with several examples that are realistic to be implemented in the future.

For example, we will analyse a trip with a car equipped with a large number of sensors and an entire system that executes the logic of the Internet of Things. At a certain time while driving, one of the components starts to malfunction. Our car informs us about this fact and simultaneously sends a proper log to the manufacturer's calculation cloud. Based on adequate algorithms, the dealer communicates with the plant that manufactures the given component and orders it, while simultaneously sending information to our smartphone about the nearest authorised servicing station, including the discount provided, if service is used in the given time. It is interesting that, thanks to the continuous analysis of all car components, the engineers designing the cars and their components are able to improve them thanks to the data coming into the given corporation's calculation centres. Furthermore, better understanding of the exploitation of materials and components will allow more precise forecasting of their actual malfunction.

It is obvious that the implementation of the IoT technology on a global scale will allow savings in energy, money, time or even saving many lives. When trying to analyse further possible solutions for implementation in the future, we may assess a city the size of Warsaw, in which traffic jam analysis cameras were installed [8, 12]. A camera of the future is able to recognise the weather, accidents or traffic jams. The camera communicates with other cameras installed in the city, as they are correlated with a system that analyses traffic jams and road incidents in the city, which in turn is subject to the overall transport system (underground railway, buses, Rapid Urban Railway, etc.) The system will progress huge quantities of data each second of its operation. In conclusion, the system's camera detects a road incident – two cars collided with each other on street X. In a single moment, the central transport system is able to make the decision to call for aid, reorganise the city traffic by displaying an adequate message on information boards about a bypass around the street X. Furthermore, the system will send notifications to the local airport or modify the schedules of all city schools accordingly.

It is also worth to note the potential application of the IoT in health and nutrition. In this part I will use my own example. In the near future, an overweight person receives recommendations related to daily food rations from the nutritionist. Exactly as it is done today, but with one difference in that soon the entire system at home and outside of home will look after the treated person according to the specialist's recommendations entered into the

system. Furthermore, the doctor will have constant insight into the patient's progress. Thanks to the fitness tracker closely correlated with the smartphone, the system will continuously control the burnt calories and the refrigerator will prevent consuming additional calories if the patient, deliberately or not, wants to abandon the diet by using a self-locking mechanism. If the patient instead wants to purchase a prohibited product, e.g. a chocolate bar, the telephone payment system will prevent the purchase [5]. Of course, a refrigerator that operates in the IoT technology will only order "healthy products" recommended by the nutritionist.

#### 5. IoT and technological development

It is obvious that digital technology constantly evolves. It is thanks to its popularisation and general accessibility that the Internet of Things may rapidly develop. An excellent example is the Android system, which over the last couple of years became the most popular mobile operating system. A couple of years ago only a handful of people imagined that the telemetry of the telephones of moving users will allow the Google Maps system to illustrate the traffic of city streets in real-time. Furthermore, thanks to these data, the entire system is able to navigate us so that we reach the target in an optimal manner.

In specific restaurants based in San Francisco and New York, we are able to use the access point, i.e. system using beacons mounted in each table. Thanks to the application, the customers order meals and beverages from the menu and a real waiter brings them to the table. It is worth noting the function that allows dividing the joint receipt to persons sitting at the given table. The application allows us to make the payment for the ordered meals.

When referring to the above solution, it is worth considering the use of this type of technology (beacons) in an intelligent store/trade centre [5]. When walking through the hall with the dedicated application enabled, the user is informed about the current sales he or she is interested in. Thanks to the software, after walking into a store, the user is able to locate the given product or call the store's personnel. It is important that the trade centre/store personnel have information on the user and his or her behaviours. But that is not all, as the IoT provides even more possibilities, which are described in the paper's chapter 4.

#### 6. Summary

As shown by the conducted studies, there is no doubt that the Internet of Things is the future – it will transform our entire life, starting at home, in the office and ending with far travels. However, some time will pass before the technology is fully functional. This period of time depends on the replacement of essentially most devices that surround us and an addition of new solutions as well as analysis and data processing centres. It is not currently a problem however and similar revolutions are already

taking place or have taken place. These include the replacement of stationary telephones with mobile phones, and the latter ones with smartphones or smart watches.

In summary, the Internet of Things creates enormous opportunities, according to some it is a solution for every problem, while others perceive it as an enemy that controls all aspects of our lives, everything and everyone (conclusion elaborated based on in-depth analysis of the conducted surveys). It is necessary to agree with both sides. However, good use of technological and technical achievements lies solely in the will of the users. History has repeatedly shown that a discovery, which was originally intended for good purposes, is often used in a contrary manner (gunpowder). For example, in Beijing, people constantly have the impression of being under surveillance at each step. A camera on every fourth street lamp is obviousness, the controls of airports known in Europe are a standard in public places [1, 16, 17]. It is however necessary to ask an essential question. In what other way, without advanced computer systems using the IoT, it is possible to ensure safety to a city of 20 million residents?

## References

- [1] Atzori L., Iera A., Morabito G.: IoT: giving a social structure to the Internet of Things. *IEEE Communications Letters* 15/2011, 1193–1195.
- [2] Bui Z., Vangelista C.: Internet of Things for Smart Cities. *IEEE Internet of Things journal* 1(1)/2014.
- [3] Buyya G., Palaniswami M.: Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems* 29/2013, 1645–1660.
- [4] Comarch: <http://www.beacon.comarch.pl/> [19.11.2016].
- [5] Haiyan L., Song C., Dalei W., Stergiou N., Ka-Chun S.: A remote markerless human gait tracking for e-healthcare based on content-aware wireless multimedia communications. *IEEE Wireless Communications* 17/2010, 44–50.
- [6] IBM: <http://www.ibm.com/internet-of-things/> [11.12.2016].
- [7] IEEE website on IoT: <http://iot.ieee.org/> [11.12.2016].
- [8] Infinity: <http://getifinity.com/golden-antenna-for-virtual-warsaw/> [11.12.2016].
- [9] Intel: <http://www.intel.pl/content/www/pl/pl/internet-of-things/overview.html> [11.12.2016].
- [10] Kuo-Hui Y.: A Secure IoT-based Healthcare System with Body Sensor Networks, [DOI: 10.1109/ACCESS.2016.2638038].
- [11] Lopez T. S., Ranasinghe D. C., Harrison M., McFarlane D.: Adding sense to the Internet of Things an architecture framework for smart objective systems. *Pervasive Ubiquitous Computing* 16/2012, 291–308.
- [12] Mayors Challenge: <http://mayorchallenge.bloomberg.org/ideas/virtual-warsaw/> [11.12.2016].
- [13] Polish Association of the Blind: <http://pzn.org.pl/aplikacja-virtualna-warszawa/> [11.12.2016].
- [14] Qi L., Zhong X.: *Physical assets and service sharing for IoT-enabled Supply Hub in Industrial Park (SHIP)*, Elsevier, 2014.
- [15] Shin A.: A socio-technical framework for Internet-of-Things design: A human-centered design for the Internet of Things, *Telematics and Informatics* 31/2014, 519–531.
- [16] Yun M., Yuxin B.: Research on the architecture and key technology of Internet of Things (IoT) applied on smart grid. *Advances in Energy Engineering, ICAEE*, 2010, 69–72.
- [17] Zorzi M., Gluhak A., Lange S., Bassi A.: From today's Intranet of Things to a future Internet of Things: a wireless- and mobility-related view. *IEEE Wireless Communications* 17/2010, 43–51.

**Ph.D. Eng. Szczepan Paszkiel**  
e-mail: s.paszkiel@po.opole.pl

Szczepan Paszkiel is currently working in the Institute of Control and Computer Engineering of the Faculty of Electrical Control and Computer Engineering at the Opole University of Technology. He is a graduate of Informatics and Management and Production Engineering at the Opole University of Technology. He is a grant holder and winner of many contests for young scientists. He has been conducting research on the processing of the EEG signal. He is an author and co-author of many scientific publications.



**Eng. Maciej Matusik**  
e-mail: m.matusik.pl@ieec.org

Student of the last year of II degree stationary studies of Informatics at the Opole University of Technology. He represented the Opolskie Voivodship at the International Congress - "IEEE R8 STUDENT AND YOUNG PROFESSIONAL CONGRESS" and "CeusYP 2015". Awarded at the "II Polish Convention of Digital Poland's Lighthouse Keepers". 2013.10.22–24 study visit in Sweden as part of the "Digital Poland of Equal Opportunities" project. 2012.11.19–21 study visit in Great Britain as part of the "Digital Poland of Equal Opportunities" project. In 2013–2014, he executed the grant as part of the local action plan named "Digitalisation Globally – Realistic Locally". Member of the organisation committee of the II Conference MÓZG-KOMPUTER 2016 Opole.



*otrzymano/received: 23.01.2017*

*przyjęto do druku/accepted: 01.06.2017*