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APPLICATION OF THE INTERNET OF THINGS AND INTERNET OF EVERYTHING IN THE ACTIVITIES THAT IMPLEMENT THE CONCEPT OF ECOSYSTEM

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Introduction

When the Internet emerged in the 20th century we experienced a technological revolution in the area of computerisation. At the beginning of the 21st century we are witnessing a dynamic expansion of technologies that are based on information exchange. The Internet has ceased to be a merely simple tool of interpersonal communication. It has become a basis of social life functioning in numerous areas of the economy. Management structures in organisations cannot be devoid of a possibility to utilise the latest solutions of communication technologies. The presently exposed area where IT and communication technologies are implemented is the Internet of Things (IoT). There is also the term the Internet of Everything (IoE), which defines a network of people, processes, data and devices that are connected to the Internet. The term was originally coined at CISCO and is presently frequently used interchangeably with the term the Internet of Things. Also, a counter has been developed that counts

the approximate number of the elements that comprise the Internet of Everything. It has been estimated that in 2020 from 25 to 50 billion of devices will be connected to the network. According to the estimates the value of the IoT market in 2019 is USD 1.3 trillion (Kotowski, 2015).

The Internet of Things as it is currently perceived has not been created out of a sudden nor has it been an ingenious brainchild. It is an arbitrary set, which makes use of the developed over a longer period of time electronic and digital forms of communication. The IoT utilises the existing and developing communication technologies. It applies technologies of economy and reliability, especially for the operations of collecting, transferring and securing the data being in the possession of a given organisation, that is cloud computing. It also makes use of ICT technologies, tele-informatic technologies, software agent-based technologies (Kiełtyka, Niedbał, 2013), semantic networks technologies,

multimedia techniques and technologies (Kiełtyka, 2009; 2017), virtual organisation of operations technology (Kierzkowski, 2013), etc.

Ecosystem is one of the basic terms in ecology, yet, just as the name “ecology” itself its nature is multifaceted. The term “ecosystem” is applied with reference to any system that comprises living or living and non-organic elements, which remain in various relationships one towards another. The most frequently considered parameters, which characterise ecosystem in the area of communication include: economy, efficiency, rationality, most optimum actions that meet the build-up capacities, not disturbing the biological environment, energy-efficiency, self-configuration, self-organising capacity.

The purpose of the paper is to present primary communication factors and forms of elements of things and everything with the environment, in terms of their operation and utilisation in ecosystems. Selected situational solutions are aimed at making readers acquainted with a possibility of selecting basic commonly used products, which implemented in ecosystem structures are supposed to make their everyday life easier. Items, systems, objects, structures, elements operated based on ecosystems, are equipped with sensors that improve contact with the environment. The author presents selected forms of ecosystem solutions based on the IoT and IoE. The paper also presents an outline of the concept of applying the Internet of Things and Internet of Everything in the areas of its potential usability, provides information on developing interactions with objects and through objects with communication systems. It also seems relevant to signal present actions related to implementation of intelligent communication forms in the areas with the highest intensity of applying ICT devices such as smartphones, iPads, e-books, tablets, iPhones, etc. operating for ecosystem solutions.

It has been estimated that in 2020 there will be approximately 200 billion of the IoT devices. The Internet is not only our communication space, it is also becoming a communication space for our devices. Presently, the IoT and IoE may constitute not only devices but also objects that seem improbable to possess such a capacity, for instance a towel that analyses humidity after the bath and signals that it is time to dry or exchange it, or a container that informs the user that it is running out of water that we wanted to boil in it.

All the devices that are included into the IoT and IoE will be built in the ecosystem – this is a statement of numerous companies, enterprises, economic entities and a majority of business leaders. The capabilities of applying the concept of ecosystem through the use of the IoT and IoE are tremendous, and they may be utilised in various areas. The most significant issues (out of many), which are the most important from the perspective of users, include:

- Readiness to adapt users into the ecosystem;
- Determining the adaptation level of the IoT and IoE in ecosystems;

- Optimum analysis of purchasing potential;
- Local and global assessment of this phenomenon awareness and its usability;
- Presenting situational barriers of the IoT and IoE utilisation, considering also benefits of their application.

A dynamic development of devices that can access the network has made this idea realistic and it is indicated by consultancy firms as one of the key development drivers of the world economy of the future (Born, 2016). The scale of applying the IoT and IoE solutions is vast: from miniature clothing accessories through intelligent household appliances, building control systems and smart cities and water management or defence systems. The Internet of Things redefines the strategy of brands providing abundant business opportunities, influencing, among others, the design process (with a particular stress on executing ecosystem concepts) as well as servicing and human resources management.

According to the data by Cisco until 2023 the Internet of Everything will have generated USD 4.6 trillion in the public sector and USD 14.4 in the private one. IDC (International Data Corporation) in turn stresses the fact that popularisation of the IoT will play a key role in the process of building up the economy of the future, which will make use of ecosystems. According to them, until 2019 approx. 25% of external state's expenditures will be destined to developing innovative solutions and so-called smart cities. The benefits produced by the devices equipped with innovative solutions that utilise intelligent embedded systems that operate in smart buildings, housing estates or cities have been summarised below (Raport IoT w Polsce, 2015).

Monetarisisation of data coming from the IoT and IoE

Monetarisisation of data implemented based on the concept of ecosystems applying solutions based on the IoT and IoE, particularly in Poland, under the law of 19.10.2017, which sets the principles of the strategic scheme „Polska Platforma Przemysłowa 4.0” (Polish Industrial Platform 4.0) can be characterised by demonstrating several actions. For example:

- embedded systems frequently defined as dedicated systems, which previously only supported production. Embedded systems will be replaced by cyber-physical systems (CPS) communicating one with another. Their task will be to analyse the parameters that come from the external as well as virtual world and the ability of real-time processing and concluding based on the data;
- data exchange among freely located devices, presently called the Internet of Things (IoT). A dynamic growth in the amount of data (Big Data) corresponds with the need for its analysis. This allows to identify previously unobserved dependencies in long-time data series, which enable optimising processes, stressing ecosystem activities;

- Human-to-Machine communication, which will be possible thanks to implementing the HMI technology (Human-Machine Interface). The M2M (Machine to Machine) technology in turn will enable automatic communication among machines, which ultimately will allow for effective communication of the virtual and real world.

The IoT and IoE cause that it is necessary to level the previous practices, where the prediction model was constructed based on collected data and then operationally applied for as long as it maintained the required qualitative parameters. Tools should ensure smooth integration of new data and including it into the analyses. In order to acquire a business effect, it is enough to create a forecast or present data in the form of a decision tree. A device equipped with sensors sends measurement data to the central system where it is gathered and analysed. The speed, accuracy, economy, efficiency, rationality, etc. of the transferred data needs to be (according to latest trends) rigorously performed based on ecosystem studies.

Application areas of ecosystem concept

Primary areas where the concepts of the IoT and IoE are implemented and which comprise the concept of the ecosystem, include (Kokot, Kolenda, 2015; Kolenda, 2015a; 2015b; Kiełtyka, Zygoń, 2018):

- Smart environment monitoring – in this scenario a key role plays a vast network of sensors that collect data on temperature, wind, rainfall, level of rivers, etc. Collecting and real-time processing of this data allows to detect anomalies that may constitute a threat to human life. This activity is the least visible from the customer perspective. It is aimed at anthropogenic environment security and its operations comprise automated systems for ongoing monitoring. Its operation is optimum thanks to application of ecosystem.
- Smart energy – comprises a series of solutions that allow for management of utilities. It includes monitoring of individual consumption and also the processes of its production and usage. The analysed energy sources include renewable and non-renewable ones, mainly such systems as: solar, wind, thermal and water management.
- Smart metering – concern, among others, automation of the processes on the side of the recipient, instant billings for actually consumed resources, a possibility of changing the tariff, blocking the installation, collecting statistical data related to supplied and consumed energy, ongoing monitoring, informing about occurring anomalies.
- Smart health – comprises a wide spectre of applications used for health and physical activeness monitoring. It allows for patient security monitoring (both in hospital and at home). It offers, for example, sleep control (through smart mattresses) or teeth control (through smart toothbrushes).
- Smart industry – comprises the area that enters the solutions related to particular industries of the national economy. The possible application areas may include: resource level monitoring (water, liquid fuels, gas), storage facility condition monitoring, machine diagnostics, working conditions or product processing.
- Smart production – similarly to smart industry it comprises solutions that are entering particular sectors of the economy. The IoT and IoE solutions handle both issues related to agriculture, farming or crops, to production line control, product rotation control in shelves of supermarkets or control in storage facilities and warehouses.
- Smart transport – belongs to key segments that support the economy. It comprises logistic processes support, among others, for the following areas: transport location, controlling transport conditions, conditions of material storage and transport organisation.
- Smart water management – comprises a wide range of issues related to administering and managing environmental resources in the ecosystem, essential for the environment functioning. Thanks to the IoT and IoE it is possible to manage in real time processes of water supplies, starting with the control of its fitness for consumption and manner of storage, through supplies and seal of water supply systems, to monitoring consumption by end users.
- Smart city – a special area for monitoring and organising all the key processes pertaining to functioning of cities, from traffic to public security diagnosing. The area of particular analysis are the levels of: noise, lighting, pollution, parking space load, tremors or tourist information.
- Smart building and its surroundings – consist in smart management of the building and its surrounding. It comprises a whole series of facilities that may be used both at the individual as well as industrial level: property monitoring, movement sensors, smart watering, thermostats, etc. Possible solutions include control of external and internal conditions. Monitoring can also include information on a particular location of threats (e.g. smoke, fire, CO₂).
- Smart flat – covers a whole series of individual expectations, solutions and applications. Most of the expectations are related to household appliances. For instance: fridges (informing about the content, expiry date, need for re-supply), washing machines (enabling energy consumption in lower tariffs), cookers (allowing for remote settings of the oven), humidifiers (ensuring proper air humidity especially for small children). Solutions in this category allow for control of utilities usage (controlling light bulbs, thermostats, air-conditioning) and security (child supervision, cameras, alarms).
- Smart life – comprises a whole range of consumer solutions aimed at convenience and security. They include, for example, shopping support (compliance

with habits, monitoring the contents of allergens, expiry date), remote control of equipment to prevent accidents, weather conditions monitoring (temperature, smog, humidity, atmospheric pressure, wind force and rainfall) or personal belongings protection (wallets, jewellery, watches, mobile phones).

Ecosystem components using the IoT and IoE

Each ecosystem is built of similar components. Operation of the ecosystem that utilises the IoT and IoE depends only or maybe primarily on the area, object, situation and conditions in which they are supposed to operate optimally. Operation of the ecosystem at the basic level is created by so called system endpoints, which are sensors that perform single-type function and devices that trigger and monitor occurring changes (vibration, temperature, movement, humidity, location, etc.). Due to their joining abilities they can perform two tasks, i.e. collect and analyse data from the environment and communicate via the Internet with control systems. Another level of ecosystem's functioning create so called simple hubs. These are joining points that include a small number of sensors and actuators. Because of components, embedded into particular products, a possibility is created of their optimum operation and adjusting their functioning to habits of individual users. Thus, products can be transformed into so called smart products having joining abilities. They may constitute an integral part of a particular product or they may be installed in it (Wielki, 2016). The third level of the ecosystem create so called integrating hubs. They join together simple hubs and offer a wide range of joined together services of a similar type. An example of such a solution is Apple HomeKit, which is a platform that integrates simple hubs from various producers adjusted to work with it. This allows users to control with the use of a smartphone application various household appliances. Simultaneously, an appropriate infrastructural layer is indispensable for the holistic functioning of the ecosystem. Its creation is impossible without using a series of leading technologies, which offer a tremendous transformational potential themselves. This concerns Cloud Computing, Big Data and mobile solutions (Burkitt, 2014; Heppelmann, Porter, 2014; 2015).

Software incorporated in the product itself as well as in the infrastructural layer offers greater capacities of monitoring. This allows for remote control of a product and its functions and personalisation of its operations to the extent that was impossible to achieve previously.

The monitoring capacities and acquired in this way a wide stream of data combined with the potential in the control area that is offered by smart products allows organisations to optimise their operations in an exceptionally wide range. This concerns such aspects as: a significant improvement in the functioning of the product itself or its diagnostics and repair. Four types of functionality associated with smart joined products

allow smart products to achieve an unprecedented level of autonomy (Heppelmann, Porter, 2014).

Strategic implications for the ecosystem

While considering its involvement into a strategy that incorporates the assumptions of ecosystems each organisation has to answer a key question about its role in the ecosystem that is being created. In this problem domain, from the strategic point of view, one can distinguish three large categories within which organisations may develop their operations. They include (Burkitt, 2014): – entities developing and implementing technologies indispensable for ecosystems functioning based on the IoT and IoE (enablers); – entities designing, developing, integrating and providing the IoT and IoE services to customers (engagers); – entities designing their own adding value services, expanding and integrating the offer that has been developed by organisations that belong to the previous category (enhancers).

Strategic counselling McKinsey distinguishes four foundations of competing, based on which organisations may build their position within one of the abovementioned categories. The following are included by McKinsey to the forms of competing: – owning a distinctive technology; – owning own distinctive data sets; – the ability to create own provider platforms; – the ability to provide end-to-end solutions.

Having defined its own vision of the place in the created ecosystem each organisation has to assess its potential and experience in the technical dimension. An analysis of this type is indispensable from the perspective of such issues as, for example, utilising services of external entities that develop the IoT and IoE solutions and cooperating with them while implementing a specific vision of taking advantage of the ecosystem concept (Gartner, 2015).

Apart from the indicated above challenges of inter-organisational nature there is a whole series of various barriers and limitations of external nature and as ecosystems are complex solutions, based on technologies of various types, their scale and diversity is significant. In the context of technical issues, solutions with a created ecosystem may both limit as well as stimulate their development.

Also, existent non-technical challenges have to be taken into consideration. In the ecosystems operated by the IoT and IoE value is to a large extent created on the basis of the acquired, transferred, processed and analysed data (Heppelmann, Porter, 2014). The issues that are related to it constitute one of the key aspects that may become barriers to the development of this concept or stimulate its development.

Conclusions

Each organisation must profoundly analyse to what extent an intense implementation of ecosystem is in line with the mode of its functioning. Organisation that

strive to be at the top should relatively quickly analyse its value creation and make decisions regarding its potential position in the fast-developing ecosystem. They also need to profoundly assess their experience and capabilities in the scope of developing and implementing solutions based on the philosophy of the Internet of Things and Internet of Everything. It can be stated that nowadays the attitude to introducing ecosystems in organisations is at the moderate stage of its development. A proper and prompt positioning in the ecosystem may constitute an element that will decide about further development of an organisations for years. However, while making strategic decisions of this type each organisation must be aware of numerous challenges that this concept involves. The direction of development is an increased interaction between man and object (Xia et al., 2012; Ghosh, 2015).

Effective work and data analysis may influence, for instance, reduced product of exhaust gases, water or other components. This is becoming an ever more significant factor for many customers while choosing a given brand. The Internet of Things requires the media and brands to be perfectly prepared with regard to analytics and data processing. Understanding the key role of the digital marketing in the communication between the organisation and recipients of goods or services is an indispensable element and a guarantee of a success in business.

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Zastosowanie Internetu Rzeczy i Wszechrzeczy w działaniach realizujących koncepcje ekosystemu

Streszczenie

Realizacja wybranej przez organizację koncepcji przystosowania się do wdrażania działań opartych na rozwiązaniach ekosystemowych jest zagadnieniem, jakie postawiono w niniejszym artykule. W relatywnie zwięzły sposób przedstawiono ideę koncepcji ekosystemu poprzez wykorzystanie IoT oraz IoE, prezentując najistotniejsze zagadnienia z perspektywy użytkownika. Zwięźle nawiązano do założeń rozwoju technologii w ramach „Polskiej Platformy Przemysłowej 4.0”. Nieco szerzej omówione zostały obszary, w których realizowane są koncepcje ekosystemów. Krótko przedstawione zostały inspiracje strategiczne dla ekosystemu.

Słowa kluczowe

Internet Rzeczy, Internet Wszechrzeczy, ekosystem