APPLICATION OF "INTERNET OF THINGS" IOT SERVICES IN THE TRANSPORT SYSTEM

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Review article

Summary: *The development of modern society is accompanied by a continuous increase in the need for transportation (transportation), which results in traffic congestion, a lack of parking spaces in stationary traffic in urban areas, and an increase in transportation costs, a decrease in safety, and an increase in harmful effects on the environment. In the past, efforts were made to solve these problems by increasing traffic capacity through the construction of new traffic infrastructure and by improving the technical characteristics of vehicles, but it is evident that these measures did not produce the expected results, even though they required enormous investments in infrastructure and vehicles, and the need to occupy increasingly large areas of land that increasingly limited in urban areas. From the above, it follows that a completely new approach and new solutions are needed to solve the mentioned problems, which will ensure sustainable mobility and meet the demands of users for transportation while respecting the requirements for environmental protection. Thus, the approaches to solving these problems have evolved over time and were greatly influenced by current technical achievements, so we can expect that the progress of the Internet in general, and in particular the segment that is more recently called the Internet of Things (IoT) and which as a fairly new concept enables the improvement of existing and the development of completely new solutions. This paper aims to provide an overview of some already known solutions in the field of traffic that are based on the IoT concept and to provide guidelines for the possible further application of IoT solutions to improve traffic and mobility in general.*

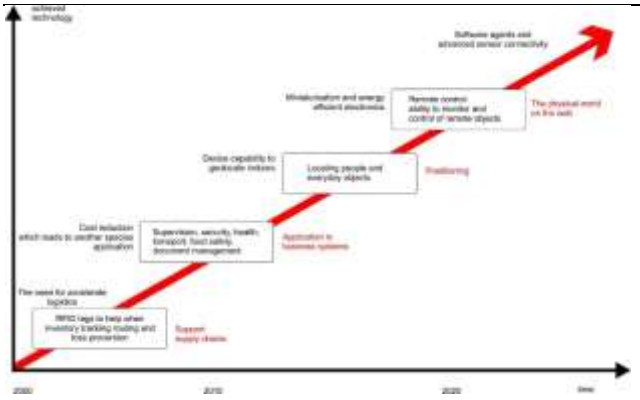
Keywords: *Internet of Things IoT, 5G networks, Artificial intelligence AI (Artificial intelligence), Ambient intelligence Aml (Ambient Intelligence), Information and communication technologies ICT.*

1. INTRODUCTION

One of the basic conditions for reducing the harmful effects of traffic in cities is the establishment of methodologies for collecting, processing, analyzing, and distributing information and data. Traditional information systems (cameras, magnetic loops, infrared and ultrasound detectors) used in traffic monitoring and management in cities collect data and send it to traffic management centers from where it is managed. These systems or devices are located beside the road and on the road and have the role of detecting vehicles, weather conditions, speed of movement, etc. in order to provide accurate information about relevant traffic parameters at the location where they are installed. The disadvantages of these systems are high implementation costs and later high maintenance costs. In order to obtain precise data on all parts of the road, it is necessary that the devices are densely placed, and this requires large material costs. Modern technologies offer opportunities to overcome these problems. It is believed that the application of the Internet of Things (IoT) can bring improvements and reduce costs in the field of transportation. At the moment, there is no clear definition of IoT, and the ITU (International Telecommunication Unit) defines IoT as a global infrastructure for the information society that enables advanced services by connecting (physical and virtual) "things" that are based on already developed interoperable information and communication technologies. as well as those that are still developing. The possibilities of applying this technology are diverse: from e-health, environmental monitoring, to the creation of smart cities, buildings, classrooms, etc. This concept can find a huge application in all types of traffic. This concept allows road users to send useful information to traffic management centers, and the data can still be used in short-term operational management or in the development of long-term management strategies.

2. INTERNET OF THINGS CONCEPT – IoT CONCEPT

With the development of technology, the concept of the Internet soon changes, and from a network that connects billions of computers, it slowly grows into a network that connects various digital devices, objects, or "things". "Thing" can be defined as an object from the physical ("physical thing") or informational world ("virtual thing") that has the ability to be identified and integrated in communication networks. Information and communication technologies ICT have made it possible to connect "anytime" and "anywhere", while the concept of "internet of things" IoT gives a new dimension to the connection of "anything", which enables communication between people and things, but also mutual communication of the integrated things themselves into an IoT system. The development path of IoT is shown in the following figure.



Pic 1. Development path of IoT.

A "physical thing" can be represented in the information world by means of one or more "virtual things", while a virtual thing can exist independently of a "physical thing". "Device" represents a piece of equipment that serves for communication, and can also have the ability to perceive, act as an actuator, store data and process data. Devices collect information and pass it on through information and communication networks to information centers for later processing. They can also communicate with other devices via communication networks, but also directly without them. Communication networks have the task of safely and efficiently transmitting data collected by devices, whereby already existing networks based on the TCP/IP protocol can be used, as well as some new ones developed for that special purpose.

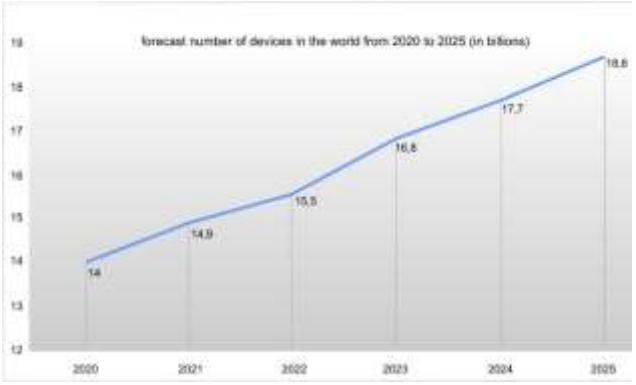
The IoT reference model consists of four layers:

a) application,
b) a layer that serves as service and application support,
c) intermediate layer i
d) of the layer related to the device itself.
The service and application support layer can provide general support such as data processing and storage so it can be used by various IoT applications, but also specific support related to specific IoT applications. The network layer has the role of controlling network communication and transferring information. The number of connected devices is growing at a high speed, which also determines the growing number of IoT platforms. The IoT platform has the ability to access data detected by intelligent devices, to save, store and transform them, but also to securely connect and integrate this data with business processes and systems.

3. THE ROLE OF THE 5G NETWORK FOR THE DEVELOPMENT OF IoT TECHNOLOGY

For the development of the Internet of Things technology, the technology of networks used for global communication, which are divided into wired and wireless, is of crucial importance. The rapid development of Internet of Things technology requires a new network generation in order to make the access and flow of information faster and more efficient. Current 4G mobile networks were not developed to meet the demands of the Internet of Things, but were intended to provide broadband Internet for mobile devices. The fifth generation or 5G mobile network will enable more efficient data transmission in the Internet of Things concept, the 5G network will provide 1000 to 5000 times greater capacity than the previous generations of mobile networks or the 4G network, it will be able to connect up to 100 times more devices per square kilometer than with 4G network, and will enable data transmission at speeds of 10 to 100 Gbps. The new generation of mobile networks allows us to travel data from 1 to 10 milliseconds from one point to another. If we compare it with today's mobile networks, whose speed of sending data is from 40 to 60 milliseconds, it can be seen that the global data flow will be significantly accelerated, which from the aspect of traffic and transport is very significant. It is completely wireless communication, without

any restrictions that supports the Wireless World Wide Web (WWWW). It is more reliable and faster with lower maintenance costs. It provides high capacity, faster data transfer, but will also support interactive multimedia. Fifth generation (5G) networks use 5G standards, which will use new promising network technologies, such as Software Defined Networking (SDN), Massive MIMO, Network Function Virtualization (NFV), Informatics-centric networking (ICN), cloud-based networks and the like . The following diagram shows the forecast of the number of devices connected to the network system.



Pic 2. Forecast of the increase in the number of devices from 2020-2025.

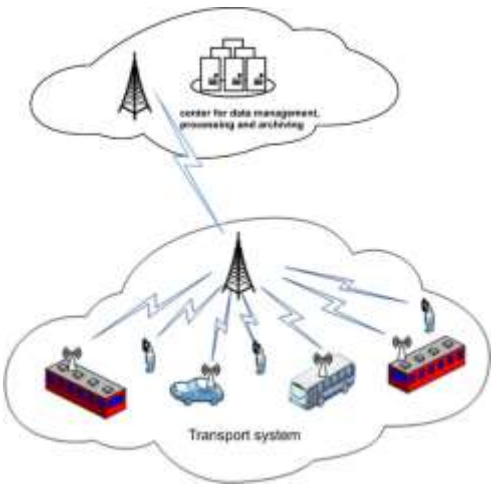
4. THE ROLE OF ARTIFICIAL INTELLIGENCE IN THE IoT SYSTEM

The term artificial intelligence AI (Artificial intelligence) refers to the creation of systems that can draw conclusions about the world around them, can understand natural language, recognize the meaning of visual forms and situations, and perform other tasks that require human intelligence. The development of AI enables the inclusion of intelligence in our environment, which resulted in the development of ambient intelligence Aml (Ambient Intelligence). The development of ambient intelligence Aml implies a balanced application of operational technologies (sensors, communication devices, computers) at the operational level and AI at the intelligent level. Ambient Intelligence Aml (Ambient Intelligence) represents a digital environment that proactively supports people in their daily activities in an unobtrusive way. Aml integrates sensor networks, computer networks and interfaces enabling flexible and intelligent services for users in their environment. The concept of ambient intelligence Aml in the area of transportation provides opportunities to improve the mutual interaction of system components and communication with the environment. In addition to the name ambient intelligence, which is accepted, other names are also used in Europe, such as smart environment or intelligent environment. Ambient intelligence puts the user first by demanding that technology be designed for people, not that people adapt to technology. The ambient intelligence of IoT systems presupposes technologies and systems that are sensitive, responsive to context, interconnected, transparent and intelligent. Artificial intelligence technology AI has a wide field of application in the field of transportation. Significant results have been achieved in various areas such as: transportation predictions, transportation management, shape recognition, optimization, etc. These technologies are suitable for their flexibility, adaptability, ability to innovate and ability to process large amounts of data. Existing technologies in the transportation (transportation) system enable the collection and processing of a large amount of data that has value for users only if it is understandable and useful. It is necessary to distinguish providing information to the user through notifications and recommendations from intelligent applications. Intelligent applications know the user's intentions and understand what information he needs in a certain situation.

5. APPLICATION OF IoT IN TRAFFIC

IoT also brings a new type of transport system: the smart transport system. A smart transport system is a transport system based on ICT information and communication technologies that deals with solving traffic problems. Information and communication technologies ICT enables us to collect data and information, not only for the purpose of their analysis, but also enables a better understanding of transport processes and a better use of available resources, that is, ICT can be viewed as a digital platform that enables the creation of a network of information and knowledge. ICT in the traffic and transport system must be viewed as a complex system, consisting of subsystems, components and devices with nodes as endpoints that are interconnected and make up the system. Securing and managing the necessary information through the use of ICT enables improved preparedness for possible events and more effective responses to problems that may arise. ICT-enabled predictions help identify certain trends to recognize areas of risk and predict potential problems.

By integrating the physical infrastructure, ICT enables the exchange of information and knowledge, which is shown in the following figure.



Pic 3. Application of ICT technologies.

The application of ICT technologies in transport systems is based on location information: the movement of a certain number of vehicles is observed in order to obtain information related to the determination of travel times, travel conditions, traffic accidents, etc. Some of their goals are to reduce the emission of harmful gases, determine the best possible route, and make it easier to detect dangers. IoT also brings a new type of transport system: the smart transport system. A smart transport system is a transport system based on information and communication technologies that deals with solving traffic problems.

6. CONCLUSION

Aware of the fact that the number of inhabitants in cities is constantly increasing, and with the increase in the number of inhabitants, the need for movement, i.e. mobility, is also increasing. Due to these needs, the number of transport units, both individual and those for mass transport, is continuously growing, which again results in a burden and in the end congestion of the traffic network, an increase in transport costs, a decrease in safety and an increase in harmful effects on the environment. These problems were tried to be solved by building new transport infrastructure capacities and improving the technical characteristics of vehicles, but these attempts did not give the expected results because they required large investments in infrastructure and vehicles, and the need for larger areas of expensive land that is in short supply in urban areas. From the foregoing, it follows that a completely new approach and new solutions are needed that will ensure sustainable mobility and meet the needs of users for transportation. The development of ICT information technologies, 5 G networks and "Internet of Things" IoT services are recognized as a new approach that will enable improvements in the traffic and transport system and ensure sustainable mobility in cities.

Many traffic and transport problems are a consequence of the lack of timely, relevant and accurate information and the lack of management tools based on artificial intelligence technologies to coordinate and support management decision makers. The systemic approach to the development of IoT implies the unification of the technical concept and institutional measures required for the integration of key technologies in order to ensure a better quality of service. IoT includes the complete upgrade of existing, but also the creation of completely new systems and services in the area of traffic and transport, the use of applications that, by applying artificial intelligence methods, aim to provide innovative management services for different types of transport and enable users to be better informed in order to use the traffic network better .

The development of modern information and communication systems based on the 5G network and IoT devices of the new generation, as well as achievements in the field of application of artificial intelligence give the right to solve complex traffic and transport problems, both in the segment of traffic planning with the aim of responding to increasingly complex urban transport requirements mobility, as well as in the segment of traffic management, is based on the most modern solutions that will include the application of artificial intelligence in full capacity with the aim of optimizing and solving traffic and urban mobility problems.

7. LITERATURE

[1] Jusufranić I., Stefanović G. (2014). *Sistem prevoza putnika u gradovima.* Travnik: Internacionalni Univerzitet Travnik.

[2] Larsson, C. (2018). *5G network: Planning, Design and Optimization.* London: Elsevier Ltd.

[3] Stefan Rommer, Peter Hedman, Magnus Olsson, Lars Frid, Shabman Sultana, Cathrine Mulligan. (2020). *5G Core Networks: Powering Digitalization.* London: Elsevier Ltd.

[4] *5G Americas Whitepaper, 5G Services and Use Cases.* (2017). Preuzeto od https://www.5gamericas.org/5g-services-use-cases/

[5] T. Semertzidis, K. Dimitropoulos, A. Koutsia, and N. Grammalidis,. (2010). *Video sensor network for real time traffic monitoring and surveillance.* IEEE Transactions on Intelligent Transportation Systems.

[6] A. Uzelac, S. Mladenović, D. Zoranović, S. Zdravković, i S. Janković. (2015). *Komparativna analiza IoT platformi.* XLII Simpozijum o operacionim istraživanjima.

[7] Mehanović, D. M. (2017). *Planiranje u saobraćaju, prevozu i komunikacijama* Sarajevo: Fakultet za saobraćaj i komunikacije.

[8] Drago, E. (2018). *Inteligentni transportni sustavi.* Sarajevo: Fakultet za saobraćaj i komunikacije Univerziteta u Sarajevu.