# SATELLITE TELECOMMUNICATIONS ADVANCED NETWORKS FOR GLOBAL MONITORING ENVIRONMENT & SECURITY

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## Abstract

The GMES (Global Monitoring for Environment & Security) services are currently being developed to support public policy makers' needs in the domain of environment and security.

Telecommunications will be a key component of the future GMES architecture, improving data collection to enhance reactivity of GMES service providers, dissemination of products whenever and wherever it is needed and also improving service quality through higher volume and data rates.

TANGO "Telecommunications Advanced Networks for GMES Operations" is a European Commission FP6 Integrated Project focusing on the use of satellite telecommunication solutions to serve the needs of the GMES community.

The paper presents the synthesis of telecommunications requirements collected through major GMES projects per each key GMES theme, focusing on emergency services.

Emergency core service is covered in TANGO through two major thematics, risk & crisis management (dedicated to Civil Protection requirements in Europe) and humanitarian aid (including Civil Protection requirements out of Europe and other humanitarian aid community needs).

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To answer to those requirements, key telecommunication components and technologies able to answer GMES needs are designed: data relay optimized architecture, in-situ improved data collection, broadband to fixed and mobile users and satellite radio broadcast for reliable data dissemination including early warning systems, as well as broadband combined with terrestrial mobile systems for fast and reliable network deployment in support to rescue teams and civil protections.

Transversal to the above components is the Common Telecommunications Services Platform. Its aim is to facilitate the access of GMES community to telecommunication solutions.

The paper presents the major steps of the project and how this contributes to enhance the GMES services for emergency situations from the provision of adequate telecommunication solutions in specific demonstrations up to the definition of conditions for a full operational TANGO platform.

## 1 Introduction

The GMES "Global Monitoring for Environment and Security" is a joint initiative of the European Commission and the European Space Agency for the implementation of information services dealing with environment monitoring and security, in order to support policy decisions and investments, as well as improving the quality of life of European citizens. GMES services are currently being developed, based on data coming from Earth Observation satellites and in situ sensors, which will be analyzed, combined and processed to obtain GMES friendly final products for end users.

GMES will mainly support decision-making by both institutional and private actors, like environmental agencies, local, regional and national authorities, civil protection organizations, etc…

GMES products will allow the above mentioned end users to anticipate potential threats, take decisions and intervene in a timely and efficient manner.

TANGO "Telecommunications Advanced Networks for GMES Operations" [1] is the first European Commission FP6 Integrated Project focusing on the use of satellite telecommunication solutions to serve the needs of the GMES community.

This paper aims at presenting the TANGO main activities related to emergency situations management, which are covered through two major themes: risk & crisis and humanitarian aid. These activities start from the synthesis of the GMES main projects telecommunication requirements, going through the proposed TANGO solution to cover these needs and the validation of this solution through demonstration scenarios.

## 2 Project overview

TANGO is a 36 month program, started 1st November 2006. Led by EADS Astrium, the project gathers 24 research and industrial partners including key GMES players (GMES service providers, GMES data providers and end-users representatives) as well as Satellite Communication's leading expertise in the area. TANGO website includes the detailed list of project partners (see § References). TANGO consortium aims at developing and providing operational telecommunication solutions to the immediate GMES services needs, and at preparing the definition of optimized satellite telecom infrastructures to expand the future GMES services.

The project addresses key environment and security applications for 6 different thematics: maritime services (including fisheries management, maritime surveillance and ocean applications), land cover, atmosphere, security, risk & crisis management and humanitarian aid. This paper focuses on activities related to risk & crisis management and humanitarian aid.

TANGO projet objectives

Within that framework, the following drivers and key objectives have been identified:

1. To support the GMES service providers in the expression of their telecommunication needs.
2. To enhance GMES services through the definition, adaptation, and service provision of enhanced satellite telecommunications solutions able to meet these needs. The satellite telecommunications addressed in TANGO cover the whole chain from data collection, data transport, up to GMES product dissemination (including early warning), and deployment of Adhoc networks, in particular in support to crisis situations.
3. To integrate these solutions into a Common Telecommunications Services Platform to provide to GMES service providers a privileged and unique interface to satellite communications services. This unique management platform will optimize the use of each solution, taking care of the GMES applications requirements in terms of service area, reliability, data rate, end users terminals characteristics and costs.
4. To validate the TANGO satcom solutions as well as the TANGO platform through demonstrations on various GMES themes, including risk & crisis management and humanitarian aid.
5. To define the conditions for an operational exploitation of the TANGO platform, and to define the optimized future telecommunication infrastructures to serve future GMES needs.

The study logic presented below relies on an involvement of the GMES community from the start and during all the steps of the project.

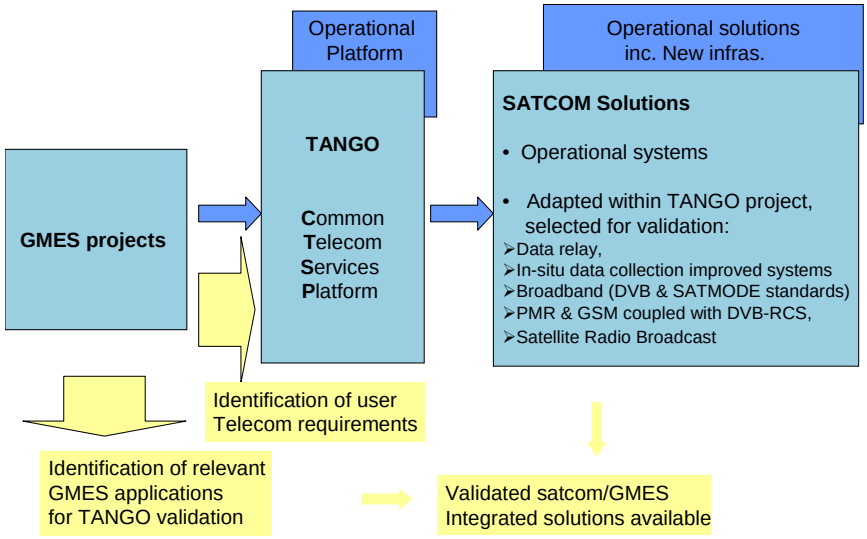


**Figure 1: TANGO project logic**

## 3 Collection of GMES requirements in terms of telecommunications

The first key TANGO objective was the collection of telecommunication requirements from the GMES community. This phase was successfully achieved during the first six months of the project. A systematic approach for assessing the needs was established based on the use of common terminology and through the definition of a common TANGO architecture for all the TANGO themes.

The general architecture for GMES services in TANGO has been defined according to the segmentation presented in the following figure:

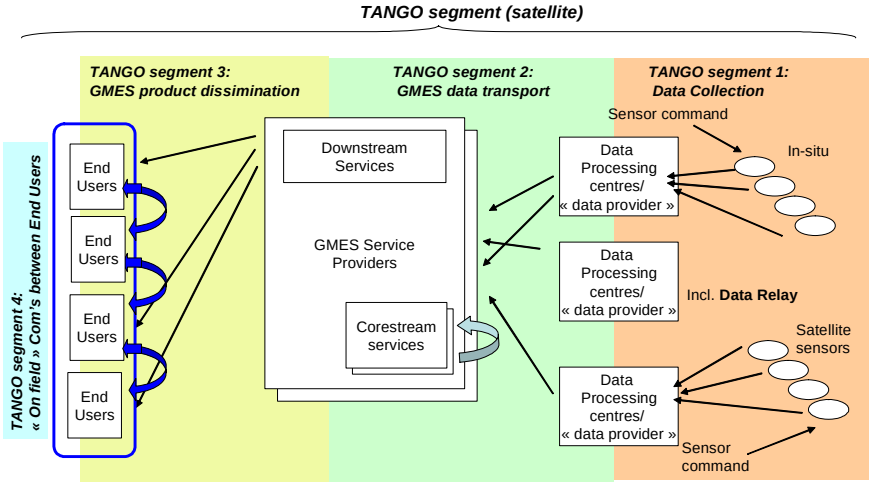


**Figure 2: TANGO architecture**

Four segments were defined:

- **Segment 1-Data collection:** related to the collection of data from satellite sensors, either in situ sensors, towards data providers / data processing centres.
- **Segment 2-GMES data transport**: related to the transport of data from the data providers / data processing centres towards the services providers.
- **Segment 3-GMES Product dissemination**: related to the product dissemination from the services providers to the end-users.
- **Segment 4-On field communication and data exchange for on-field users**: This segment is related to on field communication and data exchange between end users and between end users and the headquarters. This segment includes the deployment of ad-hoc networks for on field communications when terrestrial infrastructure does not exist.

The collection of needs was performed through an on-line questionnaire developed within the frame of the project. This questionnaire was completed for each theme by TANGO GMES partners largely involved in the GMES field, representing GMES service providers, end users or GMES projects. For each GMES project, specific services and scenarios were defined and their needs completed. Telecommunications needs for more than 40 scenarios and 29 services related to 15 different GMES projects have been completed in the database, providing a consistent overview of the current and future needs of the GMES community.

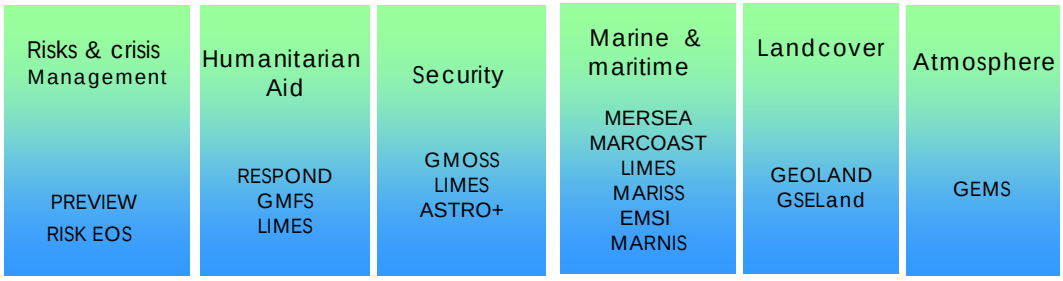


**Figure 3: TANGO addressed themes and GMES projects**

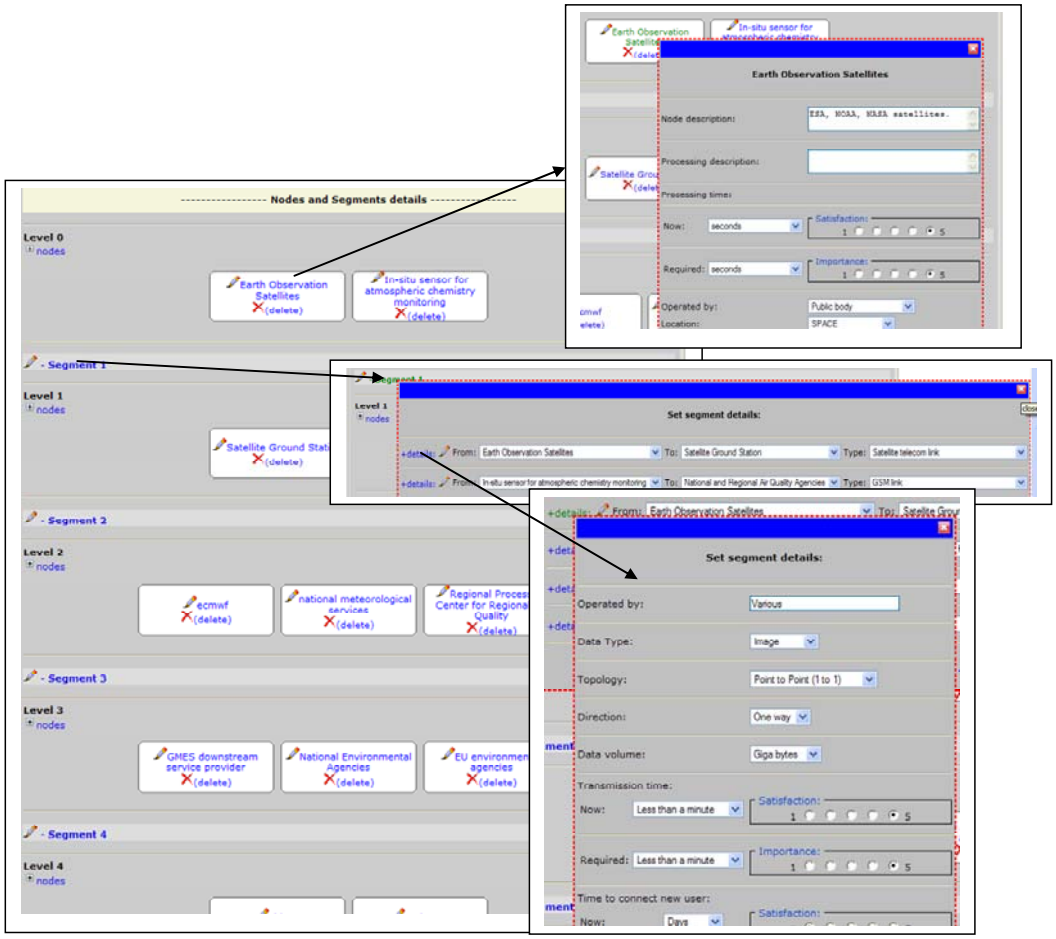


**Figure 4: TANGO questionnaire data base**

All information gathered from the questionnaire was stored in a centralized database in order to facilitate the synthesis, traceability and extraction of results. Results are obtained in a graphical and numerical way in order to easily identify main trends for each theme or for each group of parameters.

A synthesis of results for each theme has been produced in order to identify areas with high value added for satellite telecommunications and areas where improvement is needed.

Major trends for improvements could be highlighted which are common to all segments for several thematics:

- Reduce the time to access to the GMES service
- Higher data rates are expected
- Portability and mobility specially for communications on the field
- Global coverage

Main identified requirements for risk & crisis and humanitarian aid themes are indicated in section 5 of this document.

# 4 The TANGO solution

The general objective of the TANGO project is to undertake a coherent technical and programmatic integration of GMES services platforms and telecommunication infrastructures to meet some of the most stringent requirements of GMES applications. For this, the TANGO solution aims to develop a unique Common Telecommunication Services Platform (CTSP) based on a set of SATCOM solutions to offer to GMES community additional capabilities.

Common Telecommunication Service Platform (CTSP)

The main objective of the CTSP is to facilitate and optimize the access of GMES service providers to different telecommunication means. Through an user-friendly interface, the GMES service providers will be able to express their needs in terms of telecommunications to support their services.

The platform will provide a unique access point to several satellite and terrestrial communication solutions, thanks to specific contractual agreements defined in advance with telecommunications providers.

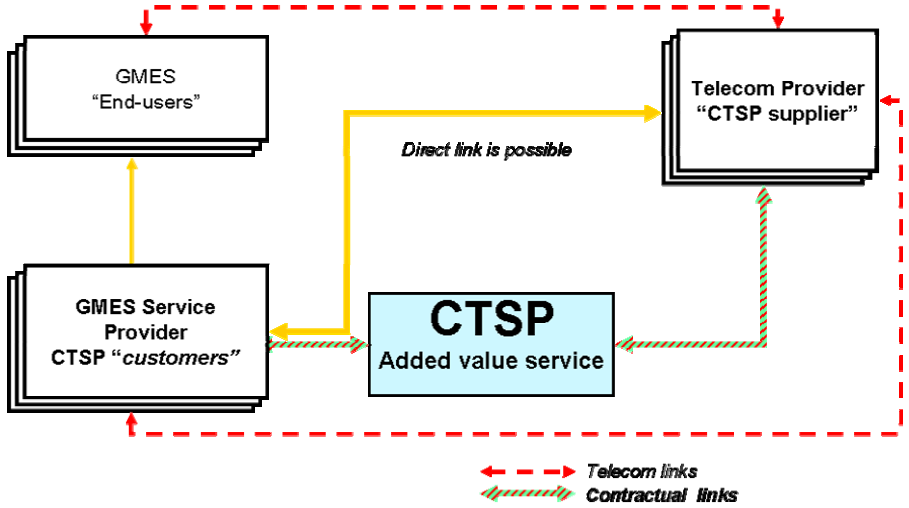


**Figure 6: CTSP environment**

The CTSP will identify the most adapted solutions answering to the expressed needs, taking into account a set of input characteristics such as coverage, type of connectivity, type of terminal, data rate, and balancing demand versus offer. Once the network is defined, the CTSP will also provide efficient tools for network management aspects.

The benefits of the CTSP can be summarized as follows:

- To provide to GMES service providers a common interface towards various communication solutions, including satellite and terrestrial networks.
- To coordinate the resource provision in a centralized way in order to reduce costs of telecommunication means.

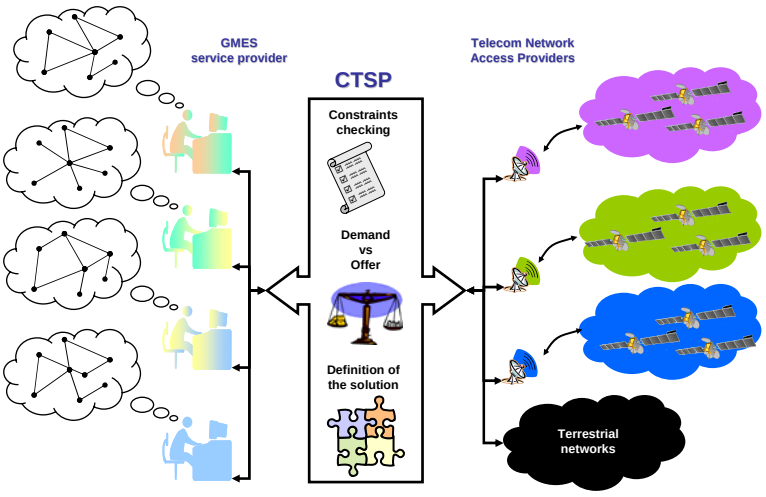


**Figure 7: CTSP Network Definition**

TANGO telecommunications solutions

The following satellite telecommunication solutions are currently being adapted for integration to the CTSP platform:

- In situ improved data collection through the integration of improved Argos-3 service (two way communications with the Argos mobile terminals, higher data rate and longer messages)
- Broadband to fixed and mobile users for reliable data transport and dissemination, relying on standard technologies DVB-RCS and SATMODE, adapted within TANGO to GMES applications
- Satellite radio broadcast including early warning systems, through the definition of two types of terminals, including a low cost terminal and a two-ways terminal for providing acknowledge, advanced mobility and autonomy features.
- Hybrid solutions, combining broadband satellite access with terrestrial mobile systems for fast and reliable network deployment in support to rescue teams and civil protections teams. Satellite/PMR and DVB-RCS/GSM architectures have been defined, including the definition of a fast and easily deployable GSM/satellite and WiFi/satellite solution named RECOVER, based on small size containers.
- In addition to these technologies, and to answer to a stringent need expressed by the GMES community to reduce and optimize time to access GMES products, Data relay services (DRS) solutions have been studied, including the design of future operational data relay infrastructures compatible with earth observation satellites, as well as with Unmanned Automatic Vehicles (UAV) and High Altitude Platforms (HAPS).

The Common Telecommunications Services Platform will continuously enlarge its telecommunications cataloguing by integrating other operational satellite and terrestrial telecommunications solutions.

# 5 TANGO activities related to communications on Emergency situations

## 5.1 Risk and Crisis thematic

With regard to the Risk and Crisis thematic, in order to ensure a full understanding of the overall scope, significant effort was spent to define the scenario and categorise the telecommunications needs according to the steps of GMES service elaboration and on-field dissemination. A special focus was made on the GMES services developed within the projects Risk-EOS and PREVIEW. Those services are listed as follows:

| | |
|---|---|
| • Fire services | • Landslide services |
| • Flood services | • Rapid mapping services |
| • Earthquakes and Volcanoes services | • Assets mapping services |
| • Man-made risks services | • Windstorm services |

Following work was performed:

- Collection of requirements on telecommunication services based on meeting and interviews with different crisis management actors such as Civil Protection agencies, GMES service providers, members of the International Charter on Space and Major Disasters.
- In some cases, satcom solutions were presented and demonstrated to end users so as to collect directly their feedback. This approach allows verify whether their expressed needs can be satisfied by the proposed satcom solutions.

**Collected user telecom needs for Risk & Crisis management**

Main telecom needs and expectations obtained for risk & crisis thematic are the following:

- Satcom solutions have to allow continuous and consistent situational awareness through regular elaboration and update of information related to the overall context and the on-field areas.
- For crisis management operations, satcom solutions have to provide levels of priority, availability, reliability and robustness
- Satcom solutions have to contribute to enhance the overall coordination by allowing crisis actors:
    - To benefit of broadband services (e.g. voice, data , video, web access),
    - To communicate with each other in an effective and efficient manner,
    - To communicate between the disaster on-field areas and the command centre as well as the external world,
    - To benefit of information access guarantee.

**Risk and Crisis demonstration scenarios**

So as to illustrate how satcom solutions can bring efficient answers to the above needs, demonstrations are planned. Their purposes are to highlight the added values of the proposed satcom solutions during all the crisis management process.

A generic demonstration scenario related to an on-field crisis management context has been elaborated. This scenario will serve as a framework for a set of specific demonstrations in actual context, which are currently being defined.

- Step 0: First alert and risk map transmission by GMES service centres to Civil Protection centres. This first step will illustrate on one hand the use of GMES

services for early warning and rapid mapping and on the other hand Early warning Satcom solutions.

- Step 1: Early warning messages are dispatched from the Civil Protection command centres to the villages and city halls.
- Step 2: Activation of the "International Charter on Space and Major Disasters" (referred further as "Charter") and use of near real time means (Artemis and earth observation satellites): set-up of the optical relay data link between Artemis and earth observation satellites, data acquisition of the defined area, data processing, as required for the evaluation of the situation. This step will illustrate the use of Data Relay service.
- Step 3: Continuous monitoring of the situation and exchange of information between the command centres and the local authorities. Satellite telecommunications facilities have to support efficiently the sharing of a common understanding between the crisis actors.
- Step 4: Due to the evolution of the crisis, on-field transportable stations are deployed on the disaster site. This deployment allows installing the on-field command centre and the unit bases. This step will illustrate:
    - the dissemination of GMES services to on-field crisis area through Satcom solutions such as DVB-RCS
    - the added valued of on-field transportable stations allowing the extension of terrestrial communication networks by satellite, and the availability of broadband applications to the on-field area.
- Step 5: The regional command centre will use the data sent from the on-field command centre as input for the near real-time disaster monitoring as well as for the mapping update.
- Step 6: In parallel, satellite broadcast/multicast with return channel services are used to send warning and information messages from the regional command centre to the local administration and population. This allows local authorities and population to have a continuous overall view, to follow closely the course of the event and to take adequate actions.

Thus, within the disaster area, satellite communications links will replace damaged or overloaded terrestrial communications infrastructure. On the one hand, satellite communications services will allow rescue teams to work and communicate with each other as well as with the regional command centres and Headquarters. On the other hand, the services will also allow population to have communications within the region and between the region and the external world.

### 5.2 Humanitarian Aid thematic

The deployment of satellite terminals immediately following the December 2004 Tsunami, as well the 2005 South Asia earthquake, powerfully demonstrated the critical role of emergency telecommunications for disaster response and relief activities. Such field technology is proven to facilitate the timely flow of essential information needed for the coordination of relief activities throughout the disaster cycle.

For the collection of telecommunication requirements in the humanitarian aid thematic, the TANGO project has focused on the requirements from GMES services developed within projects regarding humanitarian platforms: RESPOND, GMFS, GMOSS and LIMES.

| | |
|---|---|
| • Rapid and Field mapping | • Crop acreage mapping and yield forecast |
| • Reconnaissance | • Critical resource monitoring |
| • Alert services | • Population monitoring |

**Collected user telecom needs for Humanitarian Aid**

The collected requirements confirm the need to prioritize communications in case of humanitarian emergencies. This elevated priority is essential because public telecommunication networks are often damaged during the disaster, and any remaining capacity is generally overwhelmed with high traffic demands, thus resulting in severe congestion or total system failure. In such circumstances, technical features need to be in place to ensure that priority users have access to a functional, uninterrupted and secure communication system with the best possible quality of service.

The sentence "When disaster strikes, telecommunications save lives" is put in evidence with the requirements of faster transmission during emergency situations. There exists a general requirement to improve the time response for all the communications segments, and in particular to reduce the time between the acquisition of satellite imagery and the delivery of the data to the image provider. Significant delays of several hours can elapse because satellites must wait until an authorized ground station comes into view during an orbit before data transmission can begin.

Providing relief and assistance following natural disasters and humanitarian emergencies such as earthquakes and floods can have duration of several weeks or months. Then for Humanitarian Aid, there is a need to build a less transitory communication network with wireless nets (WiFi, WiMax) and even mesh networks.

The teams working in the field need to have one single terminal integrating several functionalities: location, GIS capabilities, voice and video transmission. The equipments have to be transportable, suitcase size with tendency to pocket size and have at less for 48 hours of autonomy.

To have an effective disaster early warning system there is a need of broadcast services for segment data dissemination. To improve the activity of the humanitarian community working in regions like Africa there is the need for the provision of reliable communications when terrestrial networks are not capable enough.

**Humanitarian Aid demonstration scenarios**

To demonstrate the potential of TANGO support for the humanitarian aid activities, it is planned to realize demonstrations in support to two main operational GMES projects for humanitarian aid thematic: RESPOND (Geographic Information Services for the Humanitarian Aid) and GMFS (Global Monitoring for Food security in Africa).

In order to evaluate the potential benefits of TANGO telecom support in typical case of humanitarian aid, "RESPOND scenario" will focus on preparedness operations and hazard maps processing aiming to mitigate the effects of a potential floods induced by the yearly monsoon in the south East Asia. "GMFS scenario" will focus on agricultural field survey and data transmission from rural remote areas to increase the food security in African regions.

For both scenarios, a team will be deployed in the field to collect data necessary to prepare and plan relief operations (in the case of RESPOND scenario) and to anticipate food security problems in the medium and short terms (in the case of GMFS scenario). Indeed, there is a lack of systematic collection of standardized data that can be stored in retrievable databases (information, photos, GPS points, voice and videos), but also a lack of telecom assets to send

the information collected from remote areas, where no telecommunication system are available. The collected data will be first transmitted to a regional operation centre or “field base”, before to be retransmitted from this field base to service provider headquarters located in Europe. The service provider will validate the data and update the corresponding GIS databases (map, data base, model), before to send them back to the regional operation centre with additional requirements for complementary data if needed. The process will be reiterated two or three times until the regional operation centre obtains all needed information to reach their goals: hazard maps and contingency planning maps for the case of RESPOND scenario, and crop information for yield forecast for the case of GMFS scenario. At the end of the exercise, it is planned to transfer and integrate all information processed (geographic databases) into the regional operation centre GIS databases, to improve local capacities and insure local benefits.

Several requirements will be tested in these scenarios, among them to provide reliable communications when terrestrial networks are not capable enough and to test solutions for the field team activities with portable equipments integrating several technologies.

## 6 Conclusions

Adequate telecommunications solutions will be key for optimised and efficient GMES service provision. Satcom solutions and services bring added values to support rescue organisations, national/regional authorities and population in the management of emergencies.

Those particular added values are:

- SatCom solutions can be rapidly deployed in the crisis remote on-field areas where terrestrial infrastructure is either overloaded or damaged if not inexistent.
- The solutions are simple to install, to use and can be transportable due to their limited size.
- The telecommunications satellite allows
    - A seamless and wide geographical coverage
    - With an easy and immediate provision of access to communications

So far the use of Satcom solution for emergency management is often limited to voice communication and transmission of files and photos.

So as to provide stronger support to the emergency management, this use can be extended towards:

- the dissemination and exploitation of geo information, GMES products to the on-field areas for the benefits of rescue organisation and local authorities,
- the offer of enhanced telecommunication services (emergency dedicated broadband applications, internet access, data sharing, fleet tracking, video conference) to decision makers for risks prevention and crisis management activities.

The paper presented the related challenges and the role TANGO project will play in particular to enhance emergency response services providing adapted satellite telecommunication solutions. Demonstration will be conducted at the end of this year to validate the TANGO solutions in relation to these domains.

## 7 Acknowledgements

EADS Astrium wishes to thanks the TANGO “Telecommunications Advanced Networks for GMES Operations” consortium partners and the European Commission Project Officer.

## 8 References

**[1] Website**: http://www.teladnetgo.eu/

## 9 Author biography

Sophie Defever is graduated from Ecole Nationale Supérieure des Télécommunications (Paris, France). She joined Matra Marconi Space (now EADS Astrium) in 1990. In the Telecom Systems department of Telecom Satellites Business division, she participated to mobile and broadband advanced projects, and was responsible for satellite system architecture activity in the past few years. She is now leading the TANGO "Telecommunications Advanced Networks for GMES Operations" European Commission FP6 project.

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