TEAM LINKAGE VIA GIS AND SATELLITE TELECOM

Evacuating Remote Areas

Civilian evacuation operations generally take place in remote areas where normal communication networks are often either destroyed, limited or controlled by unfriendly parties. Portable satellite telecommunications can link teams co-ordinating an evacuation. This article describes an exercise in rapid delivery of geospatial data by satellite telecommunications which enhanced the security of operations. GIS technology and high-resolution satellite imagery were integrated in a complete â€˜Evacuation GIS' complying with NATO standards.

This exercise dealt with a scenario in which EU nationals were affected by a crisis situation outside EU borders, and was one of the major milestones in the Telecommunications Advanced Networks for GMES Operations project (TANGO) funded by the European Commission as part of the Sixth Framework Programme. The main objective of TANGO is to provide telecommunications support for Global Monitoring for Environment and Security (GMES) services.

EUSC Co-ordination

Operations were co-ordinated by the European Union Satellite Centre (EUSC) in collaboration with partners from various technical areas, among them EADS Astrium, Centre National d'Etudes Spatiales (CNES), Infoterra France, Charles University Prague, and Avanti Communications. The island of Madeira was chosen as the scene of simulated evacuation operations and given the codename ‘Alania'. Existent telecommunication networks were ignored during the exercise, simulating the lack of terrestrial communication infrastructure during a crisis.

Overall Architecture

Architecture (Figure 1) was planned to provide a robust flow of encrypted geospatial data using satellite telecommunications. The data flow included all actors involved in the exercise: EUSC in Torrejón (Spain), the Joint EU Situation Centre in Brussels, the Field Base in Madeira that acted as headquarters, and a Mobile Unit used to lead the evacuation convoy.

Geospatial Data

The base-map used to support the evacuation was prepared at EUSC using high-resolution air- and space-borne sensors for accurate representation of the terrain. Aerial photography at 40cm resolution was used for spatial map accuracy. But valuable information was also extracted from lower-resolution multispectral satellite imagery (Spot 5 satellite, 2.5m resolution)
by analysing its infrared bands (Figure 2).

The photo and satellite imagery provided a suitable basis upon which to build the geospatial backbone of the entire evacuation operation: a very accurate transportation network map of Madeira capable of supporting automatic generation of evacuation routes (Figure 3). For this the transportation network had to have the following features:

- road categories providing a good hierarchy for the automatic route generation algorithm

- accurate road directions (one- and two-way streets and roads)

- accurate representation of complex intersections (level crossings)

- clear representation of tunnels, bridges and viaducts

- integration of terrain-slope values with vector transportation network.

The first four points are straight-forward, requiring only careful analysis of existing geospatial data. But the last point was more of a challenge. To meet this, a 10-m resolution DTM of Madeira was used to derive 10m equidistant contour lines. These were intersected with the transportation network in order to cut it into shorter, more homogeneous segments. The resulting network was subdivided into short segments to which was applied a slope equation. Slope values were later used to establish a time-correction factor when calculating driving times along evacuation routes.

Network and Back-up

From the aforementioned geospatial data almost twenty layers of information were generated and adapted to NATO standards (STANAG 3596). These provided information on civil and military facilities: military headquarters and barracks, electronic installations, airfields, port installations etc. All layers were combined with the transportation network, aerial photography, satellite imagery and the DTM to form an 'Evacuation GIS' made available for operational purposes via a desktop solution at EUSC in Torrejón. The main operation here was automatic route generation, and the resulting route describing the best way to proceed from collection area to evacuation point was delivered by telecommunications to the team leading evacuation in the field.

While evacuations routes were to be derived using the GIS at EUSC and delivered via satellite communications to the field, a backup solution was also arranged. An ArcGIS powered server with network analysis capabilities was set up by the Charles University in Prague to publish the Evacuation GIS on the internet. This way the Mobile Unit was able to make its own route analysis in the field while leading evacuation operations, using only broadband internet provided by satellite communications.

Sharing by Satellite

Satellite telecommunications were used to share data between the EUSC and Joint SitCen, as well as between Field Base and Mobile Unit in Madeira. The Field Base was equipped with Risk and Emergency COntainers for Valuable and Essential telecom Recovery (RECOVER), a modular, compact CNES system (Figure 4) consisting of a set of containers. Its objective was to build a communication network in the crisis area by providing during the evacuation exercise:

- internet connection by satellite through an SCPC link locally distributed via wireless network (WiFi)

- voice communications through extended private cell, allowing connection between teams in Madeira also connected to the rest of the world by satellite backhaul.

RECOVER was deployed prior to the exercise at the military facilities of Madeira Operational Command. During the exercise it provided simultaneous videoconferencing of actors involved in the evacuation, and facilitated exchange of files such as satellite imagery. Using satellite connections also allowed RECOVER to establish access for several terminals of a DECT cell to the international telephone system within a radius of 600 metres of the cell. This way, members of the Field Base team were able to communicate by voice with actors in Torrejón (EUSC) and Brussels (SitCen).

Riskframe

Another system had to be used to link the Mobile Unit with the Field Base. As this was to be transported in the Mobile Unit along the evacuation routes, it had to be small, robust and portable; the telecommunication solution ELISEO from Infoterra was used (Figure 5). This is a highly portable system consisting of several terminals using low-rate iridium links and high-rate Inmarsat links to send data via telecommunications satellites. During the exercise, three ELISEO terminals were used: two in the Mobile Unit and one at the Field Base, featuring rugged laptops, several Iridium beacons, an Inmarsat antenna and a GIS application called Riskframe. During the whole evacuation exercise a sat-phone was connected to the Inmarsat antenna to establish voice connection between the Mobile Unit and Field Base. The Inmarsat connection also provided an internet connection in the Mobile Unit with a maximum data rate of 492Kb/s, facilitating exchange of raster data with other actors.

The low-rate iridium beacons were used for tracking purposes: the Field Base tracked the Mobile Unit in real time via the ELISEO terminal, and EUSC and SitCen in Europe could track it via a Google Earth interfaced server. The beacons were also used to deliver small geo-objects to update the Evacuation GIS. This use of the Riskframe application allowed operators in the Mobile Unit to digitise new events onscreen as they took place, for example blocked roads, fires etc. At the Field Base the ELISEO operator received and visualised these updates against the background of high-resolution aerial photography. The exchange of geospatial data was a near-real-time and bi-directional process between the Mobile Unit and Field Base.

Testing the Network

During the exercise we successfully tested the architecture of a network to support encrypted geospatial data transport between actors involved in evacuation operations. A circular link was established between the EUSC (Torrejón), the Joint EU SitCen (Brussels) and Field Base and Mobile Unit in Madeira. GIS data of evacuation routes were exchanged and updated based on ground truth and unexpected events, such as blocked roads. In the absence of a conventional terrestrial communication network, satellite telecommunications were used.

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