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MONITORING AND CONTROL OF DANGEROUS GOODS TRANSPORT ITS PILOT PROJECT IN THE CZECH REPUBLIC

The paper presents the result of national ITS project "Monitoring and control of dangerous goods transport with help of GNSS (Global Navigation Satellite System)" within which the practical pilot trial on different traffic infrastructure is tested. Presented solution relates to route selection of the dangerous goods transport, so monitoring and control of real movement on selected route is automatically reported.

MONITOROWANIE I KONTROLA TRANSPORTU TOWARÓW NIEBEZPIECZNYCH. PROJEKT PILOTOWY ITS W REPUBLICE CZECH

Referat prezentuje wynik krajowego projektu ITS "Monitorowanie i sterowanie transportem towarów niebezpiecznych za pomocą GNSS (Global Navigation Satellite System)" w ramach którego testowana jest praktyczna instalacja pilotowa na różnych rodzajach infrastruktury ruchowej. Prezentowane rozwiązanie odnosi się do wyboru trasy transportu towarów niebezpiecznych, więc monitoring i kontrola ruchu na rzeczywistej trasie jest raportowana automatycznie.

1. INTRODUCTION

Basic terminology. In order to be able to speak about a system it should be at least necessary to describe such defined system as a final automat defined by mapping the system inputs with respect to internal state plus mapping the inputs and internal state with respect to the system outputs.

A subsystem must be describable through an identical methodology like a system; in its substance a subsystem is a system to be described at a more detailed distinguishing level.

A system shows both a structure and architecture while the structure is usually much more detailed than the architecture. The architecture defines the basic arrangement of subsystems and functional blocks in the space (we speak about a functional block if we cannot or may not define the given block as a system or a subsystem). The architecture is more global and its objective is to be arranged and intelligible as clear as possible.

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The structure goes up to systems elements, and it is more complex and more complete but less clearly arranged.

A process reflects the chained events within a system. An event may mean a change of a system state brought about by an initiation on inputs (transfer of input values) or initiation of internal system state (going to extremes: "to equip" the internal state of some element or to change the function of an element may be sometimes "triggered", for instance, spontaneously by means of a disturbance, etc.) or "only" in the course of the external time. A set of all activated processes at possible environmental conditions defines the system behaviour.

A system structure may be also flexible like, for instance, in the computer field where the structure is being changed according to a certain quality criterion. Such approach is based on the so called configurator, which is, for instance, a table plus evaluating and operating SW through which it is possible to reconfigure a system structure or architecture.

2. ARCHITECTURE OF SYSTEM FOR MONITORING AND CONTROL OF HAZARDOUS GOODS

The Fig.1 describes the architecture of design system for dangerous transport control and monitoring. The designed system has links to both organizations responsible for transport forwarding processes (transport infrastructure manager, forwarding companies, transport operators, etc.) and organizations connected to transport-forwarding process (rescue services, public authorities, custom authorities, etc.). The system for monitoring of dangerous goods transport is connected to information systems of each mentioned organization and provides them with selected information. The received information could be automatically used by telematics means e.g. the on-board units of rescue service vehicles, transport operator vehicles, infrastructure manager, etc.

The designed system will derive benefits from maps' data, roads and railway infrastructure for specific attribute concerning e.g. protected regions, speed limits, databases of all dangerous goods accordingly ADR/RID, and so on. Main goal of the telematics system it to monitor all information about all carriages performed by dangerous loads on territory of the Czech Republic (pilot project only in the chosen part of Ostrava).

One of very important parts of designed system is the maximal use of existing internal and external information for

- route selections and dangerous transports tracks monitoring;
- emergency call in case of accidents, accident location;
- processing of available information (models of contamination, traffic information, etc.);
- instruction for intervention;
- re-routing of traffic, warning the public, etc.;
- accident impact evaluations;

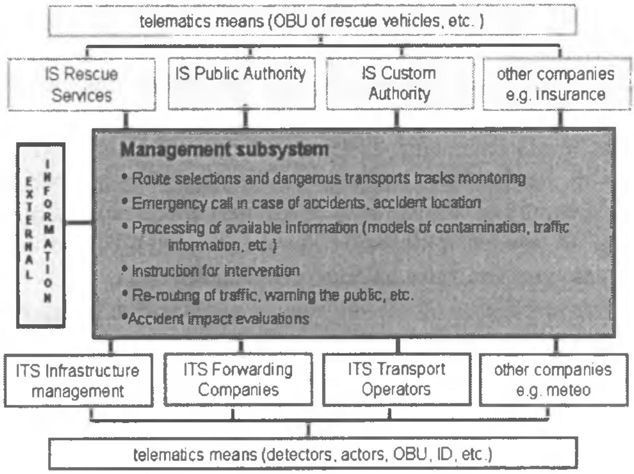

Fig.1. Architecture of system for dangerous transport control and monitoring

3. UML MODEL OF DESIGNED SYSTEM

System tries to simplify a transportation of dangerous goods, with reference to safety of population. Into the system, two types of users are expected to enter:

Free of charge users (public services, administration of water supply, distribution of gas, power control energy, control of watercourse, etc ...) - administrator will implement these components into the information system. Every component obtains own user name and password and will derive benefits from the system free of charge, according to subsidiary law.

Users, who will pay for using the system – sender, recipient, dispatch service (transporter). These components enter individually to the system, but system will be capable warrant of their reciprocal relationship. These users will be registered with the system administered by public office. Every one of this subject will have to request permission to participate in cargo dangerous goods by appropriate government office. This request will be paid according to the rates.

Description of users could be summarized:

- System administrator – to register or discard users and assign them their rights, collects taxes for commercial services of the system, generates statistical data, manages and provides all data in databases.
- Government office - disposes (gives or rejects) different users applying for permission and collects the administrative fees from them; likewise are registered a transport units. This data is provided by the administration system. Database of the users is under the central control.

- Municipal, town or regional authorities - They are registered into the system automatically, have the right to monitor a situation in the appropriate territory. Because system is decentralized, these authorities offer data to the regional autonomy and to the government administration. In case of the breakdown or crisis, a common or local autonomy automatically informs system together with municipals autonomy to coordinate rescue services.
- District and local components of rescue service - They are registered to the system automatically. Rescue service enters only in case of breakdown, any emergency or lawbreaking (e.g. load moves outside the permitted route). Components of rescue service has all needed information about transported dangerous goods online (to know accurate position, type and kind of substance etc.).
- Infrastructure managers - These subjects are registered in the system, but they do not have rights to enter into the system. In case of breakdown or other contingencies, system alert for arisen situation.
- Border checkpoints - Subjects are registered in the system, with the view of data insertion about vehicles coming and leaving the Czech Republic.
- Sender - Subject (physical or corporation) sending the load. All information about this subject has to be stored in database of the system.
- Dispatch service - Subject, which secures transportation between sender and recipient – negotiates for several transporters transported loads. All information about this subject has to be stored in database of the system. User has right to enter and edit relative data into system after obtain his user's name and password (place loading, transfer unloading, single transporter, type and quantity transit material). Can monitor data about his orders force his permission and so on.
- Transporter - Subject (transport operator or vehicles), reaches goal destination. Between a transporter and sender is wroten a contract of carriage (contract about transportation dispatches). Subject has the right to enter the information system, monitor and edit fields of the contract.

Information system includes database of information about subject's dangerous loads that is automatically registered by the system administrator (rescue service, state and municipal office, border checkpoint, etc.) or was registered by means of permission near government office (transporter, sender, recipient, dispatch service).

Further, the system includes information about all transports of dangerous loads in the Czech Republic. Every transport unit that transports dangerous material according to ADR/RID has own identification (ID) and arrangement for on-line monitoring.

System cooperates with application of Geographic Information System, which contains road database, to enable to monitor to trace down the vehicles with dangerous load. Information system includes database of all dangerous matters, dividing, accordingly ADR, inclusive instruction, how to behave in case of emergency, breakdown or in an unpredictable state of load.

An UML sample view on designed system is shown on Fig.2 and Fig.3.

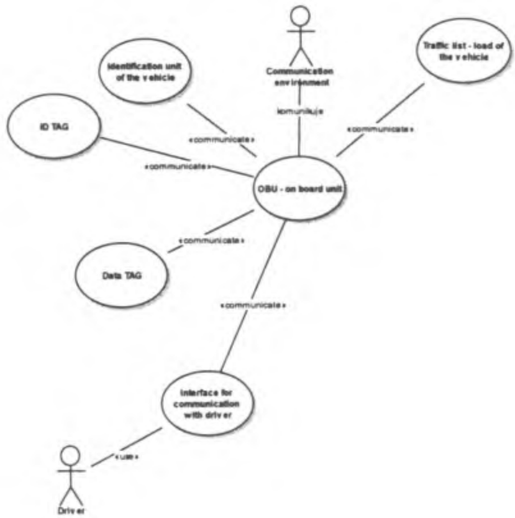

Fig.2. The OBU (on board unit) interfaces

Fig.3. The functions of OBU (On-board Unit)

4. PERFORMANCE PARAMETERS REQUIREMENTS

First step in addressing the application monitoring of hazardous goods using GNSS should be the analysis and establishment of performance requirements. For following individual systems parameters a methodology for their measurement should be developed:

- Safety (risk analysis, risk classification, risk tolerability matrix, etc.)
- Reliability (the ability to perform required function under given conditions for a given time interval)

- Availability (the ability to perform required function at the initialisation of the intended operation)
- Integrity (the ability to provide timely and valid alerts to the user when a system must not be used for the intended operation)
- Continuity (the ability to perform required function without non-scheduled interruption during the intended operation)
- Accuracy (the degree of conformance between a platform's true parameter and its estimated value), etc.Substantial part of the systems parameters analysis regarding telematics application is represented by a decomposition of systems parameters to individual subsystems of the telematics chain, including a proposal for macro-functions of individual subsystems and information relations between macro-functions. Part of the analysis is the establishment of requirements on individual functions and information linkage so that the whole telematics chain should comply with the above defined systems parameters.

The completed decomposition of systems parameters will enable the development of a methodology for a follow-up analysis of telematics chains according to various criteria (optimization of the information transfer between a mobile unit and processing centre, maximum use of the existing information and telecommunication infrastructure, etc.). One of the criterions appropriate for transport-telematics applications with a GNSS system is the synthesis of the telematics system with minimized systems requirements on a locator, the resulting systems parameters of the telematics application under study to be maintained. Here it is necessary to indicate that the synthesis does note relate only to technical or technological part of the solution because the safeguarding of systems parameters of telematics applications is to be ensured by organizational and legislative instruments as well.

5. PROCESS ANALYSES

Basic processes of the life cycle of the transit describe the ELH (Entity-Life diagram) at Fig.4. The processes P1-P10 (leaves of the diagram) are sorted in three branches – Creation, Course and Storage of the transit data. In the following text will be some of these processes described

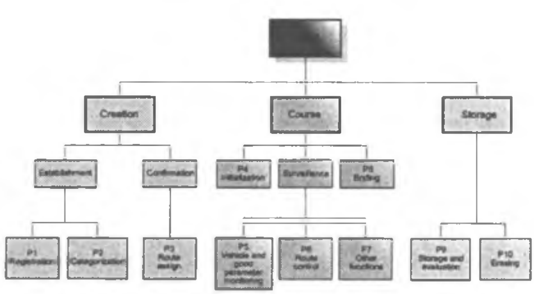

Fig.4. ELH diagram of the transit in system
The asterisk * signifies repeating process, double-lines mean parallel process

Every transit in the system is announced by the security advisor or another contact person in the company with rights to register the intended transit of dangerous good. The transit is authorized, when both the carrier and consigner company put the same valid transit data into the system. That way we expect to reduce the number of faked transits.

After validation of transit data, the categorization and route is assigned. The transit is now ready to start, with it's driver, vehicle, good, route and category of importance (danger).

The proper on-line monitoring of the transit is realized primarily at OBU (On-Board Unit). The OBU application is implemented as autonomous expert system with GUI, sensors and secured network connection to server. The client determines its states from available data and acts according to its state.

Thin client has also been developed, with minimum of logic on its side, but some actions resulted slowly due the connection leaks. Although the thin client needs less hardware resources, its development was paused as it was too unreliable.

The transit entity has relation with states from 5 state groups. The set of these states gives relevant and sufficient meta-information about the transit in real-time. Exact values of input data are also transmitted and stored in the server database. The states are determined either on OBU, or at the server, or both. If both decide, additional check of decision match is performed.

6. DATA MODEL

Server and OBU database structure is similar, although server database is significantly complicated with functions, triggers and necessary entities. The core data structure is demonstrated in ER diagram in Fig.5. Entities are coloured along their purpose.

The main entity Transit (white) has relation with it's time identification and decided state (green). Company and user data are stored in blue entities. GIS – related data are stored in gray tables. Although not shown, there are many tables related with various information and locations, derived from the national address register and Tele Atlas data. Vehicle types, technical data and other information about vehicles are stored (orange). Data types and structure of dangerous goods (yellow) come mainly from ADR table A, where main entity Cargo type and its M:N relationship with Transit is shown.

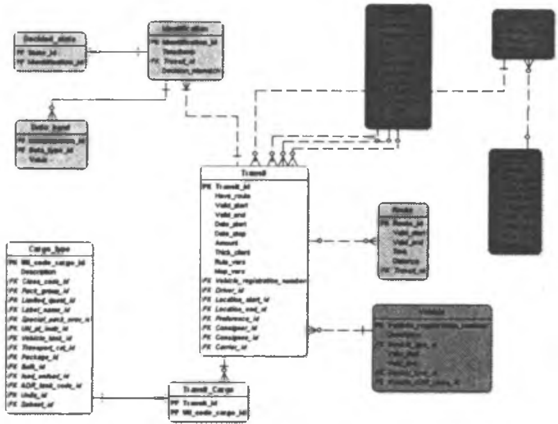

Fig.5. Main data structure

7. CONCLUSION

The dangerous goods transport is a complicated social problem for Europe because it could result in grievous fallouts. The paper reacts upon this claim and designs the information system for decreasing the dangerous goods transport accidents by registration of all dangerous goods transports and by real time tracking and tracing of vehicles with dangerous goods. The benefits of the designed system could be seen in the following areas:

- the system can compare all relevant information from different organizations and check their integrity and correctness;
- the system can provide the rescue services by all relevant information and can be the guideline for intervention instructions;
- the system is able to provide special statistics for public authorities;
- the system can inform all organizations about the dangerous goods transport and they can performe special measurement, e.g. rerouting the transport, hazardous measurement in tunnels, etc.

All mentioned benefits of the designed system are very up-to date and the system could be implemented all around Europe to minimize accidents as well as acts of terrorism.

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