RATIONALE OF A EUROPEAN INITIATIVE FOR THE DEVELOPMENT OF CIVIL PROTECTION SERVICES USING SATELLITE COMMUNICATIONS

EXECUTIVE SUMMARY

The impact of both natural and man-made disasters is increasing dramatically, with a fourteen-fold rise in their associated costs since 1950. Prior to 1990 there had been only three disasters whose insured cost exceeded US$1 billion; since then there have been sixteen and they have affected all regions of the world.

Communications are of paramount importance in responding to and mitigating the effects of disasters but terrestrial networks are often disrupted or destroyed at the onset of a major disaster. Their capacity is also often inadequate in disaster situations.

A survey of civil protection authorities in 2005 revealed that they regard satellite communications as complementary to land-based technologies and useful for overcoming some of their limitations. They recognised the need for a Europe-wide approach to obtaining the potential benefits of satellite systems, with harmonisation between different projects and transmission technologies.

Satellite communications systems can provide a robust network largely unaffected by events on the earth’s surface. In both their coverage and their allocation of capacity they can respond flexibly to disaster situations. This document proposes a programme aimed at fulfilling the benefits of satellite communications for civil protection.

The programme’s focus would be on the development of services supporting: backup of terrestrial networks; ubiquitous coverage; training of civil protection personnel; disaster intervention; geo-location; alerting and information dissemination.

Services to be developed would be selected against the criteria of interoperability, standardisation, security, sustainability and overall socio-economic benefit; they would also be user driven and pan-European in nature.

Proposals for specific short term actions include increasing the telecommunications capabilities of European security forces during projections abroad; and increasing the robustness of terrestrial services in a major disaster configuration.

It is suggested that civil protection experts convene a meeting to consider such a programme and how it might be structured.
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1. Introduction

As new threats continue to arise and disasters to happen, European citizens expect a higher degree of security to be maintained, with civil protection forming a critical element of this defence. Against this background, the French Directorate of Civil Defence and Security and the European Space Agency are seeking a consensus on the actions required to enable a more effective use of satellite communications, as one element that can further improve civil protection across Europe and beyond.

The International Conference on Civil Protection and Space Telecommunications (Palais du Luxembourg, Paris, 29/4/05), presented the results of a survey of civil protection authorities. Responses to the survey revealed that satellite communications are not regarded as complete alternatives to terrestrial systems but as complementary solutions for overcoming some important limitations of land-based technologies. In particular all participants saw the need for a Europe-wide approach to civil protection, with harmonisation between the various projects and transmission systems being highly desirable. Several individual Civil Protection Authorities have also shown an interest in exploiting satellite communications for their own specific needs.

The purpose of this document is to present the rationale for a user driven action programme aimed at achieving the optimum use of satellite communications for civil protection both in Europe and beyond. Specifically, this document seeks to address:

- why satellite communications have a key role to play;
- why a Europe-wide programme is necessary and advantageous;
- why any such programme must be user-driven by the civil protection agencies;
- the possible content of such a programme and first steps towards its creation.

2. The cost of disasters

All regions of the world are subject to both man-made and natural disasters (which include earthquakes, floods, landslides, storms, tidal waves, volcanoes and wildfires). The financial impact of natural disasters is increasing dramatically. From the 1950s to the 1990s it increased by 14 times, with losses in each successive decade dwarfing the previous record. In 1995 the total insured loss was US$190 billion, equivalent to 0.7% of world GDP. More recent losses have been even worse: prior to 1990 there had been only three events costing more than US$1 billion - but there have been 16 such events since. Moreover, these statistics do not cover the full economic costs, which include uninsured property and indirect costs from interruptions to trade and falling productivity. Nor do they capture the full human cost of such disasters. Table 1
provides a summary of major disasters that have affected Europe in recent years, with some indication of the human cost in terms of lives lost.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquakes</td>
<td>- 1999 Turkey, 18,000 dead; 1999 Greece, 193 dead; 1980 Italy, 2,739 dead; 1976 Italy, 977 dead; 1953 Greece, 455 dead.</td>
</tr>
<tr>
<td>Floods</td>
<td>- 2002 Germany, Czech Rep, Austria, Switzerland, Hungary, Slovakia, 94 dead, cost estimated at €20 billion; 1973 Spain, 350 dead; 1963 Spain, 500 dead; 1962 Germany, 400 dead.</td>
</tr>
<tr>
<td>Landslides</td>
<td>- 1998 Italy, 159 dead; 1966 United Kingdom, 144 dead; 1963 Italy 1,759 dead.</td>
</tr>
<tr>
<td>Forest fires</td>
<td>- 2003, France, Italy, Spain, Portugal &amp; Greece: 740,000 hectares of forest destroyed, EC estimate of cost up to €2.5Bn, with dozens of people killed.</td>
</tr>
</tbody>
</table>

Table 1: Major disasters in Europe since 1950

3. The role of communications in disasters and crisis situations

Access to information is paramount during crisis situations, but communications links are almost always disrupted during the first hours of a major disaster. When disaster
relief workers arrive on the scene there is often an urgent need to establish effective communication links both between different teams inside the affected area and with the national disaster response facilities and the wider international community.

Almost by definition, disasters and other crisis situations are unpredictable in nature and extent. Therefore it is important that any emergency telecommunications system should be able to cope with variable requirements for coverage area and capacity.

Civil protection agencies and their field workers rely on telecommunications to obtain and transmit a wide variety of information between central facilities and the field, to coordinate the complicated logistics of rescue and aid operations. This includes accurate information such as maps of the area, architectural plans of buildings and the location of hazardous materials. This information is typically stored in databases at headquarters, so a communications infrastructure must be put in place to allow access and retrieval from the field. The agencies may also need to know e.g. the number of casualties; how many need transportation; where people may be trapped; and where search and rescue teams are most needed. All of this requires communications.

3.1 Communications classification and requirements

There are three classes of communications for Public Protection and Disaster Relief (PPDR):

- **Distress calls:** communications from citizens to authorities/organisations in case of distress (emergency call handling): Access to police, fire department or ambulance services by dialling a service code such as 112.

- **Professional services:** communications between authorities/organisations during emergencies: This includes communications between authorised users and may require preferential treatment on public networks or the use of private networks.

- **Alert & information dissemination:** communications from authorities/organisations to citizens during emergencies: This includes use of TV, radio, mobile phones, etc.

PPDR operations involve a wide range of organisations at local, regional and national level. In order to utilize their resources cost-effectively they need to co-operate both nationally and internationally, especially since disasters are often cross-border. This need for interoperability has led to international standardisation efforts. At the European level the EMTEL OCG (Emergency Telecommunications Operational Coordination Group) is responsible for the co-ordination of these standardization activities within ETSI. It has specified a set of service requirements for emergency telecommunications, as listed in Table 2.
### Table 2: basic functional requirements for PPDR communications

<table>
<thead>
<tr>
<th>Functional Requirements</th>
<th>Description of Telecommunications Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced Priority Treatment</td>
<td>Services supporting national security and emergency preparedness missions must be provided priority treatment over other traffic.</td>
</tr>
<tr>
<td>Secure Networks</td>
<td>Networks must have protection against corruption of, or unauthorized access to traffic and control, including expanded encryption techniques and user authentication as appropriate.</td>
</tr>
<tr>
<td>Restorability</td>
<td>Should a disruption occur, services must be capable of being reprovisioned, repaired, or restored to required service levels on a priority basis.</td>
</tr>
<tr>
<td>International Connectivity</td>
<td>Services must provide access to and egress from international carriers.</td>
</tr>
<tr>
<td>Interoperability</td>
<td>Services must interconnect and interoperate with other selected government or private facilities, systems, and networks.</td>
</tr>
<tr>
<td>Mobility</td>
<td>The communications infrastructure must support transportable, redeployable, or fully mobile communications (e.g. personal communications services, cellular, satellite, high frequency radio).</td>
</tr>
<tr>
<td>Ubiquitous Coverage</td>
<td>Services must be readily accessible to support the national security leadership and inter- and intra-agency emergency operations, wherever they are located.</td>
</tr>
<tr>
<td>Survivability/Endurability</td>
<td>Services must be robust, to support users under a broad range of circumstances from the widespread damage of a natural or man-made disaster, up to and including nuclear war.</td>
</tr>
<tr>
<td>Voice Band Service</td>
<td>Voice band services must be provided in support of governmental, professional and other communications.</td>
</tr>
<tr>
<td>Broadband Service</td>
<td>Broadband services are required to support national security and emergency preparedness missions (e.g., video, imaging, web access and multimedia).</td>
</tr>
<tr>
<td>Scaleable Bandwidth</td>
<td>National security and emergency preparedness users must be able to manage the capacity of the communications services to support variable bandwidth requirements.</td>
</tr>
<tr>
<td>Affordability</td>
<td>Services must leverage network capabilities to minimize cost (e.g., use of existing infrastructure, commercial off-the-shelf technologies and services).</td>
</tr>
<tr>
<td>Reliability/Availability</td>
<td>Services must perform consistently and precisely according to their design requirements and specifications, and must be usable with high confidence.</td>
</tr>
</tbody>
</table>

The required service characteristics of Public Protection and Disaster Relief (PPDR) communications may be summarised as interoperability, robustness, ubiquitous coverage and security. This must be achieved through solutions that minimize cost and are backwards compatible with existing services and systems.
3.2 Analysis of current communications services and their limitations

For effective and cost-efficient fulfilment of all user and service requirements, a PPDR communications network must seamlessly integrate a wide range of communication technologies (fixed telephone, wireless telephone, Internet, satellite, etc). Public communications infrastructures such as PSTN, GSM or UMTS networks must also be complemented by dedicated infrastructures, specifically designed to meet the operational needs of PPDR users.

Over the years civil protection authorities have developed a set of procedures for emergency response that have in most cases proved effective in mitigating the consequences of accidents and disasters. These procedures rely on a variety of communication technologies, each with their own features, integrated into an overall emergency communications network. This involves the use of both public networks and separate infrastructures designed specifically for PPDR purposes.

3.2.1 Public communications networks

Fixed communications mainly use the public PSTN, enhanced where possible with priority management and security techniques. Mobile communications between civil protection authorities mainly use Private Mobile Radio (PMR) infrastructures, rather than public mobile networks such as GSM and terrestrial UMTS. The main problem with all public networks is that they are often destroyed or disrupted by the disaster or emergency to which PPDR users are responding. They are also subject to overloading or capacity shortfalls in crisis situations and to inadequate levels of security.

3.2.2 Private/Professional Mobile Radio networks (PMR)

PMR networks are specifically designed to meet the growing needs of PPDR users and have features either unavailable or not optimally provided for by public networks (broadcasting/multicasting; different levels of priority call handling; group calls with the associated dynamic group management techniques; security of communications; and adaptability and responsiveness to unusual operational situations).

While public mobile networks are mainly duplex mode oriented, PMR networks have been designed to simplify the management of various working parties. In particular, group call and direct mode, which guarantee communications within groups even when outside of network coverage, are widely used during operations.

Existing PMR networks are deployed at national level, each with their own management procedure and financing sources. This lack of harmonisation leads to interoperability problems between European countries.

When looking at the current situation in Europe, a wide range of PMR systems are being used in different countries. Even within countries the various public authorities involved in PPDR (fire department, police and civil security) often use different
technologies and management procedures. This lack of homogeneity greatly complicates cooperation between different organisations, especially when joint action is required across different member states. This has led to significant standardisation efforts and it is expected that future networks will ultimately be based on ubiquitous standards. Those standards are still under definition, so it will take some time for the equipments to become available and additional time for users to replace existing infrastructures. In the meantime convergence processes focus on IP solutions to improve interoperability.

In terms of coverage, the situation for PMR is similar to that for public broadband access. Due to the cost of the infrastructures, networks are mainly designed to cope with the normal geographical distribution of capacity requirements. This means that most of the capacity is dedicated to highly populated areas. Consequently coverage and/or capacity in sparsely populated areas are often poor, especially in remote and mountainous regions.

A further shortcoming of terrestrial PMR networks is that they are restricted to narrow band carriers designed to deliver simple voice communications (both point-to-point and point-to-multipoint) alongside embedded Short Message Services. These basic services in the “push-to-talk with data” category form the basic platform of mobile communications for Civil Protection agencies today. Yet evolution toward broadband capabilities is a key demand by end-users. Due to spectrum limitations and propagation constraints, broadband capacity using terrestrial infrastructures is not expected to be available on a nationwide or pan-European basis. As with public 3G mobile networks, coverage will be limited to densely populated areas.

### 3.2.3 Alert and information dissemination

Several recent cases such as Hurricane Katrina in the USA have shown the importance of providing accurate and timely information and advice to the population in disaster and emergency situations. A European case study – the AZF chemical plant explosion in Toulouse - is analysed in detail in Annex A.1. In that instance the local road system became jammed with traffic, further hindering relief efforts, mainly because of a lack of public information and advice.

Getting information to the population is critical, especially in major disasters. This is especially true at the start of a crisis, to tell the population what to do.

Alert management is a difficult subject, since it involves both PPDR professionals and ordinary citizens. Only a short time is available to take the right decisions and to inform the citizenry. In Europe, sirens are still the most common way to give warnings to the population, despite their limited capability to convey information (sirens only indicate that there is a problem, but not when, where, or what to do).

A more capable way of alerting the population is via media like television or radio. With television, warning messages will mostly appear as sub-title texts, making announcements and recommending appropriate radio channels to tune into for further information. But the value of those solutions is badly limited because people are not always watching or listening.
Another solution is to use a “Cell Broadcast” system, which allows the broadcasting of messages to all handsets located within a GSM cell. This enables quick alerting of the local population about specific concerns and the provision of information about what to do. There are several pilot implementations of emergency and warning information tools based on Cell Broadcasting in Europe.

Cell broadcast messages can be employed in several ways when a number of cell phone users in a geographical area need the same urgent information. Such information may include text messages and (for 3G cells and phones) pictures of wanted or missing persons, suggested escape routes and maps of areas to avoid.

Terrestrial alerting solutions using mobile communications technologies do however have three major limitations:

- Cell broadcast has a very limited bit rate capacity and is not suitable for providing multimedia information like audio or video-streams; extending broadcast capacity is simply not envisaged in GSM/GPRS and it is inducing heavy constraints in UMTS networks;
- Terrestrial mobile networks are not dependable, because their infrastructure is often damaged in case of flooding, storms or earthquakes;
- Not everybody has a cell phone, or keeps it switched on.

In the short term Cell Broadcast is seen as an efficient and cost effective way to deploy pilot networks and to conduct field trials and local experiments with security agencies. It can deliver valuable findings about concept effectiveness with respect to population expectations and feedback. In this way the broadcast capabilities provided by existing mobile networks will probably help to make the case for a satellite mobile broadcasting system and to enhance the reliability of its roll-out.

The management of alerts is as important as the technological means of delivering them. This is illustrated in the case study on the ICMESA chemical pollution incident in Seveso (Annex A.3). People need to have confidence in the alert messages they receive, which may affect their lives in many ways, up to and including evacuation. Governments need to ensure that alert messages originate from authoritative sources whose mandate is in the public interest. Cooperation from the telecommunications network operators is also vital and this also requires assurances: besides not being held liable for any information that turns out to be false, they need to protect the reputation of their network and the interests of their customers by ensuring that messages are timely, pertinent and not seen as a nuisance by the recipients.

3.3 The role of satellite communications networks

The inherent characteristics of satellite systems make them a valuable asset in crisis communication networks. Primarily this is because they provide a reliable and robust network unaffected by events on the earth’s surface, coupled with flexible coverage and capacity allocation. Considering the user requirements summarised in Table 2, this section explains in detail why satellite systems have an essential role to play in improving PPDR communications capabilities.
• **Coverage of remote, inaccessible and sparsely populated areas**
Coverage by terrestrial emergency systems is, like broadband rollout, mostly confined to urban and other densely populated areas. There is seldom good coverage of thinly populated, rural or remote areas such as mountain ranges and islands. In contrast, satellite systems can provide near ubiquitous coverage, irrespective of location – and this is not limited to Europe but is available worldwide.

• **Instant and flexible hot spot capacity, including broadband services**
In case of a major crisis, high capacity communications capabilities are required, which often leads to overloading of existing networks. This is especially true for PMR networks due to their limited spectrum, which cannot support enhanced emergency applications requiring broadband delivery (see Annex 1). By using mobile satellite beams and flexible capacity allocation it is possible to deploy additional capacity quickly to meet sudden high requirements. Broadband satellites could also be used to complement terrestrial capacity by providing ad-hoc connectivity between PMR cells.

• **Backup for terrestrial networks**
Satellite communication systems are largely impervious to ground based damage caused by natural or man-made disasters. Hence they constitute a reliable, robust and “always-available” communications network and can replace, complement or back-up terrestrial infrastructures in case of damage or saturation. For example, most of the base stations of PMR networks are interconnected by RF links, which require line of sight between adjacent cells and are thus vulnerable and sub-optimal for coverage of remote or isolated sites. Other public users such as the utilities suppliers can also benefit from a back-up solution in case of major outage of terrestrial infrastructures.

• **Facilitation of international connectivity and cooperation**
Existing emergency communications networks are mostly national and use different standards and equipment. To improve cross border communications, satellite systems provide a natural interface in terms of coverage, bandwidth requirements and technology compatibility. In addition, the management of a European-wide satellite infrastructure dedicated to PPDR would require the setting up of a network management system which would implicitly promote international cooperation.

• **Broadband access capability for civil protection authorities**
The role of satellite in providing broadband access to civil protection authorities is three-fold: the distribution of information to multiple distributed sites; the centralisation of the information provide by remote authorities (using a high data rate return link); and the inclusion in information flows of civil protection authorities that are located in remote or rural regions. This broadband access could be used day-to-day for training and simulation (i.e. tele-education for the personnel of responsible authorities), as well as for the simultaneous dissemination of information to authorities during emergencies.

• **Secure communications**
Current satellite systems offer communications security levels equivalent to those available in terrestrial networks. Proof of this is provided by existing military satellites. The technologies involved, together with encryption and user authentication techniques, ensure the highest levels of confidentiality and integrity of exchanged data. This is particularly useful for broadband applications because in order to support them, terrestrial networks will probably need to use public networks and associated technologies (like WiFi), where security requirements are not always met.

- **Rapid broadcasting of alerts and other data**

Broadcast and multicast technologies supported by satellite networks allow the simultaneous transmission of information with minimal delay and optimal bandwidth consumption. This is particularly important for alert messages, which can be destined either to civil populations or PPDR personnel. In this context the advantages of satellite systems lie in their excellent coverage and system survivability.

| Both broadcast and point-to-point mobile satellite services can provide an “always-available” complement to terrestrial mobile networks |

Mobile satellite services have an inherent broadcasting capability that can be developed to efficiently complement 2G/3G mobile networks. By broadcasting alert messages to standardized 3G “mass market” user terminals, such a system would be able to warn and advise the maximum number of citizens about a potential crisis. Mobile satellite broadcasting could also be used to inform local authorities and emergency field workers. Ensuring inter-operability with terrestrial systems would be of great benefit for all the technologies and services involved, especially in supporting broadcast capabilities to users’ handsets. Terrestrial systems with broadcast capability would benefit from the additional reliability provided by the satellite infrastructure; while satellite systems would benefit from the cost-effective proof-of-concept provided by the terrestrial systems. Thus although some of the envisaged traffic requirements would be too large for terrestrial networks, most mobile networks are currently implementing “Cell Broadcast” functionalities that could be used during the implementation phase of an integrated satellite-terrestrial solution. Some terrestrial systems could therefore be used in low intensity crises, while satellite broadcasting would prove its value during major crises or for regional/trans-border events.

This integrated system could also provide point-to-point communications. An enhanced 3G mobile handset could benefit from a low data rate satellite return link, e.g. allowing users to send distress messages when outside terrestrial mobile coverage. Using transportable terminals, professional emergency workers would benefit from enhanced services with higher data rates such as real-time video, plus direct connectivity between any pair of mobile users. With their fast deployment and flexible coverage area, satellite mobile systems would complement terrestrial PMR infrastructure should it be unavailable, saturated or damaged.

In order to facilitate interoperability with PMR networks, the terminals used should be dual mode, enabling roaming from satellite to terrestrial networks according to the status of the terrestrial infrastructure in the disaster area. These dual mode terminals
must be easy to use, relatively light weight and highly robust (water-proof, impervious to a wide range of external temperatures and with a long battery life).

- Network integration through IP

In line with worldwide trends, the key players in PPDR and satellite communications have chosen the Internet Protocol (IP) as the convergence layer to facilitate the interfacing of different systems and services. This means that satellite broadband services will increasingly provide seamless integration of solutions, improving and simplifying the management of terrestrial emergency networks whilst also complying with requirements for backward compatibility.

By using broadband IP-based open standards, satellite solutions can integrate seamlessly with terrestrial emergency networks, complementing them in terms of coverage, bandwidth, redundancy and broadcasting capability.

4. Description of a programmatic framework

The foregoing sections suggest a possible programme of actions aimed at using satellite communications to complement existing PPDR communications and to overcome some of their limitations. Such a programme may be considered to have both a vertical axis (its main themes in terms of the communications capabilities required by civil protection users) and a horizontal axis (the qualities necessary to fulfil those requirements).

It is preferable that any proposed programme should also encompass the objectives of European Community cooperation in the field of Civil Protection, namely:

- To support and supplement efforts at national, regional and local level with regard to disaster prevention, the preparedness of those responsible for civil protection and intervention in the event of disaster;
- To contribute to the information of the public with a view to increasing the level of self-protection of European citizens; and
- To establish a framework for effective and rapid cooperation between national civil protection services when mutual assistance is needed.

4.1 The vertical axis: programme themes

The programme should cover all of the following communications capabilities:

- Back-up of ground infrastructure: replacement and supplementary links for terrestrial communications networks;
- Ubiquitous coverage: availability of capacity wherever required, including regions where terrestrial network capacity is inadequate, plus the ability to support actions outside the EU;
• *Training*: provision of distance learning to multiple sites, with two-way interactive services including video;

• *Disaster intervention*: rapid access to capacity over any location or area, plus rapid deployment of mobile or transportable user terminals, immediately able to support the full range of PPDR communications services and applications;

• *Geo-localisation*: location-based services enabling improved management of assets (e.g. vehicle and personnel tracking), distress alerting (e.g. satellite beacons) and disaster avoidance (e.g. automatic position reporting systems);

• *Alerting and information dissemination*: provision of initial alerts and subsequent information and advice services, both to professional PPDR users and the general public, by means of both one-way services (broadcasting and multicasting) and two-way interactive services.

### 4.2 The horizontal axis: required qualities for programme elements

The satellite communications services developed under this programme shall possess the following qualities, in order to meet PPDR requirements:

• *Interoperability*: the services to be developed shall be fully inter-operable with existing and planned ground and space based services; this shall be reinforced by developing applications and interfaces using IP-based platforms;

• *Standardisation*: the programme shall promote the use of global open standards, especially where European-originated, to achieve the multi-vendor provisioning of user equipment and services that is fundamental to achieving economies of scale and the creation of an open competitive market;

• *Security and robustness*: services developed under the programme must meet existing standards and PPDR security gradations, including high levels of robustness to be determined in consultation with civil protection agencies;

• *User driven*: services shall only be included in the programme if the participation of civil protection agencies has been secured in all stages of the service development cycle, from specification to operational implementation;

• *Pan-European*: in selecting services and actions, priority shall be given to those which involve trans-border, multi-agency and pan-European delivery and participation;

• *Sustainability*: programme elements shall only be adopted when they have secured the financial involvement of the relevant user entities, in order to ensure that they are valued highly enough to be sustainable;

• *Socio-economic benefit*: evaluation of the socio-economic benefits of each proposed service shall be the ultimate means of measuring its worth relative to other proposed services.
5. Short term projects

It is proposed that consideration should be given to implementing some short-term projects, as outlined below. These are intended to demonstrate how a European programme based on satellite services can reinforce operational telecommunications systems. Monitoring them within an overall programme is discussed in Section 6.

5.1 Increasing the telecommunications capacities of European security forces while in projection abroad

5.1.1 Enhanced (broadband) services delivering information to the tactical command centre

As previously noted, current private terrestrial radio systems are based on narrowband technology that is designed to provide (with a high level of reliability and permanence), core operational information to units and command centres at the tactical level. It is intended for both day-to-day use and crisis management. When and where possible, however, security units that are not involved in crisis situations would like to activate non-combat services for improved routine management (real time snapshots, refreshing of GIS, etc) and for various broadband applications (medicare, pull/push to databases, distributed command systems with on-board modules, etc).

Unfortunately most of the broadband solutions currently available to security services are designed and implemented for citizens and not for defence and security services; hence they lack guarantees on reliability, re-provisioning, traffic capacity for specific users during high demand periods, delivery times like SMS, etc).

The satellite services defined, developed and implemented for security services should provide these kinds of broadband services to support central operational applications, distributed at the tactical level.

5.1.2 Links between the national radio network and a temporary terrestrial radio communications sub-system, at the operational theatre level

The efficiency of close cooperation between national security forces, especially in the case of multi-origin units working within the same operational theatre, is best served by avoiding the use of a specific technical solution dedicated to international crises. Instead, the solution(s) used should be based on maintaining the existing day-to-day telecommunications and command systems that are normally used by each end-actor.

In this case, a satellite service would be employed to provide long-distance links from the units to their respective national networks: firstly to enable activities to be coordinated from the home command centres (in the case of projections outside Europe); and secondly to achieve interoperability with the local command centre by interconnecting both or all of the national networks involved. This implementation should be technology transparent: it might for example involve interworking with TETRAPOL/TETRA networks.
5.2 Increasing the robustness of terrestrial radio communications systems in a major disaster configuration

Proprietary terrestrial radio communications systems are the only technology currently able to:
- guarantee operation in the case of a technical crisis occurring within a very localised area;
- maintain communications free of the limitations of public telecom operators’ networks (saturation or interference resulting from public use, large-scale destruction or breakdown, etc).

Thus, in order to operate satisfactorily in a private/emergency mode, public services would have to be improved to the point where they could cope with major crises affecting wide areas, coupled with the destruction of terrestrial infrastructure.

Satellite systems could provide an overlay of services, as the necessary complement to the existing terrestrial systems that have been designed for day-to-day to disaster operations. The satellite element would provide the necessary technical diversity and independence from the terrestrial networks, for use in cases of ground infrastructure destruction or cumulative effects such as network saturation.

So, the satellite services should be defined, developed and implemented in a way to restore technical links between:
- the main terrestrial radio communications system and a radio base station that was initially isolated by the crisis, which is delivering a minimum set of services via local radio coverage in the crisis area;
- the main terrestrial radio communications system and an independent radio base station that is activated temporarily in order to restore local radio coverage in the crisis area.

6. Conclusion and way forward

6.1 Preliminary meeting to consider an Advisory Board

It is proposed that as a first step, a meeting of interested parties be held to consider how to structure a programme. A possible agenda item might be the setting up of an Advisory Group, consisting of experts in the PPDR field drawn from a variety of civil protection agencies at both national and international institutional levels.

The purpose of such an Advisory Group would be to monitor the programme and ensure that it meets the user requirements of the civil protection agencies.

Whatever the precise structures and mechanisms adopted, a user-driven approach is recommended as the best way of achieving buy-in from civil protection agencies and their responsible ministries across Europe.

Specific tasks of an Advisory Group might include:

- agreeing a programme structure;
considering proposals on which satellite systems, capabilities and services offer the optimum means of meeting civil protection communications requirements;

reviewing the progress and results of trial applications and short term projects (as outlined in section 5);

recommending which services and applications should be carried forward to end-to-end implementation;

providing a permanent observatory of satellite communications development and integration within European civil protection systems;

advising on the development of joint actions with other national and international entities where relevant;

considering funding sources and mechanisms; in due course agreeing and reviewing associated budgets;

reporting findings to the wider community of European and international civil protection agencies and other interested parties.

In reaching its recommendations on which services and applications should be carried forward, the Advisory Group might consider the following criteria:

- results of trial applications and short term projects;
- commitment of funding and co-funding by interested parties;
- benefits and importance in meeting civil protection requirements; and
- user feedback.
Annex 1: Case studies with a telecommunications perspective

The following case studies illustrate different ways in which satellite systems can help to improve the effectiveness of PPDR teams.

A.1: AZF explosion in Toulouse

On 21 September 2001, a powerful blast razed the AZF factory in Toulouse, France. The human impact was tragic: 30 people were killed and more than 800 were taken to hospital. From a telecommunications standpoint the key factor was the bandwidth that would have been required to meet all the needs of the disaster response services.

It is easy to understand that the quality of the overall crisis management in such a disaster depends partly on the available communications. Advanced communications capabilities such as real-time video surveillance of the crisis area or remote patient monitoring facilities can help save lives.

Recommendation M.1390 in the radio communications section of the International Telecommunication Union has defined a method for calculating the bandwidth requirements for day-to-day wireless networks, which can also be used in case of emergency and crisis situations. This methodology has been applied to the crisis situation following the AZF explosion, to calculate the communications capacity that would have been required if the emergency workers had been equipped with advanced communication capabilities such as those listed in Table 3.

The results of the calculation show that providing emergency workers with enhanced communications capabilities would have required at least 75MHz of bandwidth. Such large amounts are not available using existing terrestrial networks, even close to large cities. The potential of satellite systems to provide instant additional capacity, combined with their capability to concentrate communications resources on a crisis area, means that they could be a key tool in managing crisis situations of this kind.

<table>
<thead>
<tr>
<th>Means</th>
<th>Relevant applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Paramedical Emergency Medical Services MS staff: 120</td>
<td>1. Number of active Streaming Video units: 30 (Online Video streaming, MPEG4 Compression @ 700 kbps)</td>
</tr>
<tr>
<td>2. Ambulances: 40 (shuttle)</td>
<td>2. EMS Still Picture sequencing units: 50 units</td>
</tr>
<tr>
<td>3. Fire-fighters: 25 Trucks</td>
<td>3. Stills from scene (Patients) (JPEG @ 250 Kbytes per still)</td>
</tr>
<tr>
<td>4. Rescue Squad Members: 50</td>
<td>4. Fingerprint Scanning: 20 Units (500 dpi) (AFIS Standard from Police/Law Enforcement, image 1 x 1 Inch : File size 2 Mbit uncompressed)</td>
</tr>
<tr>
<td>5. Law Enforcement Officers: 35</td>
<td>5. IP Voice Streaming (Online IP Voice streaming (@20kbps))</td>
</tr>
<tr>
<td>6. Air Surveillance by video</td>
<td></td>
</tr>
<tr>
<td>- Ground Transport Logistics</td>
<td></td>
</tr>
<tr>
<td>- Road access and route assistance</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Enhanced telecommunication requirements
A.2: Flood management for river basins

In August 2002 five countries (Germany, the Czech Republic, Austria, Hungary and Slovakia) experienced severe ‘100-year’ floods, as the Danube, Elbe and Mulde rivers all burst their banks. The estimated cost of the cleanup and reconstruction effort is approximately 20 billion Euros. Over the last few years France and the UK have also endured major floods involving damage running into tens of millions of Euros.

Experience in these cases has shown that floods frequently destroy the normal terrestrial telecommunications networks (fixed and mobile). This contributes to delays both in keeping the local authorities informed of the evolving situation and in warning the population (i.e. to prepare for evacuation). Lives and property could have been saved if people had been warned earlier. Robust and reliable communications are a key issue for the operational teams managing such a crisis. The main user needs identified during the floods were:

- To have dependable means of communications, either by hardening the existing terrestrial infrastructure or by offering alternative solutions like satellite communications at an acceptable cost.
- To have access to all the existing means of communications, by ensuring interworking to allow all actors to communicate and to retrieve data.
- To facilitate collaborative work between decision makers (video and voice multicast, data exchange, multi-sites conference).
- To optimise the management of mobile operational units by knowing their location.
- To be able to broadcast alert and information messages to the citizens and local authorities.

A.3: ICMESA chemical pollution in Seveso

On 10th July 1976 an explosion occurred in the ICMESA chemical plant of Seveso (near Milano, Italy), with the result that a cloud of poisonous gas containing dioxin covered a wide area. This led to one of the worst chemical disasters in history. About 300,000 inhabitants were involved and the alert was raised over all Europe.

As a consequence of this disaster the European Community issued two directives in the following years to guarantee the safety of people living close to potentially dangerous chemical plants (Directives 82/501/CE and 96/82/CE).

Looking at the detailed chronology of the Seveso disaster, it appears that initially its effects were seriously under-estimated. It was five days after the initial explosion before the mayor of Seveso decided to issue an emergency decree, and the area surrounding the ICMEA plant (15 hectares) was not evacuated until two weeks after the explosion.

The short term consequences of the pollution on the population were relatively limited (447 persons with their skin burned and 179 persons poisoned). The long term effects, however, are still affecting the area, with an increase both in the percentage of people...
affected by cancer and in the number of births with malformation. The ground was heavily contaminated and grass, trees and animals died. Indeed, in the area close to the plant (between the villages of Seveso and Meda) it was necessary to remove the superficial stratum of ground to a depth of about 40 cm.

It should be noted that the disaster did not damage the existing terrestrial communication infrastructures, which continued to operate correctly. However, at the time mobile communications were in their infancy: only direct radio communications were available for the emergency workers and broadcasting via radio and television was used to inform the population about the risks.

Should a disaster such as Seveso occur today, the role of a satellite based infrastructure would essentially be twofold:

- to provide a means of exchanging broadband information between the emergency workers present in the crisis area and their operations centre, positioned elsewhere on the national territory; and
- to allow both point-to-point and multicast communications between the emergency workers in the field and public authorities.

The use of satellite systems would increase the efficiency of operations, improving the co-ordination between emergency workers in the field and decision makers. Direct links could be created allowing the rapid and secure transfer of information at any level, enabling a complete and up-to-date picture of the situation. This would enable an alarm to be given to the population more promptly, thus saving human lives, avoiding injuries and protecting goods and property.

### A.4: Hurricane Floyd

An emergency report recently issued in Florida after the Hurricane Floyd disaster highlights some valuable lessons. When the hurricane edged along Florida’s coastline in September 1999, with winds exceeding 240 Km/h and an area extending out over 300 km from the centre of the storm, the state of Florida experienced the largest evacuation in US history. Over two million residents evacuated but only 1.3 million of these were actually ordered to leave. The other 700,000 people were living outside the most vulnerable areas but decided to leave anyway: a phenomenon that behavioural scientists call “shadow evacuation”.

These additional evacuees exacerbated the already challenging road conditions and increased the need for public shelters and hotel rooms. Most of those who had been ordered to evacuate finally reached their destination only to discover there was no room left at hotels or shelters, forcing them to drive further to find a vacancy.

The Hurricane Floyd case – and equally the recent Hurricane Katrina disaster – emphasises the need for the widespread dissemination of public safety information and guidance, as well as pre-disaster alerting. Satellite broadcasting systems, especially where integrated with terrestrial mobile services, would provide a major improvement.