NEW POSSIBILITIES OF CONSIGNMENTS LABELLING IN THE POSTAL SERVICES

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The article deals with improving process of postal operators and their services. Specifically we discuss possibilities of replacement of the existing one dimensional bar code labelling by smart labels with Radio Frequency Identification (RFID). Research on proper location of RFID tag on package was made in automatic identification laboratory. We simulated the real operation conditions by using linear conveyor belt and different type of package with different content. Percentage of read RFID tag should be high for correct functioning of new system. The whole consignments labelling system has several layers. The top layer consists of information systems and the bottom layer consisting of consignments labelling. In the case of replacement of the current system by RFID the lowest layer would be RFID subsystem. The article deals with the lowest layer of the system: the hardware part, which is primarily consisting of RFID tags as information carriers. And last but not least the article deals with the format in which the information will be coded on the tag and label. One possibility is to use the format of the Electronic Product Code, which is assigned by a non-profit organization GS1. We discussed other possibilities of code format coded into RFID tag for new system requirement. Replacing the current status would open new possibilities for the higher layers of the system and the processes in the post.

Keywords: RFID, post, labelling, EPC, bar code, consignment

1. Introduction

Information is currently still the best competitive tool and which controls it before gaining a big advantage. Using automatic identification technology information from the manufacturing, logistics and business areas in near real time can be extracted. These technologies are indispensable aid in identifying, tracing and tracking of any object.

Radio Frequency Identification (RFID) and Electronic Product Code (EPC) are technologies, emerging after bar codes for automatic identification products and information sharing between trading partners; bring new opportunities to improve and simplify the relationships between business partners and their properties, extend the capabilities of labelling, while not intended to replace now the most prevalent technology for identifying products - bar codes.

Electronic Product Code (hereinafter EPC code) is a new generation of labelling the incoming bar codes. Its creator is a scientific research Auto-ID Centre (now Auto-ID Labs), which has been developing systems for automatic identification.

EPC code can be characterized as [12, 13]:
- a number encoded in electronic form and stored on a storage medium - chip, which transmit data to the computer using radio frequency,
- an internationally standardized system that is used to uniquely identify objects and goods throughout supply chains,
- EPC code is a number that indicates a specific item. This means that in addition to identification of the manufacturer and the type of product also contains a serial number to identify each individual product,
- Code, which allows the manufacturers, distributors and traders the movement of goods across supply chains, accelerates business processes (e.g. handling of goods, delivery, etc.) and reduces the risk of stolen goods.
2. Current Status in Slovak Post

Slovak postal is using one dimensional bar CODE 128 for pack labelling. This code can contain alphanumeric characters. This bar code consists of 13 alphanumeric characters including control number. First two characters are reserved for code of service (Table 2). These two characters are followed by 8 characters string. This string contains number and this number is growing in range that was granted by Slovak postal. Bar CODE128 has three variants. Basic variant can support alphanumeric characters. CODE128B support alphanumeric characters as well but it can obtain small alphabet characters, too. The third variant can support longer string up to 19 characters, but only support numbers. Slovak postal need only large alphabet characters and numbers (Table 1), therefore CODE 128 is sufficient [2].

![Figure 1. Current label](image1)

![Figure 2. Current label decomposition](image2)

3. Possible Data Structure Stored into RFID Tag

EPC- Electronic Product Code. This code uniquely identifies a product, item, room, place or any object. It was created in the centre of the MIT Auto-Id. Acronym EPC itself means electronic product code. And whole identification is based on electronic form. The identification number is coded and stored to RFID tag, for example. EPC code itself is possible to store not only on RFID tags but it can be stored on various carriers (2 dimensional codes). With this unique code, we can identify any one item or product individually and uniquely [1].

This ensures uniqueness of the numbers. The number as such is meaningless without connection to database. EPC number is shortcut to database information about items, rooms or in our case packages. Format and type of information in the database is on us. And EPC as a unique key allows accessing data on a particular product, which are stored in databases, therefore, by creating label, we need to create cloud data about this package.

EPC structure:
- Head - defines type of EPC code. For each type of EPC is different 8 bit combination.
- EPC manager number. Prefix of company and assigned number from GS1 – GS1 company prefix.
- Type of item- Type of product, not unique product but group of products (yogurt, milk).
Serial number - this number refers to certain product, you may find additional information about the product [1].

Company can gain GS1 prefix only from GS1 organization and this number contains info about this organization. GS1 prefix is followed by prefix of company and together are creating GS1 company prefix. This structure is mandatory and we have to stick with it.

EPC URI (uniform resource identifier) is the preferred way to uniquely identify specific physical object within information systems. EPC URI is a string that shall take the following form:

\[
urn: epc: id: scheme: component1.component2. ...
\]

Where the scheme is an EPC scheme and component1 and the following sections represent the elements used by GS1 key corresponding to the EPC code. Example for SGTIN:

\[
urn: epc: id: SGTIN: 0614141.112345.487
\]

The structure of the EPC URI guarantees the uniqueness of all physical objects and applications around the world.

EPC codes may take three forms. In computer systems, including electronic documents, databases and electronic messages shall EPC code form. Another form, which may EPC codes acquire the form of the so-called EPC tag URI.

Memory bank code EPC RFID tag second generation also includes an EPC code and "control" information (filter), which is used to guide the process of collecting data from RFID tags. This information can be used to filter tags, or to improve their reading efficiency. EPC tag URI is a URI string that represents a specific EPC code with specific settings for the "control" information stored in the memory bank EPC code. In other words, it is a text equivalent of the entire contents of the EPC memory bank. This form is often used by the data collection, when reading RFID tag of "control" information interest application that provides data collection.

The EPCglobal Architecture Framework is used in the form of "events at the application level". Example EPC tag URI when used SGTIN key:

\[
urn: epc: tag: SGTIN-96: Filter.GS1_firm_prefix.kinfogs_items.serial_number ->
urn: epc: tag: SGTIN: 3.0614141.112345.487
\]

Another form, which can acquire EPC codes, is a form of binary encoding. Memory bank code EPC RFID tag contains the second generation compressed encoding EPC code and "controls" information in a compact binary form. Converting between EPC Tag URI and binary form in the second generation RFID tag is 1:1. Binary form is used for low level software or hardware and usually converted into the EPC Tag URI or URI clear identity before being presented to form EPC code application logic. While pure identity URI is independent of RFID, EPC Tag URI and binary encoding are specific to the second generation of RFID tags (RFID EPC Gen2), because they contain a unique EPC identifier in addition to the "control" information. The EPCglobal Architecture Framework, this form uses the "Protocol for Sensor low level" and the "Air Interface Class 1 Gen2 and High Frequency". Example binary encoding:

00110000111101000100101111111101000111011000010000000000000000
0000000000000011100111.

This article deals mainly on the proposal of the possible use of electronic product code in the mail and logistics, focusing in particular on the package labelling and transport units (containers, containers, etc.) using EPC codes and displaying data in enterprise information systems.

4. Possibilities of RFID Technology in the Post

RFID (radio frequency identification): RFID technology is using electromagnetic field for communication between terminal and electronic tag. The tag is attached to the object, goods or room about which carries identification data. This identification data can be easily read by reading device and store or send for further data processing by system [5].
<table>
<thead>
<tr>
<th>Binary representation</th>
<th>Hexadecimal form</th>
<th>Size in bits</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1111 1111</td>
<td>FF</td>
<td>undefined</td>
<td>Reserved for heads longer than 8 bits</td>
</tr>
<tr>
<td>0011 0011</td>
<td>33</td>
<td>96</td>
<td>GRAI-96</td>
</tr>
<tr>
<td>0011 0010</td>
<td>32</td>
<td>96</td>
<td>SGLN-96</td>
</tr>
<tr>
<td>0011 0100</td>
<td>34</td>
<td>96</td>
<td>GIAI-96</td>
</tr>
<tr>
<td>0011 0110</td>
<td>36</td>
<td>198</td>
<td>SGTIN-198</td>
</tr>
<tr>
<td>0011 0111</td>
<td>37</td>
<td>170</td>
<td>GRAI-170</td>
</tr>
<tr>
<td>0011 1000</td>
<td>38</td>
<td>202</td>
<td>GIAI-202</td>
</tr>
<tr>
<td>0011 1001</td>
<td>39</td>
<td>195</td>
<td>SGLN-195</td>
</tr>
</tbody>
</table>

Combinatory gives us 256 possible combinations of head (2^8). This value is relatively high but we cannot forget it is limited. Some of combinations are reserved, undefined or already in use.

EPC code is code that exists in various forms and can be stored on various types of media. It is not necessary that the EPC code is stored on the RFID tag only. Databases can work with EPC code and it does not matter form where EPC code was read. EPC standalone above hardware solution and RFID tag is one of possibilities to store it [7].

5. Use of EPC Codes, Created by the Existing EPC Standards in Mail and Logistics

Implementation of RFID - EPC tag second generation (EPC GEN2 tag, see Figure 1) to the postal service would be an increase in efficiency and productivity of the sector. Price tags steadily declining and because the postal sector should pay more attention to the integration of this technology into their business processes, thereby ensuring not only increases efficiency and productivity, but also increase the visibility and accuracy of postal operations.

EPC codes, created on the basis of existing standards may be used throughout the supply-demand chain, from producer to consumer. Mail can also be used such EPC codes in their activity. Proposal to use the EPC code developed based on existing standards is described in the following example (see Figure 1).

Imagine postal processes such as Supply Chain. The automatic data collection throughout the chain will serve data carrier, in which the memory will be stored EPC code itself, in this case, the EPC Gen2 RFID tags. To identify will be Gen2 EPC RFID tags

EPC scheme used in this case:
- SGLN to uniquely identify physical locations, specific place,
- SGTIN to uniquely identify a specific type of product,
- SSCC to uniquely identify logistic units.

The data encoded in the tag memory will be scanned EPC sensors. EPC sensor will be placed at strategic points in the supply chains in order to track the movement of goods in the chain. Sensor data then executes software EPC middleware, which sends the data to the EPC IS or other existing enterprise information systems. Sharing data provide EPC IS, from which the distributor can (e.g., Slovak Post) require specific information about the product.

Search Services (Discovery Services) allow users to access data related to a specific EPC code, and also allow users to request access to this data.
Manufacturer (postal operator) produces business unit (letter, parcel). To indicate the business unit uses EPC code developed on the basis of standard SGTIN. Growing the business units will be stacked so
that together created with a variety of pallet units (container), which will be labelled EPC code created under SSCC standard. Strategic locations where the production takes place (income items), loading/unloading, selling (supply items) goods, or the place where the goods are stored shall be labelled EPC code generated by standards-based SGLN. Marked points help locate the exact location of goods in the warehouse or goods traced anywhere in the supply chains. In table (Table 2) we can see an example of viewing flow data in database presentation and on Figure 5 we may see EPC code in various form during whole process of operating.

6. Selection of Proper Label for Application

Selection of the proper type of data carrier-RFID tag is an important step in the system design. RFID tag is mechanically connect to the package and in some way identifies the package or its properties. Later if it is necessary can be this information read from the data carrier using radio waves. When measured under laboratory conditions we have a full range of RFID tags available. We can try to find solution practically with any type of RFID tag, but the difference occurs in the realistic conditions, where RFID tags are used in large numbers and cost is key feature. We must balance minimum price and tag functionality required. Price tags range from a few cents for the simplest passive models to hundreds of Euros for specialized active tags designed for extreme conditions.

There is a wide range of labels from different manufacturers with different functionality. Our task was to find a suitable combination of RFID data carrier and the application for which the RFID tag will be determined. Application, we are dealing with, is known “using of RFID technology in package sorting” and we must find suitable data carrier.

For labelling packages are not suitable RFID tags in the form of pendants or key rings or in any shape that would sticking out of the package. The label must be the most natural part of the package. Thickness of RFID tag should be as small as possible. And as it is a part of paper packaging, it should be largely flexible without damage.

In our application will tags on the packages be read in an indoor environment (main processing centre) without undue interference signal by weather conditions. Reading distance for passive RFID tags is up to 10 metres (depending on operating frequency). This distance is sufficient and it is not necessary to extend it by using active source. Selection of passive technology is essential for reasons of cost per piece RFID tag.

Measurements we made within AIDC laboratory (Automatic Identification Laboratory), confirmed good readability of passive RFID tags operating at HF frequencies. Acceptable alternative are also RFID tags operating at UHF frequencies.

During the measurements, where we simulate different content of package, did not accrue any problems with reading. We used many problematic materials that could be transported through Postal chain such as metal and water. Since transported objects are always packed in carton or other packaging material, this material serves as sufficient insulation and therefore there is no problem with the reading.

6.1. RFID Smart labels

One of the options to replace current postal system based on one-dimensional bar code is the use of smart labels. This is elegant combination of the bar code and identification using RFID. The advantage could be the use of two-dimensional bar code with additional information readable for humans or optical readers on top layer. Smart labels are basically two-layer tags. The top layer is a layer of printed information for people or bar code readers. The bottom layer contains an electronic circuit and antenna-chip RFID tag. The label is typically located on the silicon substrate, which sticks to the labelled item. Whole smart tag is very thin, flexible and behaves like ordinary stickers and can be delivered and stored in rolls. In the current system is information printed in CODE 128. This status can stay and be expanding by system solution based on RFID tags. Or it may be to review the existing system and we can change information on the visible part of the smart label. For easy visual identification by human, one can just use the top layer of the label and can read information (printed text). Not always we have available optical or RFID reader, but the system has 3 level backup (one is text for humans, the second one is information for optical readers and the third one is information coded in RFID tag) and the chance that we will not be able to read any of this forms are relatively low [9].
6.2. Marking of transport units and shipments by Smart labels

One option to replace the current system of labelling shipments and transport units with one-dimensional bar codes is the use of smart labels. Smart label, also called Smart tags (smart label / tag, see Figure 4), is a type of RFID tag with a slim design that is inserted under the label, which contains a bar code and may also contain additional information about the shipment, transport unit, etc. This is a neat connection bar codes with RFID technology. This connection creates two layers, the top layer is a layer of printed information for people or for bar code readers and bottom layer comprises an electronic circuit chip and antenna. The advantage of smart label is just wireless (invisible) and visible to the naked eye identification within a thin self-adhesive labels. Smart tags can be applied to such packages or shipping units.

The complete solution for creating and printing labels of any kind NiceLabel software provides. This software allows you to create simple design labels, formatted text and graphics, work with variables, provides a link to a text file or a wide range of database systems and also allows you to print reports or forms. NiceLabel contains

1. The basic command line, which allows you to create new labels, save them, open existing labels, organize data on the label and also allows as preview before printing.
2. The toolbar with quick access, which allows you to instantly store labels, format text, images, variables, insert shapes (lines, ellipses, frames ...) and also allows you to connect to an existing database, which can include data about the object to which the label is created, or the value generated bar code, etc.
3. Button text box that allows you to create a text box. This text box can be placed anywhere within the established labels.
4. Bar code button, which allows you to insert bar code labels, from 2D codes (QR codes, Datamatrix ...), the GS1 bar codes (EAN-13, GS1-128 ...). Allows you to set the parameters of each bar code, calculate check digit, set the dimensions of the bar code, etc.
5. Image button, which allows you to upload pictures to labels, whether from a file or clipart, and allows formatting of images.

### Table 2. Example of visible flow of data in corporate information systems in a database

<table>
<thead>
<tr>
<th>TIME</th>
<th>status</th>
<th>URI - urn:epc:id</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:25</td>
<td>arrival</td>
<td>:sscc:5638575.2234012378</td>
<td>transport unit with serial number (#2234012378)</td>
</tr>
<tr>
<td>7:44</td>
<td>arrival</td>
<td>:sgtin:5638575.223401.535389</td>
<td>shipment with serial number (#535389)</td>
</tr>
<tr>
<td>7:45</td>
<td>arrival</td>
<td>:gdti:5638575.53787.12513</td>
<td>shipment with serial number (#12513)</td>
</tr>
<tr>
<td>8:00</td>
<td>arrival</td>
<td>:gsrn:5638575.5370666856</td>
<td>dispatcher A</td>
</tr>
<tr>
<td>9:35</td>
<td>exit</td>
<td>:gdti:5638575.53787.12513</td>
<td>document with serial number (#12513)</td>
</tr>
<tr>
<td>11:55</td>
<td>arrival</td>
<td>:sgtin:5638575.201223.503279</td>
<td>shipment with serial number (#503279)</td>
</tr>
<tr>
<td>13:20</td>
<td>exit</td>
<td>:sscc:5638575.2234012378</td>
<td>transport unit with serial number (#2234012378)</td>
</tr>
<tr>
<td>14:05</td>
<td>exit</td>
<td>:sgtin:5638575.223401.535389</td>
<td>shipment with serial number (#535389)</td>
</tr>
<tr>
<td>15:54</td>
<td>exit</td>
<td>:gsrn:5638575.5370666856</td>
<td>dispatcher A</td>
</tr>
<tr>
<td>15:59</td>
<td>arrival</td>
<td>:grai:5638575.89632.31215</td>
<td>return assets with serial number (#31215) ...</td>
</tr>
</tbody>
</table>
Figure 5. EPC code in individual layers architecture the RFID
7. Conclusions

Use of EPC code in the postal service may vary. In combination with RFID tags, such as the medium of the EPC code, can be used for marking of the transport units. Transport units can be described by using smart tags.

The value-added comes by the very RFID technology that allows you to capture traffic units without direct optical visibility and allows you to read more labels for a short time and at a greater distance, as many of the radio technology operating at extracting enable transmit and receive signals more efficiently than optical scanners. The advantage of labelling logistic units using smart labels is the ability to "advance reading" these labels. "Advance reading" resides in the fact that bar code scanners or RFID readers combined may not always be available.

In such a case worker for easy visual identification makes use of the top of the label and the information can be read. The system has thus insured a number of ways of reading a good chance that the tag will be read one way or the minimum.

The problem with using EPC codes in the mail may be in the absence of headers for operators. At present, the header does not exist for operators. Mail would have to create such a request header organization GS1. Mail would need to have a strong "lobbying" as if it were a difficult approval process and creating standard for operators. Favourable solution would therefore use existing EPC standards (header) and add the data according to their own needs, and the data must remain for the structure, which binds to the selected header.

References


Grant support
This contribution was undertaken as part of the research project VEGA 1/1321/12 Research of new trends in management in the era of globalization.

Centre of Excellence for Systems and Services of Intelligent Transport II, ITMS 26220120050 supported by the Research & Development Operational Programme funded by the ERDF.

Tento článok vznikol v nadväznosti na riešený projekt spolufinancovaný zo zdrojov EÚ s názvom „Kvalita vzdelávania a rozvoj ľudských zdrojov ako piliere vedomostnej spoločnosti na Fakulte PEDAS Žilinskej univerzity v Žiline, ITMS 26110230083.“

Moderné vzdelávanie pre vedomostnú spoločnosť / Projekt je spolufinancovaný zo zdrojov EÚ

This article was created in response to tackle a project co-funded by the EU titled "The quality of education and human resources development as pillars of the knowledge society at the Faculty PEDAS at the University of Žilina, ITMS 26110230083"

Modern education for the knowledge society / project is co-financed by the EU