LBS Applications & Services to support Security management in humanitarian relief

Giovanni Cannizzaro, Luca Bocci, Sergio Proietti

***Abstract* — The last occurred events such as the conflicts in Afghanistan and Iraq, the Tsunami and the Hurricane Katrina disasters have raised the need for the humanitarian and emergency response organization to making use of advanced satellite technologies (i.e. Earth Observation, Satellite Communication and Navigation) for receiving support during the preparation and execution of the relief operations. In this context, this paper will describe an LBS Applications & Services solution aiming to support emergency workers during the execution of the humanitarian relief interventions. Such solution constitutes the first assessment and deepening of what will be further discussed, developed and tested in LIMES (Land/Sea Integrated Monitoring for European Security), a forthcoming Integrated Project (6° Framework Program / GMES Security) that has the goal to define and develop prototype information services, based on the integration of different satellite technologies (i.e. Earth Observation, Satellite Communication and Navigation), to support security management at EU and global level.**

***Index Terms*— AGPS, EGNOS, EPS, GNSS, GPS, LBS, Navigation, SISNET.**

I. Introduction

The last occurred events such as the conflicts in Afghanistan and Iraq, the Tsunami and the Hurricane Katrina disasters have raised the need for the humanitarian and emergency response organization to making use of advanced satellite technologies (i.e. Earth Observation, Satellite Communication and Navigation) for receiving support during the preparation and execution of the relief operations.

.Facilitating the delivery of map-accurate satellite imagery is of critical importance to emergency workers since it provides a common operating picture that is invaluable to relief operations and to those running them. To have the opportunity for the emergency workers to determine their exact location also in hostile environment as well as to make it available to the others work forces deployed on field or at an command the others work forces deployed on field or at an command center, is invaluable to the successful of the relief operations.

The following sections describe an LBS Applications & Services solution aiming to support emergency workers during the execution of the humanitarian relief interventions. The main idea is to provide the emergency workers with an advanced LBS applications and services package, developed on top of EGNOS technology, aiming to guarantee tracking every where anytime. Moreover, it aims to empower emergency on-field workers with the ability to rapidly collect and move time sensitive data from the field to decision makers and to ensure on-field operators get timely information according their current location, while on the move if necessary, that can support their operations

The proposed solution takes into account the experience gathered by Telespazio through the participation in EU projects regarding the security management thematic (i.e. ASTRO+, MARNIS, …).

Manuscript submitted 19 July, 2006.

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II. LBS Applications & Services solution

As previously introduced, the LBS Applications & Services solution aims to define and develop prototype information services to support security operations in different humanitarian relief. In particular, the main idea is to implement a LBS applications & services system (see Fig. 1) that, based on an Enhanced Positioning System (EPS) technology, enables:

- the emergency *workers deployed on field* (i.e. referred to below as *on-field operator),* to determine their exact location as well as the location of the other workers (this also in hostile environment) and, to rapidly collect and receive time sensitive data accordantly to their current location;
- the *worker at the on-field command centre* (i.e. referred to below as *on-field manager*), to track and guide every where anytime the on-field operators and, to manage and certify the received information about the intervention areas.

The core of the prospective LBS applications & services is

the *LBS platform* by which the users (i.e. on-field operators/manager) accesses the required services. The LBS platform consists of (see Fig. 1):

- *Positioning Service Centre (PSC)* that, developed on EPS technology and therefore on top of EGNOS, is in charge to provide a robust, reliable and, accurate positioning service. It is also in charge of collecting and managing all the position data of the on-field operator in order to make them available to LBS applications.
- *LBS Centre (LBSC)* that is in charge to provide the on-field operators/manager with a set of LBS applications & services like logistics management, geofencing and information management.

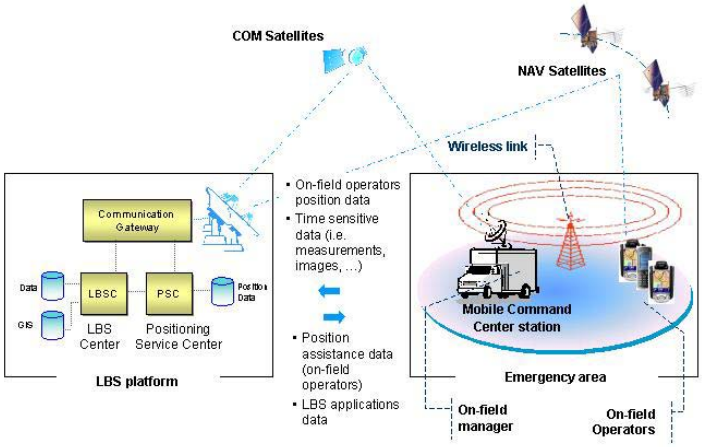

FIG. 1: LBS APPLICATION & SERVICES SYSTEM OVERVIEW

The service scheme is based on three main actors: the *on-field manager*, the *on-field operator* and the *LBS Platform* (i.e. PSC and LBSC).

The *on-field manager*, having the responsibility of tracking and handling the on-field operators, can access the LBS applications via the Web and standard PC connecting to LBSC where the applications are running. LBSC interfaces with the PSC to retrieve the on-field operators positioning data.

The *on-field operators*, equipped with a mobile terminal including AGPS device, can access to the LBS platform and therefore, in a transparent way:

- to the PSC to receive assisted e/o differential correction data for the computation of their exact position;
- to the LBSC to access the LBS applications.

The section below gives a description of the technology implemented in the PSC to provide assisted and differential corrections data to the mobile terminal.

III. ENHANCED POSITION SYSTEM TECHNOLOGY

Precise positioning and navigation services are a vital requirement in all phases of civil security operations. The effective management of logistics entails to obtain and use up to date knowledge of the location, status of assets (vehicles, personnel, supplies and equipment) and their proximity and accessibility to zones of crisis.

Global Satellite Navigation Systems (GNSS) such as the U.S. owned Global Positioning System GPS provide an indispensable component of global infrastructure in terms of communications, navigation and earth observation. Navigation by satellite in particular has been a rapidly expanding sector in many civil and military areas. However, the GPS system is limited in its availability and in its reliability and Europe's growing dependence on a system outside its control is a cause of great concern.

In 1994, the Council of the European Union (EU) directed the European Commission (EC) to develop a European satellite navigation initiative. This initiative is known as the Galileo program. Being fully interoperable but independently operated from GPS, the Galileo system will provide significantly enhanced accuracy, availability and reliability. Galileo will also be the first radio satellite navigation system fully under European and civil control.

In the meantime, GALILEO are being fully operative, the above mentioned LBS Application & Services solution focuses on Enhanced Position System (EPS) technology that allows to overcome the known limits of the standard autonomous GPS and, therefore, performs to guarantee tracking facilities everywhere, anytime and continuity of the navigation signal in outdoor and difficult access areas.

The technology rests basically on an hybridization satellite based navigation system and wireless telecommunication means. In particular, EPS is based on the integration of GPS, EGNOS (satellite based augmentation system), and local area augmentation system (i.e. Assisted GPS, Pseudolite, Differential Corrections) techniques (see Fig. 2).

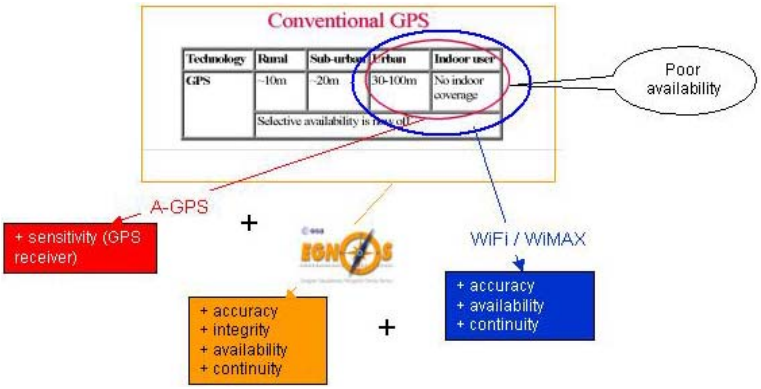

FIG. 2: ENHANCED POSITION SYSTEM – INTEGRATED TECHNOLOGIES

As previously mentioned, GPS enables a GPS receiver to

compute its position by measuring the distance between the receiver and the satellites that are “in view”. Unfortunately, the accuracy and level of confidence the user can obtain with this computation does not meet air navigation requirements as a result of some design characteristics and possible failure of GPS satellites. Moreover, signal propagation can be delayed by environmental phenomena (ionosphere, troposphere, environmental noise) sometime significantly degrading the accuracy of the computed position. To overcome these limitation and therefore to improve the GPS performance in term of accuracy and integrity, EPS takes benefit of differential corrections data provided by EGNOS.

EPS makes use of EGNOS in conjunction with GPS, as SBAS, to improve the GPS performance in term of accuracy and integrity

In areas with weak signal conditions, i.e. under heavy tree cover, in urban areas, when the user is located in "urban canyons", or even indoors, the A-GPS, Pseudolite and Triangulation (i.e. WiFi, WiMax) technologies can improve the performance of conventional GPS receivers to determine their position.

EPS makes use of A-GPS, as LAAS, and Pseudolite/Triangulation technologies in conjunction with GPS and EGNOS, to improves the performance of conventional GPS receivers in weak signal conditions (i.e. Urban areas).

The standard architecture (ETSI, 3GPP) for position services is based on a set of network entities that will provide the positioning service. Through a LCS (LoCation Service) client, the mobile terminal can request the position to the network and after performing registration and authorization, the LCS sends positioning requests to the other network nodes and receives final location estimates from the corresponding entity.

LBS applications and services solution, and in particular the EPS approach is to link and embed these elements, into a seamless modular System Architecture including the *Positioning Service Centre*, the *Communication Gateway* and the *on-field Mobile Command Centre Station* (see Fig. 1), making use of the latter as a ground pseudo-satellites transmitting satellite-like signals that, received by mobile terminal, are used as additional ranging sources.

As *Mobile Terminal*, EPS allows to use an integrated device that equipped with a standard A-GPS and a dedicated positioning software, will be able to compute the position with a high level of performance in term of accuracy and sensitivity (i.e. in hostile environments) and with a short time to fix.

The PSC is interfaced to the *on-field Mobile Command Centre Station* and the *Mobile Terminal* through HTTP and TCP protocols over wireless satellite/terrestrial network, by means of the Communication Gateway.

The PSC is in charge to provide the mobile terminal with both assisted GPS data (i.e. almanacs, timings, …) and differential corrections (i.e. EGNOS) in RTCM standard format. The corrected position and integrity calculated by the *Mobile Terminal* will be then sent back to the PSC that collects these position data in order to make them available for LBS applications.

The possible operational modes for the PSC are: Complete AGPS mode, Aiding AGPS mode and EGNOS mode.

In the complete AGPS mode, the mobile terminal is in charge of acquiring raw data from the satellites and send them to PSC. Here the position is manage for LBS applications.

In the aiding AGPS mode, the PSC is in charge to send the assistance data like timings and almanacs, and to receive the position computed by the mobile terminal. Ephemeris are obtained via SISNeT.

In the EGNOS mode the PSC is connected to an EGNOS receiver or to SISNeT. The PSC receives the raw position by the mobile terminal (NMEA standard) and provides back to the mobile terminal the differential correction data in RTCM stream. These correction could come from a local differential station, from a network of differential station or computed from the SBAS regional corrections. The corrected position and integrity will be calculated on the mobile terminal and sent back to the PSC.

As for EGNOS, it is important to note that PSC focuses on a solution consisting in sending EGNOS corrections in RTCM format to mobile terminal rather than to send the complete EGNOS message and, therefore, to perform the conversion in RTCM format inside the mobile terminal (see Fig. 3).

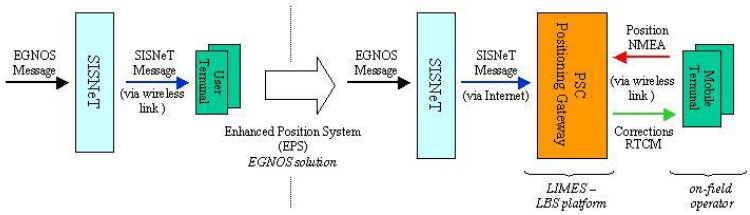

FIG. 3: ENHANCED POSITION SYSTEM – EGNOS SOLUTION

The main advantage of feeding the terminal with RTCM corrections is the large use of this standard in the navigation receiver market (so with low cost).

IV. LBS APPLICATIONS & SERVICES FEATURES

The LBS Applications & Services are provided to both the on-field operator and on-field manager. Two type of services have been identified (see Fig. 4):

- *on-field operational services*: the on-field operator equipped with a mobile terminal supporting A-GPS facilities (i.e. smart-phone, wrist worn PC, …) can

access to: Positioning Services (i.e. to determine the exact location and send back it to the LBS platform); Logistics Services (i.e. show his position and the position of others on-field operators on a map, to send message or an emergency to the on-field command centre); Geofencing Services (e.g. to receive an alarm if he is moving in a polluted area); Information Services (i.e. to collect time sensitive data in accordance to his current location and transmit them to the on-field command centre).

- *on-field command services:* the on-field manager, equipped with a standard PC can access to: Logistics Management Services (i.e. tracking of the on-field operators; emergency management); Geofencing Services (i.e. area monitoring, corridor monitoring); Information Management Services (i.e. normalization and validation of the received information by the on-field operators).

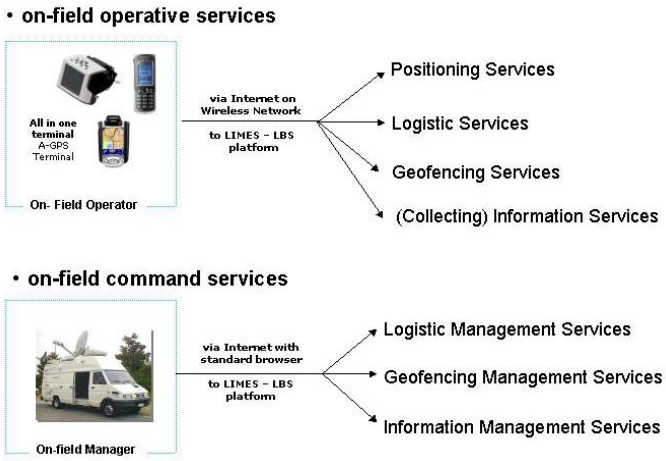

FIG. 4: LBS SERVICES

As for the *on-field operational services*, the on-field operator accesses these service connecting to LBS platform via Internet (i.e. HTTP and TCP protocols) over wireless satellite/terrestrial network. He makes use of a standard mobile terminal (i.e. smart-phone) with A-GPS facilities and a light dedicated software to access the Positioning Services for the determination of his exact location. Regarding the Logistics, Geofencing and Information Services, these are accessed by a standard browser and, therefore, the mobile terminal does not need dedicated software.

Several types of off-the-shelf mobile terminals, like smartphones and PDA, are currently available in the market. In different ways they integrate and support GPS, A-GPS, wireless radio communications, high performance CPU and memory system features. Depending on the test scenarios that will be selected, different devices may be adopted in order to support humanitarian relief activity. An example could be the WWPC (Wrist Worn Personal Computer) that was recently introduced to the market. It consist of a wrist wearable PC that may be of special interest to the emergency operations and in particular in any area where hands-free access to large amounts information is a necessity.

FIG. 5: WRIST WEARABLE MOBILE TERMINAL

As previously introduced, the *on-field operational services* consist of the following main facilities:

- Positioning Services

The Positioning Services aim to support the on-field operators, equipped with A-GPS mobile terminal (i.e. smart-phone), on the determination of his exact location. This is done by providing the mobile terminal with position assistance data (i.e. EGNOS differential correction, …). Moreover these services allow the on-field operator to communicate his computed position to the on-field manager.

- Logistics Services

The Logistics Services allow the on-field operators to track his position as well as the positions of the others on-field operators by visualizing these positions on a cartographic map. Taking into account feedbacks received by on-field operators (e.g. positioning of other rescue teams), this facility seems to be invaluable for the success of the relief operations. Moreover the Logistics Services send/receive messages (i.e. an emergency) to/from on-field command center.

- Geofencing Services

The Geofencing Services allow on-field operators to receive an alarm if they are moving in dangerous areas or out of a protected area. In the same way, these services allow on-field operator to receive alarm in case they are not moving along a planned corridor.

- Information Services

Taking into account the relevance of having continuously updated information about the intervention areas, this services allow the on-field operators to collect time sensitive data (i.e. images, short movies, measurements …) in accordance to their current locations and therefore to sent these data to the on-field command centre. The data are collected by the on-field operators also through the use of the main

facilities of their mobile terminal like for example the photo-camera.

Regarding the *on-field command services*, these are web based applications and, therefore, are accessible by a normal standard browser. As for the security, the channels is protected using SSL protocol (HTTPS only site) and the authorization is mediated by a role system where each on-field manager has a specified logging/password and operational profile. Three types of services have been identified:

- Logistics Management Services

The Logistics Management Services aim to perform the management and tracking of the units (on-field operators, vehicles, …) deployed on-field. These services foresee that each unit is equipped with a mobile terminal including a GPS receiver and are able to communicate the current position. These services are provided by the following applications:

- Logistics Manager, dedicated to the management and configuration of the units to track (i.e. add/remove unit, modify unit data, …)
- Tracking and Tracing (T&T): it performs the tracking and tracing of the units deployed on-field visualizing their current positions on a cartographic map. In particular, it aims at retrieving information about a given unit(s); at visualizing the position of a given unit(s) on a cartographic map; at searching for units around a given position or unit.

- Geofencing Management Services

The Geofencing services aim at performing the control and monitoring of "protected/polluted/dangerous area" or along a particular "corridor". An alarm is generated if a given unit (i.e. on-field operator or vehicle) or group of units move in or move out a pre-defined area or corridor. These services are provided by the following applications:

- Area monitoring: it aims at performing the control and monitoring that a given unit or group of units move in and/or move out a specified area. It generates an alarm each time it occurs.
- Corridor monitoring: it aims at performing the controlling and monitoring that a given unit or group of units move along a specified corridor/route. It generates an alarm each time it does not occur.

- Information Management Services

The Information Management Services aim to perform the management, validation and certification of the time sensitive information about the intervention area sent by the on-field operators.

The Humanitarian relief application and demonstration scenario could require specific adaptation and tailoring of the systems and subsystems described so far, in order to take into account the specific environment and the related requirements. The latter can be summarized as follows:

- Easy to use services and devices for people operating in the field.
- Robust devices
- Quick time for infrastructure set up.
- Infrastructure flexibility vs. number and kind of services which are required on a case-by-case basis

V. THE LIMES PERPECTIVE

The solution presented in this paper constitutes the first assessment and deepening of what will be further analysed, developed and tested in LIMES (Land/Sea Integrated Monitoring for European Security), an Integrated Project (EC 6° Framework Program / GMES Security), currently in the final negotiation phase, that should start in October 2006.

LIMES has the goal to define and develop prototype information services, based on the integration of different satellite technologies (i.e. Earth Observation, Satellite Communication and Navigation), to support security management at EU and global level in the following thematic/policy areas of interest (see Fig. 6):

- Surveillance of the EU borders (land and sea);
- Surveillance and protection of maritime transport for sensitive cargo;
- Organization and distribution of humanitarian aid & reconstruction;
- Protection against emerging security threats.

FIG. 6: LIMES' THEMATIC AREAS

LIMES is a 42 month project that will be carried out by a Consortium composed of around 50 EU Partners including users, research institutions, industry and service providers. The services developed by LIMES will support the building up of a common cooperation framework between the major EU research and operational actors on Security management.

With regards to the "Organization and distribution of

humanitarian aid & reconstructions" topic area, LIMES aims to realize and apply the proposed LBS application & services solution in order to provide the emergency worker with a package of services aiming to guarantee, tracking every where anytime.

VI. Conclusion

LBS Applications & Services solutions aiming at supporting emergency workers during the execution of the humanitarian relief interventions has been above described. The solution focuses on the following main features:

- Enhanced Positioning System (EPS) technology that coupling GPS, EGNOS, A-GPS and Pseudolite techniques aims to overcome the know limits of autonomous GPS. As for EGNOS, an innovative solution consisting of feeding the mobile terminal with RTCM corrections has been taken into account. Moreover, with reference to the LBS application & services system architecture (see Fig. 1), EPS considers the possibility to make use of the *on-field mobile command centre station* as a ground pseudo-satellites transmitting satellite-like signals that, received by mobile terminal, are used as additional ranging sources.
- A modular and scalable System Architecture adaptable both to different emergency scenarios and preexisting civil protection command and control hierarchical structures.
- Advanced LBS applications and services package, developed on top of EPS technology, aiming to guarantee tracking every where anytime.
- Innovative Information Management Services aiming to empower on-field operators with the ability to rapidly collect and move time sensitive data from the field to decision makers and to ensure that on-field operators get timely information according their current location, while on the move if necessary, that can support their operations

Abbreviations and Acronyms

3GPP: 3rd Generation Partnership Project AGPS: Assisted GPS
EPS: Enhanced Position System
ETSI: European Telecommunications Standards Institute
GMES: Global Monitoring for Environment and Security
GNSS: Global Satellite Navigation Systems
GPS: Global Positioning System
LBS: Location Based Services
LBSC: Location Based Services Centre
LCS: LoCation Service
LAAS: Local Area Augmentation System
LIMES: Land/Sea Integrated Monitoring for European Security
PSC: Positioning Service Centre
RTCM: Radio Technical Committee, Marine
SBAS: Satellite Based Augmentation System
SISNET: Signal-In-Space through the internet

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