Sisnet as a tool in crisis management

ANDRZEJ FELLNER[1], JAROSŁAW SULKOWSKI[2], PAWEŁ TRÓMIŃSKI[2], PAWEŁ ZADRĄG[2]
[1]SILESIAN UNIVERSITY OF TECHNOLOGY, KATOWICE
[2]AIR FORCE INSTITUTE OF TECHNOLOGY, WARSZAWA

ABSTRACT

Crisis management can be studied on many aspects of our modern societies. Many of public services are involved in dealing with it more often. The paper covers fire-brigade operation.
Fire brigade deals daily with many emergency situations such as fires, floods, earthquakes, accidents occurring during transportation of hazardous materials or traffic accidents. Every mentioned situation can result in injuries and even loss of lives. It means that all possible means have to be used for the most efficient dealing with an unpredictable event that occurred - the best technologies should be used on every stage of crisis management to minimize negative consequences.
In this case SISNeT/EGNOS data implemented and used for dealing with crisis is considered. The fundamental purpose of the task is to develop and test monitoring platform based on GNSS and data from SISNeT/EGNOS corrections, which fulfils following conditions: accuracy, reliability and continuity of service at a level required by a highly demanding user (fire service unit).
The project identifies benefits and potential of SISNeT/EGNOS system especially for user like public forces who have to assess, understand, and cope with a serious situations.

Sisnet jako narzędzie wsparcia w zarządzaniu kryzysowym

STRESZCZENIE

Zarządzanie kryzysowe może być analizowane pod wieloma aspektami w nowoczesnym społeczeństwie, wiele służb publicznych jest zaangażowanych w proces reagowania kryzysowego. Artykuł prezentuje wykorzystanie narzędzia SISNET w zarządzaniu kryzysowym na przykładzie oddziału straży pożarnej. W trakcie wykonywania zadań straż pożarna spotyka się z wieloma nadzwyczajnymi sytuacjami takimi jak pożary, powodzie, trzęsienia ziemi, wypadki drogowe lub przy transporcie materiałów niebezpiecznych. Przy każdej akcji strażacy narażeni są na utratę zdrowia i życia. Oznacza to iż należy wykorzystać najwydajniejsze rozwiązania, technologie tak aby zminimalizować negatywne skutki pracy w niesprzyjającym środowisku.
Głównym celem zadania jest opracowanie i przetestowanie platformy monitorującej opartej na technologii GNSS i poprawkach z systemu SISNeT/EGNOS, które podwyższają następujące parametry: dokładność, niezawodność i ciągłość usługi na wysokim poziomie(zdefiniowanym przez specyfikę odbiorcy jakim jest straż pożarna).
Artykuł prezentuje korzyści i potencjał SISNet/EGNOS zwłaszcza dla użytkownika takiego jak służby publiczne, który musi ocenić, zrozumieć i wykonać zadanie w sytuacji kryzysowej.

1. PURPOSE

The aim of the task is implementation of monitoring system for fire service units, using SISNeT/EGNOS signals and corrections as a base. The task should result in a comprehensive IT and -telecommunication-based solution which was offered to officers of the fire brigade, and in the future to other services (after the necessary adaptation to their requirements). The most important part of the proposed system is a high quality information about the location (position error < 3 m), that allow conducting rescue/intervention actions even in very unfavourable weather and operational conditions.
The fundamental purpose of the task is developing and testing of the monitoring platform based on GNSS and data from SISNeT/EGNOS corrections, which allow to get: accuracy, reliability and continuity of service at a level required by the user (fire service unit).

2. OBJECTIVES

Crisis management is a critical organizational function. Can be characterised by the element of surprise and a short decision time and every failure can result in serious harm, losses, or other unpredictable consequences for public safety.
It is a process and can be divided into three phases. The pre-crisis phase is concentrated on prevention and preparation. The crisis response phase is actually responding to a crisis. The post-crisis phase concentrates how to better prepare for the next crisis.
Crisis management can be studied on many aspects of our modern societies. Many of a public forces are involved in dealing with it. The paper covers fire-brigade operation.
Fire brigade deals daily with many emergency situations such as fires, floods, earthquakes, accidents occurring during transportation of hazardous materials or traffic accidents. Every mentioned situation can result in injuries and even loss of lives. It means that all possible means have to be used for the most efficient dealing with an unpredictable event that occurred – the best technologies should be used on every stage of crisis management to minimize negative consequences.
GPS technologies would be a very useful resource of information on every stage of a crisis management.
The project identifies benefits and potential of SISNeT/EGNOS system especially for user like public forces who have to assess, understand, and cope with a serious situations.
The Crisis Management part of SISNeT Application project is aimed at an experimental augmentation of the positioning and monitoring system used by fire-brigade units with EGNOS/SISNeT corrections: defining the enhanced system, implementing and testing it in real operational conditions.
GPS technologies improve Crisis Management on every stage. Not only units or members of the rescue teams equipped in GPS are easy to govern by a dispatcher in an operational centre which can be situated miles from the place of operation, unlike an on site mobile office. But also it improves organization of work lead in real time having all essential information in the main crisis centre. In the centre dispatcher easily assesses scale of a danger and after analysing all the factors can make decisions about moving ahead, regrouping or retreat of units for safe and efficient dealing with the danger. Not only one attendant can make decisions about the rescue operation but also a group of qualified specialists can be introduced into the situation. Thanks to better point of view on operation it can be supervised efficiently and safely. Decisions about concentrating more people in one position or to covering bigger area may be taken not only on a base of experience but also on a base of real time knowledge about the situation.
Last but not least important is the possibility of post crisis stage analysis. It means that all information provided during the emergencies like position of a specified unit or member of a rescue team, velocity of a unit, progress of a rescue operation on every stage can be stored in a database once the operation was finished. That gives unbelievable opportunities for investigations, trainees and for future success of a next operations.
Summing up it can be stated that implementation of SISNeT/EGNOS system into Crisis-Management increases real-time efficiency of operation and gives a tool for post-crisis analysis of occurred situation. Both factors clearly certify that SISNeT/EGNOS based technology is the best solution for the future of Crisis Management.

3. GENERAL OVERVIEW

Level of human safety in everyday life in big cities but as well in small rural areas depends on level of branch security (e.g. flood, fire). Threats can come from different sources and directions. City lying on the sea coast in tropical zone is in bigger risk of tsunami than village in the very centre of Australian continent where fires and droughts happen on a regular basis.

Protection against fire is different than the one against floods. Drought cannot be fought the same way like biological threat. A new sort of threat, very dangerous and unpredictable is a terrorist attack. Latest history shows us that the danger of an attack is comparable in places of military operations e.g. Palestine, Iraq, Afghanistan, but also in centres of human habitat in every part of the world like New York, London, Madrid, Mumbai, Moscow, etc.

In order to maintain a certain level of safety in society two levels of safety systems can be distinguished:

- rescue system – concentrates on means and efforts of counteraction for emergencies which can be fought using standard public safety operations,
- crisis management system – system responsible for safety in case of emergencies which results cannot be eliminated by standard public safety operations but only by introducing extraordinary law procedures e.g. declaration of the State of emergency.

Quantity and quality of efforts inevitable for maintaining certain level of safety, its governance, rescue operation performance and after threats operation depend on kind, scale and future perspective of a similar or other threats.

What is Crisis Management used for?

According to the source we can identify two types of safety threats:

- natural threats, typical natural disasters or such environmental phenomenon as earthquakes, volcanic eruptions, tornadoes, floods, landslides, droughts that threaten life, property, and the environment itself.
- civilization threats caused by human application of science and technology that can cause disaster.

Natural crisis, climate anomalies are the main factors causing natural threats for people and environment and developing natural disasters. During last decade a significant increase of these incidents can be noticed. It is caused mainly by ongoing environment degradation, deforestation and global warming which can be connected with constantly increasing gas emission. Due to disturbed balance between development of new technologies and environmental protection, fragile relations between components of natural environment are changed. Rupture of small ecosystem in one part of our planet can lead to dramatic consequences thousands of miles away.

All actions undertaken by people influence on Earth climate and may result in creation of an uncontrolled natural disasters e.g. tornadoes in places that were not common before or earthquakes causing big tsunami not recorded in our modern history. Majority of climatologists share an opinion that unexpected hurricanes, heavy deluges and floods will occur more often. Many of them say that our activity accelerates natural changes in planet's climate and that global warming is a next step of Holocene glaciation coming to an end.

Hence today's floods are not more serious than before but river regulation, industrial development of a natural backwater (issuing permission for construction on backwater polders) cause financial losses and even losses of lives in such a scale that affects thousands of people.

Natural threats:

- floods: coastal floods, arroyo floods, river floods, urban floods,
- strong winds and hurricanes,
- long t extreme temperatures,
- atmospheric discharge,
- seismic waves,
- intensive snowfall or rainfall,
- atmospheric precipitation,
- landslips,
- droughts,
- river, lake and water reservoir icing,
- epidemics of human and animal contagious diseases,
- accumulation of pests, rodents, insects.

Structure of Crisis Management

Crisis management as a process can be divided into four phases: prevention, preparation, response and reconstruction. Each phase complies of following tasks:

1. prevention phase:
   - identification and reduction or elimination of probable threats,
   - anticipation of threat in order to limit effects of an incident,
   - research of public acceptance for existing level of threat,
   - assessment of a possible threats effects on a spatial development,
   - preparation of security legal acts,
   - estimation of probable operational budget,
   - informing public about crisis management.
2. preparation phase:
   - planning response methods for crisis situation,
   - increasing amount of resources inevitable for an effective response action,

- planning an information exchange and methods of communication between forces of crisis management,
- preparation of a Crisis Management Centre,
- special monitoring system preparations,
- creation of database used for visualization and simulation of potential risk.

3. reaction phase:
- activation of a Crisis Management Group,
- coordination of all public forces taking part in the operation,
- constant update of infrastructural and operational database,
- providing supplies of food, running water and other goods inevitable for living,
- providing support to the sufferers,
- ongoing threats limitation,
- limitation of major losses and devastation.

4. reconstruction phase:
- restoration of a response abilities,
- improvement of procedures using gained knowledge,
- restoration of supplies for public response forces,
- restoration of key infrastructural networks on voivodship level: telecommunication, energetic, fuel, transport, WSS,
- restoration of natural environment,
- estimation of crisis management expenses.

Relations between each phase of Crisis Management is shown on Figure 1.

GPS based technologies would be a very useful source of information on every stage of a crisis management.

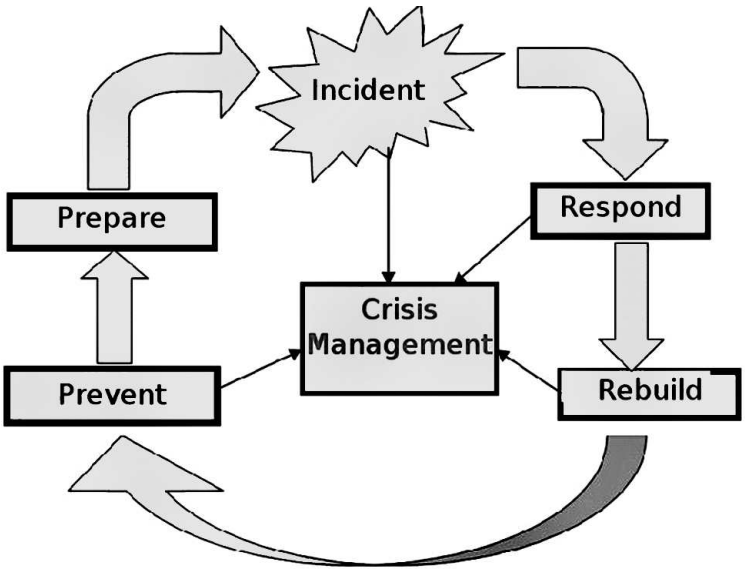

Figure 1. Crisis management cycle

Most demands for precise location come from the crisis management process itself. It is indeed very important for the control centre to know in real-time an exact location, speed and moving direction of units sent to fight the threat. Even if accuracy is a very important factor of efficiency, it is not the main argument and demands are more directed to a high degree of reliability and integrity of the service. Global Positioning System and its application SISNeT/EGNOS operate on integrity and reliability level of 99%. The benefits of these key factors, associated with the real-time knowledge of the evolution of rescue operation and location of the deployed forces will be part of the project evaluation.

4. USER CHARACTERISTICS

The National Fire fighting and Rescue System (NFRS)

The basic unit of crisis deployment is The National Fire fighting and Rescue System (NFRS). It is organized on three different levels of authority: county, voivodship and national level. All basic tasks are managed on county level. Aims of voivodship and national levels is to support and coordinate emergency situations where resources from various units need to be used.

The aim of The National Fire fighting and Rescue System is the protection of life, health , property and environment when fighting fires, other local threats and natural disasters as well in the course of:
- technical rescue operations,
- chemical rescue operations,
- environmental rescue operations,
- medical rescue operations.

The National Fire fighting and Rescue System (NFRS) consists of following units:
- fire fighting and rescue units of State Fire Service,
- rescue units of Military Fire Service,
- in-plant Fire Service,
- in-plant Rescue Service,
- Commune Fire Service,
- County Fire Service,
- Voluntary Fire Service,

other rescue units.

5. RESCUE OPERATION

Even though every kind of threat has to be fought using different methods there are few common conditions that need to be fulfilled by services dealing with crisis situations.

3W rule

To ensure a fast rescue operation which is a crucial case for lives of people implicated in an incident, a 3W question needs to be answered.

- Who? or What? – who/what do the rescue services have to safe and who/what caused the threat,
- When? – when did the incident happen and when the rescue units can reach the site,
- Where? – where did the incident happen and where are located rescue services capable to undertake a rescue operation.

Answering those 3 basic questions can give a quick overview on situation and helps to make decision about the rescue operation. Rescue system based on SISNeT/EGNOS consists of constantly updated database with a position and availability of rescue units which gives an answer for last 2 questions. Once the system knows the position of all rescue units (which is given automatically) and location of the incident (which has to be input into the system), quickest route of getting on site can be calculated for every unit.

Sources of information

After receiving an information about incident, dispatcher has to make quick decisions about sending troops to the site. His mistake can cost many human lives, big losses in industrial and/or natural environment and can affect life conditions of many people on big areas. Data collected, processed and projected by SISNeT/EGNOS system is reliable source of position determination which is a basic component used for many derivative calculations, like time of getting on site, coverage of site with units, alternative ways of fighting the threat.

Weakest link axiom

First few minutes after start of incident are crucial for lives of people and for future progress of rescue operation. History of rescue operations shows us that only a proper cooperation between rescue units and use of appropriate resources in correct order can lead to success of a rescue operation. In many tragic cases, vehicles fitted with best, specialized equipment could not reach the site because of blocked road leading to the site by other rescue units. Traffic jams sometimes were a reason that vehicles from the base lying closest to incident reached the site after units from the base lying within a bigger distance. In big metropolitan areas the same names of streets, squares and avenues can be found in different towns, sometimes lying far away from each other. This fact can lead to mistakes with a tragic consequences.

According to the weakest link axiom it can be stated, that the crisis management system is as strong as the weakest level of preparation for a particular threat or stage in rescue operation.

It means that even if rescue service based in seismic zone is prepared for fighting fires but does not know how to deal with effects of an earthquake, the level of safety is very low. Equally, if rescue services know how to fight all threats and are equipped with the best devices possible, but have problems with getting on site and coordinating their actions – their actions will not be effective and overall state of safety will be also low.

Implementation of SISNeT/EGNOS system into crisis management in rescue operations increases level of safety by better coordination of actions between different units on site, giving a real-time overview of situation on site, storing obtained data for analysis purposes.

Rescue operation management

In every rescue operation, regardless of incidents causing it, six stages can be distinguished:

- receiving notice about the incident, which requires operation of rescue forces to eliminate dangerous effects,
- analysis of situation and decision-making about assembling of necessary resources required for conducting rescue operation most efficient way,
- assembling resources and delivering them to the place of incident,
- rescue operation,
- return of all resources from the incident site,
- completion of rescue operation – completion of documentation of performed operation, reconstruction of resources and preparation for next rescue operation.

Receiving notice

Procedure of receiving an emergency notice depends on the source of the information. If incident happens on fully monitored site, than the information from monitoring devices is sent automatically. The rescue operation starts immediately and follows the procedure written for this kind of incident. In other case, place of incident, it's size and scale must be determined prior to starting the rescue operation. The crucial task is a fast verification of incident, so that false alerts can be eliminated.

Analysis of situation and decision-making

After receiving an emergency notice, following factors need to be analysed:

- most efficient way of conducting a rescue operation,
- determination of resources indispensable for effective undertaking of rescue operation,
- estimation of resources available for use by local rescue services and notification of other rescue services (if needed) e.g. Police, Medical Rescue, Military Rescue Services.

SISNeT/EGNOS based system is capable of increasing effectiveness on this stage of an operation by providing real-time data about availability of the resources and visualization of the shortest way to the site.

In case of incidents causing severe damage on large areas, assistance of branch rescue services (e.g. Gas, Electrical, WSS Rescue Services) is obligatory. Rescue operation needs to be conducted within a predefined procedure called decision table.

Following units are established within Rescue Service:

- leading service – plays a managing role in rescue operation,
- additional services – support operations conducted by leading service,
- cooperating services – undertake actions within limited, specified area, e.g. switching off electric supply.

Decisions made by leading service are forwarded to units participating in rescue operation. All units must undertake actions according to their role dispatched by leading service and follow all necessary procedures defined for particular incident.

Reaching the incident site

Time interval between passing the decision about assignment of units to rescue operation and zero hour depends on:

- distances between locations of rescue operation units,
- managing qualifications of rescue operation units,
- quality of resources used by rescue operation units,
- time needed for bringing all resources to availability.

Period of time required by units for reaching the incident site depends on the distance from base to site and speed of vehicles used by units. Very often the shortest route doesn't coincide with the quickest one. GPS receiver placed in a vehicle can calculate the position of a vehicle and than, using SISNeT/EGNOS application communicate with operational centre to send information about location and receive operational data for rescue operation.

Conducting a rescue operation

Efficiency of a rescue operation conducted by available Services and resources depends on proper assignment of duties between the units, depending on available equipment and abilities to it is competent use. Assignment of insufficient resources extends time of rescue operation and decreases it's efficiency.

Dispatcher having SISNeT/EGNOS based system has real-time overview information about vehicles and each participant of the operation. Can communicate via the systems with fire-fighters and provide them with orders or warnings. Also on-site users have ability to view other participants of a rescue operation in order to asses situation and plan the next step of a rescue operation that should be undertaken.

Assignment of insufficient resources extends time of rescue operation and decreases it's efficiency. On the other hand, excessed dispatch of not adequate resources provokes unnecessary rise of costs, impedes efficient run of rescue operation and disables use of equipment in different operations at the same time.

Return from the incident site

Resources coming back from a rescue operation may be used in different operation. Information about amount of resources available , it's overall conditions, position and availability for next rescue operation in some cases are crucial. This all can be send real-time to operational centre using GPS. Also all data collected using SISNeT/EGNOS system can be used afterwards for planning similar operations or training purposes.

Completion of rescue operation

On this stage, following tasks need to be performed:

- reconstruction of availability of resources for future rescue operations,
- completion of documentation of undertaken rescue operation.

Figure 2 Presents general procedure of decision-making process used in rescue systems.

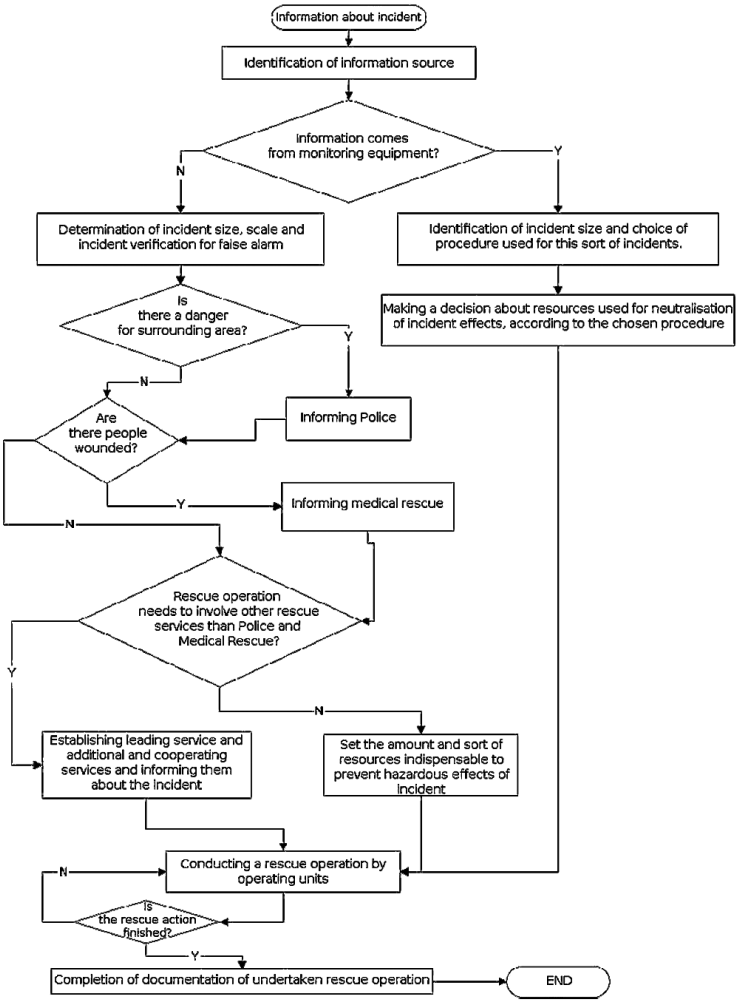

Figure 2. General procedure used in case of incident requiring conducting a rescue operation

6. SOFTWARE DESCRIPTION

Mobile client screens:

Server side application

Basis of action of an online platform is data obtained from GPS and corrected with SISNeT/EGNOS data.

Platform is divided in 4 elements:

– Listening Server,
– Processing Module
– GUI Layer,
– Database.

Listening server. Its task is to listen to data from personal locators and AVL and then to receive corrections from SISNeT server. Upon receipt of the data the application on the server performs MSG command with decoded corrections.

Processing Module

Processing module utilises information provided by the listening server. Its first function is decoding of SISNeT messages and isolating each data for the following operations. Raw data are temporary collected for proper calculation. In the next step pseudoranges corrections are prepared as well as ionosphere and troposphere coefficients for calculation of final corrections. For this process processing module uses a position obtained by listening server form client side application. A product of next block of algorithms are final position calculated from input user position and corrections provided by SISNeT messages. This position is transferred to database for further utilisation and to communication server which sends it to Client side application.

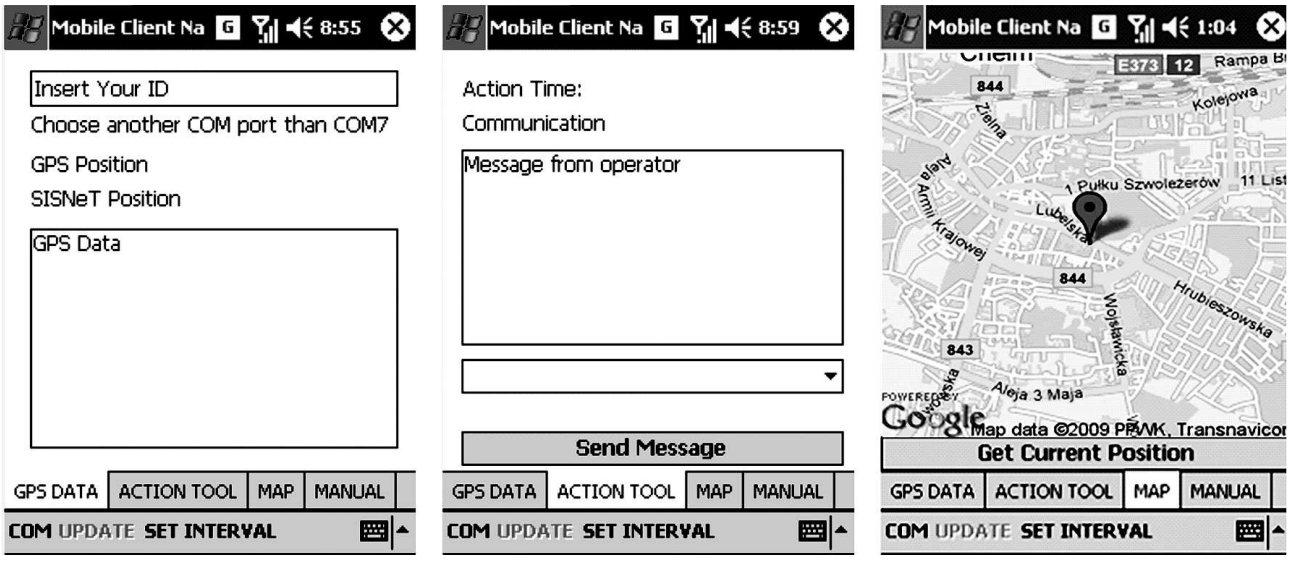

Figure 3. View of three panels: main, chat and map

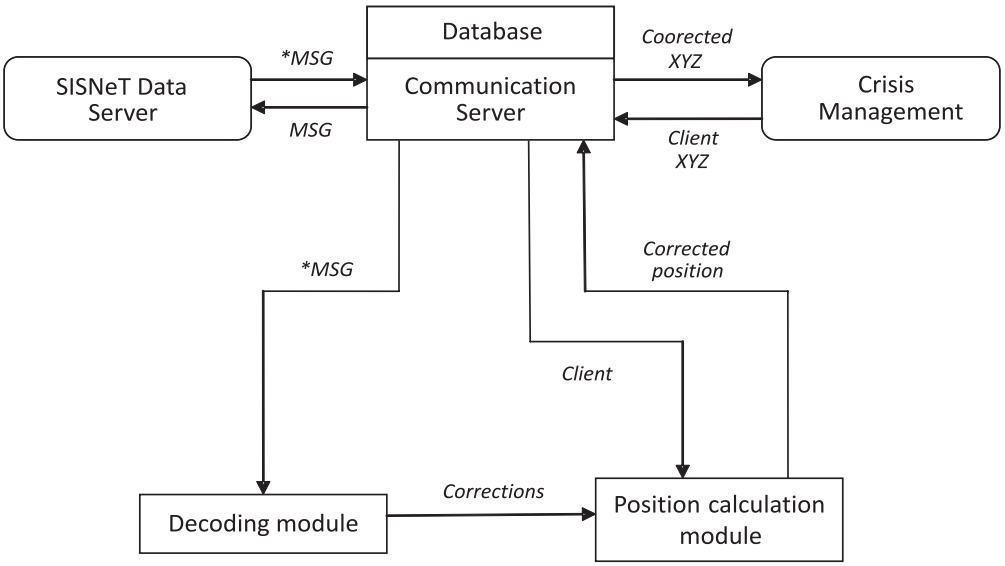

Figure 4. Data flow chart

GUI is a web application written in Java, which visualises location of individuals on the digital map. The application allows tracking the single user as well as the entire fleet. It is a web application with consequence of its mobility and a low cost of the implementation. The application has extended options for reporting, charting and map files (GoogleEarth kml files) for analyses in post processing. It also has possibilities of controlling entitlements of the access to data and the visualisation for individual users and groups.

7. INPUT DATA DESCRIPTION

GGA – essential fix data which provide 3D location and accuracy data,

GSA – GPS DOP and active satellites. This sentence provides details on the nature of the fix. It includes the numbers of the satellites being used in the current solution and the DOP. DOP (dilution of precision) is an indication of the effect of satellite geometry on the accuracy of the fix. It is a unitless number where smaller is better. For 3D fixes using 4 satellites a 1.0 would be considered to be a perfect number, however for over determined solutions it is possible to see numbers below 1.0.

There are differences in the way the PRN's are presented which can affect the ability of some programs to display this data. For example, in the example shown below there are 5 satellites in the solution and the null fields are scattered indicating that the almanac would show satellites in the null positions that are not being used as part of this solution. Other receivers might output all of the satellites used at the beginning of the sentence with the null field all stacked up at the end. This difference accounts for some satellite display programs not always being able to display the satellites being tracked. Some units may show all satellites that have ephemeris data without regard to their use as part of the solution but this is non-standard.

RMC – NMEA has its own version of essential gps pvt (position, velocity, time) data. It is called RMC, The Recommended Minimum, which look similar to: $GPRMC,123519,A,4807.038,N,01131.000,E,02.4,084.4,230394,003.1,W*6A

Time, Latitude, longitude, altitude, PRNs of satellites used for fix, Speed, Track angle in degrees.

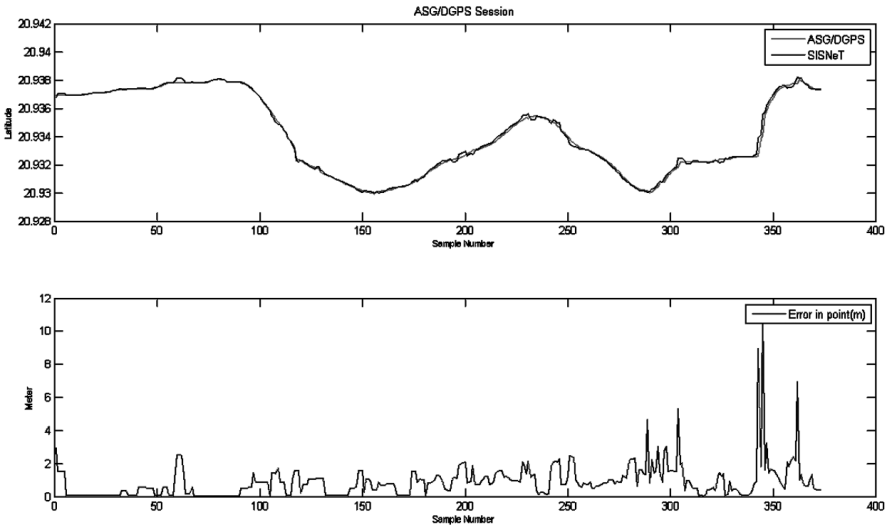

Figure 5. Latitude and error in point plot

8. OUTPUT DATA DESCRIPTION

- From GPS: Time, Latitude, longitude, altitude, Speed, Track angle in degrees,
- From SISNeT: Time, Latitude, longitude, altitude, Speed, Track angle in degrees.

9. GPS/ASG-EUPOS – SISNET TOUR

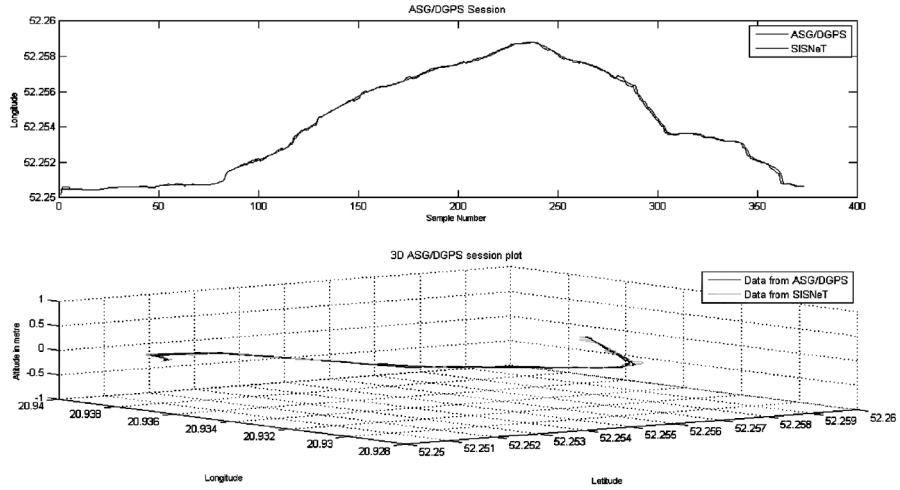

Figure 6. 3D track and Longitude plot

10. SUMMARY AND FINAL CONCLUSIONS

GPS technologies improve Crisis Management on every stage. Not only units or members of the rescue teams equipped in GPS are easy to govern by a dispatcher in an operational centre which can be situated miles from the place of operation, unlike on site mobile office. But also it improves organization of work by delivering all essential information to the main operational centre. In the centre dispatcher easily assesses scale of a danger and after analyzing all the factors can make decisions about moving ahead, regrouping or retreat of units for safe and efficient dealing with the danger. Not only one attendant can make decisions about the rescue operation but also a group of qualified specialists can be introduced into the situation. Thanks to better point of view on operation it can be supervised efficiently and safely. Decisions about concentrating more people in one position or to covering bigger area may be taken not only on a base of experience but also on a base of real time knowledge about the situation.

Last but not least, one of the most important and innovative factors is the possibility of post crisis stage analysis. It means that all information provided during the emergencies like position of a specified unit or member of a rescue team, velocity of a unit, progress of a rescue operation on every stage can be stored in a database once the operation was finished. Each stage of rescue operation can be restored and analysed step by step. That gives remarkable opportunities for investigations, training and for success of future operations

Summing up it can be stated that implementation of SISNeT/EGNOS system into Crisis-Management increases real-time efficiency of operation and gives a tool for post-crisis analysis of occurred situation. Both factors clearly certify that SISNeT/EGNOS based technology is the best solution for the future of Crisis Management.

REFERENCES

[1] Böheim W.C., Vallant J., Hofmann-Wellenhof B., Aichhorn K. *"GNSS-based wood logistics management".*

[2] Toran-Marti F., Ventura-Traveset J. and Gauthier L.. "*EGNOS Project Status". Navigation News (Magazine of the Royal Institute of Navigation)*, issue of January / February 2005, pp. 15-16.

[3] Toran-Marti F. and Ventura-Traveset J.. "*The ESA EGNOS Project: The First Step of the European Contribution to the Global Navigation Satellite System (GNSS).*" *Proc. Of ION-CH Navigare Conference*, Winterthur (Switzerland), June 2004.

[4] Lachapelle G., *"Pedestrian navigation with high sensitivity GPS receivers and MEMS"*, October 2006.