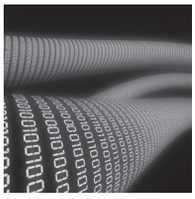

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Monitoring and managing systems based on GPS in the land and air communication

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ABSTRACT

The article presents conception of author's management and monitoring system based on GPS, for application in the transport and land and air communication. This system arises as an answer to demand of local Civil Services, which are member of a crisis management. System purpose is to increase the effectiveness and safeties during salvage actions. In following years the system evolved, allowing its use not only in land conditions but also in the transport and the air lifesaving. Article shows future plans connected with the system development and the extension with ADS-B system (Automatic Dependent Surveillance - Broadcast).

KEYWORDS: navigation, GPS, EGNOS, GSM/GPRS, ADS-B, monitoring, communication, management, system

1. GPS tracking service

Crisis situations are often safety-related operations. They are at most times critical missions that public safety forces have to operate. Lives, environment and important economical interests are at stake during such crisis situations.

In such safety related cases it is important for public safety forces to be more and more effective even if crisis situations are already processed with a great efficiency. Crisis management systems are very useful tools for operational emergency services, helping them to manage with more effectiveness any emergency situation that could occur, such as forest fires, floods, earthquakes, accidents occurring during transportation of hazardous material. If appropriate services are available via SISNeT/EGNOS, they will allow a better effectiveness of emergency forces.

Among the task planned in the SISNeT Application project to provide concrete demonstration of the interest and potential of SISNeT/EGNOS for user community and potential investors, one project is devoted to the application of SISNeT to Crisis Management System. The Crisis Management task of SISNeT Application project is aimed to define and implement an experimental monitoring system for fire-brigade units using EGNOS/SISNeT corrections.

The need to create the proposed system is based on fire-brigade officers' experience with GNSS-based monitoring, and its defined levels of accuracy, reliability and continuity. After analyzing all factors and conditions, a plan to implement a system complemented with SISNeT corrections will arise.

The aim of the task is implementation of monitoring and management system for fire service units, using SISNeT/EGNOS satellite systems and corrections as a base. Project should result in a comprehensive IT and -telecommunication-based solution which will be offered to officers of the fire service, and in the future to others services, after the necessary adaptation to requirements of

other crisis management services. The most important part of proposed system is high quality information about location (position error < 3m), that will allow conducting rescue/intervention actions even in very unfavourable weather and action conditions.

The main aim of the project is to point out advantages of Galileo for crisis management systems. It will demonstrate on the field and evaluate the benefits of the use of SISNeT Technology as an advanced GNSS with reliable, guaranteed services during crisis management operations.

2. Description of the firefighters' work during action

The rescue operation is being started with the moment of accepting the application; a computer system should locate the person ringing on the base of a telephone number. Implementing the rescue procedure is a further step, a sound alarm is starting. From this moment we can divide the salvage in two:

- Managing tasks, supported and monitored from the head office (it is playing an important role in the head office that the data get from the area is accurate, therefore it is so important that the system uses corrections from SISNeT/EGNOS),
- Rescue and managing tasks in the field (the commander of the action is also using the visualizing system; the accuracy and the speed of the obtained information have the significant effect to the course of a rescue operation).

Course of a rescue operation in the head office.

The dispatcher after starting the alarm procedure is informing the commander of the rescue team of the purpose and the current situation on the scene (information obtained on the basis of the telephone application).

There is a solution drawn up consisting in using tactile terminals, of which a visualization of the rescue order and the optimum route of the journey to the scene will be a purpose including the current situation on the road (traffic). This, however, will be carried as part of other project but basic property still will be an accuracy of the data obtained from GNSS system and corrected by SISNeT/EGNOS(it results from conversations already carried out and analyses in the environment of firefighters and on the basis of current experience from SISNeT/EGNOS).

On the position in the head office generating the route is taking place – the event and the visualization on the digital map on which every mobile units are visualized (rescue vehicles) participating in a rescue operation. On the basis of the generated route the dispatcher with the help of vocal announcements can lead the individual at the target and correct and route dynamically to existing situations on the road (traffic). Key elements letting dynamically lead units to target are:

- Frequency of the data transmission from the vehicle to the head office (max interval - 10 s)
- Accuracy of obtained details about the position speed and of direction of the ride. Providing with the accuracy of the data about the position with the not bigger mistake is essential than 3 m horizontally, using corrections from SISNeT/EGNOS is guaranteeing getting such parameters.

The work of the dispatcher isn't only ending and exclusively on taking individuals to the scene. He controls putting all mobile terminals participating in the action of firefighters with the help with which they are equipped, what allows to aim them to strategic places e.g. of hydrants, of cutting away the main energy power supply etc.. The dispatcher is communicating with single firefighters via GSM.

After the completed action the dispatcher controls the safe return to the base of the individual participating in a rescue operation.

Course of a rescue operation performed by the rescue team.

Rescue team notified with sound signal about commencing the action, is moving into the hall with armored vehicles, in the same time a communication of the dispatcher accepting the call with the commander of the accident ward is taking place, he/she is reaching for transmitting necessary information: of aim of the action (address, location), of kind of the event (fire, car accident, water flood etc.). The branch is setting off to the scene in the armored vehicles led with vocal instructions by the dispatcher which controls individuals in the head office. During the journey to the scene firefighters are starting their portable PDA with built in the GPS and GSM. After reaching their destination firefighters are commencing a rescue operation at that time PDA is sending details about the position, speeds, heights, of direction, for number of seen satellites etc. to the database server in the head office, obtained data in the real time is being sent to the SISNeT/EGNOS server, which server is returning corrected position data, this way obtained data are being entered into the database and visualized in the system. During the action the commander of the unit has the possibility to keep up and monitor all participating firefighters on his PDA what lets him effectively conduct rescue operations even in the most not favorable conditions. After the return to the base the personal PDA is being turned off.

3. Description of the crisis management system

We can divide action of the crisis management system in three main categories:

- Human factor, persons managing and participating in the salvage,
- The equipment factor, the device and vehicles used in the lifesaving
- System factor, computer system coordinating, managing.

Human factor:

- The chief coordinator, the person responsible for keeping the share and coordinating and managing everyone participating in the action (usually the province governor, the mayor of the city or the board member of the crisis management),
- Commanders of individual rescue units: commander of the fire service, police, border guard, doctor supervising the medical lifesaving,
- Commander of rescue units, are persons commanding individuals participating in the task in the field,
- Members of the rescue teams: firefighters, policemen, border guards, medical lifeguards, volunteers

Equipment factor:

- Rescue vehicles: fires engine, ambulances, police cars, vehicles of the border guard,
- Devices being used for a direct lifesaving,
- Communication devices,
- Location devices,
- Computer hardware

System factor:

- Communication and exchange of data systems (duplicated),
- Visualizing systems,
- Tracking systems,
- Database systems.

Coordinated connection of all above factors allows the effective way to perform rescue operations.

The scheme for crisis management action is as follows:

After announcing the situation of the threat a convened board of the crisis management which under the leadership of the chief coordinator is making a decision about commencing action and dividing of individuals rescue teams. Next decisions are taken on the level of the command which is commissioning detailed action to individual unit commanders, performing action in the field.

Most demands for precise location come from the crisis management process itself. It is indeed very important for the control centre to know exactly where the deployed forces are located. Even if accuracy is a very important factor of efficiency, it is the main argument and demands are more directed to a high degree of reliability and integrity of the service. So, the benefits of these key factors, associated to the real time knowledge of the evolution of the event and of the location of the forces deployed will be part of the project evaluations.

4. Description of the firefighter's work as the user being an element of the system critical management

Single user of the system is a firefighter. Their basic tasks are: performing rescue action of e.g. putting out a fire, pumping out water, eliminating the building threat, rescue operation during a car accident.

The firefighter as the user of the system is only a supplier of data i.e. has PDA which is automatically sending details about his position and may be used for the verbal communication. A special case is a commander which can keep up with the situation and coordinate everyone participating in the action (however, every user of the system has such an option it is being dedicated for the commander, special case when every participant of the action can use it is e.g. forest extinguishing - when single branches and personal individuals can be distant from oneself on the great distance and in this case every firefighter can locate oneself and his partners).

An officer in the head office is a next user of the monitoring and management system.

5. Actions of the fire service

The fire service has the broad model scope for activity, e.g.:

- Firefighting,
- Lifesaving in road accidents,
- Lifesaving in train accidents,
- Lifesaving in flying accidents,
- Actions of chemical contaminating,
- Rescue operations on the height,
- Rescue operations at building accidents,
- Rescue operations associated with flooding, with flood.

Apart from the actions mentioned above the fire service runs trainings and courses of safety and lifesaving.

Units of the fire-brigade as a most important part of crisis management service will be the end-user of the

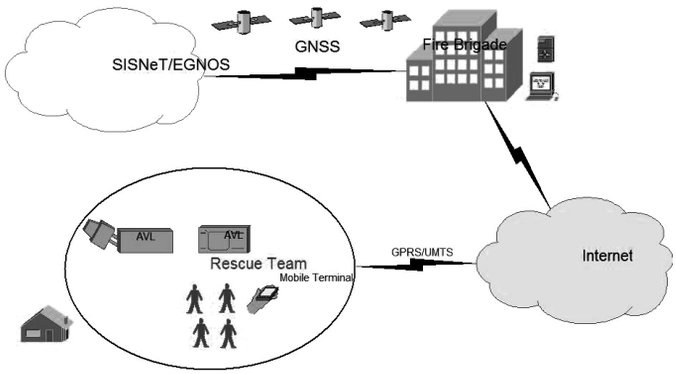

Fig.1.Schema GPS/SISNeT tracking system

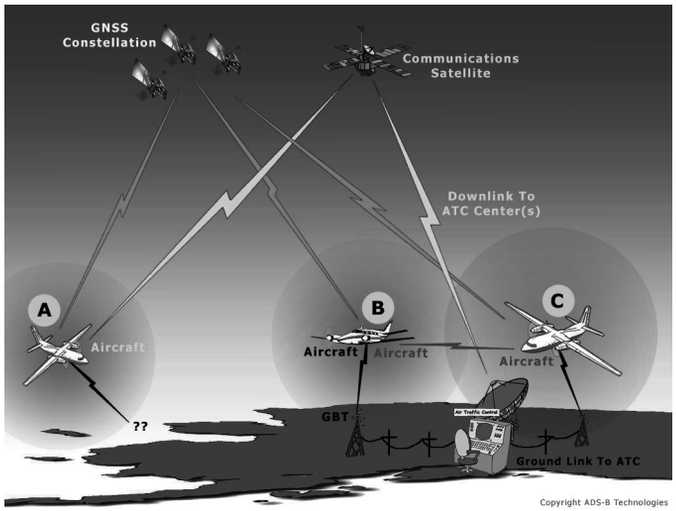

Fig.2.ADS-B overview

system. A fire service as a recipient imposes high requirements with regard to accuracy of data acquired from GNSS, caused by requirements of their working conditions incl. frequent rescue operations.

Factors and scripts pointing at the legitimacy of using the SISNeT/EGNOS system as the support system for the location system based on GNSS.

Basic feature of the obtained information are: details about the position from the SISNeT/EGNOS system with the accuracy lower than 3 m what lets traffic lane identify on which a rescue individual is, it is essential for conducting the effective action as well as to the possibility of the adduction to the system in case of road accidents or existing arguable situations (data is being saved in the database and they can be used at any moment). The system allows to take the firefighter with the great accuracy to landmarks in the field e.g.: hydrants, electric transformer, water cut-off points etc. it is also essential to keep the share on the large area where is taking place for it being distracted by individuals, he lets control everyone as well as he is helping the single user not to get lost in the unknown area.

Fig.3.Example of TIS-B service on ADS-B equipped aircraft

6. Other situations

The possibility of obtaining of SISNet/ENGOS corrections lets the fire service invoke the system in arguable situations; there are these credible archived sources of information about undergone rescue operations. The system allows also to perform analysis of undergone actions in terms of the speed of reaching its destination, deportment of firefighters during the action it is excellent training material letting firefighters improve its workroom.

7. ADS-B (Automatic Dependent Surveillance - Broadcast)

As a preparation to new challenges appearing in aviation technology activities undertaking units (planes)

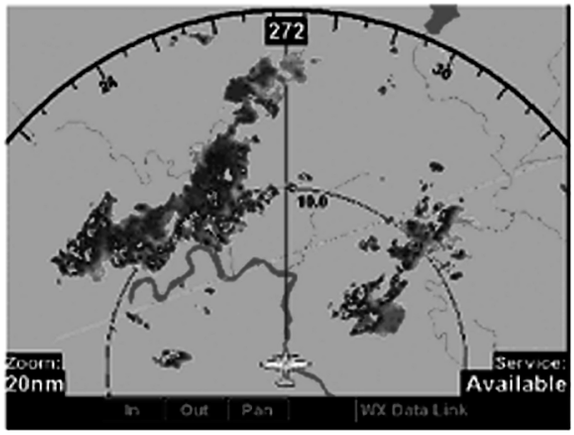

Fig.4. Example of FIS-B on-board transmission

localization using the ADS-B technology has been made. The primary goal of this project is creation of own system of units (planes) localization and propagation of the weather information using ADS-B as a base (FIS-B Flight information services-broadcast).

Automatic dependent surveillance-broadcast (ADS -B) is a cooperative surveillance technique for air traffic control and related applications. An ADS-B-equipped aircraft determines its own position using a global navigation satellite system and periodically broadcasts this position and other relevant information to potential ground stations and other aircraft with ADS-B-in equipment. ADS -B can be used over several different data link technologies, including Mode-S Extended Squitter (1090 ES), Universal Access Transceiver (978 MHz UAT), and VHF data link (VDL Mode 4).

ADS-B provides accurate information and frequent updates to airspace users and controllers, and hence supports improved use of airspace, reduced ceiling/visibility restrictions, improved surface surveillance, and enhanced safety, for example through conflict management.

Under ADS-B, a vehicle periodically broadcasts its own state vector and other information without knowing what other vehicles or entities might be receiving it, and without expectation of an acknowledgment or reply. ADS -B is automatic in the sense that no pilot or controller action is required for the information to be issued. It is dependent surveillance in the sense that the surveillance-type information so obtained depends on the suitable navigation and broadcast capability in the source vehicle.

8. Conclusions

Essential solution for ground localization systems is to connect the GNSS technology with mobile communications (GPRS). This solution unlike the radio broadcast is giving the possibility of embracing practically unlimited area and the better communications characteristics in the urbanized area. Monitoring in the extreme areas of the globe is possible with the help of satellite communication; unfortunately this solution is still very expensive. In near future usage of WiMAX technology for the data transmission will be possible, and it will allow not only to receive data but also to broadcast large data amounts to the vehicle. The only obstacle is costs terms.

Air solutions are characterized by a fact that communication system must operate on the large area and at great heights. The GSM system lets to monitor an airship on maximum height of 1000m, what is disqualifying it (GPS) for air applications in the area of the flight inspection (however it (GPS) is used in General Aviation monitoring). Undoubtedly the future in aviation systems is ADS-B system, which with the beginning of 2012 will be installed on all airplanes as a default.

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