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MONITORING DANGEROUS CARGO VIA SATELLITE TOLL SYSTEMS

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Abstract: The growing intensity of hazardous material transport increases the risk of endangering participants in the road traffic and a harming the environment. The transport unit with dangerous goods is equipped with an active or passive RFID chip in generally. The largest disadvantage of the current dangerous cargo monitoring system is the fact that there is no information about the immediate location of the shipment available. This article presents an idea of connecting the system for monitoring dangerous goods with the system of electronic toll collection. This technology together with information technologies (IT, mobile data transmission systems GSM, navigation systems GPS and others) offers almost unlimited possibilities of monitoring and record-keeping of hazardous materials.
Keywords: Toll systems, dangerous cargo, satellite, RFID

1. INTRODUCTION

Traffic infrastructure is one of the key indicators of a country's development stage. It is not only an inseparable part of the citizens' life but also contributes to increase of employment rate, thus curbing economic growth and competitiveness of the country, tourism and inflow of foreign investment. Slovakia is a country which progressively invests into predominantly road infrastructure (new highway and expressway sections, road tunnels, maintenance, reconstruction and renewal of traffic facilities). Development of road infrastructure consists of its modernization and implementation of new traffic services, closely connected to intelligent traffic systems. [1]

Intelligent traffic systems (IDS) provide services which include activities of road network administrator and operator, provider of traffic services, transporter as well as a participant of road traffic. An IDS is an information and communication technology or a system placed within the traffic infrastructure or a vehicle, aiming to optimize and regulate road transport, mobility, traffic safety and fluency, administration and maintenance of ground communications, public transport services and environmental issues. It also serves interfaces with other types of transport, securing transfer, collection, processing and exchange of information between service operators, providers of traffic information and traffic infrastructure users. [2]

IDS are a significant tool for management and regulation of traffic. They make the traffic system safer, more efficient and productive but they simultaneously must fulfil environmental and financial requirements related to development of road transport. Furthermore, IDS help traffic operators and emergency services to monitor the traffic, discover and intervene in accident and inform the public on traffic situation via the Internet, traffic facilities and media.

As new paid and secured traffic sections are being constructed, the issue of environment of the road network is widely discussed. Except of other negative factors (insufficient renewal of transport road, outdated vehicle stock, overloaded trucks etc.) the situation is complicated by the potential threat arising from carriage of dangerous substances. Even if all legal regulations are abided by, the environment is threatened by technical malfunctions, failures and accidents which may lead to disruption of tightness of packing and leakage of dangerous substances. A human failure might cause breakdown of traffic in such sections (tunnels, sections with water resources etc.). Transport might lead to fire, gas leakage, explosion or other dangerous situations with serious consequences both for citizens and environment in the locality. Therefore the transport of dangerous cargo requires significant amount of attention.

2. INFORMATIONAL SYSTEM FOR MONITORING OF DANGEROUS CARGO

According to ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road), dangerous goods are substances and items whose transport is prohibited or permitted only under specific conditions. The current system for monitoring dangerous cargo has many faults. The most relevant one is the fact that there is no information on the current location of the carried dangerous goods. The records are still in paper form which is why the necessary information is not available to all interested parties. It is therefore necessary to create an electronic system for monitoring dangerous cargo (extended by overweight and

oversized cargo) possibly of continental extent with secured access necessary. According to imparted competence, the relevant information can be read, changed and entered. Introduction of such a system would lead to increased safety of citizens and lower the risk of ecological accidents. [3]

2.1. Monitoring storage area via RFID

The qualities of the RFID system (Radio Frequency Identification) make it suitable for monitoring of dangerous cargo. It is an informational system which functions in the high-frequency zone. RFID consist of three basic parts:

- **scanning unit** – a device which communicates with identification media and reads information written in the media or writes in it;
- **identification media (RFID)** – the carrier of the information, a device comprising the communication circuit for transfer of information into/from the scanning unit, memory circuit and necessary support units;
- **information processing unit (operating unit)** – most frequently a unit operated by microcomputer. Its basic task is to manage the communication between SU and IM, process the information read from the IM and perform an activity based on usage of identification accordingly (recording information on dangerous cargo into a database etc.).

The basic principle of RFID system, depicted on Figure 1, is very simple. The entity (in our case a shipment of dangerous goods) which we want to identify automatically and contactlessly must be equipped with RFID chip which sends out its identification data in the proximity of SU upon request. The active element in this process is the sensor which emits electromagnetic radiation into the space with predicted presence of identified entity. The identification chip is activated by this energy and transmits its identification data.

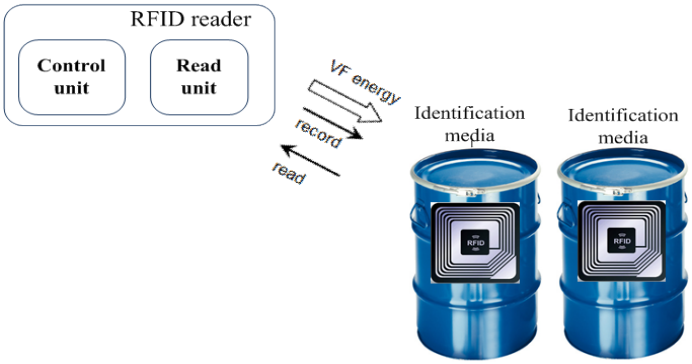

Figure 1. An image of radio frequency system for monitoring of location

The transport unit (palette, barrel etc.) with dangerous goods is equipped with an active or passive RFID chip. Before the transport, important data on the cargo (name, designation, amount, information on origin and destination) as well as instructions on what to do in case of an accident, are saved into an active RFID chip with RAM. When using a passive RFID chip with ROM, identification number connected with corresponding data in the database.

2.2. Principle of monitoring cargo

The whole process of monitoring dangerous cargo between two storehouses is depicted on Figure 2. In every entrance of an object storing dangerous substances and materials (storehouse A and B) there is an RFID scanning unit. After loading the goods, the chip is scanned and the ID number saved in it is subsequently transferred into the central database of dangerous goods transport (DDGT). By this method, information related to transported dangerous cargo is assigned to every ID number in the database. By entering a specific ID number into a presentation server (PS) cooperating with an application server (AS) we can immediately obtain information not only on the substances being transported but also on their origin and final destination. [5]

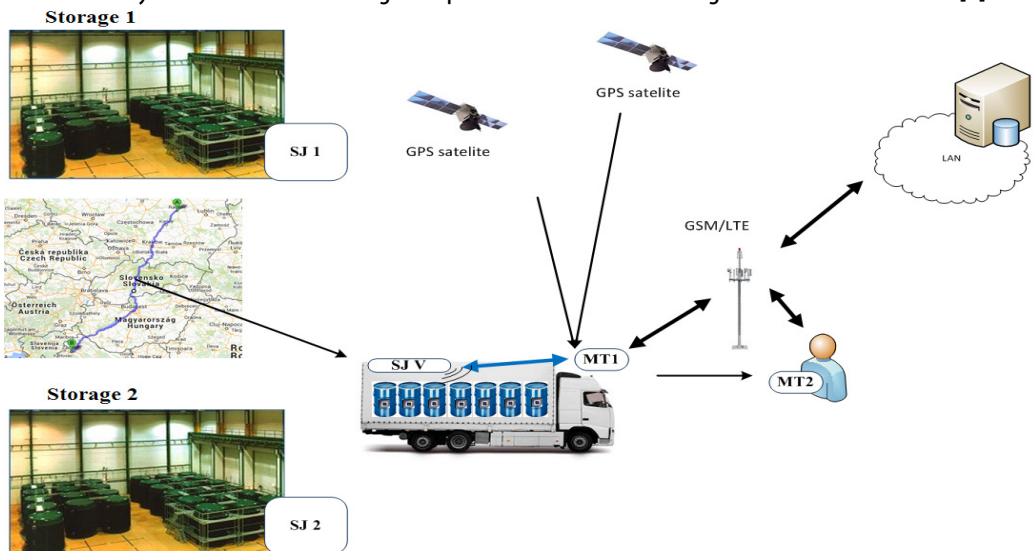

Figure 2. Process of transporting dangerous cargo

The outer packaging (tank, container etc.) the unit is transported in is equipped with RFID scanning unit (SUV). It monitors the presence of shipment located in the container during the whole shipping period. Information obtained in this way is compared to the information saved in the database. In case of change of secure status (e.g. a barrel with a dangerous substance shifts from the container) the system records it and immediately informs the driver of the truck via active signalisation. For this purpose, the driver is equipped with a mobile terminal (MT1) connected to monitoring technology. The function of this terminal could be performed by Personal Digital Assistant (PDA) combined with mobile communicator by means of which the driver sends out a warning to relevant authorities and informs them of his location. A second option could be an extended On-Board Unit. In case of a traffic or ecological accident the police and fire brigade do not have to wait for expert examination of the container which might last several hours. Via mobile terminal (MT2) equipped with RFID scanning chip unit they are able to find out the ID number located in the chip. By connecting to the central database they are able to gain information about the cargo and about measures to be taken to secure safety of people and environment. Upon reaching the final destination the whole cargo is scanned via RFID scanning unit (SU2) in Storehouse 2 again and all data on dangerous cargo are sent to archive for further processing (statistical data). The operating unit simultaneously examines whether the loaded and transported dangerous cargo has really reached its destination and has been unloaded.

3. LOCATING A SHIPMENT OF DANGEROUS GOODS

One of the largest disadvantages of the current dangerous cargo monitoring system is the fact that there is no information about the immediate location of the shipment available. A shipment of dangerous cargo can be localized in real time by several methods.

The control scanning unit MT2 can be either stationary or mobile depending on the application. For the purpose of monitoring dangerous cargo both types ought to be used. A stationary scanning unit should be placed in strategic traffic spots (border crossings etc.). The main idea is connecting the system for monitoring dangerous goods with the system of electronic toll collection. In this case one scanning unit would be used for both purposes as (an additional function) and it would be placed in road toll gates. The mobile scanning unit would be available to policemen and integrated rescue brigade enabling them to obtain all necessary data on the transported cargo.

As the dangerous cargo passes the checkpoint gate for electronic toll collection for the first time, data on dangerous cargo as well as the initial current location of the shipment is transferred into the system. Such method of localization can be used on the road network (highways and first and second class roads) in the whole area of the Slovak Republic.

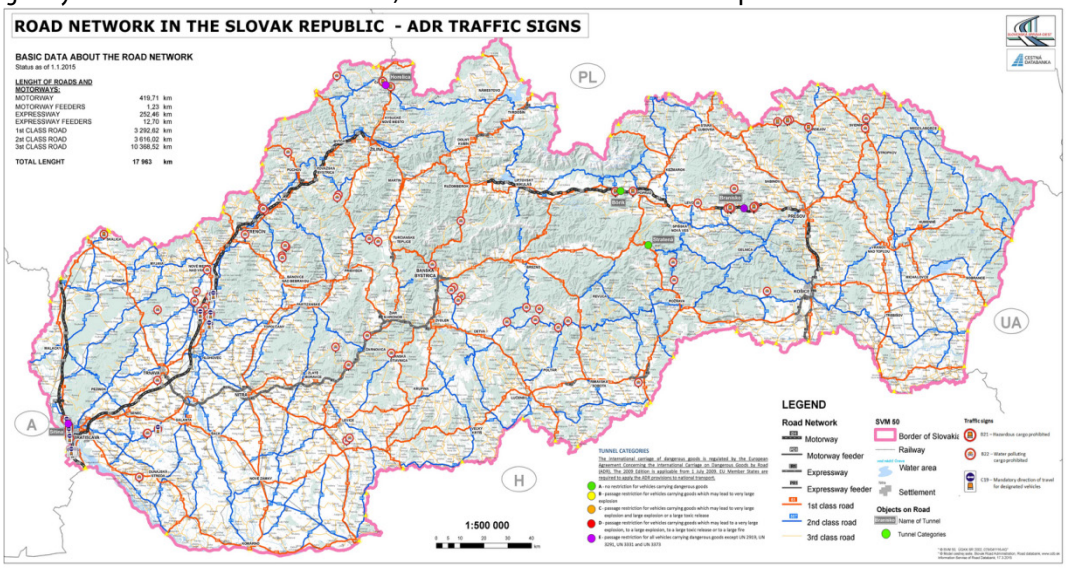

Figure 3. Slovak Republic road network [6]

The system must be designed in a way enabling only the authorized persons to access the selected data from any place with the possibility of data connection to the network. The data must be carefully "personalized" so that every user of the information system (IRS – Integrated Rescue System, self-administration, transport operators, other users) has authorization data (username and password) imparted to them by the system administrator. Some of the participants thus have the competence of only reading the system information while others can write or change the data. Transfer of data within the whole system must be performed via security communication protocols [4].

4. CONCLUSION

With growing volume of trade and increasing transit cargo transport, the road traffic is taking up a larger part of it in comparison with rail transport which has unavoidable negative influence on environment, road traffic density and quality of life - particularly in

urban areas. If we want to provide protection to the citizens and create suitable conditions for survival in extraordinary situations, it is necessary to know the risks of transporting dangerous goods. The current situation requires creating an electronic system for monitoring of dangerous cargo replacing the insufficient system of today. This system would contribute to increasing security not only of participants of road traffic but also of citizens living in proximity of road communications where dangerous cargo is transported and also protection of the environment.

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