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**Satellite Earth Stations and Systems (SES);
Overview of present satellite emergency
communications resources**

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

Introduction

Recent major catastrophes have raised awareness of the need for effective emergency telecommunication networks. Satellite communication, observation and navigation are the cornerstones of emergency management because they are resilient to Earth damage and provide a wide coverage of service.

Based on these considerations, TC SES has created in September 2006 a new working group dedicated to Satellite Emergency Communications, namely SatEC, and requested SatEC to start its work by a survey on satellite emergency communications.

The present document is a revision of the initial document TR 102 641.

1 Scope

The present document present an overview of concepts, systems and initiatives related to the use of space resources in the context of disaster management, including:

- An introduction to the field of disaster management and the relation with Information and Communication Technology.
- The role of space technology in disaster management.
- The requirements of telecommunication systems deployed for disaster management.
- A list of typical space resources used, covering earth observation, satellite navigation and satellite communications.
- A list of initiatives in the field of emergency communications, including standardization activities.

The present document does cover extensively any given technology through e.g. project descriptions or equipment characteristics as it is meant as an overview document.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] "Environmental health in emergencies and disasters: a practical guide". Edited by B. Wisner and J. Adams, World Health Organization, 2003.

[i.2] ETSI TS 102 181: "Emergency Communications (EMTEL); Requirements for communication between authorities/organizations during emergencies".

[i.3] ITU-T Recommendation X.1303: "Common alerting protocol (CAP 1.1)".

[i.4] ETSI TR 103 166: "Satellite Earth Stations and Systems (SES); Satellite Emergency Communications (SatEC); Emergency Communication Cell over Satellite (ECCS)".

[i.5] ISO 22320: "Societal security -- Emergency management -- Requirements for incident response".

[i.6] OASIS, OASIS Emergency Management TC: "Common Alerting Protocol Version 1.2".

[i.7] OASIS, OASIS Emergency Management TC: "Emergency Data Exchange Language Resource Messaging (EDXL-RM) 1.0".

[i.8] "EU Handbook on assistance interventions in the frame of the Community Mechanism for Cooperation in civil protection", European Commission, Environment Directorate-General, May 2003.

[i.9] ETSI SR 002 777: "Emergency Communications (EMTEL); Test/verification procedure for emergency calls".

[i.10] ETSI TR 102 180: "Emergency Communications (EMTEL); Basis of requirements for communication of individuals with authorities/organizations in case of distress (Emergency call handling)".

[i.11] ETSI TR 102 299: "Emergency Communications (EMTEL); Collection of European Regulatory Texts and orientations".

[i.12] ETSI TR 102 476: "Emergency Communications (EMTEL); Emergency calls and VoIP: possible short and long term solutions and standardization activities".

[i.13] ETSI TR 102 410: "Emergency Communications (EMTEL); Basis of requirements for communications between individuals and between individuals and authorities whilst emergencies are in progress".

[i.14] ERC Report 25: "The European table of frequency allocations and applications in the frequency range 9 kHz to 3000 GHz (ECA table)".

[i.15] ITU Radio Regulations.

[i.16] UN resolution 61/110: "United Nations Platform for Space-based Information for Disaster Management and Emergency Response".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BGAN	Broadband Global Area Network
CAP	Common Alerting Protocol
CEPT	Conférence Européenne des Postes et Télécommunications
COP	Common Operational Picture
COSPAS	Cosmicheskaya Sistyema Poiska Avariynich Sudov
DC	Direct Current
ECA	European Common Allocation
ECC	European Communications Committee
EGNOS	European Geostationary Navigation Overlay Service
ELT	Emergency Locator Transmitter
EMTEL	EMergency TELecommunications
EO	Earth Orbservation
EPIRB	Emergency Position Indicating Radio Beacon
ETSI	European Telecommunication Standardization Institute
EXDL	Emergency Data Exchange Language
FSS	Fixed-Satellite Service
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
GSO	Geostationary Orbit
ICT	Information and Communication Technology
IPR	Intellectual Property Right
ISO	International Standardization Organization
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union Radiocommunications Sector
ITU-T	International Telecommunication Union Telecommunications Sector

LEO	Low Earth Orbit
MSS	Mobile-Satellite Service
NOAA	National Oceanic and Atmospheric Administration
NRBC	Nuclear, Radiological, Bacteriological, Chemical
OASIS	Organization for the Advancement of Structured Information Standards
PAMR	Public Access Mobile Radio
PCP	Partnership Co-operation Panel
PLB	Personal Locator Beacon
PLMN	Public Land Mobile Network
PMR	Private Mobile Radio
POES	Polar Operational Environmental Satellite
PPDR	Public Protection and Disaster Relief
PSTN	Public Switched Telephony Network
RDSS	Radio Determination Satellite Service
SARSAT	Search and Rescue Satellite-Aided Tracking
SatEC	Satellite Emergency Communications Working Group
SCN	Satellite Communications and Navigation Working Group
SG	Study Group
SLA	Service Level Agreement
TC SES	Technical Committee Satellite Earth Station and Systems
TC	Technical Committee
TETRA	Terrestrial Trunked Radio
TR	Technical Report
TS	Technical Specification
VPN	Virtual Private Network
VSAT	Very Small Aperture Terminal
WGFM	Working Group Frequency Management
XML	Extensible Markup Language

4 Positioning of the problem

According to ETSI EMTEL Special Commitee, emergency is *an urgent need for assistance or relief*.

Emergencies are roughly categorized as (1) daily emergencies which are handled by regular emergency services (fire brigades, emergency medical services, …) and (2) disaster emergencies (disasters for short) which are - according to the definition of the World Health Organization, *a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses that exceed the ability of the affected community or society to cope using its own resources [i.1]*. Disasters result from natural or man-made hazards.

The outcome of a major disaster are mainly characterized by:

- A wide area is affected.
- Environmental damages are occurring.
- Human lives are in danger.
- Water, electricity and transportation infrastructures are impaired.
- Daily emergency organisations and infrastructures are deeply affected and overwhelmed so they can not ensure their missions.
- The economical situation of the affected country may be impaired on a long-term basis (several years).
- Terrestrial telecommunications infrastructures are destroyed, saturated or simply not available.

The present document focuses on the use of satellite telecommunications systems in order to optimise disaster management hence mitigate the negative impacts of a disaster on these occasions. Because of the scope of SES/SatEC the present document will focus on emergency telecommunications.

While not within the major focus of the present document, the following topics are also related: (a) the use of satellite-based navigation and Earth observation services for disaster management and (b) the management of daily i.e. regular emergencies such as day-to-day fire fighting missions and the emergency medical service.

4.1 Disaster management and response

4.1.1 Disaster management cycle

The United Nations Department of Humanitarian Affairs defines disaster management as *a comprehensive approach and activities to reduce the adverse impacts of disasters*. It is important to note that disaster management is not limited to the response upon the occurrence of a disaster.

In order to better grasp all activities related to disaster management; it is often split in four broad phases:

- Disaster mitigation and prevention: a set of measures to reduce or neutralize the impact of natural hazards by reducing social, functional, or physical vulnerability.
- Disaster preparedness: the organization, education, and training of the population and all relevant institutions to facilitate effective control, early warning, evacuation, rescue, relief and assistance operations in the event of a disaster or emergency.
- Emergency warning and response: a sum of decisions and actions taken during and after disaster, including alerting, immediate relief, rehabilitation, and reconstruction.
- On-going recovery and relief: a set of measures aiming to restore the affected place to its prior state (i.e. before the disaster).

The disaster recovery phase is likely to trigger a new iteration of disaster management starting with disaster mitigation and prevention. For this reason, disaster management is often represented as a never-ending cycle of mitigation, preparedness, response and recovery as shown in Figure 1.

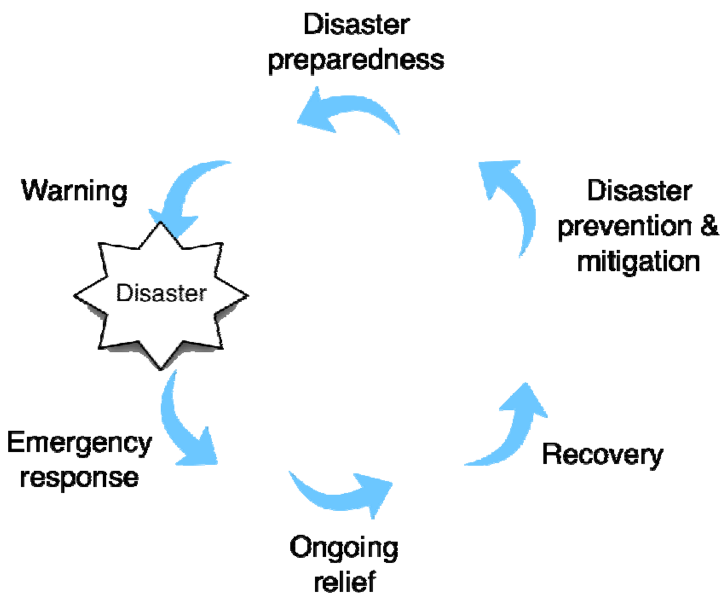

Figure 1: The disaster management cycle

Efficient and effective disaster management relies on proper coordination. Coordination calls for communication among the involved parties. Communication relies on the availability of adequate telecommunications systems fitting the specifics of the environment (distance among the parties, mobility, topology), the context of information exchanges (nature and amount of the information, frequency of the exchanges).

The next paragraph describes more in details the response phase. Indeed, upon a disaster, existing telecommunication infrastructures are often destroyed, severely impaired or saturated (if present at all).

4.1.2 Disaster response

Disaster response is the most acute phase of disaster management. It encompasses several types of missions:

- Alerting: citizens are alerted (e.g. about sheltering procedures). Emergency responders and authorities are alerted.
- Scouting and evaluation assessment: the situation is assessed in order to identify existing threats, define the proper answer and estimate the resources to deploy.
- Emergency response: immediate and urgent actions are taken so to (a) minimize the number of casualties, (b) mitigate the impact of immediate and significant threats (e.g. distributing iodine pills in case of nuclear contamination, first aid/medical care, emergency sheltering/lodging, fire fighting).
- Disaster relief: actions are taken so to cope with situations where life is not immediately threaten (e.g. installing water sanitization plants and power generators, decontamination against NRBC agents, psychological assistance, food and medics supply) but endangered on the medium term.

In order to ensure effective response and an efficient use of resources, several measures are taken in the organization of the response:

- The operation area (i.e. the area suffering the consequences of a disaster) is partitioned into zones so to ease management and cope with the escalation of the operation.
- Responders are scheduled and dispatched according to their disciplines with the objective to compartment as much as possible the activities on the operation area in order to ease global management and relax constraints on communication.
- Command and reporting follows a hierarchical scheme in order to ease coordination and make sure that relevant information is available at the right decision level.

Figure 3 shows the communication relations that are likely to take place among the participating entities. This diagram is inspired from TS 102 181 [i.2]. and focuses on satellite communication aspects. Other satellite services like Earth observation are not explicitly depicted.

The entities are dispatched on two areas: the disaster area [i.8] including the operation area and the off-site area. The distance from the disaster area and off-site area can range from tens of kilometres (for a small-scale disaster) to thousands of kilometres (e.g. responders sent abroad in case of a large-scale disaster).

Several coordination task forces exist whose roles are to realise an effective and efficient integration of all disciplines active on the operation area. While the present document mostly focuses on emergency telecommunications for responders, it is worth noting that the affected persons (directly such as victims or indirectly such as their relatives) are in need of communication capabilities so to call for help, communicate with their family, etc.

The means of communication links among entities display a wide scope of requirements pertaining to:

- The range: close range (i.e. hundreds of meters) from the operation area to the field conntrol center and long range (hundreds to thousands of kilometres) from the field temporary task force to the off-site coordination task force.
- The motion of the communicating entities: mobile for rescue teams, semi-mobile for field control centers and fixed for the temporary coordination task forces.
- The number of communication terminals and bandwidth needs.
- The nature of the communication: mostly voice in a group-call mode for the operation area and point-to-point broadband data upward.

The diversity of communication relations and their respective requirements hints the difficulty to establish a global telecommunications network answering all user needs.

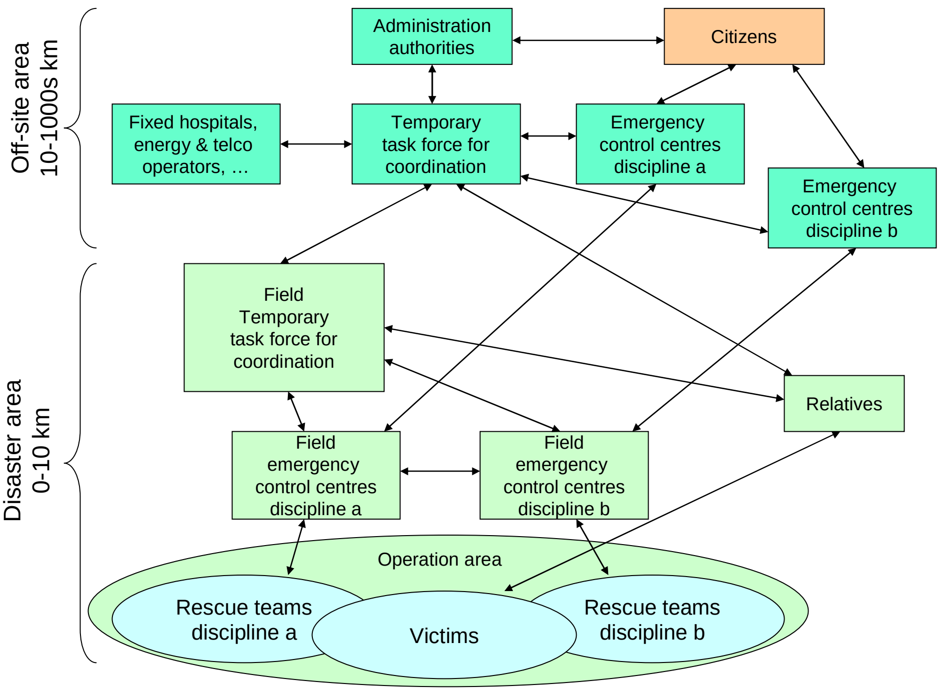

Figure 2: Role model in disaster management

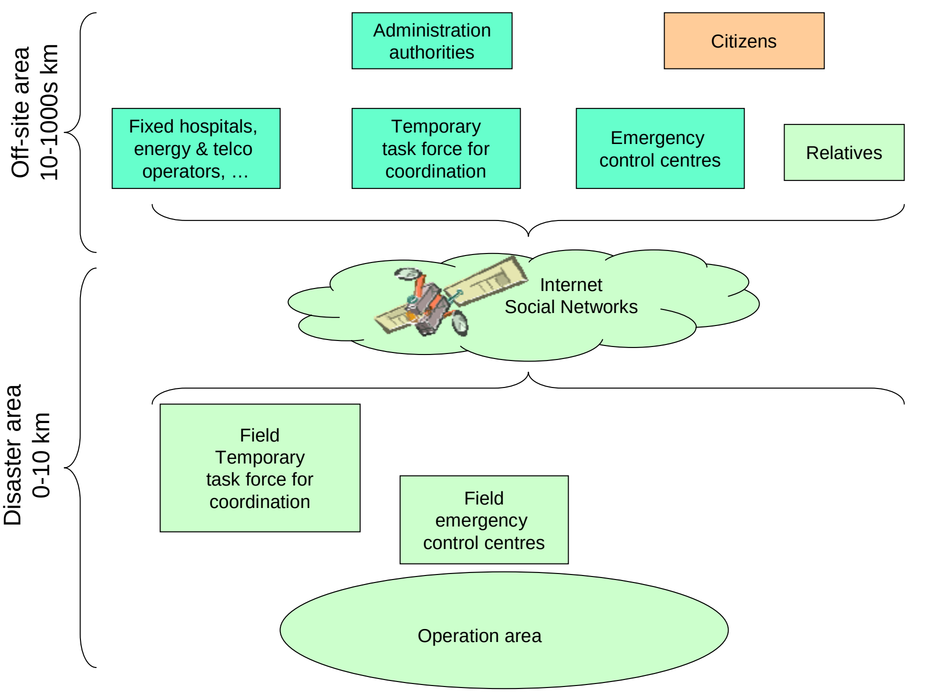

Figure 3: Satellite communication services for a typical disaster response organization

4.2 Disaster management and Information & Communication Technology

ICT helps to make information exchange quick, easy and reliable. These properties make it possible to build systems where the availability and circulation of information generates added value for the society. One can see the immediate benefit of ICT on disaster management. Still, disaster management has also to cope with the challenges and entropy inherent to the context of a catastrophe. Therefore, the complexity stemming from elaborate ICT systems may render the applicability of these solutions more demanding or costly than with other -regular- usages.

The following paragraphs provide a list of applications (further than "simple" data transmission) relying on ICT and being meaningful in the context of emergency response. For the reasons cited above, not all of them are currently widely deployed.

Command and control: this application is the basis of disaster response and often relies on voice communication. It is interesting to note that voice communication in the context of emergency fields displays requirements quite different from telephone communications: push-to-talk and group calls are mandatory features. Point-to-point voice communication is more common in higher level of the hierarchy (e.g. between the coordination task force on the near field and the back headquarters).

Alerting and early warning: alerting is usually categorized as alerting from the authorities to the citizen and alerting among authorities (alerting from the citizen to the authorities is addressed in the next item). Depending on the category, different requirements may exist in terms of reliability, scalability and content of the alert messages. It is also important to consider that an alerting chain may involve many different steps starting from the measurement of a physical phenomenon (e.g. the level of the sea in open water) to notification of thousands of citizen.

Emergency call management and response dispatching: emergency call management (e.g. a 112 call centre [i.9] to [i.13]) is a daily activity for fire brigades and emergency medical services. It is also often the first point of alerting when a disaster strikes. For this reason, robustness and reliability of the supporting telecommunication system is a mandatory feature. Emergency call management is often linked to response dispatching management that makes it possible to track the location and status of regular response units sent on the emergency scene. At a certain extent, it may even include information about the availability of specialized units in the hospitals that are part of the rescue chain.

Common operational picture (COP): consists in providing to operation managers (and field teams) a common and up-to-date view of the situation. This common view includes map of the area that shows all necessary features such as topological information, building descriptions or water/electricity supplies. It also includes the location of every response unit. Other information, depending on the typology of the event, may include forecasting of a fire progression, future extension of chemical spill-offs, etc. Finally, the COP can be augmented with different media coming from the field such as video footages and pictures.

Telemedicine and emergency medical care: telemedicine in its widest accepted definition is the communication between a medical expert in a remote location and a patient and possibly a field responder on the field. The objective of telemedicine is to mitigate the negative impact on the patient health of the absence or rarity of medical experts on the field. Telemedicine may be remote health monitoring, remote patient assessment and diagnosis and even remote surgery. Telemedicine is not the only application when it comes to ICT-aided emergency medical care. Triage (the prioritization of patient care during mass casualty incidents) is also a field of application that would beneficiate from mobile computing and communications.

Supply chain logistics: supply chain logistics copes with the transport and distribution of goods (e.g. shelters, medics, food) from supply platforms to point of distribution on the field. Swift transition of these goods through the customs and effective planning of distribution (based on the status of the road network and the location of refugees) are two examples of tasks requiring ICT.

4.3 Satellite-assisted disaster management

Space technology contributes to ease and improve disaster management practices by providing means for better decision making, improved team communication and enhanced mission planning. Table 1 lists examples of services that may be put in place during the different phases of disaster management.

Table 1: Examples of space-based services for disaster management

Disaster management phase	Space-based service (Earth observation, positioning, telecommunications)
Mitigation/prevention	Remote sensing, terrain evaluation (Synthetic Aperture Radar, optic).
Preparedness	Terrain mapping, early-warning.
Response	Mass alerting; sensor network data gathering; response team and assets tracking; navigation, indoor/outdoor localisation with ground and satellite based augmentation systems; situation assessment; PMR backhauling; PLMN and PSTN backhauling; Internet access; VPN; terrestrial networks restoration, augmentation and control.
Recovery	PLMN and PSTN backhauling; Internet access.

The following clause addresses emergency telecommunications more in details, focusing on the characteristics and constraints.

4.4 Emergency telecommunications

We define emergency (tele)communications as *a set of interoperable telecommunications resources (pre-)deployed in order to effectively support emergency operations and mitigate the impact of a disaster*.

As such, several examples listed in Table 1 fall in that category. Compared to day-to-day, consumer-targeted telecommunications, emergency telecommunications display one important difference: rather than technology driven, their development is user and usage driven. In addition to that and because they are a mission critical link in the chain of disaster management, they should also display a palette of wishful properties, such as:

- **Ease of use:** the terminals should be easy to use both from the functional standpoint (e.g. one button, one function) but also from the practical standpoint (e.g. usage with gloves, in low light/low contrast conditions or in noisy environments).

- **Ease and rapidity of deployment:** for equipments providing infrastructure functionalities it is important that the deployment can be realized by non-professional teams (e.g. for a VSAT terminal, people not extensively knowledgeable of satellite communications). The equipment should also be rapidly deployable ruling out for examples solutions where batteries need to be charged during several hours before being able to activate the terminal.

- **Practical form factor and weight:** the equipment should have an adequate size compared to the offered capabilities. For a portable, single user terminal, it means fitting in a pocket for example. For VSAT terminals, it is often correlated to the communication capabilities of the terminal. Suitcase form factor terminals (including the antenna) are popular, however the downlink throughput offered does not exceed 500 kbit/s (L-band type). Achieving a throughput of about 1 Mbit/s or more often requires dish-like antennas - auto-pointing or not - resulting in a larger form factor (e.g. an airborne grade container). In any case, handling should also be taken into account by ensuring that two persons or less are required for transporting the equipment on small distances and proceed with deployment/operation.

- **Physical robustness:** emergency telecommunications equipments are expected to be robust with respect to environmental conditions: shocks, humidity, water/mud projection, dust, high electro-magnetic activity, poorly regulated electrical supply and high/low temperatures. This holds true when the equipment is functioning but also when it is transported to/from the deployment site. In addition to proper packaging, this may also call for ruggedized connectors, regulated power supply, thermal control and filtered airflow.

- **Reasonable cost of buying and use:** when a disaster strikes, all public telecommunications infrastructures are likely to be knocked down or saturated. Emergency communication equipments are intended to provide a replacement. In addition to that, the need for communications (voice, data and messaging) will increase dramatically compared to daily use. These elements advocate the need for affordable terminals and affordable cost of use (i.e. cost per minute or megabyte) especially considering that emergency responder organisations have limited financial means.

- **Flexibility of energy supply:** in disaster situations, regular electrical supply (i.e. wall plugs) is often disrupted. Emergency telecommunications equipments are expected to support alternative ways of energy supply such as: rechargeable or replaceable batteries (e.g. providing sufficient autonomy in order to deploy a power generator), solar panels or power generators. This calls for a stringent dimensioning of the equipment energy budget and the use of standard DC voltages (12 V or 24 V).

- **Resilience to network disconnections and missing infrastructure:** disaster situations often incur challenging conditions for the responders but also for the equipments. Mobility of the network nodes is not controlled and may yield network partitioning where nodes are isolated. In such cases, the telecommunications equipments should provide graceful degraded operating modes. The ability for a PMR terminal to operate either in infrastructure or tactical mode (also called "direct" mode) is an example.

- **Reliability of communications:** responders often emphasize the need for reliability. Conversely, they are also aware of the challenging environment that may impair telecommunications facilities. Reliability in this context means that the telecommunication system should do "the best it can" and - this is important - report when a failure occurs (e.g. report when a message was not correctly delivered).

- **Scalability with respect to the number of users:** the number of responder is likely to be variable as the disaster response is rolled out. For this reason, the telecommunications solutions that are deployed should be able to serve a variable range of users from several users to thousands (e.g. by bonding similar equipments and offering aggregate capacity). As another example, scalability covers the capability to create talk groups on a PMR system so to cope with a large number of users not participating to the same mission. These talk groups may be dispatched on different frequencies/channels (calling for quick re-configuration/set up) or may use signalling schemes (such sub-audible tones on analogue PMR) to mute terminals that belong to other call groups.

- **Versatility of uses:** as shown in Table 1, there is a variety of services: data exchange, localisation, voice communication, audio/video streaming. It is desirable that these services are implemented on an integrated architecture so to minimize the number of involved technologies and optimise the usage of resources through mutualisation and prioritisation.

- **Security:** emergency communications are now expected to be secured according the three basic services which are: terminal/network authentication, communication integrity and communication confidentiality.

- **Compliance with standards:** disaster response is by definition multi-institutional and often international. Internetworking and interoperability are two key properties ensuring smooth integration of all the telecommunications means - whatever their origin - in a global network. Internetworking and -interoperability- is guaranteed through the acceptance and implementation of standards.

Note that these properties cover both the terminals and the network infrastructure. Also, it is likely that all these properties cannot be met at the same time and a proper compromise has to be achieved (achieving such a compromise is certainly the key to the success of an emergency telecommunications solution).

The specifics of emergency communications call for revisiting our approach to the design and provision of telecommunication equipment and services. The following paragraph lists several common misconceptions:

- **"Emergency telecommunications play only a role during the disaster response phase":** as seen in Figure 1, disaster management cannot be restrained to disaster response. Using and deploying emergency communications have to be planned. It also plays also an important role during disaster recovery when the regular telecommunications infrastructures are gradually restored, replacing emergency ones.

- **"Emergency telecommunications are only of interest during disasters":** there are at least two good reasons to consider the use of similar equipments during disasters and day-to-day emergencies. The first one is optimising the return on investment. The second one is training: the efficiency and effectiveness of the responders rely on extensive training. Part of this training covers the use of telecommunication facilities. Using the same equipments during day-to-day emergencies and disasters is a straightforward way to ensure acquaintance with the telecommunications equipments whatever the situation.

- **"Emergency telecommunications are like other telecommunications means":** as seen above, emergency telecommunications display a set of stringent requirements which may be contradictory with the rationale driving the design and development of mass market telecommunications. Above all, the design is primarily driven by the user needs rather than technological developments.

- **"Designing emergency telecommunications solutions is mostly a technical problem":** nowadays, the general belief in the emergency telecommunications community is that the major issue is related to spectrum availability and the capability to allocate - on an international basis - a sufficient amount of spectrum bandwidth to accommodate all emergency telecommunications services.
- **"Regular, public infrastructures can effectively replace the need for dedicated, emergency telecommunications provided adequate SLA are established between the private operators and the authorities":** besides the fact that SLA policies do not prevent base stations to be blasted, knocked down or flooded, it is also important to guarantee emergency responders that upon a disaster a significant amount of the public infrastructure capacity will be made available. This capacity will be - by definition - directed off the regular users and this might constitute a breach in the commercial contract. In addition to that, discriminating between regular and high-priority users (on what basis?) may prove to be difficult.
- **"The higher the bandwidth, the better":** providing continuous and dependable connectivity should be considered as the first priority and the larger bandwidth as the second.

5 Satellite systems for disaster management

Satellite systems also provide Earth Observation or positioning data. Integrating those systems create added value services.

5.1 Narrowband telecommunications

Narrowband systems support small message (up to 1 kB) transmission, low bit rate (up to 64 kbit/s) Internet access and voice communications (either pure voice or facsimile). For such systems, the terminal form factor is small, close to the size of a mobile phone.

Narrowband systems play an important role in disaster management because of the portability of terminals supporting an anywhere/anytime paradigm. The popular services are voice communication and team/asset tracking. Narrowband systems are a key asset during the first hours of the crisis (e.g. scouting assessment and more generally the early phase of response).

Satellite companies providing such services in Europe are (but not limited to): Globalstar (voice, data and messaging), Inmarsat (voice, data and messaging), Iridium (voice, data and messaging), Orbcomm (messaging) and Thuraya (voice, data and messaging).

5.2 Broadband telecommunications

Broadband systems support data rates typically from 400 kbit/s to several Mbit/s. Broadband systems can be further subdivided as: mobile, portable and transportable. Mobile terminals make use of either mechanical steerable or beam-forming antennas, data rates are in order of 1 Mbit/s for the uplink. Transportable or nomadic terminals support data rates starting from 400 kbit/s up to 1 Mbit/s. They are packaged either in small notebook form factor terminals (featuring patch antennas) or quickly deployable dishes (e.g. fly away dishes) and compact indoor units. Vehicle mounted terminals are usually more bulky (i.e. using an airborne grade container or mounted on a vehicle). They embark auto-steerable antennas, power generator, multi-mode modems, computers and support up to several Mbit/s of data rate.

Broadband systems are deployed on the field after some hours or days, depending on the size of the terminal and the transportation requirements/availabilities. They are positioned as the communication hub of the outpost, providing Internet access and backhauling of GSM/UMTS pico-cells, Voice over IP and PMR.

Satellite companies providing such services in Europe are (but not limited to): EADS Astrium Services, Eutelsat, Inmarsat, SES, Telespazio, Thuraya and more generally VSAT operators.

5.3 Global navigation and positioning

Global Navigation Satellite Systems (GNSS) provide localization information through the measurement of the characteristics of specifically formed radio (satellite) signals. Rather than the GNSS signal itself, the use and distribution of localization information is an important topic of emergency telecommunications. Typical applications are: team/assets tracking, passive victim localization and emergency beacons.

Most GNSS are implemented as a constellation of LEO satellites: Glonass (Russia, 24 satellites in 2012), Navstar/GPS (United States of America, 32 satellites in 2012), Galileo (Europe, 24 satellites in 2014) and Beidou/COMPASS (Peoples Republic of China, 35 satellites in 2020, among them 5 GSO satellites).

COSPAS/SARSAT is a search and rescue service developed internationally. It is composed of radio emergency beacons (they may use GNSS signals to compute and transmit their position) and satellite-based repeaters (currently NOAA/POES and METOP for LEO satellites and NOAA/GOES, INSAT and Meteosat for GSO satellites).

GNSS may also beneficiate from space or terrestrial assistance in order to improve the accuracy of the localization information or speed-up the acquisition of the signals. Assisted-GPS (in 2G and 3G mobile networks) is an example for the Navstar/GPS constellation. EGNOS is a satellite based augmentation system for the GPS, Glonass and Galileo constellations in Europe.

5.4 Observation

Earth observation satellites provide imagery and other information (e.g. soil moisture, water temperature) for the purpose of cartography and scientific measurements. Imagery satellites cover the visible range, but also the near infrared and infrared ranges. Their resolution (i.e. the area covered by one "pixel" of information) can be as accurate as 0,5 m x 0,5 m. EO satellites can also host synthetic apertures. EO satellites play an important role in the assessment of an emergency situation. Typical examples are: the evaluation of a flooded area or the detailed assessment of the status of a road network to organize evacuation or logistics supplies. Another traditional use of EO satellites is weather forecasting.

6 Regulatory and standardisation aspects

6.1 Regulatory aspects

6.1.1 Basic overview on current spectrum allocations

Today there are frequency bands allocated for various applications within the mobile satellite service and the fixed satellite service, mobile service, that can be used in disaster management.

The main frequency bands are listed in ERC Report 25 [i.14] (The European table of frequency allocations and applications in the frequency range 9 kHz to 3 000 GHz (ECA table). This report contains the European Common Allocation Table and includes a comparison with frequency bands allocated to services in ITU region 1.

The ECA is a tentative European harmonization of the national tables of frequency allocation. For further details the relevant documentation (ITU Radio Regulations [i.15] for all regions, or ERC Report 25 [i.14] for CEPT) should be visited. In most cases these bands are shared on an either co-primary or secondary status with other services.

A well known worldwide operational satellite system dedicated for rescue missions is COSPAS/SARSAT. This system is based on the usage of radio beacons (EPIRB, ELT for ships and aircraft, and PLB on land) operating at 406 MHz to 406,1 MHz.

6.1.2 International Organisations

The responsible body for regulatory aspects with an interregional/worldwide scope is the International Telecommunication Union (ITU). More specific, ITU-R Study Group 4 is dealing with satellite issues such as possible new spectrum allocations. General information about the responsibilities of ITU working parties for different disaster phases are given by the following website: http://www.itu.int/ITU-R/index.asp?category=information&rlink=emergency&lang=en. Related to emergency telecommunications and disaster management the ITU has published several handbooks which can be found at the following website: http://www.itu.int/ITU-D/emergencytelecoms/publications.html.

The ITU promotes satellite communications equipment use for preparedness and disaster relief. The ITU fosters a space services emergency database including available frequency bands, provided by administrations, for the use in emergency situations. These systems are mostly operated in frequency bands around 400 MHz, 1,5 and 1,6 GHz. A few systems are operated in 2,4 GHz, 3,7 GHz, 5,9 GHz, 6,3 GHz, 11 GHz and 14 GHz (website: http://www.itu.int/ITU-R/space/res647/index.asp).

The European Conference of Postal and Telecommunications Administrations (CEPT) is a European cooperative body of, currently, 48 national regulatory administrations in the field of posts and telecommunications. It is a recognised regional organisation acting in accordance with pan-European goals set up by CEPT, is covering a large part of ITU region 1 and the ECC as part of the CEPT develops common policies and non-binding regulations in electronic communications and related applications for Europe, and provides the focal point for information on spectrum use. Its primary objective is to harmonize the efficient use of the radio spectrum, satellite orbits and numbering resources across Europe. The ECC has established a project team for satellite related topics (WGFM 44, see http://www.cept.org/ecc/groups/ecc/wg-fm/fm-44) and a project team for PPDR related topics (WGFM49, see http://www.cept.org/ecc/groups/ecc/wg-fm/fm-49).

6.2 Standardization aspects

Several institutions and fora address explicitly standardization for emergency communications. These are: ITU-T, ETSI, ISO and OASIS.

ITU-T has established under the auspices of Study Group-2 a Partnership Co-operation Panel (PCP) for handling telecommunications for disaster relief and early warning (TDR/EW). ITU-T has recently endorsed the Common Alerting Protocol (see below) [i.3]. See also: http://www.itu.int/ITU-D/emergencytelecoms/.

ETSI hosts four relevant groups: the EMTEL Special Committee and the SES/SatEC working group. EMTEL missions include: the capture of users' requirements from stakeholders and the publication of technical requirements. Most of the activity of EMTEL is currently gravitating around alerting: either through the handling of 112 calls (the European emergency number) or for the alerting of citizens by means of public warning systems. TC SES/SatEC is focused on satellite-based emergency communication services and has recently produced a Technical Report (TR 103 166 [i.4]) describing how satellite communications may be used to provide on-field interconnection with others networks such as the Internet, PLMN and PSTN. TC SES/SCN covers radio and transmission aspects related to Fixed, Mobile and Global Navigation Satellite Systems operating in any bands allocated to FSS, MSS or RDSS. It produces architecture and service requirements, interfaces (user, control and management planes), transport and network protocols, service enablers for future satellite systems. ETSI also publishes standards related to TETRA through its TETRA technical committee.

ISO has issued the International Standard ISO 22320 [i.5] entitled "Societal security - Emergency management - Requirements for incident response" that lists different processes involved in emergency managements together with requirements. The topic of emergency management is handled by ISO/TC 223/WG 3.

Finally, the Organization for the Advancement of Structured Information Standards (OASIS) has published through its Emergency Management TC two XML-based languages for the exchange of emergency-related information. The first on is Common Alerting Protocol (CAP) [i.6] and the second one is this Emergency Data Exchange Language (EXDL) [i.7] and its derivatives.

7 International initiatives

7.1 The Tampere Convention

The Tampere Convention aims to ease the deployment of telecommunication facilities during a disaster. It has been ratified by 44 countries (as of January 2012) since its creation in 2005. Upon a disaster, a requesting state may query the help from a assisting state for the provision and deployment of emergency telecommunications. The assisting state is granted with immunities and tax exemption but is also bound "not to interfere in the domestic affairs". National regulatory barriers and procedures are also softened. The collaboration may be ended by the requesting state at any time. The Tampere convention oblige each state willing to participate to sign and ratify the convention.

7.2 The International Charter on Space and Major Disasters

The Charter aims to ease the provision from members of space data that may contribute to the anticipation or the management of a crisis. Members are space agencies and other organizations. Authorized users (e.g. civil protection units) or the United Nations are given a confidential telephone number used to activate the Charter network. According to the type of request, the most appropriate members are solicited and provide images to a value-added reseller that organizes the post-processing of raw data. Post-processed data are then send to the authorized user. In 2011, 32 charter activations took place.

7.3 UN-SPIDER

The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) has been created as a result of UN resolution 61/110 [i.16] in December 2006. Its mission statement is "Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle". Among the relevant initiatives, UN-SPIDER provides a Space Application Matrix (At the time writing under construction) where for disasters such as earthquakes, floods, etc. a classification of available space applications from earth observation, satellite navigation and satellite communications are provided. These space applications are also categorized according to the phase within the disaster management cycle. UN-SPIDER also publishes directories about available space resources (e.g. earth observation satellites and their characteristics). Finally, UN-SPIDER organizes a yearly workshop on the topic.

History

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