UNIVERSITY OF NIS FACULTY OF MECHANICAL ENGINEERING

THE SIXTH INTERNATIONAL CONFERENCE
TRANSPORT AND LOGISTICS

til 2017

NEW CHALLENGES OF ICT USAGE IN TRANSPORT AND LOGISTICS

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Abstract

The use of ICT is the key element of today's standards for improving quality of business processes. It is very important to involve all positive influences into business processes of economic entities and other stakeholders involved within the business environment in transport and logistic area. Paper describes possibilities of integrating new e-principles into business environment and processes in transport and logistic area, based on cloud computing, Internet of Things concepts and automatic identification and data capture technologies. The mentioned group contains information and communication technologies such as radio-frequency identification, real-time location systems, near field communication, global positioning system, beacon and advanced tagging technologies.

***Key words**: AIDC, Cloud Computing, Internet of Things, e-Business.*

1 INTRODUCTION

In recent years, the global economy has been constantly growing. For this reason, faster delivery of product/services to end users is required and information and communication technologies (ICT) can affect on that. Given the prevalence of using computers and Internet as part of everyday life, new business models based on e-Business are being developed. With integration of e-Business in almost every segment of organization, the process of purchasing, processing and delivering products is much more efficient than before, the organization can enter the new market with ease and it can improve the overall internal business process.
The reasons for this are the possibility of faster data exchange, more affordable business processes, focusing employees on major business processes, improved efficiency of supply chain, etc. e-business has a significant impact on logistic processes and transport systems because of mentioned reasons.
Transport systems and logistics processes are the key components for achieving a successful global economy. The goals of transport systems and logistics processes are to deliver services/products on time and to maintain a certain quality of delivering the services/products to the end user. This research is focused on the analysis of available ICT and their impact on logistics processes and transport systems. The aim of the research is to give an insight into the possibilities of applying modern ICT and solutions into transport systems and logistics processes in the future.

2 PREVIOUS RESEARCH

Many studies have been focused on the application of ICT in transport and logistics area. Automatic Identification and Data Capture (AIDC) technologies are Radio Frequency Identification (RFID), Real-Time Location Systems (RTS), Near Field Communication (NFC), Global Positioning System (GPS), Barcode and Quick Response (QR) codes. These technologies are used for identifying mobile entities (product/packages/pallets and persons), locating transport vehicles and products and providing real-time information such as time of the product delivery and its location. Communication technologies such as Bluetooth and Wi-Fi are used in today's e-Business systems [1]. They can be used in Internet of Things (IoT) environment for connecting objects and routing collected data to Cloud Computing (CC) within the data processing and data storage is performed and forwarded to the end user.

2.1. Automatic Identification and Data Capture

RTLS technology is consisted of RFID and Wi-Fi technologies and it is commonly used in logistic systems. With its application, it is possible to provide real-time information delivery and automatic warehouse management (goods/packages receiving, delivery, warehouse refillment, loading and unloading processes). In addition, it allows to improve the efficiency of main various operational activities that occur within the warehouse, the efficiency of employees and savings in all business area [2], [3]. It can provide real-time location of entities. RTLS uses tags to locate specific objects or people. The tags are used to transmit information and they can be transmitters, receivers or combination of both [4]. Referent points are placed inside an organization to provide necessary information about the location about the location of an object. The more reference points are set, the higher is the accuracy of the location.
RFID technology in the transport and logistics area brings improved efficiency, security and gives the ability to provide quality services for the mobility of persons and goods. By using RFID technology, organizations can monitor and track packages. It is important to note that RFID supports one-way communication [5]. In the logistics area, RFID has the capacity to store data for vehicle identification, tracking and monitoring cargo/vehicles which affects on increasing security and economic efficiency. Active and passive tags are the carriers of the information [6]. Active RFID tags can be used for real-time tracking containers in ports. The organization center has the ability to manage a large number

of products and have an insight into the quantity of products that have been received or forwarded to their warehouse, to reorganize the received cargo or to place it in the specific place in the warehouse.

Augmented Reality (AR) along with RFID technology can improve the identification and detection of objects (products and goods) in indoor environment and outdoor environment using GPS systems [7]. The possibilities of using GPS systems for better management of fleet of vehicles have been studied, which has an impact on better vehicle tracking and monitoring, increased safety and quality of delivery of product [8]. It provides a more accurate information about the time of vehicle arrival at a particular location and the time of product delivery to end users which affects on the quality of decision making that will make the organization more efficient [9].

NFC technology enables electronic communication between two devices and it uses active and passive tags. Passive tags don't have power supply while active tags have. NFC technology is used for a communication between devices at short distance which makes the main difference between NFC and RFID technology [10]. The range of the NFC is up to 10 [cm] [1]. The problem that often occurs when package is delivered to the end user is that it is delivered to the wrong destination. The proposed solution which is mobile application with integration of NFC technology reduces the time needed to deliver that package and ensures that the package is delivered to the exact destination [11]. By using NFC in the tracking deliveries, it is possible to achieve greater productivity of the employees, easy warehouse management, increased accuracy of collecting information about location of package and reduction of organization costs [5], [12].

Barcode is an optical, machine-readable data display. It can be presented in one or two dimensions. Before, barcode information was read through scanner device. Technology development enabled reading barcodes from images using smartphone camera. Barcode symbols are decoded, recorded and processed so that data can be used or various purposes such as pricing, completing orders, production tracking, sorting, etc. It provides a fast and reliable data collection to ensure monitoring of a particular package and increase the quality of service for end user [2]. The most commonly used barcodes in logistics and transport are CODE 128 and MaxiCode [13].

The QR code represents a two-dimensional symbol. The main advantage is that it is resistant to distorted symbols. Symbols on packages often clutter when being transported or if they have been laid for some time on rough surface. QR codes can still provide an information, even though they are cluttered [14]. In logistics area, QR codes are used in ordering systems. They can also be used to scan items in the catalog and forward information to the system that receives the automatic order. In passenger transport, it can be used to pay for the public transport monthly ticket and collect passenger information.

2.2. Communication Technologies

Bluetooth Low Energy (BLE) technology is used for wireless data exchange between multiple devices. Its range is higher than 20 [m] [1]. It can measure distance and proximity of an object, and to achieve it better it is necessary to use Bluetooth transmitters within a warehouse. Information can be sent in real-time. It is important to mention beacon devices that affect on time and finance savings in logistics operations, primarily when locating a product within a large warehouse. If beacon devices are used, detailed information can be collected about through which shipment processes has the package passed in supply chain [15].

The integration of Wireless Sensor Networks (WSN) enables teal-time monitoring of transport processes. It is possible to detect changes that occurred while transporting the package such as increasing/decreasing of the temperature in the storage area or increasing humidity. Bluetooth technology is used to transfer information because of its wide range and availability on many devices [16], [17].

Wi-Fi is a wireless technology that uses radio frequency data between two or more devices. Wi-Fi devices can connect to the Internet over WLAN network and access point whose coverage area is larger indoor than outdoor. It can be used for locating people or objects in the organization's premises [18].

2.3. Internet of Things and Cloud Computing environment

Numerous research has revealed that Cloud Computing (CC) provides the ability for new business models to provide highly individual IT services that meets the demands of end users. Logistic applications often have specific characteristics that are being influenced by industry requirements. Transparency of each stage in the realization of logistic processes and understanding the control over important data is a priority in logistics and transport [19]. Organizations do not have to invest in ICT infrastructure and its maintenance because CC service provider takes care of it and users can access services from anywhere at any time on any device [20]. The benefits of CC for end users are scalability, availability, efficiency, flexibility and affordable prices [21]. The need for developing Fog Computing occurred because of the demands for collecting, processing and analyzing large amount of data and distributing it in real-time [22], [23]. This enables data processing in nodes that are located before CC to reduce its load. This results in faster delivery of information to end users. It is considered a suitable system that integrates all functionalities and operations of the logistic information system into a single shared system [24].

Available research shows that logistics is one of the first areas that has implemented IoT in its environment. Millions of packages are daily transported, monitored and maintained by different devices and vehicles. IoT can connect different factors together with supply chain and analyze all data obtained by those connections which can affect on providing better insight into a certain situation [25]. It is a concept that is based on connecting all the objects that are in everyday environment. That means the communication can be between devices that are not electronic. This includes the use of sensors and actuators [26]. Many processes in the production, distribution and organization of products operate in an automated way, nut using differed protocols. With IoT, all systems will migrate to open IP standards. IoT provides insight in device performances, environmental conditions power consumption, warehouse status or material flow. Using sensors, it is possible to detect problems that may arise, such as increased temperature in warehouse, machine

failure or vehicle crash. With IoT, fleet management is much better [27] .
e-Commerce has influenced on the supply chain management in the logistics area. It brought better efficiency of material flow, reduced distribution costs and expand to the global market [28], [29].
The use of ICT in business has proven to be positive for organizations in a way that their market competency is increased and that they can achieve quality relationship with other organizations in the market due to their better connectivity. The focus of ICT and e-Business is in transport systems and logistics processes is to manage logistic services, i.e. To provide support for complex logistics processes. It is obvious that these technologies have had a positive impact on business within the mentioned area. ICT have contributed to greater efficiency, easier product control, faster delivery and meeting the demands of end users. In addition, some business processes are automated and thus improve employee performance.

3 CLASSIFICATION OF E-BUSINESS MODELS IN TRANSPORT AND LOGISTICS AREA

Today, any organization which is dealing with transport and logistics is faced with user's expectation that the processes that are related to the procurement and delivery of the products are more efficient and effective than in the past. Users expect the products to be available sooner in the market, that organizations will have lower rates of creating defective products and that there will be a growing number of services that meet the needs of each user. In the transport and logistics area, it is necessary to apply e-Business concepts to ensure fast and efficient delivery of information, automation of certain business processes, availability of information to end users and the like. Business can take place between four classes of stakeholders: Government (G), Business (B), Consumer (C) and Employee [1]. Figure 1 shows the business models between the mentioned participants.

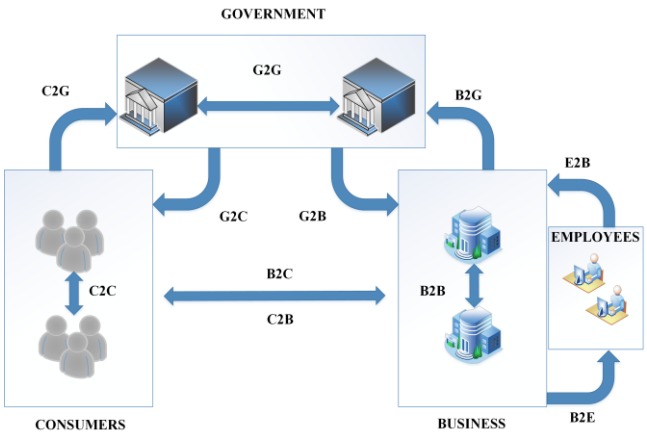

Fig. 1 Classification of e-Business model

It can be further categorized as e-Commerce, e-Procurement and e-Collaboration. e-Commerce assists the network of partners within the supply chain to quickly identify and respond to user requests collected through the Internet. e-Commerce provides the ability to exchange services and goods between two classes of stakeholders. The six basic e-Commerce business models are B2B, B2C, C2B, C2C, B2G and C2G. e-Procurement enables organizations direct or indirect procurement of materials and management of additional services related to transportation, storage, payment and documentation. e-Procurement is a subset of e-Commerce, which is based on three models of e-Business: B2B, B2C and B2G. e-Collaboration allows synchronization of different decisions and activities among supply chain partners, suppliers and customers via the Internet. It is based on using processes, strategies and application solutions to improve information sharing across the entire ecosystem of e-Business. It relies on E2B, G2G, B2E, C2C, C2B, E2B and G2B models. Production organizations will continue increasingly use the ICT and utilize the CC environment to better accommodate to user requirements and various changes in the way they work. This raises the need to link the entire business environment into the IoT environment and creating a network of sensors in order to improve data collection required for executing the transport and logistics processes [30]. All of this has an impact on transport systems and logistics processes, meaning that the data collected and the supply chain must improve their capabilities to predict market needs and enable smart warehouse management, which is linked to the B2B e-Business model. B2C is, along with B2B, most important e-Business model in the logistics area [28].

4 THE FUTURE APPLIANCE OF ICT IN TRANSPORT AND LOGISTICS AREA

There is an increased integration of ICT in logistic processes and transport systems because they can provide better, personalized services/products, improve the efficiency of the entire organization, ensure the flexibility of production and better supply chain processes. The IoT environment enables that because of the ability to connect products, objects and everything in the human environment. CC technology can be used to store and process data collected from the environment.

4.1. Appliance of technologies and concepts in the transport and logistics area

Augmented Reality (AR) provides a new perspective on logistics planning, carrying out activities and transportation. AR technology enables employees to obtain the right information at the right place at the right time. AR will be used in warehouses through smart glasses so that workers can be unhindered in their work and use their hands for selecting products, packaging, sorting, and even assembling. Today, smart glasses enable viewing specific tasks, barcode scanning and indoor navigation. AR is considered to be the next generation of navigation and auxiliary system for drivers to provide increased driver safety [31]. AR will be used to alert drivers of possible danger. Workers will be able to check every shipment using smart glasses based on object recognition technology. In addition to this, they will be able to virtually show the interior of the vehicle and define the optimal way to load the cargo.

Big Data serves to analyze a large amount of data, based on which decisions are made [32]. There are parts of the logistics area within which the Big Data concept has begun to improve efficiency in areas such as capacity planning and vehicle route optimization. Logistics and transport organizations will need to achieve the integration of structured and unstructured data from multiple data sources so that they can take full advantage of the potential of the data. Operational efficiency can be improved by using Big Data to optimize resource utilization, process quality, performance, and increase speed and transparency in decision making [30]. During transport, clever data correlation can provide real-time assignment of tasks or predicting time of arrival at the destination. User experience can be enhanced by using Big Data to create an integrated view of all user interactions and to show performance indicators. This enables accurate segmentation of users and creation of services / products according to their needs. End-to-end supply chain management can be based on forecasting analytics to achieve proactive customer loyalty maintenance and retention.

Bionic enhancements are reflected in the use of robots, but also in the use of smart support sensors. They can be used for tracking, locating the person who carries them, for recognizing gestures, while intelligent clothing can improve work routines, health and safety of staff. Smart glasses belong to this group of mobile sensors. By placing the sensor in the entire storage area and on the clothes of the personnel and the vehicles, it is possible to provide information to the worker to approach the vehicle. At the same time, information is provided to the driver that the worker is behind his vehicle. By 2020, Garner predicts that the 40% of employees will cut their healtcare cost by wearing a fitness tracker [33].

Cloud Logistics implies providing a new service Logistics as a Service (LaaS) based on business model [34]. Logistic service providers can activate and deactivate modular cloud services using payment options depending on how much the service is used. This enables high scalability of services and management capabilities without the need for traditional development, setting up and maintaining their own IT structure. The main focus in the future relates to security within CC solutions as well as to the technical performance of large-scale real-time processes within CC services. The modular CC logistic platform can provide a web-based approach to flexible, variable service and service on demand which is connected to logistic processes and that can be easily integrated within the supply chain management.

CC based supply chains virtualize information and data streams by shifting all the processes that are taking place within the supply chain on the CC platform for faster processing of enormous amounts of data and redirecting information to a specific destination. By managing parts of the complex global supply chain, logistic service providers often deal with many transactions occurring between different parties using different warehouses and transport management systems. CC has the ability to coordinate these information and present them in an integrated view. CC can provide control over the levels of their global stocks and precise control of the delivery location and organization assets.

LaaS is considered as a CC platform that connects all logistics organizations, service providers, equipment manufacturers, regulatory units, media and other industries to gather all resources into a single pool of resources. This platform would collect all customer orders that would be processed in the CC environment and classified according to the time and place of the order. Based on the processed data, orders would be forwarded to certain shipping organizations to ensure delivery of the product / service to the end user [35]. The benefits that LaaS brings are better connectivity with partners and end users, energy savings and reduced ICT infrastructure maintenance and standardization costs.

Digital Identifiers imply on the use of digital watermarking, smart labels for simpler product identification, asset location and so on [36]. NFC technology and QR codes are used for this purpose. Digital product identifiers have ability to provide identification, location, and product search from a production point to the point of sale. Managing the integrity of goods will reduce the risk of fraud and if there is a mistake in processing the material and the like and it will be possible to locate the exact moment and location when an error occurred.

According to Gartner predictions, there will be 25 billion connected devices worldwide by 2020 [37]. Connecting the warehouses, transparency and location of the entire property of an organization in the IoT environment can be achieved. Such "smart" objects can forward order information, the contents of each order, destination, and more, which can provide inventory managers with a real-time view of inventory status and the status of a product. IoT can also provide better safety and health for workers as it can easily provide lighting, heat and humidity control within the organization [38]. Intelligent transport solutions can increase transparency and integrity within the supply chain through innovative smart car concepts. For example, vehicle motion data can be collected and the ideal time to achieve the maximum efficiency of a fleet of vehicles. Considerable number of organizations today use Machine-to-Machine (M2M) communication that is key to IoT.

Autonomous vehicles will become a major part of the logistics and transport as they will increase productivity, reliability and quality of product delivery by eliminating human error. Future warehouses will use autonomous vehicles that will transfer pallets from one part of the warehouse to another. This will be possible precisely because of the development of sensor technologies and the IoT concept. Autonomous vehicles in the outside environment will also become important for transport processes. It is based on the development of vehicles based on the above-mentioned technologies that will be able to drive all the way to the end user's home entrance to deliver the product as well as be delivered at a time when the user requires it [39].

Machine learning systems will enable complete autonomous optimization in logistics [40]. Humans will no longer be an intermediary, but each system will have the ability to adapt and improve its own algorithm every time it receives new data and thus improves its results over time. By using speech recognition technology in the way that data is recognized, future logistic center services could use the user interaction systems mentioned above, first for simpler problems and later for more complex. The key benefits that will contribute are quick problem solving and decision-making, real-time data analysis and responding to problems, constant autonomous upgrading of logistics processes which will have impact on efficiency and quality.

Unmanned Aerial Vehicles (UAV) represent drones that will deliver the product to the user. In large cities in hours of high traffic burden, it is very likely that the delivery of the package will be delayed if it is done on a classic, road trip. UAV will successfully solve this problem [41].

The impact of ICT on the development and growth of transport and logistics is evident and even the current technology has impact on simplification of business processes. Developing ICT brings more opportunities for progress, not only in the transport and logistics industry but in all other industries.

4.2. Proposition of architecture based on Cloud Computing and Bluetooth technology

There are three basic models that CC technology provides show: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (Iaas). Each model is different in a way of which part of the service is managed by service provider and which part is managed by user which is shown in figure 2.

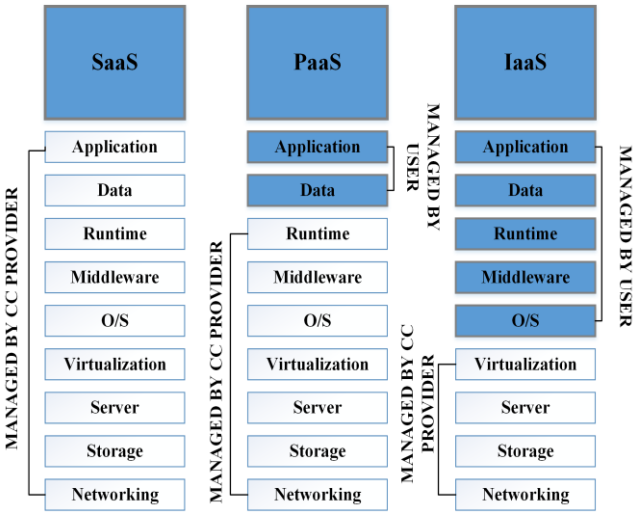

Fig. 2 Cloud Computing models

Organizations choose the model that best suits for their work. The SaaS model provides organizations with the ability to use already completed solutions, i.e. to buy software as a service. The PaaS model enables businesses a platform to develop application solutions based on their needs. IaaS model allows the organization that a third party maintains IT infrastructure that the organization expects, such as storage space, network equipment, process power, and more. In addition, organizations can select a public, private or hybrid cloud.

Public clouds imply providing services that are available on the Internet to all users and business types. Private cloud is intended for internal organization network where services are only available to employees. The hybrid cloud is a combination of public and private clouds. The supply chain depends on the collected data and information and how to collect, process, store, update, interpret, understand, and render them. It is important to collect and process information in real-time so that the key business decisions can be made.

For this reason, it is necessary to link all stakeholders, systems and processes so that everyone can use, interpret, collect and processes the data in the same way to avoid interoperability problems. The architecture in figure 3 is based on the CC concept in combination with BLE technology and beacon devices.

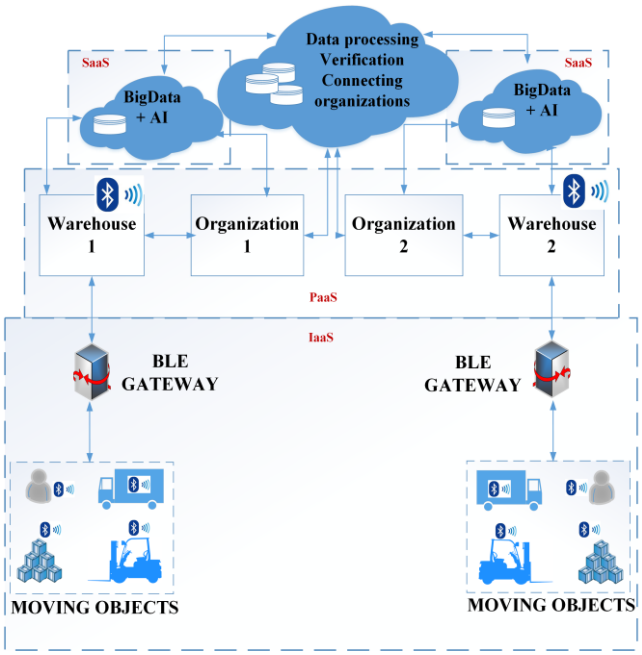

Fig. 3 Architecture based on Cloud Computing and BLE

By using proposed architecture, is possible to connect all stakeholders, systems and processes within the area of transport and logistics. It brings many advantages for organizations in the transport and logistics area. By using BigData and Artificial Intelligence (AI) it is possible to predict the trends of product demand. BigData is used to analyze unstructured data. That data can be synthesized and used to predict product demand and affect the profitability of the organization. AI has the role to make business decisions and with BigData it can serve as a tool for automated control of business processes. By using this, it is possible to increase the stock of warehouse in a preventive way to meet the customer demands in defined period of the year.

The private cloud provided by the service providers ensures organizations to work off business processes and availability of information to the employees of the organization.

When a product needs to be ordered from an organization, an order request is sent via the public cloud that uses AI and Cloud Logistics as a Serivce (CLaaS) to find a suitable organization that meets the customer demands, such as the cheapest product that can be delivered in two days. All logistic and transportation organizations are connected to a common cloud to share needed business information in real-time. This allows customers to get needed information about certain products like prices, time of the delivery of the product etc. The organization that satisfies the order conditions, executes all the processes required to deliver the product. The communication between customer, business partner and organization aswell as the process of ordering and shipping products using CLaaS platform is shown in figure 4.

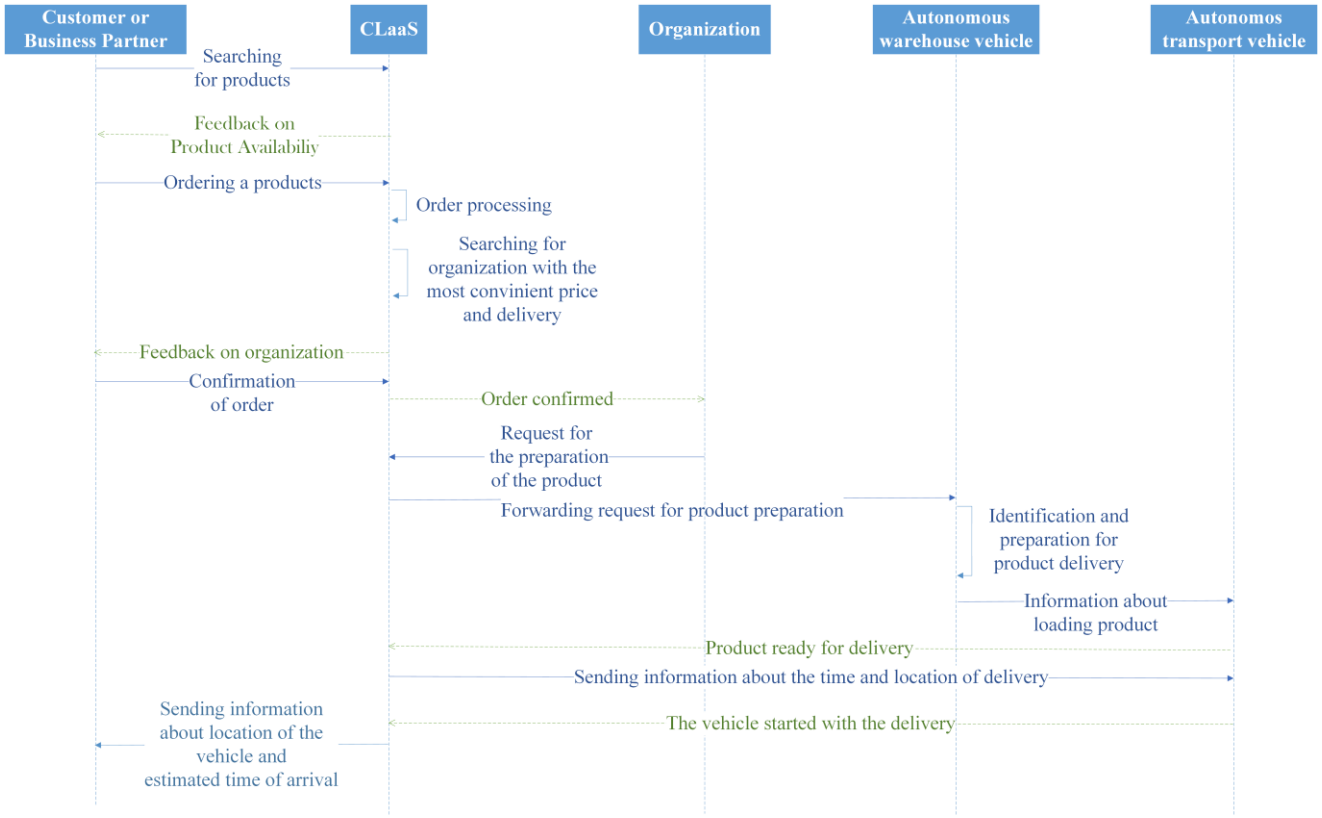

Fig. 4 The process of ordering and delivering a product

The CLaaS model combines SaaS, PaaS and IaaS models into a common model, but the way it is used depends on who uses it, customer, organization or business partner.The proposed CLaaS model is shown in figure 5.

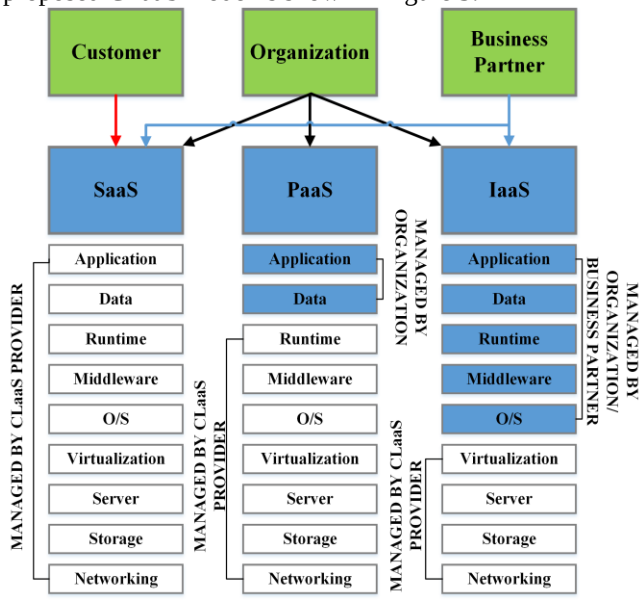

Fig. 5 CLaaS model

The customer can access the application that is available as a SaaS solution that is part of the CLaaS model and see the availability of a particular product. Customers, logistic organizations and business partners can communicate through SaaS solution. PaaS provides organizations with the ability to develop additional applications that are required for internal communication or specific logistic processes. IaaS provides the infrastructure that enables communication with moving objects in the warehouse and forward of collected information. Business partners are transport organizations that transport the logistics organization's products to the end user. IaaS provides infrastructure that enables achieving compatibility with the logistics organization's infrastructure. This allows communication between the autonomous transport vehicles and the autonomous vehicles in the warehouse.

By using CC architecture, delays in the delivery of information are reduced. The organization does not have to worry about its own IT infrastructure because it is under supervision of CC provider. In any time, organization can demand and obtain the necessary resources. To achieve the efficiency of logistics processes and transport systems, it is necessary to link all stakeholders into a common system. By exchanging information between partners and automated business processes within an organization, it is possible to provide quality delivery of service/product to the end user.

For this reason, it is necessary to link all organizations to a common public cloud. The joint work of BigData and AI enables labor force savings and more accurate assessment of future market demands. Beacon devices are used because they are easy to carry, Bluetooth technology is supported on many devices so it is easy to set up beacons using mobile applications. They are cheaper and because of their flexibility, accuracy and lower energy consumption, they are better than RFID technology.

5 CONCLUSION

Because of the ever-increasing integration of ICT in transport and logistics area, it is obvious how these technologies have had a positive impact on the work of the organizations.

Economic pressures affect organizations in a way that their business processes should be more effective and efficient and that they should take the advantage of the potentials of ICT. The ICT in the transport and logistics area is explained and divided on automated identification and data collection technologies, data exchange technologies and IoT and CC environment. Classification of e-business is given in transport and logistics area. The two most commonly used e-business models, B2B and B2C, have been identified. Autonomous vehicles, independent learning systems, unmanned aerial vehicles, Augmented Reality, Big Data, bionic enhancements, Cloud Logistics, Digital Identifiers, IoT and Sensor Technology have been identified and all of them can affect the business operations in transport and logistics area. The proposed architecture based on CC and BLE technology achieves faster delivery of information and detection of objects within a certain area. In the future, it is expected that the same effect of ICT will be on other industrial areas as well. By the 2020, it is expected that there will be 25 billion of connected devices, 10 billion of autonomous vehicles and 7 million drones. About 100 million consumers will shop in augmented reality. It is expected by 2020 that 80% of all business applications will be based on CC, while today there are only 24% of them. It is evident that IoT gives many possibilities in business environment. All the potentials of ICT need to be utilized to make business processes within the transport and logistics area as simpler as possible and focus human resources on other business processes.

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