SIMULATION OF LOGISTIC CHAIN IN GS1 SLOVAKIA LABORATORY

Viliam MOJSKÝ, Peter KOLAROVSZKI

University of Žilina, Žilina, Slovak Republic, EU,
viliam.mojsky@fpedas.uniza.sk peter.kolarovszki@fpedas.uniza.sk

Abstract

The article deals with a design of simulation program to serve for presentation of an automatic product identification cycle using GS1 standards. Its role is to clarify the issue and present the benefits of AIDC technologies. The program also presents GS1 standards for bar codes and radio frequency identification that are used in various areas and industry sectors, ranging from healthcare, retail to the automotive industry. Devices and software used in development and testing are presented within the article. The program combines basic operator input options with presentation screen with details for listeners. As a part of the simulation, the program is also linked to a real RFID printer and conveyor belt that complement the presentation and give it real-life touch. At the end of the article is presented the final version of the program

Keywords: RFID, logistic chain, GS1 standards, simulation

1. INTRODUCTION

The use of automatic identification elements to speed up and facilitate business processes has become a modern trend. The interest of private sector in this area is rising, because with these technologies companies can gain competitive advantage in form of speeding up the providing of services or providing value added services for customers. These technologies include barcodes and RFID codes developed and standardized by GS1. In addition to these activities, GS1 Slovakia also provides courses in automatic identification areas and in relevant standards. For several years, the organisation has been using SAP program for these purposes. The program, however, was created for lower resolution and older operating systems and currently is outdated. Therefore, a need for a new simulation program has emerged that will make it possible to clearly and comprehensively present AIDC technologies and relevant GS1 standards.

2. LOGISTICS

Logistics is an interdisciplinary science that deals with the activities and actions that ensure the flow of materials and information in the company from its source to the destination along with after-sale services. Logistics also includes the infrastructure, resources and equipment needed to provide the necessary flows and activities. Logistics activities are according to their classification in the production and distribution processes divided into supply logistics, distribution logistics and internal logistics [1].

3. USED STANDARDS

Standards connect the world. Thanks to them, we can encode a code on one side of the earth and decode it on the other side with the certainty that we will get the same result. By encoding standards it is possible to optimize logistics chain and improve communication between suppliers, customers and, in general, all logistics chain participants. Thanks to them, it is possible to track when and where the product was manufactured, the series in which it was produced, i.e. all the steps that have been recorded since its manufacture to date, regardless of geographical location. By using the electronic data exchange systems and corresponding decoding standard, all recorded data becomes available. This is the main subject of a simulation program that helps to present GS1 standards for automatic identification and their use within the logistics chain.

3.1. GTIN

GTIN, Global Trade Item Number, can be used to uniquely identify trade items at different levels of packaging ranging from individual pieces of goods to small transport units. A serial number can also be added to the code, through which we can identify each piece manufactured within the production series. By assigning the serial number, a serialized GTIN is created, i.e. SGTIN. The GTIN is unique to each company. Thanks to this, when we read the GTIN code in different countries and get a reference to the same manufacturer and the same product. The GTIN code is divided into 4 types: GTIN-8 (also known as EAN-8), GTIN-13 (known as UPC-A), GTIN-13 (known as EAN-13) and GTIN-14 (known as ITF-14) [2].

3.2. EAN-13

EAN-13, European Article Number, is one of GTIN codes and it is one of the most commonly used barcodes. It finds its use in labelling of consumer goods, group packs or carton packaging. It is a 13-digit code, its first three digits determine the country of origin, the following nine digits indicate the manufacturer and the type of goods, the last digit is control digit [3].

3.3. EPC

EPC, Electronic Product Code, is a syntax for creating unique identifiers that are associated with transport units, buildings and locations, retail items, and other physical items that are used in logistics and retail chains. EPC exists in two forms, in printed form and in digital form written in the memory of RFID tag, which serves as its carrier. It can be written in several ways, e.g. hexadecimal in which it is stored in the RFID tags, in decimal form, or in binary form that serves for translation between decimal and hexadecimal. EPC Tag Data Standard allows you to write data encoded by GS1 identification keys into the memory of RFID tag. GS1 identification keys that can be written to RFID tag memory via EPC include, for example, GLN, GTIN, SGTIN, SSCC, etc. [4,5].

4. METODOLOGY AND SOFTWARE

We used spiral development method in developing this software. The first step was the analysis of the devices for which the program will be designed. Based on the analysis, we chose middleware Aton AMP OnID as the appropriate software for communication with RFID devices. If offers a wide range of user options and it is also allows network communication. At the beginning of the laboratory presentation model, there is a ZEBRA RFID printer, so we used ZPL programming language to create print commands. After the initial analysis we started with software development, in which we have set milestones. Once we reached them, we have evaluated and consulted the achieved results and decided on the next steps. We could say, that we have divided the spiral of development into four stages: planning, development, evaluation and debugging.

4.1. Aton AMP OnID

Aton AMP OnID is middleware, which is used for creating control applications in RFID and AIDC systems. It is a modular software which consists of three main elements, namely processors, databases and labels. Databases are modules that are used to create a connection with database. It is enough to create this connection once and it can be used by all other program modules. Labels are used to write notes and floating comments. Processors are modules that create program functionality. They are categorized according to their usage, for example on filters, accumulators, printing processors, communication processors, etc. [5].

4.2. Zebra ZPL

ZPL, ZEBRA Programming Language, is a programming language that was created by ZEBRA Technologies to communicate with their devices. It is primarily used for creating labels and print commands.

5. SIMULATION SOFTWARE

We have decided to create the program in the form of a web application that will serve as user interface. The web application and the RFID middleware function as separate entities. Both parts are connected via a database, which also gets the logical function in addition to the storage function. User inserts commands for the lab equipment to the database through the web interface. Middleware notices the requests for executing commands, executes them, and marks them as executed in the database. We created this logic at the beginning of the programming process and the whole program is managed by it.

Presentation of the automatic identification cycle begins with the production of the product, or by stock in, when the product must be marked by identification label. The requirement was that the name of the product, the serial number, the date of manufacture, the expiry date or the best before, the EAN-13 code and batch be printed on the label. All these data are inserted by user into the database via the data entry form in the HTML web application (**Figure 1**).

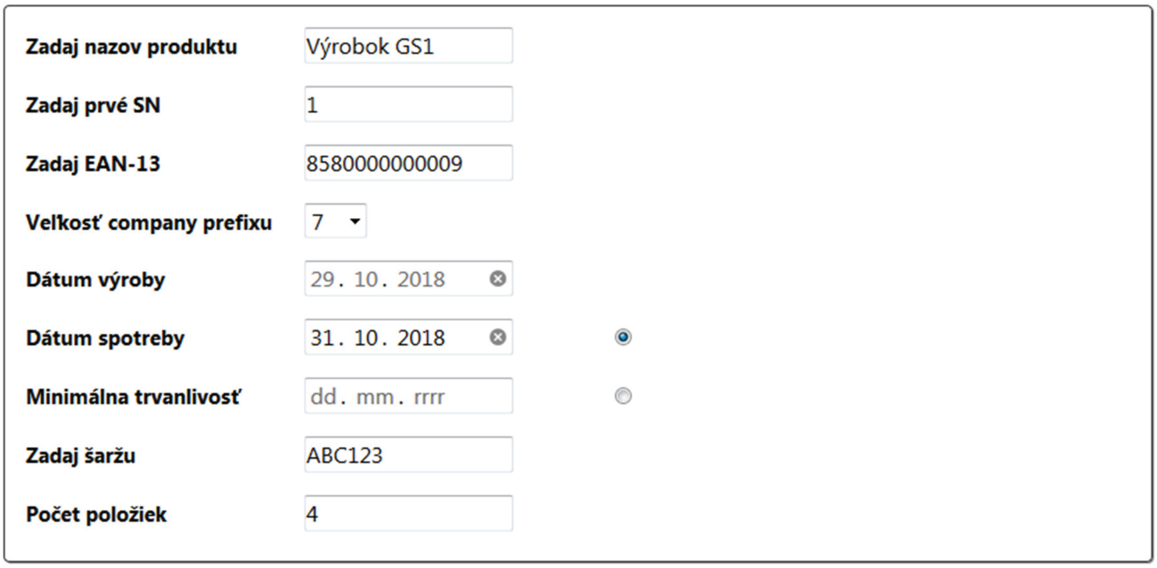

Figure 1 Data entry form

In addition, the user also inserts the company prefix length and the number of items for which the labels are to be printed. According to the number of items, the serial number will be calculated, starting with the number that the user entered first, and each subsequent number will be 1 larger. Based on the company prefix value, the script gets the GS1 Company prefix and Item reference from the EAN-13 code. These are then used together with the serial number to create the EPC code using the SGTIN standard. The encoded EPC is stored in the database in decimal and hexadecimal form. The decimal form is used to be sent to the printer, the hexadecimal is used to verify the writing of the EPC to the tag memory. Another created value that is sent to the database and to the printer is the EPC data structure. This is a structure that defines the size of individual EPC code partitions in bits. Based on the structure, the strings of the SGTIN code are encoded into the tag memory. The data structure values are obtained from the SGTIN-96 partition table, based on the company prefix length. We use the SGTIN-96 partition table because the RFID tags into which we write the EPC code have a capacity of 96 bits. This is all the data that goes from the user to the database. Some of them have been entered by user, some have been created using standardized procedures.

User-entered data is stored in two tables in the database. In the main table, where all entered and created data are stored and are always available to the user. They remain stored in this table until user deletes them. The second table serves as a buffer. It only stores the data that are needed for printing. The middleware is set to regularly check whether there are any data in this table. When it finds that data has been inserted into the table, it initializes the printing process. The data in the buffer table are sorted according to the user input and they are sent to the printer in the same order. Once the data has been printed on the label, the corresponding row in the buffer table is deleted and the next row is sent to the printer. In this way, all labels are printed out and the buffer table is emptied.

Sending the print command to the printer is provided by the middleware which has a pre-set ZPL label design template. We created two templates, one with expiry date, the other with best before. Which one will be used depends on the data inserted by the user. Both templates contain variables that are populated with data entered by user into the database. The ZPL code, populated by user entered data, is sent to the printer to print the label and apply it on the box. The printed label is shown in **Figure 2**.

Figure 2 Printed label

The boxes marked with the printed label are guided via a conveyor belt to the RFID gateway, which verifies whether was the data writing successful. We set the middleware so that the gateway reads the EPC from tag in hexadecimal form and decodes the serial number from it. Both data, hexadecimal EPC and serial number, are then stored in the database table for first gateway. They are used to verify the writing accuracy and for error detection.

Both operations, label printing, and verification are presented graphically in the user interface environment for presentation purposes. The role of the graphic interface is to clearly present the benefits of AIDC technologies and to aid the lecturer during the presentation. The first column in graphical interface has name “Print progress” and it serves for graphic representation of the print queue. After user inserts data, empty boxes are added to the column. Their number depends on the user input. When the label is printed out and applied to the box, a label and a serial number appear on the box in the graphical interface. The serial number is selected from the database from data entered by the user. As the labels are printed out and applied to the boxes, so are they labelled in the graphical interface. The printing and the change in the graphical interface take place exactly in the same order as the user input. Boxes with applied labels are guided by a conveyor belt to the RFID gateway, which is represented in the graphical interface by the “Encoding check” column. When the gateway reads the label, a image of a box with serial number is displayed in the column. If the writing and encoding was successful, the same box appears as in the previous column, but it also has a tag icon on the top. If a writing, or encoding error has occurred, a red colour box appears to alert the user. The evaluation is done at the web application level, where is compared user input to the database and RFID gateway data input. Only the EPC codes are compared, the serial number serves as a distinctive key for the user. This functionality can also be used for presentation of detection of incorrect boxes that accidentally get on the wrong conveyor belt. Through the serial number, user can easily identify the package that has been misdirected. In addition to the serial number, it is also possible to show EAN-13 on the image of the box and combine them to clearly identify the misdirected box. However, the EAN-13 is too long and it would be displayed in small font, which would be inappropriate for the presentation. Therefore, we have only displayed serial numbers on the boxes and the other options and information that can be obtained from the RFID tag are described in the course. Both columns of graphical interface are shown in **Figure 3**. Figure also shows a misdirected box detection; its serial number is 278.

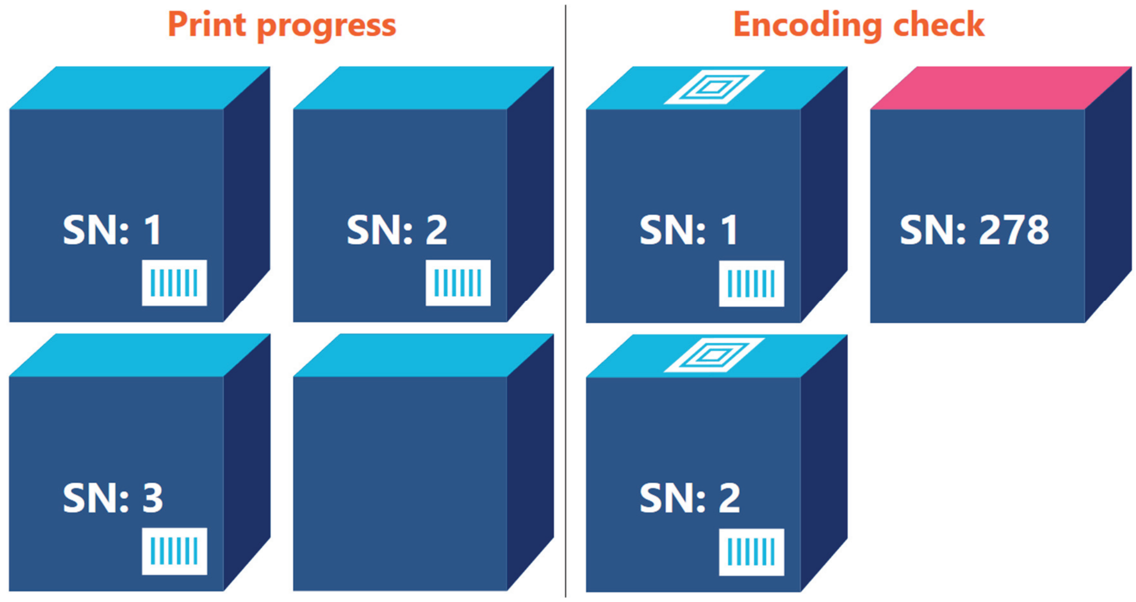

Figure 3 Columns of graphic interface

Although the program captures only the beginning of the automatic identification cycle, it already offers many options to present AIDC technologies and GS1 standards. The first step is insertion of data into the database and assigning a SGTIN identifier to them. This identifier was created automatically based on the inserted data and is unique. No other product or manufacturer has the same code when using this standard. This is secured by the combination of EAN-13 and serial number. EAN-13 is unique to the company and the serial number is unique for the product. This makes it possible to track it in both internal and external business operations. Through electronic data exchange systems, any system participant can read these labels, retrieve useful data from the database and even add additional information about performed operations, or about the location and its next destination. Information in database are also a good basis for using other standards such as SSCC (Serial Shipping Container Code) or GLN (Global Location Number). Both codes use company prefix acquired from EAN-13 code, which opens new topics to the discussion about possibilities of EAN code.

The application has already been put into real use. By using it, selected GS1 standards were presented to both public and private sector. In addition to verifying its functionality, real deployment has provided us with the necessary feedback to help us move on and improve the application. Its advantage is its modularity, i.e. the possibility of adding new functionality. As a next step, we plan to add the SSCC and GLN standards, that have already been mentioned and build on the current state of the app. By combining them, it will be possible to continue to present the logistics cycle up to the creation of the transport unit and the assigning of storage position, creating a cycle starting from production to storage.

6. CONCLUSION

Presentation of AIDC technologies and GS1 standards is a fundamental activity of GS1 Slovakia, therefore it is important for them to have the appropriate software for these purposes. This article dealt with the creation and functionality of such a program. Using this new program, presentations for public and private sector have already been made to verify this solution, its functionality and suitability. Because the solution is modular, we are working on another modules of the application in order to provide a comprehensive view of the entire logistics chain from data entry, through reading, verification, storage and subsequent operations with stored goods.

ACKNOWLEDGEMENTS

This article was supported by Project EUREKA-E! 11158 U - health - Auto-ID technology and the Internet of Things to enhance the quality of health services. Authors would like to thank to the University of Žilina in Žilina and organisation GS1 Slovakia for provided facilities and assistance.

EUREKA

REFERENCES

[1] GHIANI, G., LAPORTE, G., MUSMANNO, R. *Introduction to logistics systems management* [online]. Second edition, Last updated: 2013. Library of Congress Cataloging-in-Publication Data. pp.1-43. [viewed 2018-10-22]. Available from: https://ebookcentral.proquest.com/lib/uniza-ebooks/detail.action?docID=1120905&query=logistics.

[2] GS1 AISBL. Referencing: Global Trade Item Number GTIN. In: *Global Trade Item Number GTIN* [online]. 2015. p 1. [viewed 2018-10-22]. Available from https://www.gs1.org/docs/idkeys/GS1_GTIN_Executive_Summary.pdf.

[3] GS1 AISBL. Referencing: GTIN rules. In: *GS1 General Specifications* [online]. 01-2018. vol. 18, pp.187-310. [viewed 2018-10-22]. Available from https://www.gs1.org/docs/barcodes/GS1_General_Specifications.pdf.

[4] GS1 AISBL. Referencing: EPC URI. In: *EPC Tag Data Standard* [online]. 09-2017. vol. 1.11, pp.25 - 27. [viewed 2018-10-21]. Available from https://www.gs1.org/sites/default/files/docs/epc/GS1_EPC_TDS_i1_11.pdf.

[5] KOLAROVSZKI, P., TENGLER, J., Practical research in field of automatic identification in automotive, *CLC 2015 - Carpathian logistics congress - conference proceedings*, Tanger Ltd, 2015, pp. 92-97