Application of Mobile Technology in Delivery Process of Postal Operator

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***Abstract*—This paper focuses on the possibility of implementing Radio Frequency Identification (RFID) technology in logistic processes with a focus on the final phase of delivery to the addressee. Via SMS, the addressee is informed that he will receive a delivery, and our intention is that the sender is also notified by SMS when the consignee is taken over. The intention of our work is to improve the postal services using modern technology.**

Keywords-RFID Technology; Mobile Services; Postal Operators; Process of Delivery

I. INTRODUCTION

It is important for people to be informed - to obtain and receive information when they need it and on what interest them. In the current era of information technology, it is not a problem to obtain needed information and also to provide them. In our research, we focused on the new technology in the postal sectors and on the final phase of delivery. The proposed solution of delivery (a letter or parcel) is by using RFID technology that gives an identifier to each shipment - tag by which it is possible to track the shipment. In reality, it means that the recipient is informed about the coming consignment via SMS in advance. Moreover, when the delivery is completed, the sender receives the confirmation.

Although the possibility of notification via SMS is not new, in our research, we strive for interoperability between different technologies. One technology may not be sufficient, but the correct application of specific technologies can bring the desired value added. In our case, we focus on combination of RFID technology and mobile communication in postal processes.

Presently, one of the challenges in SMS notifications is that only the recipient of the consignment is being informed of the status of delivery - SMS is a tool for one way notification only. Our aim is to apply this technology throughout the processing chain, from point to point. This way, sender as well as recipient is being updated on the status of delivery or the delivery can be optimized in advance (e.g., receiving the information from recipient about being out of town for next three days).

At present, the provision of added value to customers and the use of advanced innovative technologies can be considered as the greatest competitive advantage, especially when the companies engaged in the logistics, do not only sell products (e.g., delivery from one place to another), but they also provide the related services (e.g., notification on delivery status, insurance, etc.). Therefore, it is necessary to use modern technology which not only saves time when handling goods, but also improves the processes of serving the end customers.

The main objective of our research was to confirm the assumed interoperability in laboratory environment. In Section II, we shortly discuss the usability of RFID technology in practice. The possibilities of SMS communication is being discussed in Section III. Finally, in Section IV, we describe the proposed solution of implementation of these technologies in the present postal processes.

II. TECHNOLOGY BACKGROUND

RFID identifier, by which the shipment can be monitored, is assigned to each consignment. It is one of the key components used in providing information to the recipient and sender via SMS. Another key component is of course SMS server that arranges the whole communication.

The advantage of RFID system is that it can be used in environments where the humidity, temperature, dust or vibrations are preventing the use of bar codes.

RFID system consists of two basic parts: readers and RFID identifiers (carriers of information). The identifiers can be active (containing power supply, e.g., battery) or passive. The reader is the crucial component of the RFID system. Depending on the particular application, it may be stationary or mobile. Readers in RFID systems have two functions. The first is to broadcast the RF signal and the other is to receive information from the RFID identifiers. This information is sent to the superior information system, where it is then processed. The broadcasted RF signal has two functions as well. The first is to ensure detection of an RFID identifier. This function is similar for passive and active systems. The second function is important in systems using passive chips. In these cases, the magnetic field created by the reader is used to obtain the energy necessary to send the signal from the RFID tags back to reader. Return signal is modulated by the information that is stored in it. Some systems used in stores for guarding the goods by Electronic Article Surveillance (EAS) operate in a manner very similar to RFID, although the information is bistable (on/off).

Complex systems can process additional information obtained from RFID tags, such as temperature, position, etc. In order to store additional information, RFID tag needs to

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be equipped with supplementary circuits granting the mentioned operations (e.g., temperature sensor). The role of the RFID identifier is that when it comes within range of the reader, it sends identification. More complex identifiers are able to process significantly larger amount of information. Each identifier is composed of an antenna, transceiver and transponder. At Ultra high frequency (UHF) technology, antenna takes the largest part of the RFID identifier. With higher frequency band, the size of the antenna decreases. The role of the antenna is to receive and transmit the signals. When receiving a signal, antenna has double role. One role is to generate energy to power the identifier and the second role is to process the code which is used by tag in communication between the identifier and the reader. Transceiver unit is a device containing transmitter and receiver that share common circuits. The unit, complemented by the received signal, will create the energy necessary for the operation of the entire RFID identifier.

III. POSSIBILITIES OF SMS COMMUNICATION

This section talks about possibility to communicate through SMS server (Ozeki) and its connection to RFID middleware.

A. Ozeki SMS Server

In our laboratory for Automatic Identification and Data Capture (AIDC lab), we operate with Ozeki SMS Server. Ozeki Informatics Ltd. is a leading supplier of software for mobile messages. It offers a program easy to use and rich portfolio of telecommunications products for businesses and organizations. The company is actively working on providing further innovations that increase productivity. Using a Global System for Mobile Communications (GSM), modem and SMS Internet protocol (IP) technologies, products enhance productivity, flexibility, and provide significant advantages for professionals to create mobile communications services. The server offers two core modules:

- **Short Message Service Point to Point** (SMS-PP) - one SMS can contain up to 160 characters. Newer phones allow sending longer messages, but the sender's phone breaks up the longer message to short parts and receiving phone merges them into one again. Message is sent between two or multi phones or applications.
- (SMS-CB) **Short Message Service Cell Broadcast** - these messages use the Cell Broadcast channels. They are used, for example, for weather forecasts, local news, and traffic situation or for determining the actual position. Message is sent to all phones in a given area that are turned on and CB is set to the appropriate channel. The maximum length of message is 93 characters.

In the following part, we discuss the possibilities of the first module (SMS-CB):

- **GSM modem** is the core of GSM / General Packet Radio System (GPRS) Modem Connection (Fig. 1) that allows to use the mobile phone or wireless modem connected to the PC (using the data cable) to send and receive SMS messages. Mobile phone or modem must contain Subscriber Identification Module (SIM) cards, which can be bought from any GSM service provider.

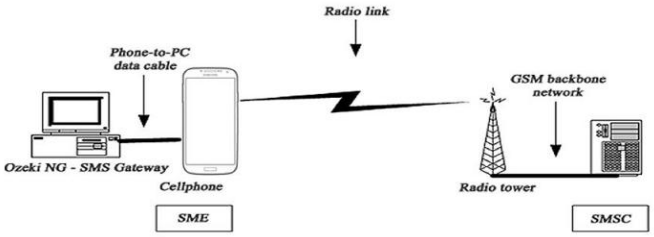

Figure 1. Configuration of GSM modem

- **IP SMS** (Fig. 2) consists of protocols Computer Interface to Message Distribution (CIMD2) Connection (), SMPP Connection (Short Message Peer to Peer), UCP Connection Universal Computer Protocol / External Machine Interface (UCP / EMI) (Fig. 3). These protocols can be used to connect the computer directly to the Short Message Service Centre (SMSC) GSM service provider. This way, SMS messages can be sent and received via the Internet or private IP network.

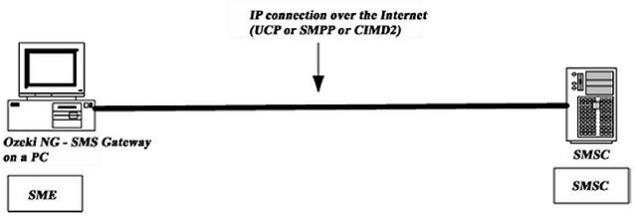

Figure 2. IP SMS connection

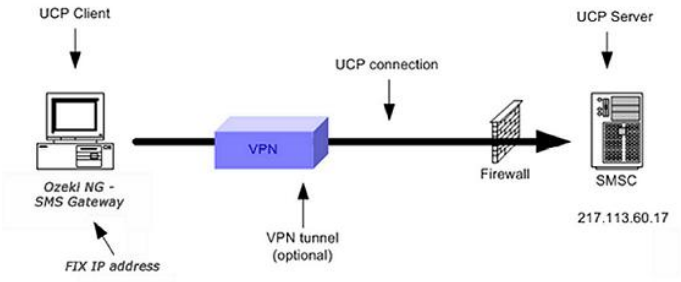

Figure 3. UCP connection

- **Pull Interface Connection** - Short Message Peer-to-Peer (SMPP) Push / Pull a special connection that implements Unstructured Supplementary Service Data (USSD) push / pull communication protocol-based Comviva FLARES. This protocol can be used to connect the standard SMPP.
- **HTTP Connection Server** (HyperText Transfer Protocol Server) - enables service providers to use the HTTP protocol for the transmission of messages coming into operation. This technology is often used

in premium rated SMS services (Fig. 4). This connection can also be used as "virtual phone" for the purposes of software development.

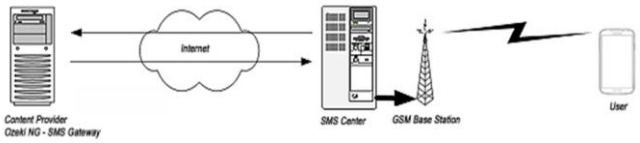

Figure 4. Architecture of premium value services

- **Simple Mail Transfer Protocol (SMTP) Connection** - Connecting the SMTP lets the user to send SMS messages via e-mail. Email connection for SMS is available with many mobile operators and IP based multichannel GSM gateway.
- **Simple Network Paging Protocol (SNPP) Connection** (**Paging**) - This protocol allows the user to send messages to pagers via the Internet.

B. RFID middleware Aton mobile platform

RFID middleware Aton uses a tool to send SMS. In this section, we show how both programs, Aton mobile platform (AMP) and Ozeki SMS server, have to be configured in order to mutually communicate and send SMS at the desired time. The graphical model of RFID information processing is stated in Fig. 5.

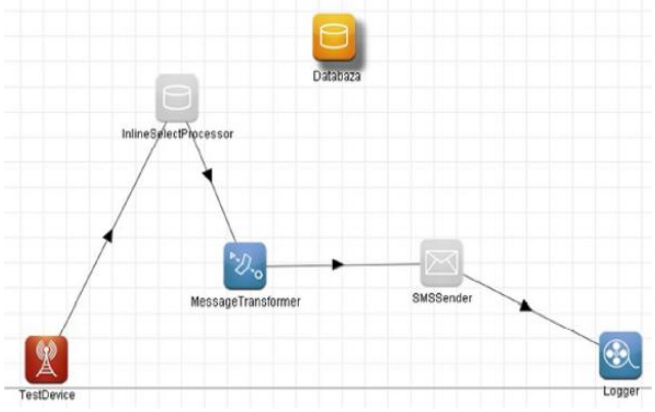

Figure 5. The basic structure of the proposed application

The aim of the solution is the implementation of RFID technology in logistics processes with a focus on final processing of postal consignments. We focus on informing the sender and recipient on the status of the delivery. Via SMS, the addressee is informed that he will receive a delivery, and our intention is that the sender is also notified by SMS when the consignee is taken over.

It is necessary to configure RFID middleware Aton and server Ozeki in the adequate way in order to send an SMS at the right time.

Basic components of our proposed application are:

- **TestDevice** - detection gateway scanned tag passes through,
- **Database** - a set of tables where data is stored,
- **InlineSelectProcessor** - processor to access and read data from the database,
- **MessageTransformer** - processor which is used to transform the input message for the correct output,
- **SMSSender** - processor for sending SMS,
- **Logger** - processor that ensures the creation of output and logging data.

The configuration parameters of SMSSender processor (Fig. 6) are set as:

- **default.sender** – OZEKI (name of service)
- **smpp.password** – abc123
- **smpp.server – address of server**
- **smpp-username** – admin
- **sms.char.maxlength** – 0 (without limit)

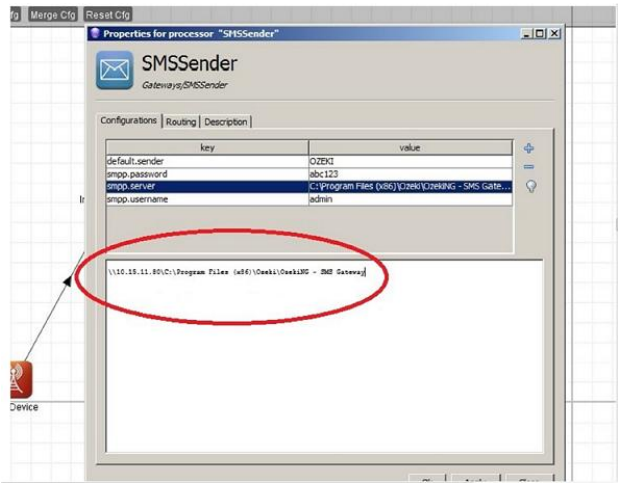

Figure 6. Settings of SMSSender processor

Admin username and password ‘abc123’ is standardly preset in the software Ozeki. According to the needs, the user can change this information. For security reasons, Ozeki Company Ltd. recommends to change the name and password immediately after software setup. The possibility of smpp.server defines the path where the software Ozeki is available, for example:

\\10.15.11.80\\Ozeki\OzekiNG - SMS Gateway.

Form of message AMP sends to Ozeki

```
<message>
 <from>mobile number</from>
 <to>
  <address>number of addressee</address>
  <address>number of sender</address>
 </to>
 <body>
  text of message
 </body>
</message>
```

Mobile number must be entered with international prefix (e.g., +421 905 555 555).

Form of message to be sent to addressee:

<message>
<from>+421915879503</from>
<to><address>+421911870113</address></to>
<body> Dear Customer. You received the shipment no. 1234, it will be delivered to your address tomorrow. For another method of service call hotline xxx
</body>
</message>

Form of message to be sent to the sender once the delivery is taken over by addressee:

<message>
<from>+421915879503</from>
<to><address>+4219114753278</address></to>
<body> Dear Customer. The shipment no. 1234 you sent on xx.yy.2016 has successfully seen delivered to the addressee.
</body>
</message>

C. Technical components

We have used a GSM modem Siemens MC35 which consists of an external GSM antenna, RS232 serial cable, SIM card and the AC adapter (Fig. 7).

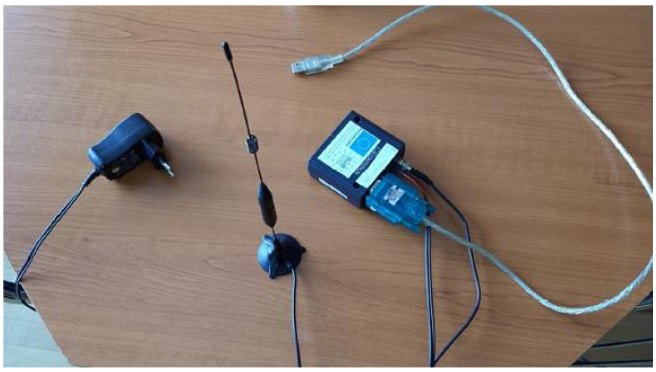

Figure 7. Parts of GSM modem

After installing the necessary Ozeki software, NG SMS Gateway is being installed (Fig. 8).

Figure 8. Module of Ozeki system

After installing a particular module, it is necessary to configure the modem before the first connection. Once the Ozeki program is open, user will automatically find the necessary hardware installed on the computer.

Fig. 9 shows Ozeki server detecting hardware on serial port COM3 (standard for this kind of modem connection). In next step, the software correctly retrieves the necessary parameters for connection. Consequently, it is necessary to set SMS center operator (we used the company Orange Slovakia, Inc.), operator number (+421 905 303 303) and mobile number of the SIM card (+421 915 879 503). Then, there is the possibility to set the modem name, in our case, we have chosen GSMModem0.

Figure 9. Name of GSM modem

Once the configuration is completed, the creation of the actual SMS is enabled by choosing “Compose” option from menu. In the first selection field, we select the text type of SMS (not multimedia SMS, etc.), the mobile number of recipient and finally the actual text of message. When SMS system Ozeki is connected to the middleware AMP, the above described steps are redundant as the text of SMS will be imported directly from AMP. The picture of test SMS is visible in Fig. 10.

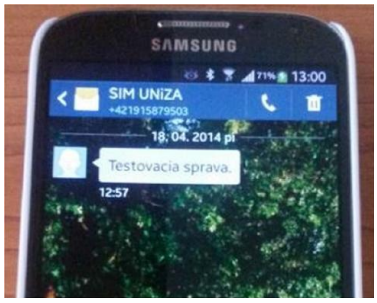

Figure 10. A demonstrative example of SMS messages

As per Ozeki system configuration, each SMS is stored in database of sent SMS. (Fig. 11).

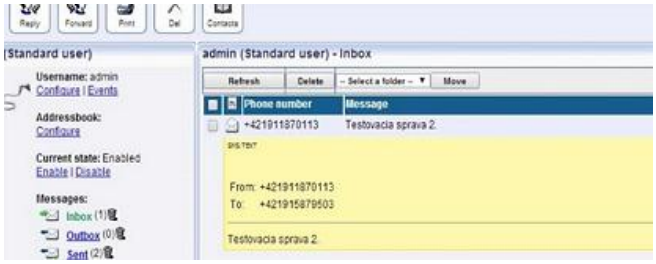

Figure 11. Database record of sent SMS

IV. DESIGN OF MAIL DELIVERY PROCESS

The following part describes the proposed process of mail delivery using RIFD technology with an emphasis on informing the recipient of the consignment via SMS, as well as the sender. The whole process of sending the confirmation SMS to the sender is triggered by the initial SMS message sent to the addressee (first database record about the consignment) and the actual final delivery. In case the consignment is not delivered directly to the recipient, but it needs to be e.g., picked up in person on post office, the system generates SMS informing the recipient about this fact.

If the consignment is being delivered directly to the address of the recipient, the sender is informed about the successful delivery by the SMS message shown in Fig 12.

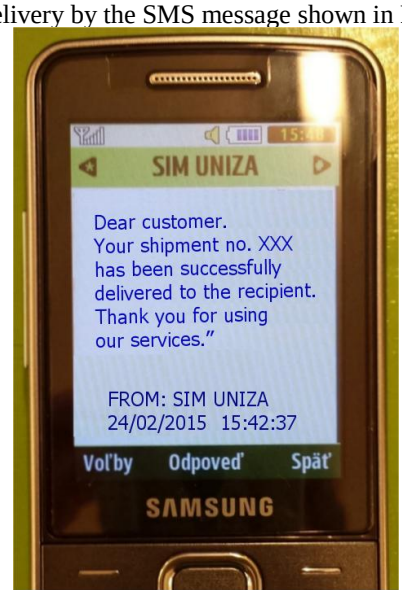

Figure 12. Confirmation message about successful delivery generated by Ozeki system

As stated, there are different ways of making the delivery (via the postman, courier, in person pick up on the post office, etc.). In our designed process, the confirmation report (text differs by the way of actual delivery) is sent in form of SMS to the sender. This terminates the whole process of delivery.

Example of processing and delivery of consignment using RFID technology and mobile network services that we have proposed and tested in our laboratory is pictured in Fig. 13:

1. Submission of shipment - The sender brings consignment to the delivery office in order to send it the recipient.
2. Expedition of shipment – Except of standard information (name of the recipient, address,..), the shipment must contain the phone number of both, the recipient and the sender; at this point, the consignment is equipped by RFID tag carrying data that will be recognized by AMP middleware.
3. Transportation by postal courses - at the beginning of transportation, RFID tag is scanned and information is inserted to the database together with the time and date of scanning and code number of the actual postal course.
4. Delivery of shipments – delivery to target post office; RFID tag is scanned and database is updated; the necessary information is sent to Ozeki system.
5. SMS message to recipient - Ozeki sends SMS message to the recipient; the system automatically sends SMS messages to all the addressees about the arrival of shipment to distribution center.
6. Optional feedback of recipient – the recipient can inform the post office of being e.g. out of town so that the date and time of delivery is adjusted.
7. Delivery to the recipient – Delivery of the consignment to the recipient (to particular address, by picking up the consignment at the post office, etc.)
8. SMS message to sender - confirmation message about successful delivery is sent to sender.

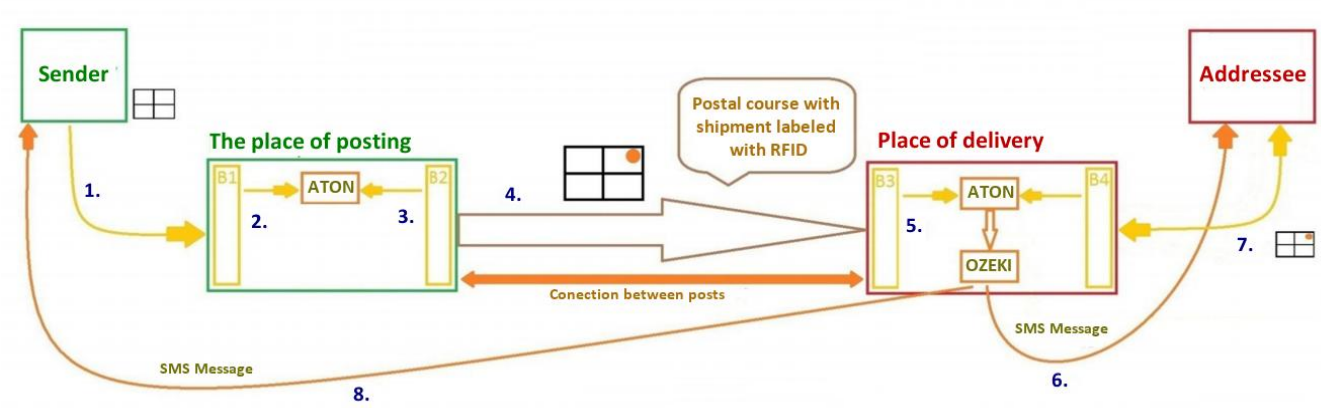

Figure 13. Example of proposed process and delivery of consignment

V. CONCLUSION

The current trend is to be constantly informed about everything that takes place around us. An enterprise, engaged in postal services, can improve its services and grant the access to more information for its customers by using the necessary technology. This is an advantage that will help to succeed in the competition for the end customer over the others competitors.

We suggest the model of using RFID technology in the postal services. Our intention is that the recipient and the sender receive a text message with the shipment status. This can be arranged for any consignment in question. In our case, we opted for recommended letters or parcels that have been equipped with RFID identifier – a tag. The position of the shipment is not only tracked, but our designed system can also provide reports and send information via SMS. Addressee receives the message at the time when the consignment reaches the distribution center, so that the recipient can choose the method of the delivery. Sender is informed about the successful delivery once the shipment is taken over.

Our proposed solution is the combination of RFID technology and mobile communication granted via Ozeki system. This combination has been proven as the most suitable during tests in our laboratory environment. RFID tag is the key element of our solution as it carries the essential information needed for future processing. Because of this, every consignment needs to be equipped by RFID tag. Additional information can be included if needed (name, address, telephone number); otherwise this information is accessible in the database.

Although we are aware of the financial cost of the proposed solution, the level of value added makes the investment very attractive. They key features are the improvement of information flow, improvement of customer service, the possibility of immediate feedback and last but not least, it can contribute to the significant delivery time reduction.

The process we propose needs to be perceived as only the beginning of future research. It is possible to develop solutions such as mobile applications for smartphones used for communication with postal operator, to generate new services such as Just-in-Place (sending the coordinates of the current position) or delivery within the specified time and many more. It would be possible to add a workaround for sharing the feedback (for example to determine the quality of the service or the satisfaction of users). However, these are solutions which we are working are the subjects of our future research.

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