THE INTERNET OF THINGS AS THE FUTURE TECH-NOLOGICAL TREND OF THE INNOVATIVE DEVEL-OPMENT OF LOGISTICS

Andrzej Magruk*

* Bialystok University of Technology, Faculty of Management, ul. Wiejska 45A, 15-351 Białystok, Email: a.magruk@pb.edu.pl

Abstract   The article presents one of the most important technological trends in the context of the development of logistics, the Internet of Things (IoT). The key aspects and main technologies used in this concept have been characterised. Several actual examples of the Internet of Things solutions in logistics operations have been presented. The potential benefits and limitations of using IoT for logistics operators have been analysed. The need to pay attention to two new developments that may have a very large impact on the development of logistics has been pointed out, ie. To the "Internet of Everything" and to the so-called fourth industrial revolution.

Paper type: Research Paper

1. INTRODUCTION

In the twenty-first century, the logistics industry faces a number of competitive and complex challenges. Such factors include, among others: possibly quickest onset of action, high efficiency, as well as flexibility, whose main function is the maximal adaptation to customer needs. The implementation of these objectives is increasingly influenced by the skillful management of modern technologies, often based on complex and comprehensive data sources, arising from and influencing the development of modern trends. Innovative technologies increasingly determine the competitive advantage of enterprises. They constitute an important component of the modern production, processing and logistics processes, enabling meeting the expectations of stakeholders (Halicka, 2015, p. 87). In a recent survey by DHL from 2014 a list of several megatrends and technological driving forces have been identified, that will have a significant impact on the development of business models and the exploitation of innovation in the logistics industry. One of the major trends being the focus of this article is the Internet of Things (IoT) (Bubner, Bubner, Helbig & Jeske, 2013, p. 3).

According to K. Ashton, who in 1999 was first to introduce the concept of the "Internet of Things", IoT has the potential to revolutionize the world probably to a much greater extent than the "traditional" Internet (Ashton, 2009, p. 1).

The Internet of Things is a concept inseparable from the new services related to new modes of communication – information connection between people and things, but in particular connection between objects (things) (Kwiatkowska 2014, p. 63).

Currently, already in more than half of Internet connections, at least one of the parties is a thing (Kwiatkowska, 2014, p. 60). It is expected that in 2020 the number of new items connected to the Internet per second should amount to 250, which in turn should translate into 50 billion items connected to the network (Brachman, 2013, p. 7).

IoT management systems have a very wide range of applications and in terms of logistics, in a direct or indirect way may cover, among others.: smart cities, intelligent industry, intelligent enterprises, intelligent buildings.

2. KEY TECHNOLOGICAL TRENDS IN LOGISTICS IN THE XXI CENTURY

The latest megatrends and driving forces concerning the demographic, urbanization, consumption and individualisation changes substantially affect the technology trends in logistics, which must inevitably be taken into consideration when formulating the operating strategies by individual companies (Bubner, Bubner, Helbig & Jeske, 2013, p. 5).

The group of significant trends in logistics include:
1. big data/open data;
2. cloud logistics;
3. autonomous logistics;
4. 3D printing;
5. robotics & automation;
6. Internet of Things;
7. localization & local intelligence;
8. wearable technology;
9. augmented reality;
10. low-cost sensor technology;
11. crypto-currencies & crypto-payment.

According to a study by DHL, the first 6 trends belong to a group that will have the greatest impact on the development of modern logistics in the coming years. They have been characterized (in addition to the Internet of Things, to which a separate part of the article has been devoted) in this section on the basis of the following scheme relating to the sphere of logistics: A) short characteristics, B) potential benefits, C) application example (Bubner, Bubner, Helbig & Jeske, 2013, p. 15):

1. Big Data / Open Data: A) thanks to the tremendous degree of digitization, enterprise data can be shared in an unprecedented way. Integrated data streams in the supply chain of many logistic suppliers and open data sources have a very high potential for logistics operations; B) improvement of operational efficiency, transparency of operations, full control over the supply chain, assets and personnel, the possibility of more accurate forecasts, and adjustment in real time; C) DHL Resilience360.

2. Cloud logistics: A) meets the challenges of complex, distributed, uncertain, less predictable logistics conditions; B) reduction of the total cost of IT services (including the cost of installation, updating, maintenance fees), services risk minimization, faster and simpler implementation, better reliability and security; C) Shipwire (Grzybowska, Kovács & Lénárt, 2014, p. 40).

3. Autonomous logistics: A) stand-alone devices can be applied throughout the supply chain: from "the warehouse of the future" through auto-driven vehicles (following the example of autopilots) to unmanned supplies. It is expected that in the coming years, autonomous devices will reach maturity and will become a reality in logistics in everyday life; B) elimination of traffic congestion, threats, accidents, congestion, enhanced reliability and elimination of human errors, increased efficiency, expansion of the logistics network C) DHL Parcelcopter.

4. 3D printing: A) technology changing the face of logistics by adding new manufacturing methods; B) possible emergence of new market segments, such as "the digital magazine" C) Sculpteo.

5. Robotics & automation: A) The new generation of robots and automated solutions with significantly better performance offers a serious alternative

to manual labor; B) effective addressing of the dynamic market volatility, optimization of tedious and time-consuming activities, Improvement of efficiency and reduction of costs; C) Multishuttle Moves.
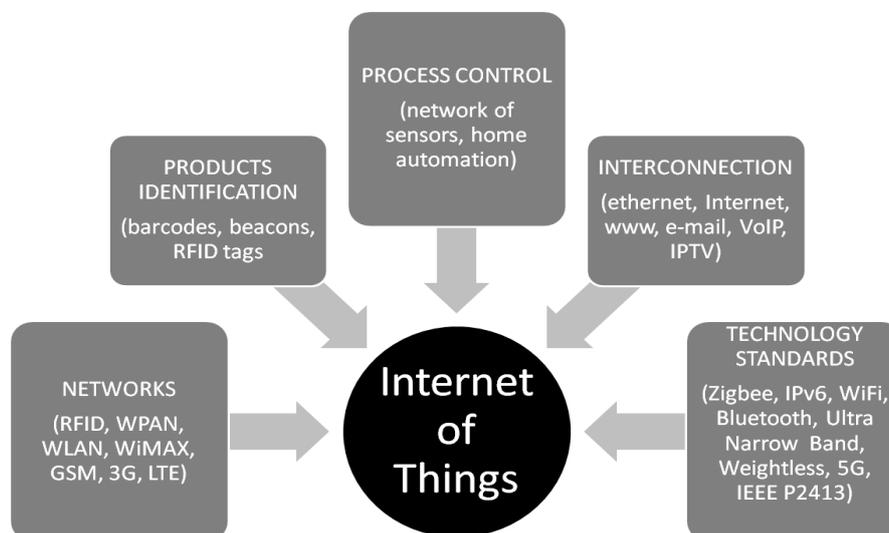
3. KEY ASPECTS OF THE INTERNET OF THINGS

The Internet of Things generally refers to the phenomenon of combination of many different items via the Internet, thereby establishing a connection between them. According to D.E. O'leary "things" (collecting information and knowledge generated from their interactions with other "things") may be (O'leary, 2013, p. 55-56): sensors, databases, equipment or software, and intelligent and "aware" items.

The concept of IoT is based on the following principles: anytime, anyplace, anything, any service, anyone, any network - Fig. 1 (Brachman, 2013, p. 5); (Magruk, 2015).
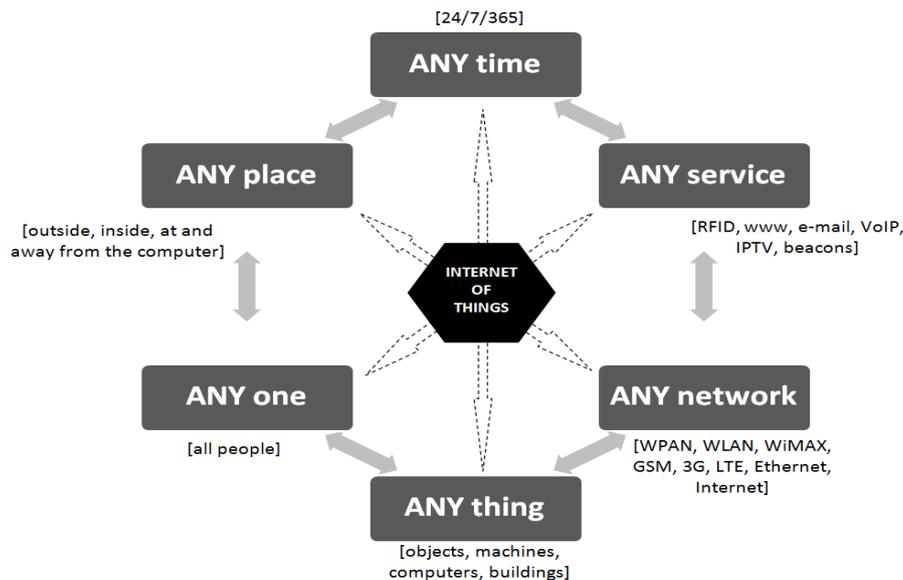
Fig. 1 Communication on the Internet of Things, own study on the basis of (Brachman, 2013, p. 5); (Magruk, 2015)

When determining in detail the concept of IoT, it should not be regarded as an independent technology, but as a combination of a number of complementary technologies: identification, communication, information processing, energy management, etc. (Fig. 2) (Chaouchi, 2010).

Fig. 2 Convergence of technologies of the Internet of Things, (Chaouchi, 2010)

Currently one of the major technologies supporting the communication process in the context of IoT is RFID (*Radio Frequency Identification*). In the areas of logistics and the supply chain, the RFID technology has been known for decades and is largely used for the tracking and monitoring of goods (Yuen, 2012b, p.24), (Szczuka, 2015, pp. 202-203). The items using RFID tags are equipped with micro-processors and thus are detectable in the environment. It facilitates the processing of information and the interaction with other devices (Clausen, Holloh & Kadow, 2014, p. 20).

Other increasingly popular technologies are the NFC and Bluetooth Smart, used by beacons (corresponding to tags) - tiny devices consisting of a Bluetooth chip and a battery. The transmitter sends a specific signal, which is captured, for example, by the applications installed on smartphones that trigger the desired function, eg. checking in at a particular place (Okopień, 2014).

4. THE INTERNET OF THINGS IN THE CONTEXT THE LONG-TERM DEVELOPMENT OF LOGISTICS

An example of the use of IoT in the concept of a smart city is the Traffic Control Centre in Gliwice. The system affects the safe and rapid passage through 60 intersections. The data collected to date is analyzed and used to adjust the length of traffic lights cycles. For example, the detection of a situation of a bus delay causes the road, on which it is located, to get a green light. (Brachman, 2013, p. 22).

One of the best known applications of RFID technology in the supply chain is located in the Wal-Mart network through the implementation of RFID tags in the pallets of more than 15,000 suppliers. With this solution the current orders declined by 10 to 15%, which contributed to the reduction of surplus stocks. Wal-Mart suppliers, such as Kimberly-Clark and Procter & Gamble are informed in real time about the "movements" of their products, accidents, etc. Marking various products with RFID tags helps to identify their availability on the store shelves (Yuen, 2012, p. 31).

In the future, thanks to IoT it will be possible to change the routes or means of transport in a short time and optimize transport chains in terms of capacity utilization, transport time, environmental factors and costs. A more effective integration of different transport modes will be possible, as well as optimization of transport and handling processes (Clausen, Holloh & Kadow, 2014, p. 31).
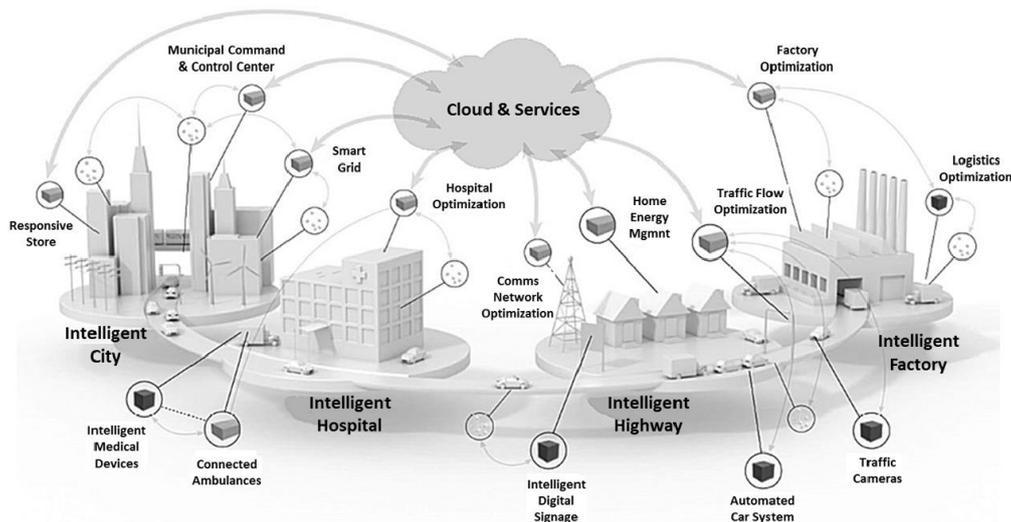
Fig. 3 The structure of an intelligent logistics system that uses the Internet of Things according to Intel, (Vermesan & Friess, 2014, p. 69)

An example of such a system is illustrated in Fig. 3. Its basic structure may be based on the following subsystems: smart cities, hospitals, roads, factories, power grids, etc. (Vermesan & Friess, 2014, p. 69). This concept can be an excellent basis for the creation of the idea of Smart Specialisation, popularized by the OECD Regionów (*Smart Specialization*). This idea applies to areas: industrial, educational and innovation, in order to identify the countries or regions in which the priority is the investment based on knowledge, focusing on their strong (competitive) sides (Glińska & Kononiuk, 2013, p. 28).

Other potential benefits of using IoT for logistics operators are (Bubner, Bubner, Helbig & Jeske, 2013, p. 35); (Clausen, Hlloh & Kadow, 2014, p. 31-32); (Vermesan & Friess, 2014, p. 69):

- increase in transparency, traceability and reliability of all logistics processes;
- automatic decision-making in complex environments,
- greater productivity through flexible use of infrastructure and logistics equipment;
- reduction of costs (inventory management, supply routes);
- real-time monitoring of the states of transported goods;
- interactive logistics solutions tailored to individual requirements and procedures;
- innovative assessment of the conditions of dispatch: monitoring of vibrations, shock, defects;
- facilitating the rapid finding of particular objects on large surfaces like warehouses, ports;
- warning of a potential proximity of containers containing flammable goods and the ones containing explosives;
- control of routes of valuable products such as medical supplies, gems, or dangerous goods;
- automatic notification of shipping companies about the location and any delays of transport vehicles through the exchange of information in vehicle-to-vehicle communication;
- ongoing monitoring of weather changes.

According to the author of this article, for the efficient utilization of the above-mentioned opportunities, offered by the concept of IoT, by logistics operators, you might want to use the prospective research approaches. Interesting results can be obtained by referring to the anticipatory management paradigm, designating the trajectory of development that goes where the leaders will be in the future. By using the foresight approach, it is possible to anticipate the future, for example regarding the emerging civilizational challenges and the ones connected with growing competition (Nazarko, 2013, p. 19).

The importance of such an approach is evidenced by the foresight activities in the field of IoT institutions such as: OECD, Foresight Valuation Group, World Future Society, Techcast Global, Foresight alliance.

At the moment the concept of IoT is also related to the potential risks and challenges (Brachman, 2013, p. 8):

- lack of a thorough assessment of the business potential of IoT;
- need to develop innovative business models for new players;
- lack of a detailed assessment of the use of IoT;
- the difficulty in evaluating young business models;
- new issues with the protection of privacy;
- possible abuse of the data collected;

- communication problems (heterogeneity), connection problems (scalability) of a very large number of devices connected to the network;
- problems with the use of electricity (network congestion), which will have to be used by billions of items;
- difficulties in the configuration of systems managing the data generated by "things".

Using the beacons, without the need for manual control, it will be possible to navigate drones so that they found their way to the next beacons (Lalik, 2014), which can be a very interesting idea in the context of postal or logistical services inside big spaces, where it is necessary to frequently move certain items eg. in the production process.

5. CONCLUSION

The Internet of Things has great potential – it can help people in making appropriate decisions, for example, determining the best route to work and health monitoring. For logistics companies, IoT will create tangible economic benefits, ranging from the improvement of the management and traceability of assets to new business models and cost savings achieved through the new models of resource management (Yuen, 2012, p. 2).

Currently, the definitions of IoT are evolving through the development of new technologies and ideas. The earlier IoT solutions operate mainly in the area of M2M (*machine to machine*). Currently IoT allows the connection of virtually any object to the network. Such universality is influenced by (The Goldman Sachs Group, 2014, p. 1); (Yuen, 2012a, pp. 5-10):

- increasingly smaller, cheaper and more intelligent sensors;
- cheap sensors – prices have fallen to an average of 60 cents in the past 10 years;
- low cost and greater bandwidth – bandwidth cost has fallen almost 40-fold over the last 10 years;
- inexpensive and greater bandwidth – bandwidth cost has fallen almost 40-fold over the last 10 years;
- innovation occurring in applications in the cloud;
- smartphones – are becoming personal remotes for IoT;
- ubiquitous wireless coverage – wireless connectivity is available at very low cost;
- IPv6 – the majority of network equipment supports IPv6, the latest version of the Internet Protocol (IP), which is already a standard. It can handle 128-bit addresses, with virtually unlimited possible connections.

The Internet of Things is on the verge of another evolution called the "Internet of Everything". The new model will cover virtually all elements (eg. devices, sensors, people, data, objects, processes, etc.) of the surrounding environment, on the one hand, facilitating the functioning of humans, but also making it face new challenges (Bubner, Bubner, Helbig & Jeske, 2013, p. 8).

An interesting approach to the development of IoT is being implemented in Germany. In the context of production and logistics, the Internet of Things is referred by the industry, universities, associations, unions, as the the Industrial Revolution 4.0, the fourth great wave of technological change (Vermesan & Friess, 2014, p. 26). Thanks to this concept, intelligent factories are arising, enabling the meeting of individual customer requirements.

The Internet of Things provides opportunities to achieve effective solutions in the retail sector by diverting the right content at the right time and right place to the right person (Vermesan & Friess, 2014, p. 69). However, one must be aware that the concept of IoT will develop fully only when there is a common "acquiescence" to it.

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BIOGRAPHICAL NOTE

Andrzej MAGRUK – researcher and teacher at the Department of Business Informatics and Logistics at the Faculty of Management of the Bialystok University of Technology. Research interests relate to: foresight methodology, e-economy, information and telecommunications technology, technology management and the theory of uncertainty. Member of the IEEE Engineering Management Society, the International Society for Manufacturing, Service and Management Engineering, IEEE Poland Section Technology and Engineering Management Society Chapter, Polish Society for Production Management, Polish Statistical Association. Involved in many projects concerning the management of future technologies.