MODEL FOR TRACEABILITY, VISIBILITY AND COMPONENT IDENTIFICATION IN THE AUTOMOTIVE INDUSTRY THROUGH RFID TECHNOLOGY

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Abstract

The article primarily deals with the application of AIDC technologies in logistic chain as well as connections with the issue of visibility, traceability and smart component identification in automotive industry. It describes the current state of automotive industry in Slovakia and the necessity of accurate identification of components with emphasis on the prevention of their counterfeiting, which can be achieved by standardized solutions. It focuses on RFID technology as a form of automatic identification and data collection and also Electronic Product Code (EPC standard). The article briefly specifies model which was created to ensure visibility and traceability and also describes software solution for component identification in automotive industry. Created web application presents a model for the registration and identification of transport and logistics units on a standardized EPC basis. It is also a model in which we point out the potential of goods identification through RFID technology across logistics chains in the automotive industry.

Keywords: Electronic Product Code, Visibility, Model, AIDC technologies, Automotive

1. INTRODUCTION

Automotive industry is growing rapidly and the production of new cars are growing demands for the identification of parts, and sub-contracting the traceability of the entire supply chain. Slovakia has many of subcontractors who produce various components and used in transport various type of transport and handling units. Technology of automatic identification plays a significant role nowadays in all the fields of logistics and economics. Regarding the optimization of supply chains, the bar code technology is utilized for this purpose in a long term. The current topic is the traceability as well as the possibility of falsifying individual components in the automotive industry. One way to prevent this phenomenon is to use standards to identify the components. These are GS1 standards, either in the form of application identifiers located in barcode or 2D codes, respectively EPC code. Since it is a global standard known mainly in retailing, it can be used across the entire logistics chain and across all continents. The article focuses on model which was created to ensure visibility and traceability and also describes software solution for component identification in automotive industry. Created web application presents a model for the registration and identification of transport and logistics units on a standardized EPC basis.

1.1. The situation in the automotive industry in Slovakia

In 2016, a trio of Slovak car factories, according to data from the Automobile Industry Association (ZAP), has already crossed the border of a million manufactured vehicles for the second consecutive year. The production lines noticed more than 1,040,000 cars (record-breaking). Kia in city of Žilina produced 339,500 vehicles in the last year, which is more than in the previous year. There were 315,050 vehicles in the PSA Group Slovakia Trnava line, which is an annually increase of four percent. Volkswagen Slovakia in Bratislava produced 388 687 vehicles. Below is a picture to compare ten consecutive years. [4, 6]

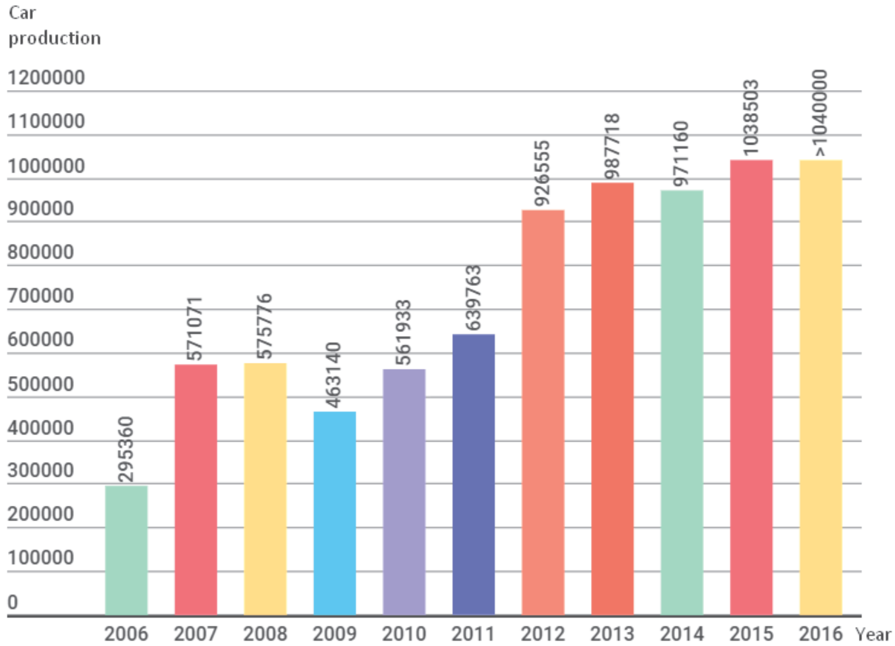

Figure 1 Car production in Slovakia in 2006 - 2016 [6]

1.2. RFID technology overview

RFID technology is complex, combining a number of different computing and communications technologies to achieve desired objectives. Every RFID system contains an RF subsystem, and most RFID systems also contain an enterprise subsystem. An RFID systems supporting a supply chain is a common example of an RFID system with an inter-enterprise. In a supply chain application, a tagged product is tracked throughout its life cycle, from manufacture to final purchase, and sometimes even afterwards (e.g., to support service agreements or specialized user applications). Radio frequency identification is a wireless data collection technology that uses electronic tags which store data, and tag readers which remotely retrieve data. It is a method of identifying objects and transferring information about the object’s status via radio frequency waves to a host database. RFID represents a significant technological advancement in AIDC because it offers advantages that are not available in other AIDC systems such as barcodes. RFID offers these advantages because it relies on radio frequencies to transmit information rather than light, which is required for optical AIDC technologies. [1, 2, 3]

There are three basic components of RFID system, RFID tags, RFID readers and middleware, which is responsible for all data transaction in the system. Each object which has to be identified has a small object called a RFID tag stuck to it. Each RFID tag has a unique identifier that enables additional information about each object to be stored. [8, 10, 11]

1.3. Electronic product code

The Electronic Product Code™ (EPC) is syntax for unique identifiers assigned to physical objects, unit loads, locations, or other identifiable entity playing a role in business operations. EPCs have multiple representations, including binary forms suitable for use on Radio Frequency Identification (RFID) tags, and text forms suitable for data sharing among enterprise information systems. [5]

GS1´s EPC Tag Data Standard (TDS) specifies the data format of the EPC, and provides encodings for numbering schemes - including the GS1 keys - within an EPC. When unique EPCs are encoded onto individual RFID tags, radio waves can be used to capture the unique identifiers at extremely high rates and at distances well in excess of 8 meters, without line-of-sight contact. The Serial Shipping Container Code EPC scheme is used to assign a unique identity to a logistics handling unit, such as the aggregate contents of a shipping container or a pallet load. The Serialized Global Trade Item Number EPC scheme is used to assign a unique identity to an instance of a trade item, such as a specific instance of a product. [9]

2. DESCRIPTION OF MODEL

The generated model presents the registration and identification of transport and logistic units on the standardized EPC basis. It is also a model in which we point out the potential of identification through RFID technology across logistics chains in the automotive industry.

The model consists of two main areas: the subcontractor area and the car manufacturer area. These areas are decomposed into particular zones (reading points) describing identification processes running within the logistic chain, respectively. material flow between the automotive component manufacturer and automotive manufacturers. [7]

The following figures describe the individual count points and steps in the manufacturing and delivery process of components from a subcontracting company to car manufacturer. It is important to note that within the EUREKA project, which was the basis of this model, a number of tests were carried out directly at sub suppliers for the automotive industry. These tests were carried out in cooperation with our project partners. The steps are used to report the results to the system based on EPC:

1. Labeling of a specific component or product with RFID tag
    - The reading point - the message *product was made*
2. Packing of two pieces of a particular product into the box - the box will be labeled with the RFID tag
    - The reading point - *the products were packaged in a box*
3. Packaging the eight boxes on the pallet, the pallet will be labeled with the RFID tag
    - The reading point - *the boxes were packed on the pallet*
4. Store the pallet in the warehouse
    - The reading point - *pallet storage*
5. Expedition
    - The reading point - *pallet are going out from warehouse, loading pallet into the semi-trailer.*

In the first step, it is about labeling the component or product which will be subsequently packaged and shipped directly to the car manufacturer. In our case, it will be tires (respectively wheels) fitted with an RFID tag that will be pressed directly into the tire (e.g. Continental makes this happen at more expensive brands). The number will be in the form of SGTIN, which will accompany the product to the manufacturer's identification process and then assembly of the entire vehicle. Within the database, we will have an overview of all produced components or products tagged with the appropriate tags. As a source, we chose the Alien RFID tag shown in **Figure 2**.

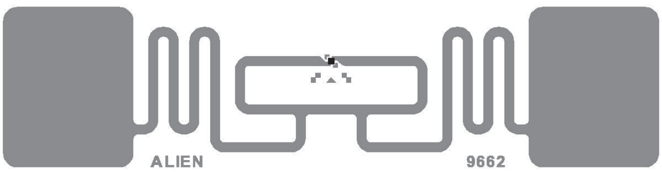

Figure 2 RFID tag used in model

The product goes down the roller track to the reading point shown in **Figure 3**. Subsequently, the SGTIN number is written to the product database and a report is produced that the product has been manufactured.

After the product is manufactured, the second step is the packaging of the selected number of products into the box (**Figure 4**).

Here are two options:
1. A predefined number of pieces in a box for a given product.
2. The number of units will be unlimited, depending on the size of the box and its capacity.

With both options, the box will be equipped with an RFID tag. Within the system and the appropriate database, the RFID tag of the produced product will be assigned to the RFID tag of the given box. This means that after reading the RFID tag of the box, an enterprise will be able to find out how many pieces are in the box and what identification numbers they have. This will also know the additional features of the product that are written in the database. The output of this point is a report about packaging products into a box.

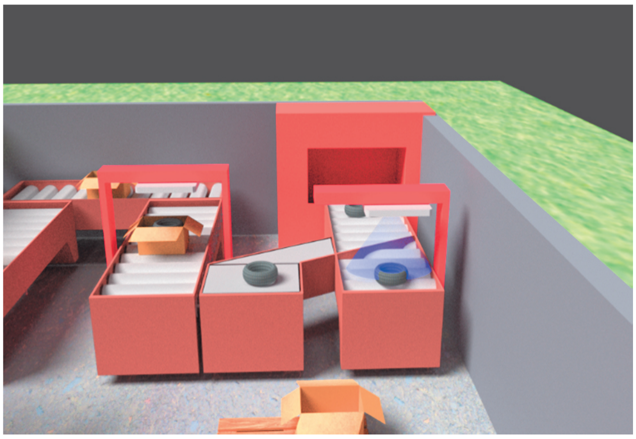

Figure 3 Loading of a manufactured product

Figure 4 Loading of the box with the placed products

A third necessary step for automatic identification of product is the packaging of eight boxes per pallet (**Figure 5**), which will be labeled with the RFID tag. The given RFID tag has a data structure associated with the SSCC application identifier. This identifier is assigned to all eight RFID tags that are placed on the boxes. After the palette tag is readied, a report is created, that tells us about packaged numbers of boxes per palette. In addition, the system works only with the SSCC identifier, based on which we know how many boxes are in the pallet and what the total number of products on the pallet is.

When the pallet tag is scanned and the palletizing process is finished, the palette is placed in the warehouse. The pallet passes through the identification gate and is subsequently assigned to the warehouse by the FIFO system. Based on the FIFO or the selection of a particular pallet tag, the pallet exits the warehouse (**Figure 6**) and is transported to the appropriate semi-trailer.

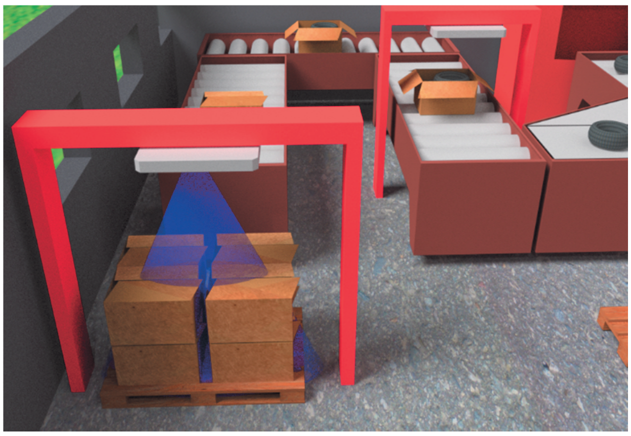

Figure 5 Loading the pallet after completion

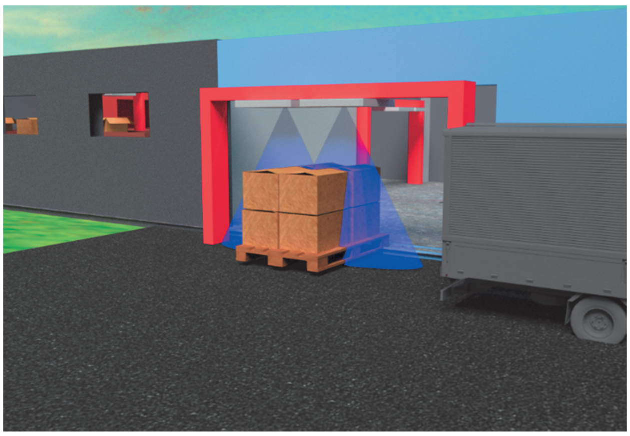

Figure 6 Reading the pallet in warehouse exit

Next comes the area of the car manufacturer, namely the process of package receipt.

The model in this second area includes the following steps (reading points):

1. Receipt of the package
    - The reading point - the palette has passed through the receiving gate
2. Storage of the package
    - Reading point - the palette was saved or stored in the warehouse.

It is important to receive the package, which is expected by the car manufacturer. After expedition, a report about the number of boxes and products with the appropriate RFID tag representing the pallet is sent. After reading at the receiving site, it is verified that the given RFID tag is correct, expected and followed by the report *"palette passed through the gateway for receipt".* Upon successful receipt of the shipment, the storage process takes place, where the pallet SSCC RFID tag is scanned and the pallet is stored at the car manufacturer. At the end of the chapter, we provide an overview of the identification within our model.

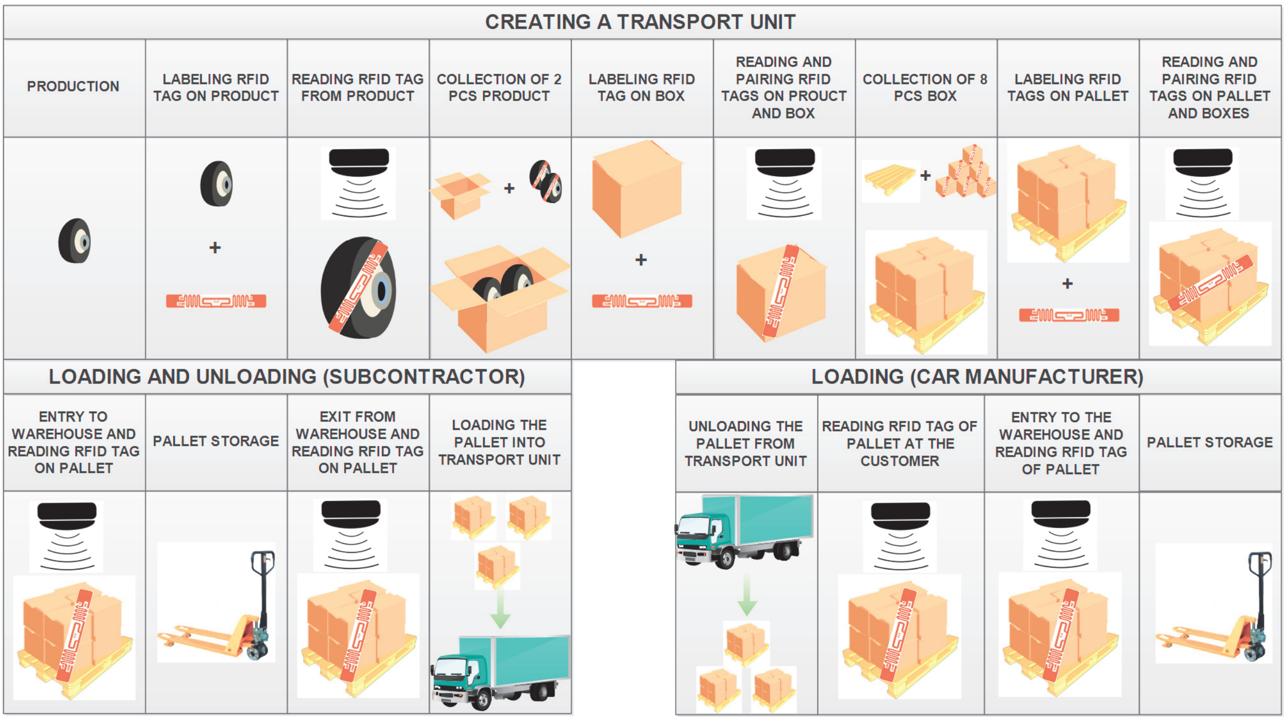

Figure 7 An overview of the identification within the model

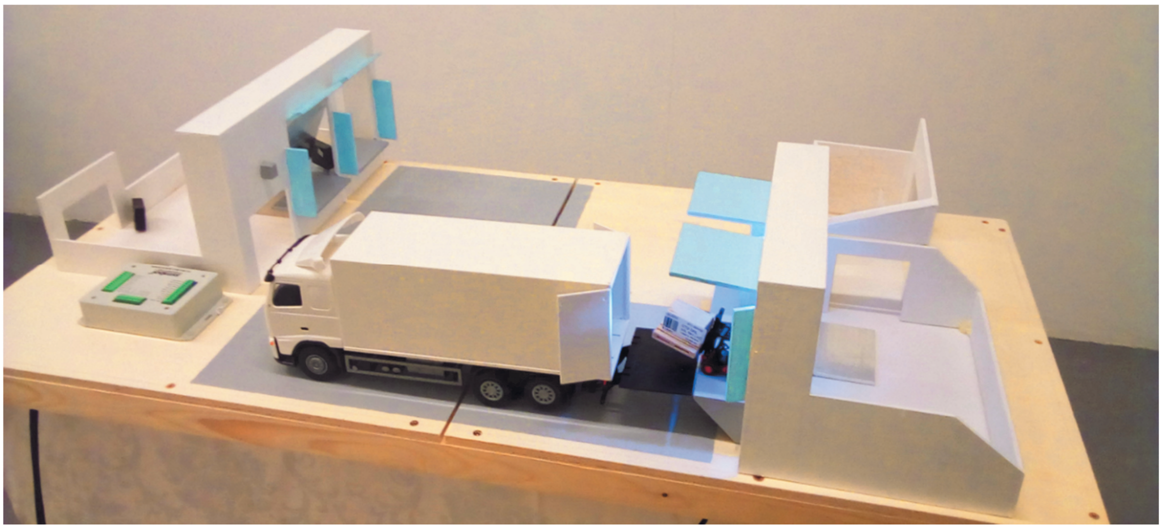

Figure 8 Created model

For verification and presentation of the proposed solution we build also a reduced model of the supply chain. This model is equipped with real RFID technology, developed for the purpose of the already mentioned Eureka project. An integral part of this model is a web-based interface that provides relevant information about the movement of individual parts within the subscriber-supply chain. The whole model is built according to the EPC Global standard.

3. CONCLUSION

The current increasing trend in the automotive industry opens the door to a new area of monitoring and identification of transport components used in automotive. We are not talking only about internal identification of goods but for standardized external identification and monitoring of several types of components through the logistics chain. Our identification is based on electronic product code and GS1 identification keys, which are represented useful solution for this type of services. With our solution we can increase visibility and traceability of products and we are able to answer on questions where, when, what and why product was. We created also software configuration based on AMP open source platform and set all processes to be useful for our EPC based solution. During the upcoming days we would like to finished our web application and show our model to representatives of automotive industry.

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