The Concept of Tracking Confidential Consignments

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The article outlines the concept of an extension for innovative e-system for managing the lifecycle of documents at different levels of sensitivity, including the function of continuous tracking of consignments from one protected zone to another. The operations of the module are based on the use of RFID tags for the documents. At particular stages of transport, the tags are read to allow automatic identification of the contents of the shipment. The transported documents are secured in special burglar-proof containers. Additionally, the containers are equipped with GPS and GLONASS location modules. The author also described an IT system which allows to monitor, store and analyze the transport route.

Keywords: RFID, monitoring, transport of consignments, Aurea BPM, GPS, business processes.

1. INTRODUCTION

This article describes the concept of an extension for innovative e-system for managing the lifecycle of documents at different levels of sensitivity. The project was implemented under the R&D project no. DOBR-BIO4/006/13143/2013, financed by the National Center for Research and Development.

As part of the project implementation, the system for marking electronic media and paper documents with RFID (Radio-Frequency IDentification) tags was developed. The system allows to track both public and secret, electronic and paper carriers, also at a secret office, within the boundaries of protected zones, including access control and methods for protecting documents against unauthorized copying.

The final result of the project shall be a prototype of the modern secret office, with the cutting-edge RFID solutions and method of functioning and management of the office adapted to such technology, allowing to work on documents at different levels of sensitivity.

The study describes the concept of extending the system by adding the function of tracking consignments transported from one protected zone to another. The proposed module for tracking shipment shall be fully integrated with the existing system. The system shall be based on the already applied RFID tags, which are to be read for the purpose of automatic identification of the contents of the shipment and protection of such shipment by using special burglar-proof containers. The containers may be opened and closed only by authorized employees using individual RFID tags to identify themselves. Both drivers and transport guards shall not be able to open the containers during transportation or at a stopping place.

2. OBJECTIVES

The main objective of the project was to develop a modern system for marking electronic media and paper documents with RFID tags. The detailed goals of the project are as follows:

1. Development of the system for remote identification of public and secret media tagged using radio-frequency identification technology at the places of storage and work in real time.
2. Development of the system for automatic inventory of public and confidential documents put into piles and included in folders, including automatic detection of changes in their location.

3. Development of the system for controlling the flow of public and secret media and documents between protected zones, including a module for authentication of persons allowed to access public and confidential documents.
4. Development of electronic system for protecting media and documents against unauthorized relocation.
5. Automatic identification of media and documents not only within the area of storage, but also at workstations.
6. Development of security technology protecting against multiple copying of public and confidential documents.
7. Development of a method for printing public and confidential documents in a limited number of copies.
8. Identification of the location of a single public and confidential document, with accuracy to the set location of a folder or volume.

Additionally, the proposed solution shall provide the system with a possibility of tracking consignments transported between the protected zones using previously prepared means of transport. The detailed requirements of such means of transport include the following:

1. Safe transport of shipment between the protected zones by using safe containers mounted on the aforesaid means of transport,
2. Complete accountability of the delivered and received documents by using RFID antennas for reading the contents of the shipment in the transport containers,
3. Tracking of transport via the in-built geolocation modules (GPS, GLONASS),
4. Assuming the lack of direct connections between various databases of the protected zones (due to data security) - development of the system for encrypted messages, through which the communication between shipment senders and recipients as well as between the protected zones (senders and recipients) and shipment containers shall be effectuated,
5. Automatic confirmation of the compliance of the contents of the container and B/L by exchanging messages between the container and protected zone, from which the shipment is sent, and protected zone, to which the shipment is delivered,
6. Automatic confirmation of metadata of the consignments and history of their processing after delivery and acceptance by the protected zone of the recipient,
7. Automatic transfer of data on the route to both the sender and recipient, allowing to track the shipment in transit in real time and retrace the already completed transport,
8. Detection of transit anomalies (changes in times or transport routes) and provision of information with respect thereto to persons in charge.

3. RFID TECHNOLOGY

The RFID (Radio-Frequency Identification) technology is the radio identification system. The objective of the system is to store a certain amount of data in the transmitter-receiver apparatus (tags). Subsequently, the stored data are read automatically at a convenient time and place to produce the desired effects for a given application [1].

The beginnings of the radio-frequency identification technology date back to the 1940s, when the first devices based on metal detectors were produced.. The first store-anti-theft systems, based on decoding labels with aresonant circuit or acousto-magnetic systems using magnetized metal plates, occurred in the 1960s. The full radio-frequency identification technology emerged in the 1970s, and Tiris - produced byTexas Instruments - was the first widely available system [2].

Nowadays, the technology grows fast and creates many opportunities for its users. The RFID system always consists of two components: a tag attached to the identified object and an RFID reader to read the electronically stored information. Depending on its structure, the system allows to read tags at a distance of up to several dozen centimeters or a few meters from the reader. What is positive in this case is the fact that the data transmission does not require the tag to be visible [1].

RFID tags are technologically advanced labels, which include electronic chips with memory and antenna for data transmission. RFID tags, depending on the type of an application, have different sizes and materials: paper and plastic. Their structure is determined by the requirements on operating frequency of the device [1].

Due to technical implementation of the RFID technology (type of encoding, size of tag memory, speed of transmission, distinguishability of many tags within the reach of the reader, etc.), many

different RFID standards are applied: Tiris, Unique, Q5, Hitag, Mifare, Icode, PJM [3].

PJM (Phase Jitter Modulation) is a new form of encoding information through radio waves by using phase modulation. The technique has been developed recently, but its basic functionalities allow to obtain significantly better parameters than any RFID standard known so far. The PJM technology guarantees efficient and flawless scanning of a large number of tags, which distinguishes it from other currently known RFID solutions, whose deficiencies make it impossible to efficiently apply them for the purpose of archiving and supervision of documents.

PJM allows faster reading of a large number of tags in a shorter period of time, which plays a key role in the document identification process. Therefore, it was decided to use the PJM standard in the project, which allows to both read a larger number of tags and eliminate identification errors in case of signal interference caused by many tags.

4. GPS/GLONASS TECHNOLOGY

The means of transport used for transporting confidential shipment must be equipped with localizers. The localizers may work on the GPS and GLONASS systems.

GPS (Global Positioning System) is a space-based satellite navigation system developed and operated by the United States Department of Defense, providing coverage of the whole Earth. The system is composed of three segments: space segment - 31 satellites orbiting around the Earth in a medium Earth orbit; ground segment - ground control and monitoring centers; and user segment - signal receivers. The objective of the system is to provide users with the information about its location and to facilitate territorial navigation [12].

The system measures how long it takes for the radio signal to reach the receiver from the satellites. Once knowing the speed of the electromagnetic wave and accurate time of transmitting a given signal, it is possible to calculate the distance between the receiver and satellites. The GPS signal includes the information about the arrangement of satellites in the sky (i.e. almanac), their theoretical route and any deviations therefrom (i.e. ephemeris). First, the GPS receiver updates such information in its memory and then uses it to determine the distance from particular satellites, which are within the reach of such receiver. When making backward spatial linear incision, the microprocessor of the receiver may calculate geographical position (latitude/longitude and ellipsoidal height) and put it into any frame of reference, usually WGS 84, together with the present GPS time stated with great accuracy.

The GPS system is maintained and managed by the United States Department of Defense. Basically, anyone may use the services provided by such system - it is enough to have an appropriate GPS receiver. The receivers are produced by independent commercial companies. The GPS system is free of charge and shall remain so according to the policy of the United States.

The Russian equivalent of the American GPS system is GLONASS, i.e. Global Navigation Satellite System or in Russian - Globalnaja Nawigacjonnaja Satelitarnaja Sistemma [13]. Officially, the system was launched in 1993. The operations of the Russian system are similar to its American equivalent - similarly to GPS, it renders services at two levels: precise - used mainly by the Russian army; its use requires special permit from the Ministry of Defense in Russia, and standard - less accurate, used by civilians.

The differences between GLONASS and GPS also refer to the frame of reference. The American system operates based on WGS-84, whereas the Russian system - on PZ 90. Additionally, the time model is also different - GPS uses universal UTC time, whereas GLONASS - the Russian state time model, i.e. Etalon UTC. American satellites transmit data by using CDMA technique, whereas the Russian satellites apply FDMA.

5. THE CONCEPT OF THE SOLUTION

The proposed solution assumes development of a special and secure container, adapted to store secret data in compliance with the clause "CONFIDENTIAL" (Figure 1). The body of such container, its doors and other construction elements shall be made of metal sheeting from the structural steel, 3mm thick, protected against corrosion. The connectors in the body of the container shall ensure its sufficient stiffness. The container may be equipped with special lockers. The door shall have an opening mechanism to block it at four edges. The opening mechanism for the bolts in the door shall be secured with two locks certified according to the requirements in their respective groups, which separately block the opening mechanism, including a mechanical multi-tumbler key lock, with a possibility of removing the key only in the closed position, protected against any form of damage, including drilling, and

a mechanical lock with variable combination setting, a three-combo wheel at least, moving quietly, with an adjustment range not larger than one and a half digit, minimum 100 digits on the knob (min. 1 000 000 combinations), including a possibility of opening by using an RFID tag. A sealed hole allowing to anchor the container shall be provided at the bottom of the container. The bottom of the container shall resist force of minimum 50 kN. The container shall have a certificate issued by a certifying body, confirming its compliance with the requirements of class B.

The container shall be equipped with RFID antennas allowing to read its contents once it is closed. It is assumed that it shall be possible to read a large number of tags placed on the consignments in the container (calculated in hundreds). The contents of the container shall be temporarily stored in the control unit of the container.

Additionally, the container shall be equipped with the geolocation module - GPS/GLONASS, and M2M data transmission module (GSM, UMTS, LTE). The geolocation module shall report current data on the location of the container to its central unit. The component data in the central unit of the container shall be transmitted to the sender and recipient of shipment, during transport, by using encrypted messages.

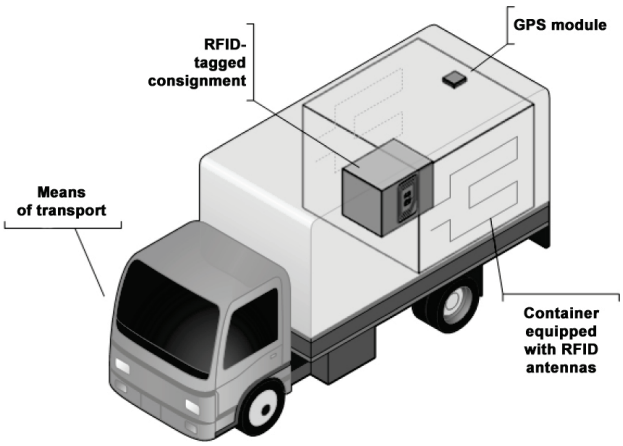

Fig. 1. Container for transporting the RFID-tagged consignments.

The shipment in transit shall be placed in the closed container. The fact of closing the container shall be recorded in the central unit and transmitted to the servers of the sender and recipient in the form of encrypted message. Once the container is closed appropriately, its contents are to be read through special RFID antennas, which identify all tags in the container. The tagged data shall be sent to the control unit and then transfered thereby to the sender and recipient of shipment. Upon confirmation of the compliance of the contents of the container with the B/L, it shall be possible to start the transport. Before starting the transport, the server of the sender shall send all essential metadata and events related to shipment (such as previous relocation, changed contents, persons responsible for accepting the shipment, etc.) in the form of encrypted messages.

During the transport, all geolocation data shall be saved in the central unit. Subsequently, such data shall be transmitted in the form of encrypted messages to the sender and recipient of the shipment. The software of the sender and recipient shall allow to track the transport and view the full route on the map. In case of any deviations from the agreed route or time scales, it should be possible to raise alarm, inform competent authorities and undertake appropriate actions.

Once the transport is completed, the container shall be opened by persons in charge with a special key and personal RFID identifier. The fact of opening the container shall be recorded in the central unit and sent to the servers of the sender and recipient. Subsequently, the shipment shall be recorded in the system of the recipient in a warehouse unit, which means that the transport is completed.

6. SOFTWARE

A combination of the cutting-edge RFID technology, facilitating quick identification of a large number of objects in a short period of time, and an appropriate IT system, processing the information collected by RFID devices, allowing automatic inventory of documents. The above refers to both single copies and sets of documents (in dossiers, folders or other office equipment intended for that purpose). The use of the IT system supporting the document flow management is essential to accomplish the goals of this project. The system tracks changed positions of the tagged copies (within the protected zone in the office) and makes the information about their location and status available on an ongoing basis.

Outside the protected zone, the transferred documents may be tracked by using the containers with the RFID reader system and location tracking systems, i.e. GPS/GLONASS.

To ensure communication between the IT system designed for the document lifecycle management and RFID device, it is essential to use

appropriate tool systems, which were developed together with the RFID technology to allow transfer of the information from the devices to business systems used for collecting and processing the collected data. The CrossTalk tool system was used in the project [7].

The document flow in the system ensures the application of the Aurea BPM tool for supporting automation of business processes and workflow. The above refers to the business process management system (BPMS), with web and mobile interfaces, equipped with the process engine and integrated process modeler, user portal, database, document repository and multi-layer interfaces for environment systems [9].

7. ARCHITECTURE OF THE SOLUTION

One of the elements of the system supporting the management and processing of the documents at different levels sof sensitivity shall be the document visualization and relocation module. To accurately characterize the manner of functioning of the module, an analysis aimed at developing the document visualization and relocation control module was performed. As a result of such analytical work, a number of diagrams describing the scope of operations of the module and logical architecture of the designed solution were created. The diagrams define boundaries of the operations of the modules as well as the scope of data exchanged between other elements of the system.

The following diagram shows a contextual diagram of the visualization module (Figure 2).

The general architecture of the module was outlined in the contextual diagram of the visualization module. The diagram shows correlations between the visualization module for relocation of the documents at different levels of sensitivity and other elements of the designed system. The visualization module communicates with the archive module, which records and collects metadata of the document from a database.

The visualization module for relocation of the documents at different levels of sensitivity collects metadata of the document from the archive module and then sends the information about the exact location of the document to the archive module. The archive module records all metadata of the document in the database. The collection of metadata of the document from the database and their transfer to the visualization module are controlled by the user of the rfiDoc system. By using the visualization module, the user not only forces collaboration between the above-mentioned modules, but also the transfer of data between them.

A more detailed characteristics of the communication between particular elements of the designed solution are shown in the logical architecture diagram (Figure 3).

The logical architecture diagram shows interfaces for data exchange between particular elements of the rfiDoc system and Oracle database. The visualization module for relocation of the documents at different levels of sensitivity is one of the components of the rfiDoc system. All data generated by the visualization module are sent to

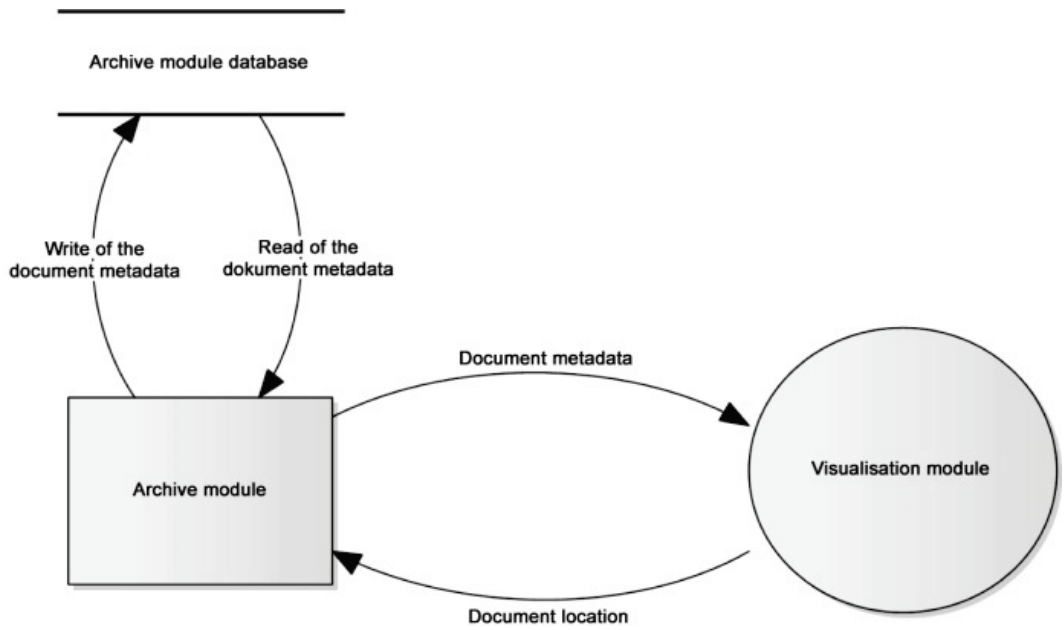

Fig. 2. Contextual diagram of the visualization module.

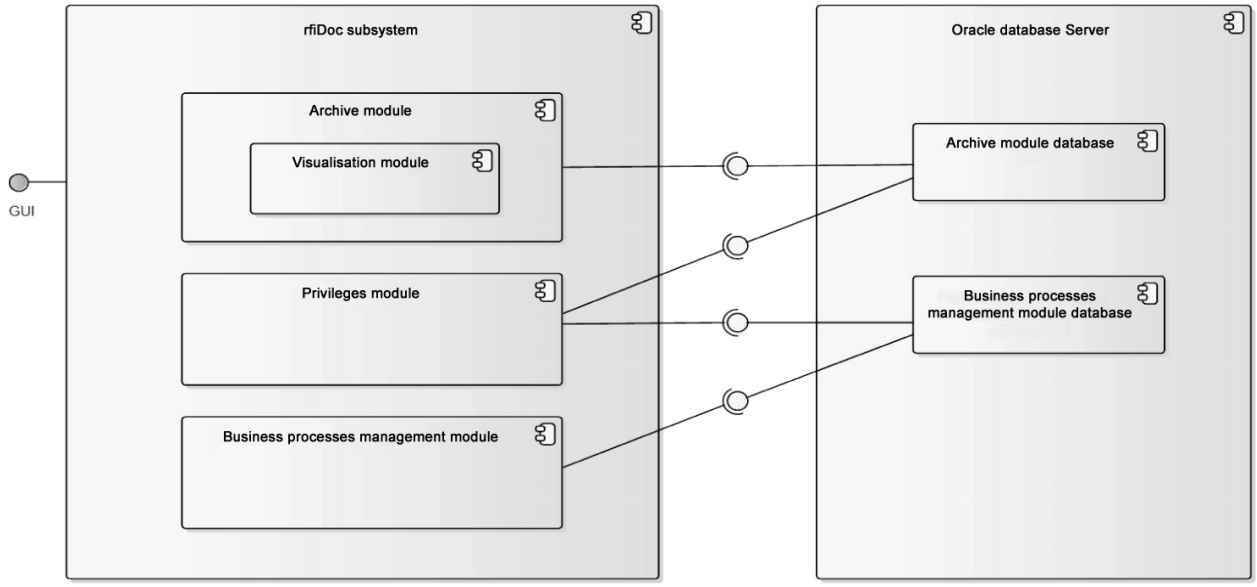

Fig. 3. Logical architecture of the rfiDoc system – division into modules.

the archive module. The data collected by the archive module are stored in the database of the archive module, which constitutes a component of the database of the entire rfiDoc system.

The diagram shows other rfiDoc modules that have significant impact on the work with documents at different levels of sensitivity. The data gathered by particular modules are stored in the database of the rfiDoc system.

The module for managing access to the documents at different levels of sensitivity uses the database of the archive module as well as the database of the module for handling business processes. The module for handling business processes uses only the data collected in the database dedicated to such component of the system. Additionally, the rfiDoc system has a graphic interface, which allows to use any of the above-mentioned modules.

The application of the RFID technology, in combination with the appropriately adapted workstations, allows to fully identify media and documents not only in the places of storage, but also at workstations. It is assumed that the appropriately adapted furniture (with proper readers allowing document identification) shall constitute workstation equipment within the predefined protected zone.

8. MAIN FUNCTIONS OF THE VISUALIZATION MODULE

As a result of the analysis carried out to design the visualization module for relocation of the documents at different levels of sensitivity, the following basic functions of the module were specified:

1. Establishment of hierarchy in the warehouse where the documents at different levels of sensitivity are stored.
2. Possibility of defining layers of the warehouse units that constitute parts of the designed warehouse.
3. Storage of data concerning the warehouse units.
4. Addition of documents to the warehouse units.
5. Establishment of hierarchy of documents within the warehouse unit.
6. Identification of location for the warehouse unit.
7. Identification of location for the document.
8. Collection of data concerning the document.
9. Keeping a history of changes in the document, including changes in the assigned location of the document.
10. Display of the history of the document in a graphical form - on a map.
11. Display of the history of the document in the form of a list.
12. Possibility of searching data on the document or warehouse unit within the entire archive module.
13. Display of the search results in the form of a list.
14. Display of the search results in a graphical form - on a map.

9. MONITORING OF SHIPMENT

Each document registered in the system has a separate history tab. The history of the document was presented in a graphical form - in the form of a map and list of actions performed on the document.

Visualization of the history on the map reflects the path of moving the documents between particular locations (Figure 4).

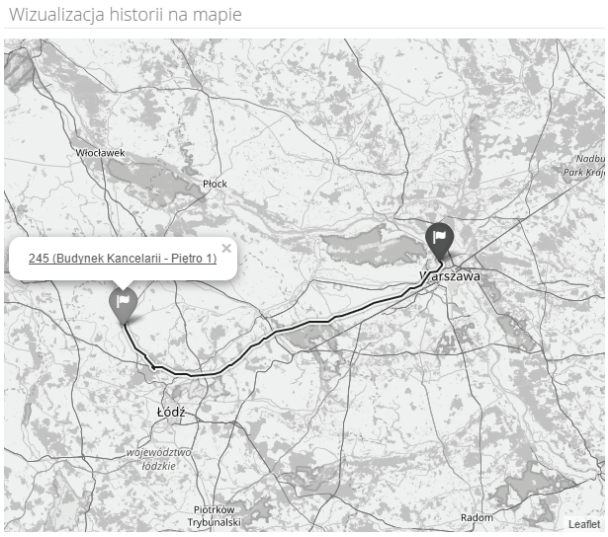

Fig. 4. Visualization of the history of the document on the map.

All actions on the document are recorded and displayed in the form of a cumulative list of changes. The list of changes constitutes the history of the document. The history of the document includes the following: action performed on the document, user who made the changes, name of the document, list containing the document and name of the unit to which the document is assigned (Figure 5).

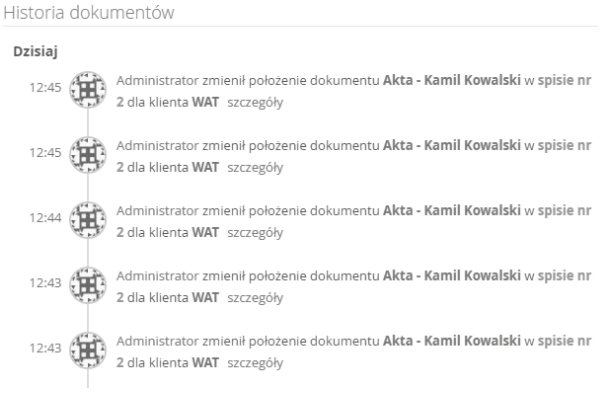

Fig. 5. History of the document.

The level of detail of searching changes when the map is zoomed. A more detailed map allows to see single tags. By choosing a single tag, the information about the searched position is shown. The information is displayed in the form of a link redirecting the user to the data editing view (Figure 6).

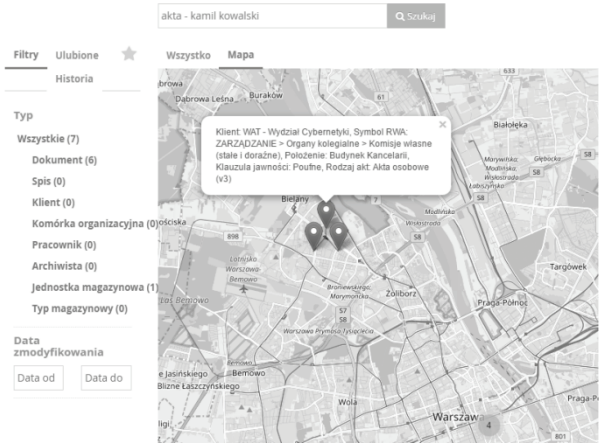

Fig. 6. Map search results - single tags.

When editing the warehouse unit, the system user shall be able to set the geographic location of such unit. The rfiDoc system allows to write an address in the search engine and automatically set a tag or mark a specific location on the map without the necessity of using the search engine (Figure 7).

The system user may add layers for each warehouse unit. The layers are added in the form of graphic images, e.g. in JPG, PNG, BMP formats, etc. It is possible to modify the width, height and settings of the layer to adapt it to the size of the building shown on the map (Figure 8).

Once the warehouse hierarchy is established, the user may define the organizational structure of the unit, to which the Office belongs. On the basis of the created organizational structure, the lists of documents and document hierarchy are created.

10. SUMMARY

The article outlines the concept of extending the IT system for the management of lifecycle of the documents at different levels of sensitivity with an option to track consignments containing documents in transit.

As a result of the project implementation, the project of the secret office was developed, including rooms, components of equipment and essential software for managing the document flow. The already existing elements of the system

may be extended by the functionality of tracking documents transported from one protected zone to another.

flow of media and documents. The implementation of the results of the project may be also useful in the field of economy - for processes related to the

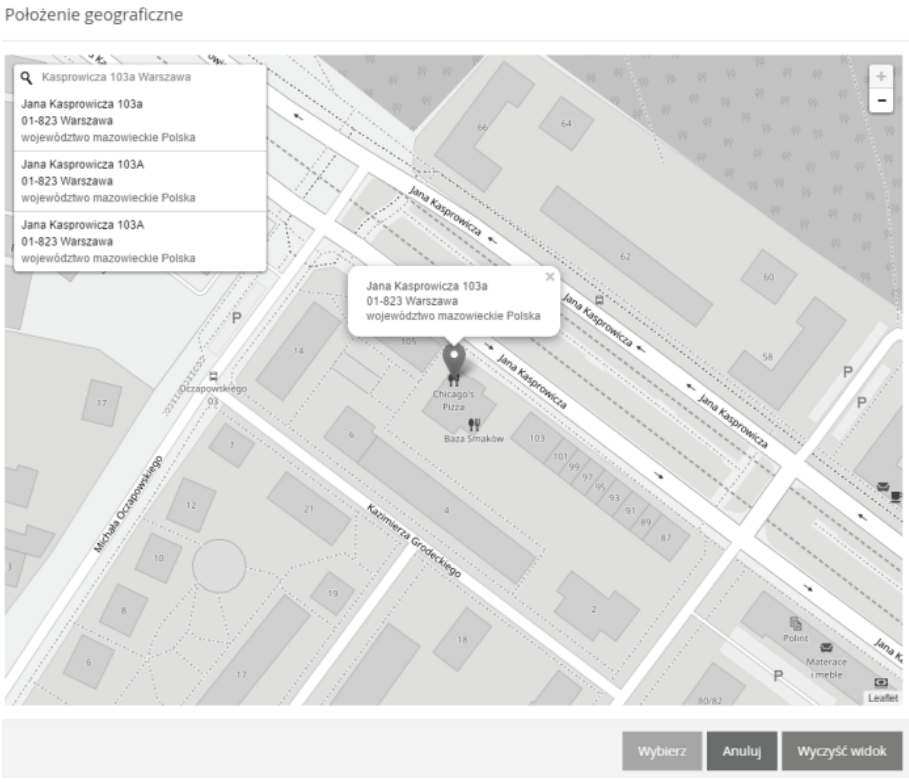

Fig. 7. Setting of geographical location for the warehouse unit.

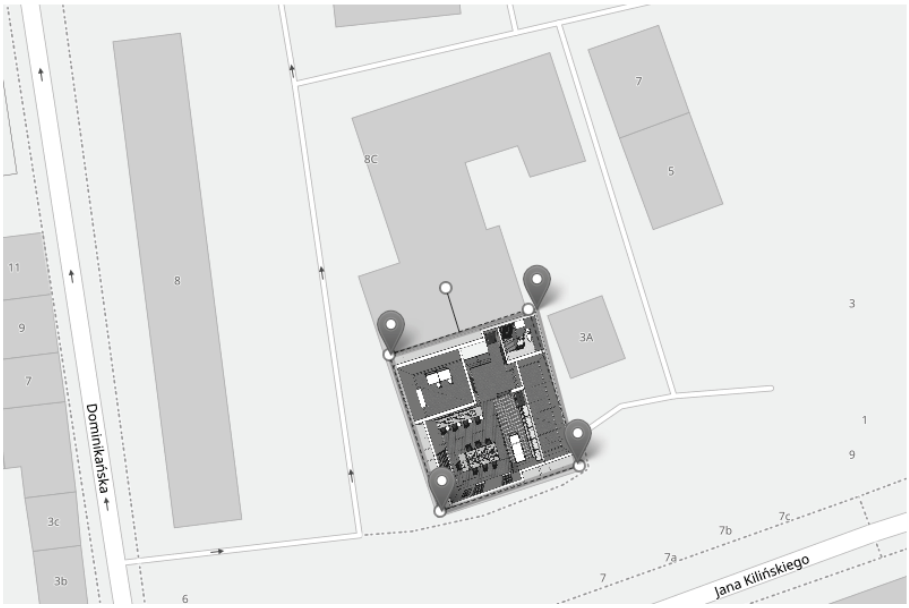

Fig. 8. Addition of layers on maps for the warehouse unit.

It shall be also possible to implement the results of the project regarding state defense and security to ensure better control of storage and access to confidential documentation as well as to track the document archiving.

As part of the performed analysis, it was possible to present the whole picture of the designed visualization and relocation module for

the documents at different levels of sensitivity. Both the perspective and architecture of the module reflecting correlations between the module and other components of the rfiDoc system were characterized.

The principles of data exchange between the visualization module and other system modules and databases were described. The visualization module mainly collaborates with the archive module. While using the metadata of the document, the visualization module locates the document and displays its location on the map in a graphical form.

Another step shows logical architecture of the designed solution. The diagram of architecture shows the entire scope of the system supporting the work of the Office.

The last part of the study describes the results of the implemented visualization module and possibilities of its expansion with the visualization of roads where the consignments containing the confidential documentation are transported.

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