TANGO		

Project no	SIP5-CT-2006-030970
Project acronym	TANGO
Project title	Telecommunications Advanced Networks for GMES Operations
Instrument	Integrated Project
Thematic Priority	Priority 4 – Aeronautics and Space

Publishable Final Activity Report

Period covered	from 01/11/2006 to 31/10/2009
Date of preparation	15/02/2010

Start date of project: 01/11/06

Duration: 36 months

Project coordinator name:	Sophie DEFEVER
Project coordinator organisation name:	EADS Astrium

Revision: 0

EXECUTIVE SUMMARY

TANGO context

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. Various European GMES projects are currently focusing on the development of applications and services able to meet end-users expectations and the existing operational modes. The applications cover a wide range of GMES themes and rely on a comprehensive earth observing system, using space borne and in-situ techniques. Satellite communications aspects are rarely considered by these projects. However, it becomes obvious that one key obstacle to better operational services in a range of global near-real time applications of earth observation is not the image processing but non optimized usage of telecommunications means in the entire processing chain.

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

TANGO objectives

The TANGO "Telecommunications Advanced Networks for GMES Operations" project focuses on the use of satellite telecommunication solutions to serve the needs of the GMES community.

With a large involvement of GMES key players, TANGO implements a bottom up approach to identify the requirements from the GMES community to further adapt, develop, integrate and demonstrate satellite telecommunications innovative solutions able to cope adequately to the various needs.

The TANGO project is a three year project started in November 2006. The project aims at supporting GMES projects, future operational GMES services and their associated end-users in the expression of unmet telecommunication needs in the domain of risk & crisis management, maritime services, landcover, atmosphere, security and humanitarian aid.

The TANGO advanced satellite telecommunications solutions have been adapted and developed to meet the various needs for GMES: improved and faster data collection, fast data dissemination, provision of GMES data products down to the end-users on-the-field, Early Warning systems, Adhoc Networking.

TANGO aims at facilitating the access of GMES community to telecommunication solutions, in particular through the development of the TANGO "Common Telecommunication Service Platform". The TANGO platform offers a privileged interface to the GMES service providers to get fast access to the telecommunication solutions and to optimise the satellite capacity utilisation as a complement to terrestrial solutions. The project also defined the conditions for an operational exploitation of the TANGO platform, based on adequate partnership.

TANGO demonstrations contributed to three European Commission identified fast tracks (marine core services, emergency response and security). Demonstrations integrated satellite telecommunication solutions with on-going GMES developments in the framework of risk and crisis management, fisheries management, maritime surveillance, humanitarian aid and security.

TANGO contributed to the definition of optimised telecommunication infrastructures to also serve future GMES needs.

TANGO major achievements

Collection of GMES telecommunications requirements

During the first phase of the project, TANGO completed collection of telecommunications requirements through major GMES projects dedicated to risk & crisis management, maritime, landcover, atmosphere, security and humanitarian aid services. A systematic approach for assessing the needs was established, relying on the definition of a clear and agreed terminology and reference TANGO architecture. The requirements were filled in a data base through a dedicated web interface developed within the project. Common trends among various themes were identified, highlighting the key benefits expected from telecommunications: 1) a reduction of the time to access GMES services and delay improvements in data collection and data transport; 2) higher data rates expected on all architecture segments from data collection to data dissemination; 3) trends towards global coverage; 4) portability and mobility with fast and easily deployable equipments for emergency situations; 5) combination of position, data and voice communications for effective communications on the field; 6) increased reliability of the links.

These trends were documented per each theme and synthesized in a public document.

Telecommunication solutions adaptation to GMES needs

Key objectives of the project were to adapt telecommunications solutions and technologies to GMES needs and to facilitate the access to these solutions to the largest GMES community.

The following key telecommunication components and technologies have been adapted, developed and validated within the project.

- In-situ improved data collection, through the integration within TANGO developments of improved Argos-3 processing chain (two way communications with the Argos mobile terminals, higher data rate and long messaging capability).
- Broadband to fixed and mobile users for reliable data dissemination, relying on standard technologies (DVB-RCS and SATMODE) and adapted within the projects to GMES applications.
- Satellite radio broadcast including early warning systems, through the definition of two types of terminals, including on one hand a low cost terminal and on the other hand a two-ways terminal providing feed back data support and advanced mobility and autonomy features.
- Broadband combined with terrestrial mobile systems for fast and reliable network deployment in support to rescue teams and civil protections. PMR extension by satellite solution, and GSM & IP/ DVB-RCS transportable solutions have been completed. A fast and easily deployable GSM/satellite solution named RECOVER based on a kit of small size telecommunications containers have been developed and validated. The full network of three mobile solutions enabling three-sites cell deployment for telephony & internet access in support to crisis context has been operationally tested for usage in Risk & Crisis and Security demonstrations.

- Part of the TANGO studied satellite telecommunications solutions, Data Relay Services should actually meet a key expectation from GMES community in reducing the time to access GMES services and providing multi-casting capability. The benefits of DRS (reduction of time between the image request and delivery, increase payload data downloading capability) have been analysed and evaluated with the help of a "Scene Acquisition Planner" tool developed within the project. The future infrastructure of DRS has been proposed. The benefits of other platforms as UAVs and HAPs and the integration of data relay on these platforms have been analysed.

Development of Common Telecommunication Service Platform

The concept of the "Common Telecommunications Service Platform" was established in order to offer GMES service providers a simple tool to facilitate the access to telecommunications services.

The CTSP acts as broker enabling service provisioning and management between GMES service providers (customers of the CTSP through a user-friendly web interface) and telecom providers.

The CTSP is in simple terms a web site which allows GMES service providers to identify, to order and manage telecommunications services. It is particularly suited to address urgent procurement needs where location or capacity requirements can not be known in advance. The CTSP can gather together on one site the offers from a wide range of telecommunication providers, allowing by simple clicks and easy-friendly browsing/select mechanism, to be guided to the different types of offers corresponding to some selection criteria.

One of the main benefits of the platform is to provide a single interface to various networks. It allows to co-ordinate resource provision to the community of GMES end-users and to reduce cost of access to telecommunication services.

Based on a generic interface easily extendable to other telecommunications providers, the interfaces of the CTSP with the TANGO telecommunications solutions have been specified, developed and integrated.

Demonstration of Telecommunications integration in GMES

Demonstrations scenarios in relation to five themes: 1) risk & crisis, 2) fisheries monitoring, 3) maritime surveillance, 4) humanitarian aid and 5) security have been settled by the project to meet a two-fold objective: to demonstrate the benefits of a large set of TANGO solutions in an actual operational context (hybrid terrestrial /satellite solutions, innovative RECOVER concept, enhanced CLS-Argos3 solution, improved UAV including satellite data relay, CTSP platform…) and to allow bringing GMES services into regions suffering of a lack of high speed terrestrial solutions. Two scenario cases have been defined through cooperation with GMES projects, TANGO bringing satellite telecommunications and CTSP platform means in support to GMES projects demonstrations (RESPOND, MyOcean).

The demonstration plan confirmed through the large involvement and attendance of end-users and GMES service providers during TANGO Second User Forum in April 2008, was conducted during the last year period from September 2008. Nine demonstrations were successfully performed during the project.

A first successful demonstration was conducted in September 2008, in the area of Risk & Crisis management, where the solution of PMR extension by satellite developed in the project was demonstrated

with end-users in Elancourt (France). The next demonstration was a simulation of a crisis management scenario in Cahors (France) in December 2008. The demonstration included the TANGO satcom solutions adapted to crisis context, on-field dissemination of GMES products and applications dedicated to crisis management, to be experimented by civil protection end-users. The risk & crisis management theme was also illustrated in actual fire crisis context in South of France in summer 2009, through liaison with SAFER project.

In the domain of Humanitarian Aid, a real time exercise was performed in Vietnam by UNOSAT and local civil protections in support to RESPOND project, dealing with preparedness and crisis phase in the case floods disaster event. TANGO provided support to field team activities with portable satcom equipments integrating technologies for voice and data communications, location and having GIS capabilities. Telecommunication solutions provided support for contingency planning, preparedness and crisis situation requirements like field information transmission in real time. This allowed to use updated GMES products for better situation awareness and optimised action of the people in the field.

To deal with Security issues, a simulated exercise of evacuation of civil people from a country affected by a crisis situation outside EU border was run.

Transportable and easy to deploy satellite communication solutions adapted for crisis management situations were demonstrated. These solutions successfully established stable and reliable communications between actors involved in the scenario to allow voice, data and internet communications, the transfer in real time of geospatial data and GPS positions collected on the field, and to provide access to near real time earth observation satellite imagery information. The geospatial information was efficiently shared between different actors of the scenario in the three sites, providing an optimised support for decision making.

The exercise allowed highlighting the benefits of providing near real time satellite imagery plus advanced real-time communications linking actors in the field with decision-making centers, to improve reactivity and situation awareness for a better management of the crisis.

In the domain of Maritime Applications, two demonstrations were conducted:

- Ship tracking and detection capacity demonstration, conducted along Atlantic and Mediterranean Seas, was based on co-operative tracking by shipborne terminals (LRIT, AIS) and non co-operative detection (detection of the ships through satellite radar and optical scenes).

  It demonstrated the added-value of extending coastal surveillance to high seas by merging standard data with satellite earth observation and telecommunication data by exchanging information in almost real time. Satellite solutions enable to reduce time to access to Earth Observation data and to have access to global coverage, including high seas, so information can be rapidly transmitted most closely to the end-users

- Met-ocean observing capacity demonstration, based on Argos-3 instruments deployed in maritime environment and processed. Argos-3 satcom solutions allowed high data rate collection for continuous and consistent elaboration of information related to areas of interest, in particular in collecting meteorological parameters (link to marine core service project MyOcean).

Three demonstrations were carried out related to Fisheries Management applications:

- Comoros demonstration showed low cost satellite solutions providing broadband connectivity and internet access as enabler to create new GMES services of Vessel Detection in areas out of reach of satellite receiving station, with poor terrestrial telecom infrastructure and limited skills end users.
- UAV and Azores demonstrations allowed real time access to collected data enabled by inspection of area of interest and real time access to VDS by patrol aircraft

Whole TANGO demonstration plan showed satellite telecommunications to bring benefits to end-users and citizens at each step of the GMES value chain:

a) Satellite telecommunications enable countries with extended needs but relatively poor infrastructure to have access to new technologies and services (e.g. VDS). Combination of real-time information is made available the closest to the end-users providing them autonomy, decision and operation.

b) Time is critical at each step of the GMES chain: Telecommunication brings real-time access to information: for crisis management (situation awareness including to and from the field), for security or for environment (e.g. fight against pollution).

c) Satellite solutions are rapidly deployable, robust, reliable and therefore particularly suitable in case terrestrial infrastructure is damaged or non-existent (crisis).

TANGO has proved that efficient operational technologies are available to meet GMES requirements. Another key step in the project was to give non-telecom aware users access to telecommunications solutions thanks to the development of the Common Telecommunication Services Platform.

Towards an operational platform

One key objective of TANGO was to "make it happen" through the definition of conditions and recommendations for an operational exploitation of the Common Telecommunications Service Platform.

A first step in economical viability was performed through Cost & benefits analysis, to evaluate the additional costs and additional benefits for GMES community to bring satellite communications and service platform.

The second step was to identify and compare candidate role models for the future telecommunication operational platform for GMES, based on the GMES business model and to issue recommendations and to propose a way forward after TANGO.

It could include TANGO platform as a major tool in the development of the emergent Telecom Risk Charter concept, which would allow communalising and sharing the potential of satellite telecommunications solutions from operators and institutions to serve the GMES community needs in case of disaster and crisis.

Telecommunications should have a key role in the future GMES model. The future and development of GMES itself relies in its pioneering infrastructure and highly-efficient telecommunication services.

TABLE OF FIGURES

TABLE OF TABLES

1 WHY TANGO?

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, and rely on a comprehensive Earth observing system, using space borne and in-situ techniques.

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.

The satellite telecommunications will be a key component of the future GMES architecture, improving the dissemination of GMES applications whenever and wherever it is needed, data collection for a better reactivity of service providers and also GMES service quality thanks to higher allowed data volume and data rates. TANGO "Telecommunications Advanced Networks for GMES Operations" is the first European Commission FP6 Integrated Project focusing on the use of satellite telecommunication solutions to serve the needs of the GMES community.

With a large involvement of GMES key players, TANGO implemented a bottom up approach to identify the requirements for telecommunication services that are not met for the delivery of GMES services. TANGO aims at providing the GMES community with the access to satellite telecommunication solutions in order to meet their needs and fulfil their missions.

2 PROJECT OVERVIEW

TANGO is a 36 month program, started 1st November 2006. TANGO consortium consists of 24 partners from 12 European countries and is coordinated by EADS Astrium. The team is representative of the entire value chain with GMES data and service providers, GMES end-users, Earth observation satellite operators, Geographic Information Systems (GIS) actors & developers, research institutes, space agencies, satellite communication operators, equipment manufacturers, host spacecraft & aircraft/aeronef manufacturers, as well as cost & benefits analysis experts.

	Participant name	Country	Domain of activity
EADS Astrium	ASTRIUM SAS	France	World leader in the design and manufacture of satellite systems including ground segments. Earth observation, Telecommunication and data relay satellite system designer and manufacturer
unitar UNOSAT	United Nations Institute for Training and Research	Switzerland	Operator of the UNOSAT Operational Satellite Applications Programme. Contributor to products & service (inc. rapid Mapping Services) in support to humanitarian relief, disaster management & sustainable development planning

EUSC	European Union Satellite Centre	Spain	Provider of geospatial intelligence services for the Common Foreign Security Policy (CFSP) and the European Security and Defence Policy (ESDP)
EUROPEAN COMMISSION Joint Research Centre	Joint Research Centre	Belgium	European Commission Joint Research Centre supporting the conception, implementation and monitoring of EU policies
avanti communications	Avanti Communications Ltd	United Kingdom	Satellite communications service and applications provider
INFRAM	INFRAM	The Netherlands	Remote Sensing & GIS applications service provider. Development of Microsost local.live.com Virtual Earth platform
cnes	Centre National d'Etudes Spatiales	France	National Space Research agency. Contributor to the International Charter on Space and Major Disaster.
infoterra	Infoterra GmbH	Germany	Earth observation satellite products provider – Commercial exploitation of TerraSAR system
ASTRA	SES ASTRA TechCom S.A.	Luxemburg	Telecommunication satellite operator and service provider SES ASTRA is the leading satellite operator in Europe, delivering services to 107 million Direct-to-Home and cable households.
SPOT IMAGE www.spotimage.com	SPOT IMAGE S.A.	France	Worldwide distributor of geographic information products and services derived from Earth observation satellites
	Politecnico Di Torino (Turin Polytechnic University)	Italy	Public scientific and technical university. Design , manufacturing & flight test of UAVs
CLS	CLS (Collecte Localisation Satellites SA)	France	Offers satellite services in location, environmental data collection and ocean observations
WORLDSPACE SATELLITE RADIO	Worldspace France	France	Satellite Radio operator and service provider
	Univerzita Karlova v Praze (Charles University)	Czech Republic	University in Prague, faculty of science, advanced digital image processing, GIS integration and information extraction
EADS DEFENCE & SECURITY	EADS Defence & Security	France	Supplier of secured digital telecommunications networks (PMR) for Defence, Public safety and civil secure applications

Newtec	NEWTEC CY N.V.	Belgium	Manufacturer of satellite communications equipment and systems (SATMODE, DVB-RCS)
TNO	Netherlands Organisation for Applied Scientific Research (TNO)	The Netherlands	Europe's third largest Research & Technology Organisation with expertise on development and operations of radar, optical, and underwater sensors for defence, industry and public applications
HYBRID AIR VEHICLES	Hybrid Air Vehicles	United Kingdom	Lighter-than-air & stratospheric platforms manufacturer
SPACECHECKER	SpaceChecker N.V.	Belgium	Network Operator and Provider of Narrowband Data Services over L-band Satellite
navigs	Navigs SARL	France	Specialist in communications solutions for the fishing industry
inov	INESC INOVACAO Instituto de Novas Technologias	Portugal	Largest Portuguese technological infrastructure in the areas of Communications, electronics and Information technologies.
infoterra	INFOTERRA France SAS	France	Information services and applications based on remote sensing, including risk and crisis management
POLITECHNIKA POZNANSKA	POLITECHNIKA POZNANSKA (Poznan University of Technology)	Poland	One of the biggest Universities of technologies in Poland, supporting Cost & Benefits analysis
POLISH ACADEMY OF SCIENCES SPACE RESEARCH CENTRE	Space Research Centre	Poland	Expertise centre in the field of space applications for the polish government

Figure 1: TANGO consortium

TANGO Project website: http://www.teladnetgo.eu/

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.

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

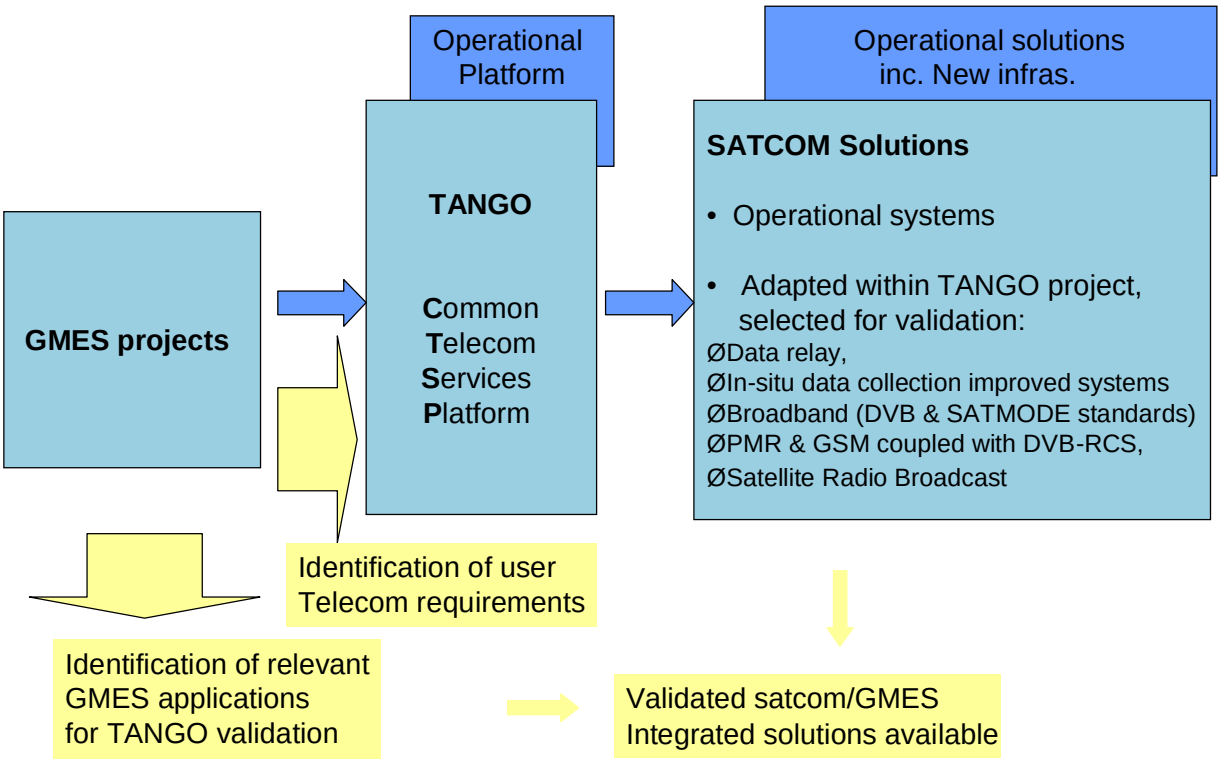


Figure 2: TANGO Project Study Logic

3 PROJECT OBJECTIVES

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, TANGO developed a unique Common Telecommunication Services Platform (CTSP) based on a set of SATCOM solutions to offer to GMES community additional capabilities.

Within that framework, a set of objectives were defined at the beginning of the project. These objectives are directly linked to the different stages of the project. These objectives are described here below, including the associated work performed during the project.

The introduction of new service capabilities implies that the various actors of the GMES chain must be prepared to take benefits of these services. Experience has shown that a necessary condition for such a project to show its effectiveness is to involve the GMES community from the beginning and at each and every phase of the project. This has been the main driver of the TANGO project, working together with GMES people during all stages of the project, starting with the collection and understanding of their needs in terms of telecommunications, following with the adaptation of satcom solutions and Common Telecommunications Services Platform (CTSP) to cover these needs, consolidated through the preparation and carry out of the TANGO demonstration exercises.

The objectives of TANGO project are the following:

1. To better understand the GMES services and to support the GMES service providers and their associated end users in the expression of their telecommunication needs.

   This objective was completed during the first year of the project, with the collection of the telecommunication needs for each of the GMES themes defined in TANGO: Risk & Crisis, Maritime applications, Landcover, Atmosphere, Security and Humanitarian Aid.

2. To enhance GMES services through the definition, adaptation, and service provision of enhanced satellite telecommunications solutions for data collection, data transport, data dissemination (inc. early warning) and Adhoc networking.

   Activity related to this objective started during the first year of the project, dealing with the review and adaptation of TANGO satcom solutions to cover the telecom needs coming from the GMES community. TANGO solutions cover all segments of the value chain for faster and improved data collection, improved data relay infrastructure for real time sensor data access from Earth Observation satellites, HAPS and UAV platforms, fast data dissemination whenever and wherever and provisioning of telecommunication deployable mobile equipment in case terrestrial infrastructure is damaged or inexistent.

3. To facilitate the access of GMES community to telecommunication solutions, providing a Common Telecommunications Services Platform integrating these satcom solutions to GMES service providers as a privileged and unique interface to satellite communications services. This unique management platform optimise 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.

   The provision of the CTSP was a key objective of the project and it was a demonstrated during the TANGO exercises.

4. To define, integrate and validate a set of representative test cases to validate satcom solutions through demonstrations on various GMES themes.

   9 demonstrations were successfully achieved during the last year of the project covering 5 GMES themes: Risk & Crisis, Fisheries management, Maritime Surveillance, Humanitarian Aid and Security. They allowed to test and demonstrate the whole satcom solutions adapted and developed under TANGO, as well as the CTSP and to highlight the benefits that satcoms can bring to GMES services

5. To communicate and disseminate on TANGO solutions able to meet the GMES needs, in particular developed satcom solutions and TANGO platform and on project results and conclusions.

6. To define the conditions and recommendations for an operational introduction of the service platform validated through the TANGO project including the definition of an operational and economic role model for the CTSP.

Financial and programmatic related issues have been tackled through Cost and Benefits activities in order to validate the economical viability of such an initiative based on information about TANGO demonstration scenarios.

4 COLLECTION OF GMES TELECOMMUNICATIONS REQUIREMENTS

The first key TANGO objective was the collection of telecommunication requirements from the GMES community, with closed cooperation with major GMES projects establishes through TANGO partners.

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 methodology, through the definition of a common TANGO architecture for all the TANGO themes.

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

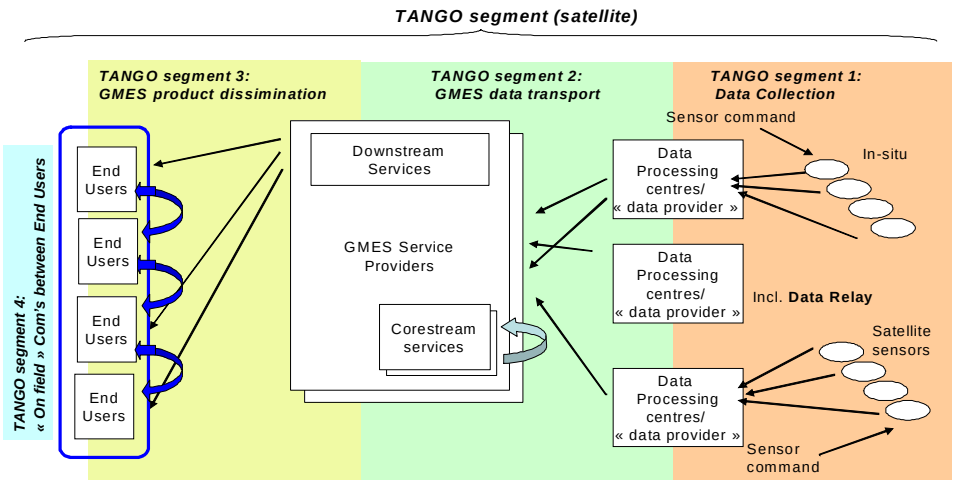


Figure 2: TANGO architecture

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 19 different GMES projects have been completed in the database, providing a consistent overview of the current and future needs of the GMES community.

Risks & crisis Management	Humanitarian Aid	Security	Marine & maritime	Landcover	Atmosphere
PREVIEW RISK EOS	RESPOND GMFS LIMES	GMOSS LIMES ASTRO+ OASIS	MERSEA MARCOAST LIMES MARISS EMSI MARNIS	GSE Forest Monitoring GSELand GEOLAND BOSS4GMES	GEMS PROMOTE
Infoterra F **EADS Astrium**	**UNOSAT** **Infram** **EUSC**	**EUSC** **EADS Astrium** **SRC**	**CLS** **EADS Astrium** **EUSC** **TNO**	**Infoterra G**	**JRC**

Figure 3: TANGO addressed themes and GMES projects

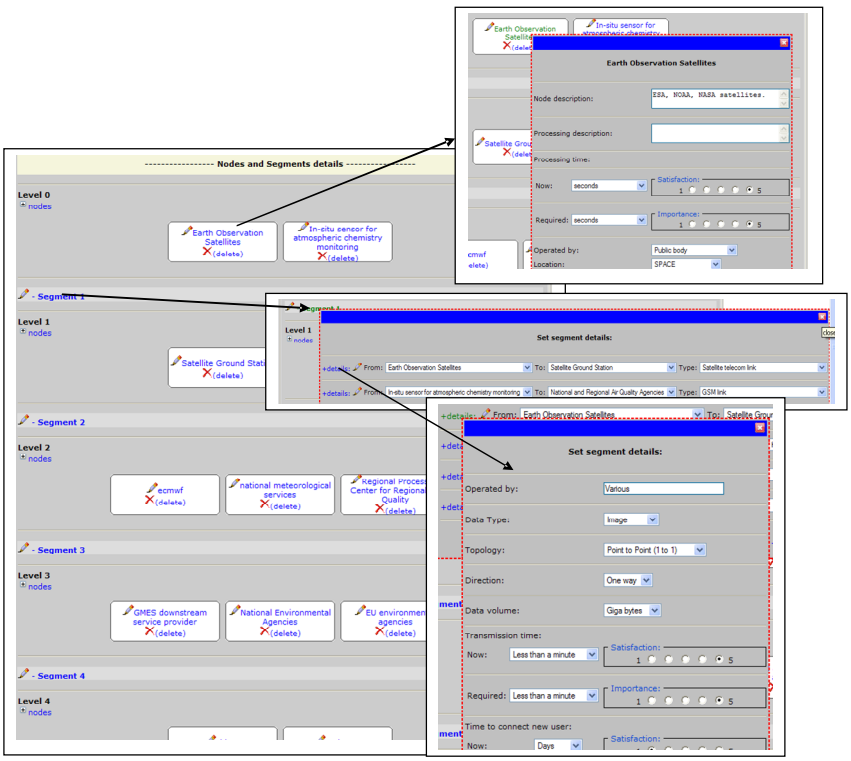


Figure 4: TANGO questionnaire data base

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

4.1 SUMMARY OF COLLECTED TELECOMMUNICATION REQUIREMENTS FOR RISK & CRISIS MANAGEMENT

Main collected 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 situation evolution:
    - Rapid access to EO imagery data and sensors
    - High data rate collection - high volume of EO imagery data to be downloaded
- Satcom solutions have to allow a good communication between all the actors of the chain, data providers, service providers, authorities and rescue teams on the field, and ensure that GMES products and services are made available to Public Safety Headquarters and command centers
    - Broadband Communications between data, service providers and end users - Higher data rates and benefit of broadband services.
    - Broadcast and multicast for data dissemination
    - Secured and reliable communications
    - Global coverage
- Satcom solutions have to provide Early Warning services, to broadcast alarm signals (voice and small data information, with high level of reliability and return channel for alarm acknowledgement.
    - Alert Early Warning services
- Satcom solutions have to contribute to enhance the overall coordination by allowing crisis actors communications with authorities and GMES Service Providers

- To benefit of information access guarantee and telecom solutions providing good levels of priority, availability, reliability and robustness
- To communicate between crisis theatre and Headquarter (HQ) and with each other in an effective and efficient manner
- Mobile communications on the crisis theatre – voice and data
- To benefit of broadband services (e.g. voice, data , video, web access) on the field
- Data collection on the field for field and rapid mapping applications
- Portability, mobility and rapid deployment
- Equipments integrating several functionalities

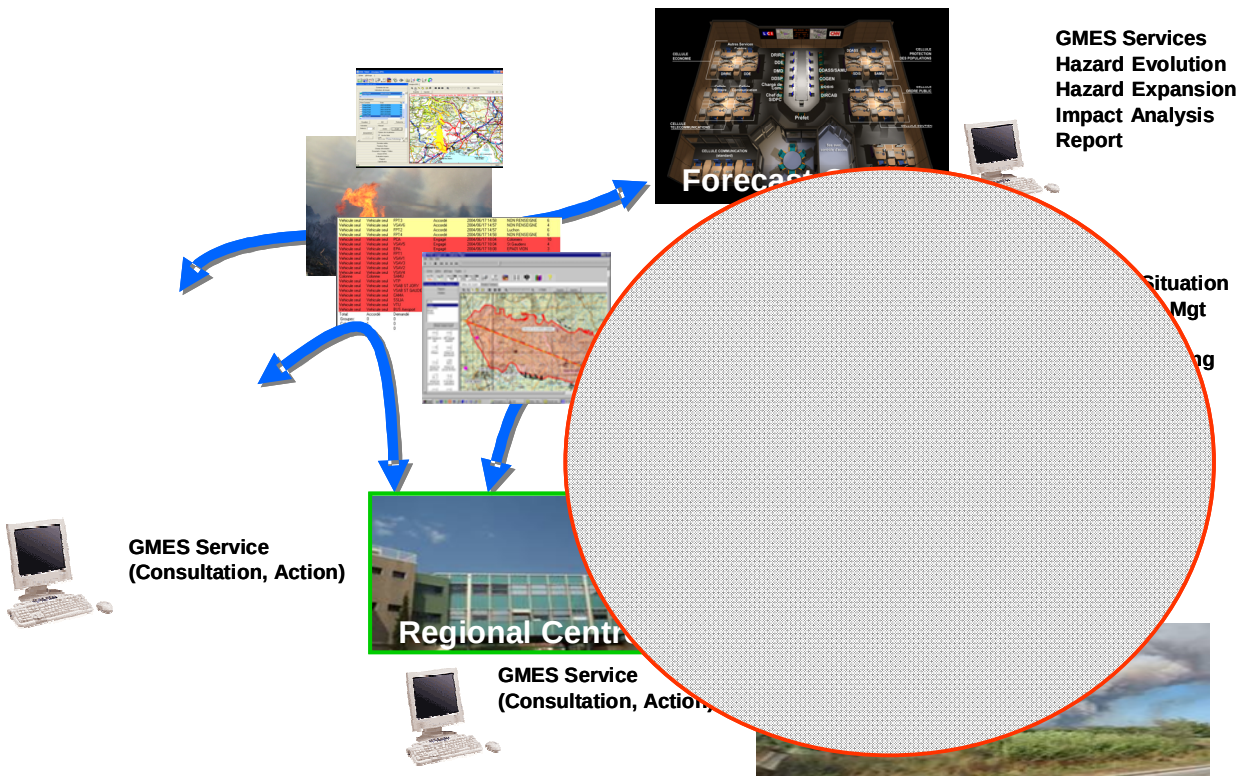


Figure 3: GMES Service Architecture overview

Figure 4: On field deployment

4.2 SUMMARY OF COLLECTED TELECOMMUNICATION REQUIREMENTS FOR MARITIME APPLICATIONS

Maritime thematic in TANGO gathers the following three themes:

- Maritime Surveillance
- Fisheries Monitoring
- Oceanography

The main telecommunications needs and expectations for the maritime surveillance theme, collected from several scenarios related to the above themes are:

- Reduce time to access to Earth Observation satellite data (i.e time between acquisition request and service delivery to actors on zone). Need of near real time service delivery for some services.
- It has been noted that the major bottleneck in data acquisition is time to program the EO satellite, that it is much longer than time to distribute the information.
- Necessity to merge different types of data to help data correlation (radar images, AIS, VMS, LRIT): users need integrated solutions to serve maritime surveillance
- Avoid duplication of systems, several projects rely on similar telecoms. Optimize costs through fusion of users needs, from specialized missions to generic and transverse services.

- High data rate data collection and dissemination required for continuous and consistent elaboration of information related to areas of interest.
- Global coverage: although most of the GMES projects are related to the European areas (EEZs, coastlines, straits), most of the actors in the maritime domain think global. It has been noted that most of bottlenecks appear for data dissemination out of Europe.
- Broadband communications on board vessels are based on well proven commercial satellite systems for some users, while for others there is a room for improved communications.

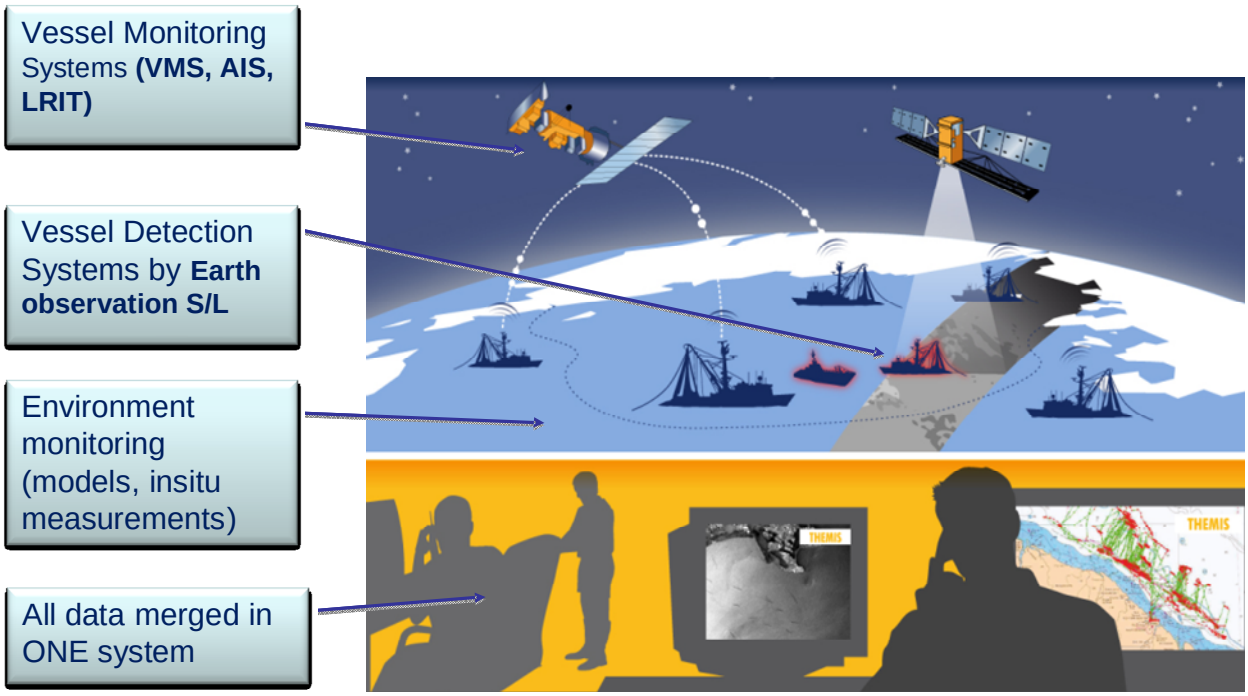


Figure 5: Users need integrated solutions to serve maritime surveillance

4.3 SUMMARY OF COLLECTED TELECOMMUNICATION REQUIREMENTS FOR LANDCOVER APPLICATIONS

The Landcover thematic in TANGO deals with services related to mapping and monitoring, without time constraints neither "near real time" needs. Cases of fast access to data bases (e.g. to provide maps for crisis situations) are dealt in TANGO within the Risk & Crisis theme.

Service requirements with regard to telecommunications for Landcover services are very different in each continent. In Europe, different data flows are assured by either ESA ground receiving stations or national receiving stations, combined with terrestrial broadband infrastructure. In consequence we can say that landcover services relies on well established European broadband infrastructure without having needs on fast data access and dissemination.

However the African continent suffers on gaps and deficiencies of telecommunication infrastructure, with strong limitations in terms of receiving stations and processing facilities. Existing infrastructures like EUMETSAT PUMA network and ESA receiving stations ensure the services today, but sustainability is not yet ensured and it becomes very difficult to reach remote African regions not currently linked to PUMA network.

In consequence the Land cover services needs in terms of telecommunication infrastructure can be summarised as to improve the dissemination of high amount of data to regions with very poor or inexistent terrestrial infrastructure.

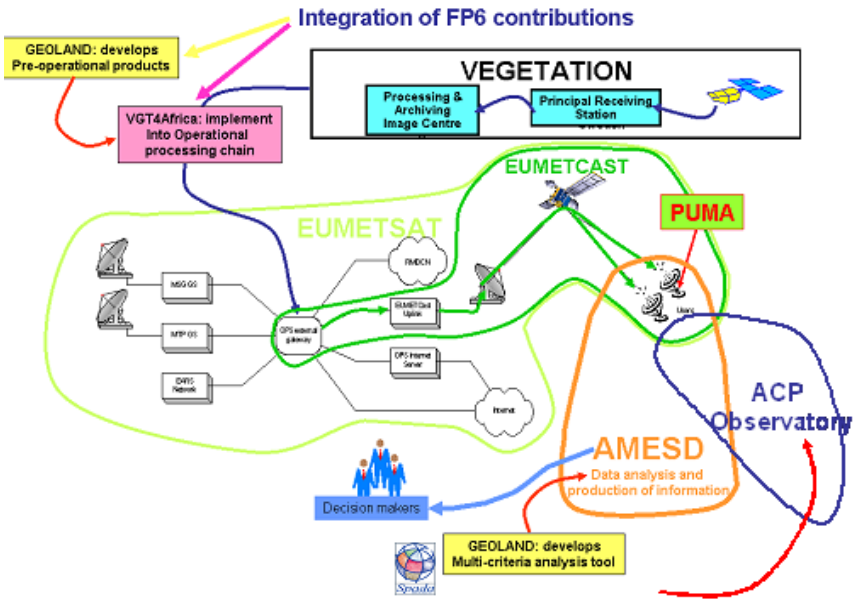


Figure 6: Global Monitoring services

4.4 SUMMARY OF COLLECTED TELECOMMUNICATION REQUIREMENTS FOR ATMOSPHERE APPLICATIONS

The service providers of Atmospheric services being developed under the PROMOTE and GEMS projects are today satisfied with the current situation. The only improvement awaited is in the delivery of regional in-situ data, but it is more of an administrative issue than a technical one.

Although the volume of data exchanged in Atmosphere scenarios is very large, there is no real requirement for telecommunication improvements. This is due to the use of existing robust and performing infrastructures from the meteorological community, namely the Global Telecommunication System, which mixes dedicated land based broadband lines and satellite telecommunication means today (i.e. Eumetcast network, as Broadcast System for Environmental Data, as Eumetsat contribution to the Integrated Global Data Dissemination Services (IGDDS), and the WMO Information System for the near future. Some services needing fast access to data are run in Europe and they can always use available terrestrial communication channels.

So, in the collection needs phase, it was concluded that atmosphere services are continuous and benefit from long standing, efficient and reliable infrastructure. There are no strong needs for improvement for Atmosphere services and no real improvement is expected from TANGO.

4.5 SUMMARY OF COLLECTED TELECOMMUNICATION REQUIREMENTS FOR HUMANITARIAN AID

The needs in terms of telecommunications collected from the Humanitarian Aid community are:

- Faster service delivery to reduce time of response for early decision in emergency situations and for evolving situation.
- Increased volume and data rate for dissemination segment. In emergencies the need for forward link is to download maps and for return link voice, text, images., and in near future video.
- Provision of reliable and semi communications on the field when terrestrial networks are not capable enough (area : Africa) and when existing terrestrial infrastructure is not available until its recovery.
- Provide rapid and easy deployable communications means to facilitate operations on the field and communications between several rescue teams and authorities: - nature of the data: Voice, Text, Video.
- Mobility in the field with pocket to suitcase size equipments, easy to use, roughed and secured.
- Secured and reliable communication links, specially when terrestrial infrastructure is insufficient.

These requirements are very similar to those collected for the Risk & Crisis management theme.

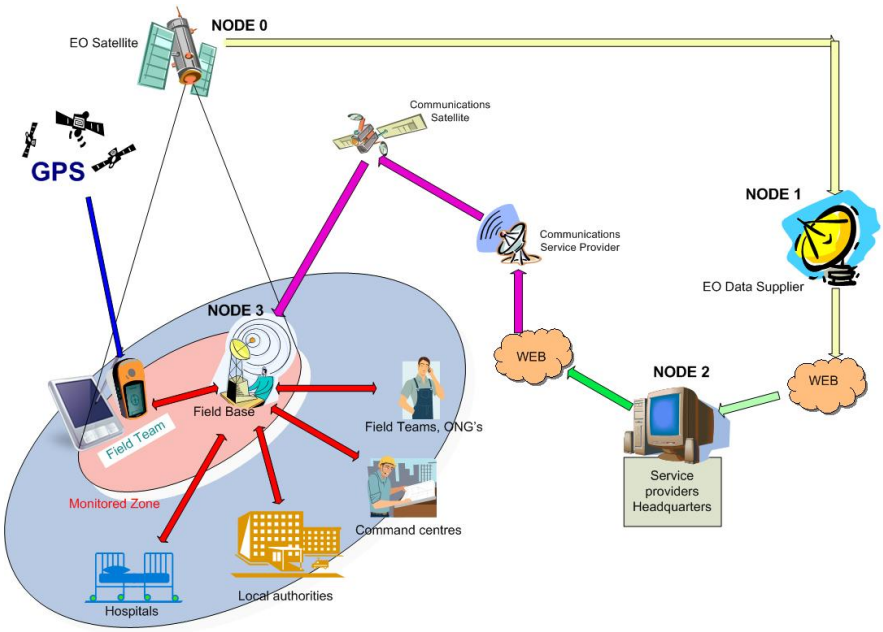


Figure 7: Typical architecture for Humanitarian Aid services

4.6 SUMMARY OF COLLECTED TELECOMMUNICATION REQUIREMENTS FOR SECURITY APPLICATIONS

In the security thematic, the collection of telecom user needs was mainly based on the following GMES projects: GMOSS (Global Monitoring of Security and Stability) and LIMES (Land and Sea Integrated Monitoring for Environment and Security). Particular attention was also paid to specific requirements for telecommunications services in the EC new member states for security.

The conclusions in terms of telecommunication needs for the security theme are the summarized here below.

- Improvements of time response for service delivery, in particular to reduce time for access satellite data images.
- Improve data rate in data transport and data dissemination segments
- Need for broadcast and multicast services for data dissemination segment
- Priority communications in emergency situations
- Secured and reliable communications links.
- To have priority, reliable and secured communications between several centers and with people on the field
- For on field interventions, need for equipments integrating several functionalities in one single terminal (location, GIS capabilities, voice, video). These equipments have to be easily transportable (suitcase to pocket size) and with autonomy of at least 48 hours.

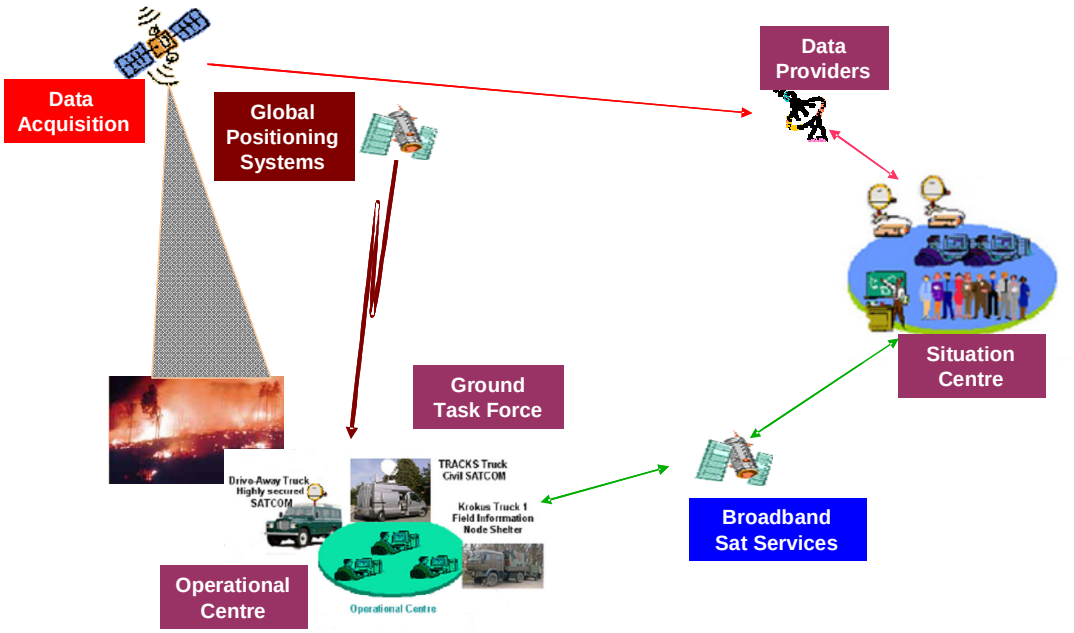


Figure 8: Typical architecture for emergency intervention

5 TANGO SATELLITE COMMUNICATION SOLUTIONS

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 includes the adaptation of telecommunications solutions and technologies to meet the GMES needs and to facilitate the access to these solutions to the largest GMES community.

The following sections present the key telecommunication components and technologies that have been adapted, developed and validated within the project.

5.1 DATA RELAY SERVICES

From the beginning of the project, special attention was paid on how the data relay can answer to GMES user demands in terms of :

- Collection and transport of large amount of data
- Ageing on information reduction
- Dissemination of the information to several points

TANGO studied data relay services implementation in three types of platforms, satellites, UAV and HAPS.

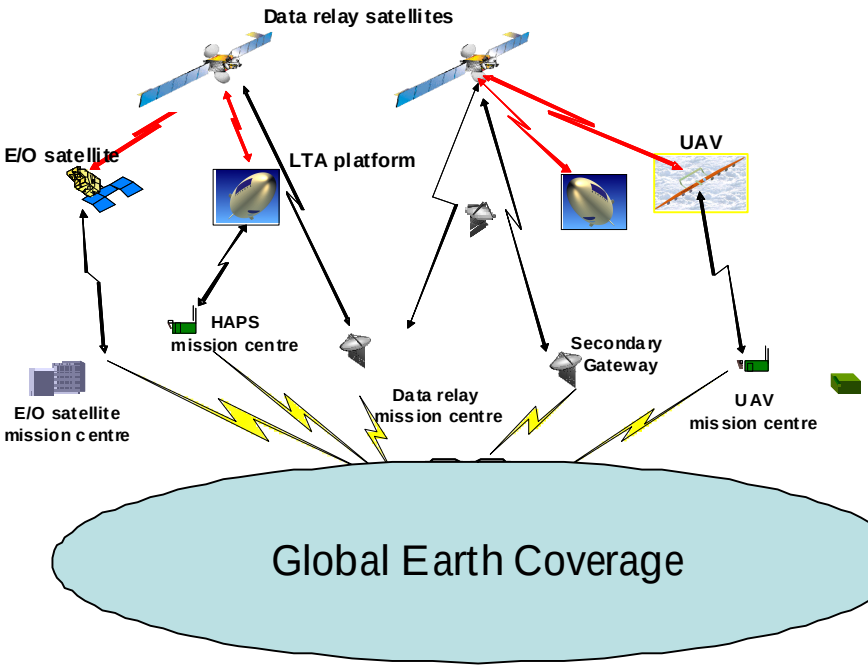


Figure 9: System architecture diagram

5.1.1 Geostationary satellite data relay

The objective of this activity was to review, adapt and design an operational Data Relay System (DRS) infrastructure within the frame of TANGO which could improve the performances of the existing space systems dedicated to data collection and transport.

The GMES community often needs an efficient communication mean at various stage of the process (data collection, transport and dissemination) of the GMES service products, mainly in crisis situations.

In these cases, Near Real Time (NRT) products should be available to the end users within less than a few hours from the sensing, in order to provide authorities and deciders with up to date GIS material to take decisions and organise rescue activities. Near Real Time products require specific and usually High and Very High Resolution EO satellite data acquisitions, producing high amount of data to be transferred in the shortest time as possible.

Some bottlenecks in EO systems have been identified for efficient EO data utilisation:

- Ø Usually more than 12 hours delay for spacecraft tasking for TC uplink. This delay can be significantly reduced in some commercial missions, through direct tasking from multiple sites
- Ø Delays for Payload Telemetry (PLTM) data collection, downloading and transport linked to the use of remote stations.
- Ø Potential congestion of X-band spectrum due to increase spacecraft acquisition capacity and thus requirement for higher PLTM download data rate.
- Ø Polar stations operational congestion due to increasing number of LEO SSO spacecraft in polar orbit.
- Ø And finally, need for data dissemination optimisation between processing centres and end-users;

There is thus a major interest to analyse how a space based telecom infrastructure could offer a more efficient use of EO systems, in particular for surveillance and security applications.

TANGO study results show that Data Relay Systems answer to all the bottlenecks previously identified:

- The Data Relay System (DRS) has been identified as a candidate to offer high data bit rate communication link for downloading EO satellites payload telemetry data (PayLoad TeleMetry-PLTM) to the EO Data Ground Station (PDGS) in NRT
- DRS can also broadcast simultaneously the information to several centres, including to GMES service providers to improve time for data transport and data dissemination.
- The DRS could support fast tasking in case of bidirectional link where the EO satellite payload could be also tasked through the relay infrastructure. This intends to avoid the tasking delay as it is not needed to pass over a TM/TC ground station. This opportunity is nevertheless submitted to a planned optical link slot between the LEO and the GEO so that the communication can be established from the GEO to the LEO.
- Use of DRS infrastructure for downloading EO satellite imagery could also help to reduce the congestion of TMI X band spectrum and polar stations.

Depending of the data rate requirement, 3 classes of Satcom data relay payload have been defined.

Satcom data relay payloads are used to provide Beyond The Horizon (BTH) data link capability. This data link capacity may be used for platform control or for payload data transfer.

Three classes of data relay payloads have been identified depending on the required transmission data rate.

- Class 1 : data rate lower than 500 kbps, that level of data rate can be met using InmarSat 4 capacity in L-band (1525 MHz to 1660.5 MHz) .
- Class 2 : data rate lower than 10 Mbps, that level of data rate can be met using Ku (10.95 to 12.75 GHz forward link, 14.0 to 14.5 GHz return link) or Ka (30-31 GHz uplink; 20-21 GHz downlink) Satcom payload.
- Class3 : data rate above 50 Mbps, that level of data rate can be met using optical payload in the near infrared (wavelength in the 800-850 nm range or 1060 nm or 1530-1560 nm range).

Whereas Class 3 is the only one applying for inter-satellite links between GEO and LEO, Class 1 and Class 2 were also considered for the case of UAV (Unmanned Aircraft Vehicle) and HAPS (High Altitude Platform System) described in the following sections.

As a conclusion, the benefits of data relay implementation for GMES applications can be summarized as follows:

- Increased amount of data broadcasted to the ground, almost two times the amount of data transmitted via the usual ground network (polar station and direct ground station).
- Reduction of delay between data acquisition and data downloading (ageing), allowing to provide the data within less than 1 hour after acquisition.
- Suppression of interference over the polar stations.

5.1.2 UAV (Unmanned Aircraft Vehicle)

Satellite Data Relay solutions on board Unmanned Aircraft Vehicles (UAV) platforms have been studied in TANGO to show how they can cover the needs coming from GMES community.

It has been proved that several UAV categories can provide viable and safe platforms to provide GMES services in several themes, providing capabilities for high data rate data collection, for reducing ageing of the collected information and improving speed of service delivery to end users.

Depending on the UAV platform characteristics, different GMES scenarios and applications can be covered.

In the Multicriteria analysis performed by TPU in the frame of TANGO, several GMES scenarios were studied in terms of payload typology (Infrared, EO, SAR, Lidar etc.), characteristics of various payloads (mass, power consumption, volume, data link etc.) and requirements of the mission (all weather capabilities, day/night operation, endurance, altitude, flight speed etc…):

- Maritime: Oceanic observations, maritime patrol, boat identification, fishering monitoring
- Risk & Crisis: Fire detection and monitoring, Environmental disasters monitoring, Emergency management
- Security: Border's patrolling, traffic control, hurricane evolution and research, evacuation event
- Humanitarian Aid: Large disaster/humanitarian operations management
- LandCover: geographical observations, archaeological observations, ground mapping….

The Assessment of the Capabilities & Performance of various UAVs was done based on reference UAV platforms (High Altitude UAV, Medium Altitude UAV, Rotary UAV and Mini/Small UAV).

Multi-criteria Analysis showed that TPU SOLAR HALE obtained a very good score for mission similar to "Border Patrol", "Fisheries monitoring", traffic control in which a very long endurance as well long range are the two main mission parameters.

In general, High Altitude UAVs will allow the integration of different payloads, with small constraints in terms of mass, volume, power consumption, and would allow to improve some of the identified GMES services.

The types of UAV data links used and their requirements highly depend on the objectives of the intended operation. The main characteristics are the operational range and the flight/mission control capabilities as well as the means deployed to increase availability and robustness of the data link.

In terms of concrete adaptations of the TPU UAV platform to cover the GMES needs, it has to be highlighted the adaptation and integration of solar panels to ensure high flight endurance of the TPU small UAV, as well as the integration of payload equipments to carry out the planned fisheries monitoring demonstration.

5.1.3 HAPS (High Altitude Platform System)

The StratSat Lighter-Than-Air (LTA) platform from HAV (Hibrid Air Vehicles) has the capability to provide two key elements in support to GMES platforms.

Firstly, StratSat provides an ultra long endurance re-taskable / geostationary platform on which radio and optical SATCOM relay devices can be installed. This option allows for the onward transmission of data from ground and air based sensors to other airborne or spaceborne assets. Its large payload capacity provides the capability to carry several data relay devices, including GSM/3-G (Internet access) type antennae capable of providing local emergency service network structures for use in the event of ground networks being disabled or destroyed by earthquake or storms.

Secondly the StratSat platform has the load carrying capability to lift significant EOIR / SAR type payloads, thus acting as a data collection entity, capable of collect imagery over 100's of km range. This is of particular interest in humanitarian and disaster relief scenarios, where local data collection on a continuous basis over many months is not possible for cost or physical access reasons.

It is also interesting for maritime applications like fisheries monitoring during the fishing season.

StratSat HAPS platform can provide key support to GMES community in all 4 of the key segments in the GMES service chain:

Segment 1 Data collection via a suite of sensors onboard the StratSat platform.

Segment 2 Via high capacity radio or optical relays provide data to the GMES service providers.

Segment 3 Take the processed GMES data and relay it back to the end users on the ground at the point of need.

Segment 4 Finally provide a local to local communications network cell

In particular, added value of Stratsat platform for Risk & Crisis, Humanitarian Aid and Security services has been identified.

Via its sensor suite StratSat can augment situational awareness from other assets particularly within the footprint area of circa 100km radius surrounding the platform.

Its data relay capacity via either optical or conventional radio links can provide an interface between the residual ground infrastructure and emergency services and the international reach of the SATCOM network.

To provide a local area temporary radio/phone network comprising many hundreds of 'cells' or 'channels' thus avoiding the need to consume valuable SATCOM capacity in support of local (sub 100km range) communications or data transmission.

Thus, within the disaster area, satellite communications links augmented by StratSat will replace damaged or overloaded terrestrial communications infrastructure. The SATCOM link will allow the global communication necessary to co-ordinate the strategic support necessary while StratSat can provide the tactical or local area communication and data service needs.

The StratSat's onboard optical and mapping sensors can provide a significant benefit over the costly acquisition of data from Satellite assets. Once over the disaster area the sensors can provide almost real time imagery of events as the unfold on the ground. With on-board processing / fusion and compression the status of ground events can be relayed to the necessary agencies very quickly ensuring that data is not limited by orbit schedules for satellites. The onwards transmission of imagery / data can be done either by the use of a line of sight ground station connected directly into any ground network still functioning (up to 100's of km away from the centre of interest) or can be up-linked to the geo-stationary satellite network.

Providing relief and assistance following natural disasters and humanitarian emergencies such as earthquakes and floods can have duration of several weeks or months. Over these durations StratSat can provide a cost effective temporary communication network comprising WiFi and even mesh networks. StratSat's low altitude (circa 60,000ft altitude) can benefit the teams working in the field via its lower link budget requirements making ground stations/terminals cheaper to manufacture and easier to carry.

5.2 ARGOS 3 DATA COLLECTION SERVICES

The Argos processing chain (called Argos-3) is in complete redesign in order to integrate the METOP-1 European satellite downlink. The major evolutions provided by METOP-1 are:

- Two way communications with the Argos mobile terminals: capability to send command to the user segment
- Higher data rata and long messaging capability for data collection
- Acknowledgement send by the instrument to the PMT when the message is received error-free.

The users will use PMT (Platform Messaging Transceivers) to use the Argos 3 capability.

These evolutions are very important to continue to serve some GMES applications, in particular ocean projects such as ARGO, which are demanding more volumes to allow new sensors, and faster data transfers to reduce the time in surface.

From a user point of view, the impacts are :

Greater volume of data transmitted during each satellite pass

Argos-3 features a high speed 4.8 kbit/s uplink, allowing ten times more data to be transferred per satellite pass than before. Combined with the downlink capability, the high data rate link increases the amount of data collected.

More efficient data transfer

The one-way Argos system (Argos-1, Argos-2) requires redundant messages to increase the probability of data being received by satellites error-free. With Argos-3, redundant messages are no longer necessary, since the downlink allows the Argos-3 instrument to send an "Acknowledgement" signal to the PMT once data has been received error-free. Once the PMT receives the "Acknowledgement," it stops sending message

Furthermore, all PMTs are equipped with satellite pass forecasting software and are able to calculate the exact time and duration of the next satellite pass, thanks to information communicated by system operators via the downlink. PMTs only transmit when a satellite is in view, reducing transmission time, conserving energy and extending platform lifetime.

Platform remote control and programming

Users have the opportunity to send short commands to their platforms (up to 128 bits by 8 bit increments) via the Downlink Message Management Centre (DMMC). Typical applications include switching a transmitter on or off, changing time or date configurations, modifying a sensor sampling rate or any other possible remote command allowed by the platform.

The services, developed based on the Argos 3 capabilities, are:

- To authorise a PMT to use the interactive data collection mode. The data sent by the PMT will be acknowledge by the instrument.
- To send to the PMT the time reference and the orbital parameters
- To send commands to the PMT with the following option:
    - To send a command once
    - To send a command every N days during a given period.
- To search a PMT : this service allows to force the instrument to send the command to the PMT.

ARGOS system adaptation to GMES collected requirements

ARGOS system improvements cover needs of the Oceanography applications (meteorology, ocean forecasting, ocean pollution). It is a data collection system of in-situ sensors, deployed all over the oceans on drifting buoys or profiles.

From Argo floats, two GMES requirements were collected during the first stage of TANGO project, from GMES projects like MERSEA:

1. The time to transmit messages must be as short as possible in order to improve its life duration and to avoid beaching due to sea surface stream.
2. The amount of data to be collected will increase and it must be collected in one satellite pass
3. Capability to remotely control the terminal in order to change the sensors parameters.

The Argos 3 instrument capabilities which answer to the above requirements are:

- the downlink capability,
- the capability to send back to the terminal an acknowledgement when a message is received,
- the high data rate,
- the new modulation that allow to reduce the C/No (signal to noire ratio).

The following table shows the Argos 3 services versus the type of application known to be compliant with GMES:

		Application			
		Profiling buoys (ex: ARGO)	Drifting buoys	VMS	Very low power terminals
Argos 3 service	Low data rate (PSK) interactive session	ü	ü	ü	
	Low data rate (QPSK) transmissions				ü
	High data rate (GMSK) interactive session	ü		ü	
	Data reception	ü	ü	ü	

Table 1: Argos 3 capabilities versus Applications

The Argos-3 processing chain has been interfaced to the TANGO CTSP through a series of XML commands and successfully tested in order to include the ARGOS 3 offer in the CTSP catalogue and to implement CTSP Service Management functions for this service.

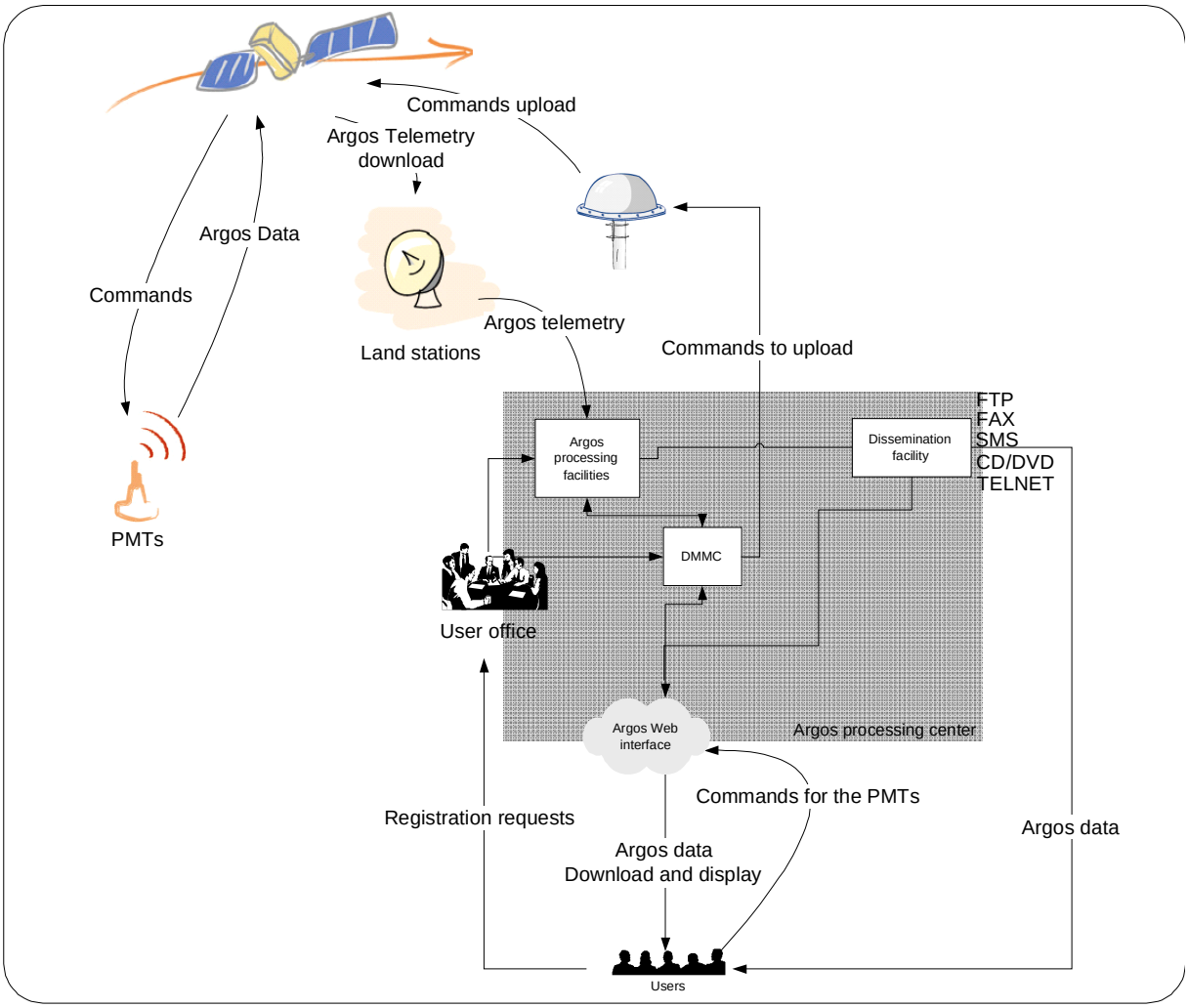


Figure 10: ARGOS Services data flow architecture

5.3 AVANTI DVB-RCS SERVICES

Avanti has been involved with DVB-RCS for several years, starting with ESA technology trial projects and progressing to commercial services, including Broadband Internet Access services, such as email, browsing, streaming & chat and Value Added services, such as data distribution and VoIP.

Avanti is using the Intelsat IS-903 satellite operates in the Ku band from a position at 34.5°W.

The IS-903 satellite coverage is limited today to Western Europe.

Avanti uses a combination of two standard technologies - DVB-RCS and WiFi - to provide communications. These technologies provide a service that is similar to terrestrial ADSL and cable.

Avanti is an Internet Service Provider (ISP) and offers a range of broadband Internet Access packages

- Two way direct satellite broadband: these services provide high speed direct access to internet backbone at a range of speeds up to 3 Mbps down/ 768 kbps up. Service is provided using a two way VSAT Hub network connected to a two way Satellite Interactive Terminal (SIT) installed at the customer premises.
- Broadband services for Home and Business via wireless (WiFi): Services are provided using 802.11a/b/g licensed and unlicensed spectrum via central wireless points of presence placed in areas where terrestrial services are unavailable. Avanti utilises a two way Satellite Interactive Terminal (SIT) for the backhaul connection in the non served area, this is then connected to a wireless access point and aerial which distributes the signal to a surrounding area dependent upon local terrain.
- Business Internet Continuity: Services automatically recover an internet connection in the event of the primary terrestrial link being severed or disabled. This enables customers to maintain email, website updates and a host of other critical online functions as there is no change to IP addressing.

The Avanti DVB-RCS system can provide the following services and applications, which can relevant for some GMES applications:

- Basic services and applications, which are directly available at the network level or terminal interface. These do not require any additional COTS software:
  - Ø GSM backhaul
  - Ø Secure multicast
  - Ø Voice over IP
- Additional services and applications, which are available at a higher level. TGhese require additional COTS software.
  - Ø Data delivery
  - Ø Data collection
  - Ø Video conferencing
  - Ø Virtual applications platform
  - Ø Business continuity
  - Ø Entertainment channel
  - Ø Community channel
  - Ø VPN
  - Ø Virtual network operator (VNO)

Particular adaptations to the Avanti DVB-RCS service have been made within TANGO to integrate the system into the TANGO CTSP and to support the CTSP management and control of the Avanti service.

However, in the frame of TANGO we met some difficulties of implementing Avanti DVB-RCS services for GMES applications for TANGO demonstrations due to Avanti system limited coverage to Western Europe.

Most of GMES services and products needs to be available anywhere in the world, as we do not know where neither when a disaster or crisis can strike. Also, for Humanitarian Aid services we met the same kind of limitations.

In the frame of GMES, this service is suitable to provide backhaul satellite communication links to deploy ad-hoc local communication cells in crisis and remote areas, for emergency and disaster management applications. This has been demonstrations in the TANGO Risk & Crisis demonstration in Cahors (France) in December 2008.

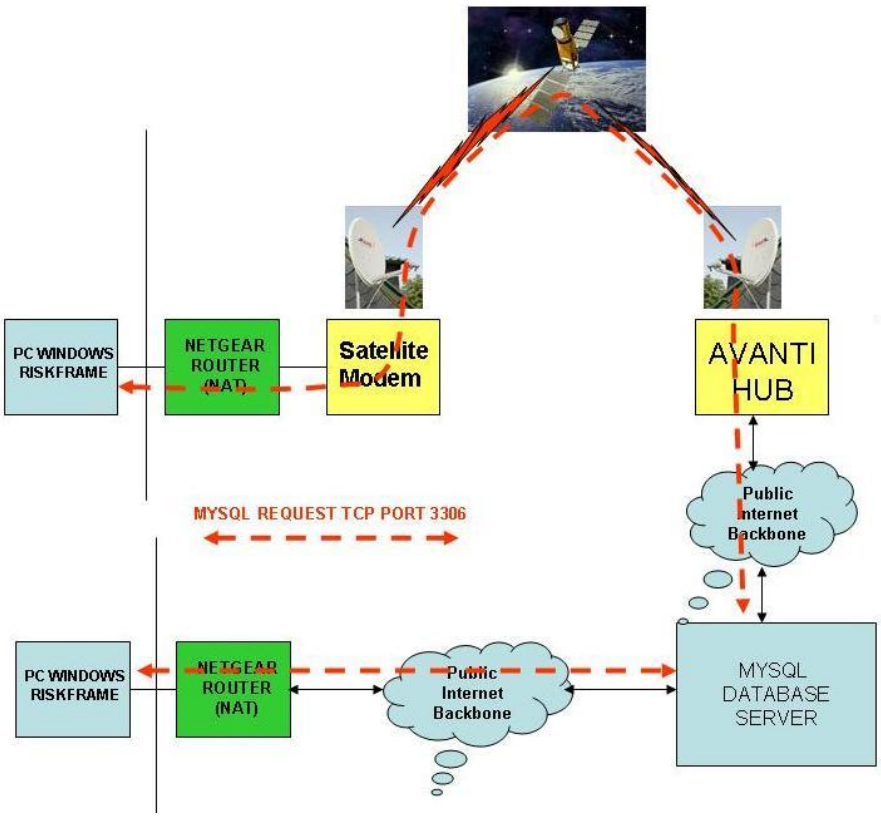


Figure 11: Avanti DVB-RCS system in the Cahors Demonstration

5.4 ASTRA2CONNECT SERVICE

The Astra2Connect product enables ISPs (Internet Satellite Providers), telecommunications operators and other service providers to offer a stand-alone, two way broadband Internet access service, including services like telephone using VoIP and IP television access, via the ASTRA satellite system. The Astra2Connect terminal provides an "always-on" IP connectivity and allows to transparently use standard Internet applications and IP devices (i.e. routers, VoIP phones, webcams, etc…).

This service targets residential market, and it is mainly addressed to users who lack access to terrestrial high-speed connectivity network. The terminal cost is low, and it is easy to install and the indoor modem is as easy to use as any ADSL modem.

The service also allows multicast of content to PCs, which has been as an important for the GMES community to cover data transport and data dissemination segments.

ASTRA2Connect means two-way satellite internet access. Because data is transmitted and received via satellite, there's no need for a telephone or any type of landline connection. Packages with up to 2 Mbit/s download speeds and 128kbit/s upload speeds are available.

The supported frequency band is Ku band, which is subject to adequate licenses:

- Reception Ku band: 10.7 – 12.75 GHz
- Transmission Ku band: 13.75-14.5 GHz
- Transmission Ka band option: 29.5-30 GHz

SES ASTRA sells the service to ISPs, and end-users have to contact to ISPs. In the frame of TANGO, the CTSP operator will be seen as an additional ISP.

The main applications of Astra2Connect service which can play an important role for GMES services as identified in the TANGO project are shortly described here after:

- High speed to internet access

  Astra2Connect services will allow broadband two way internet access, in areas where terrestrial infrastructure is reduced, damaged or inexistent, and in areas where there are not terrestrial ADSL offers. The service is designed to be transparent, all usual Internet application work, like Web Browsing, e-mail, File download, File upload, Skype, MSN, Webcams, …

  The speed of access for forward and return links are:

  - Unicast Rate, Forward: Up to 10 Mbps
  - Unicast Rate, Return: Up to 140 kbps, planned evolution up to 560 kbps
  - Multicast Rate, Forward: up to 16 Mbps

  In order to keep the service price low, the speed is often limited to much lower values in offers to residential market. For TANGO and GMES applications, specific SLA (Service Level Agreement) could be created, with typical values of 512 kbps, 1 Mbps and 2 Mbps. In case of need, SLA with higher speeds could be created.

In the frame of GMES, it is likely that a combination of terrestrial ADSL and Astra2Connect will be used to ensure an "always-on" connectivity necessary for some GMES services.

The Fair Usage Policy used for bandwidth optimization penalizes users consuming a lot of satellite capacity during the peak hours, based on the actual volume of information transferred. In case of some GMES applications, needing the transfer of high volume of information like EO satellite images, this policy can not be acceptable. It will be possible to configure the maximum volume of transferred information in the SLA in order to solve this constraint.

- VoIP

This service will offer voice communications through internet applications, and would allow having voice communications with external world in areas where other terrestrial voice communications (fixer or mobile) are not available.

- Sensor network – e surveillance

Astra2Connect could be used to carry measurement signals collected from and to address commands to a sensors network for e-surveillance applications and associated alarms.

Although PSTN networks have been used in the past for this kind of applications, up-to-date always-on network are best suited, of course, taking into account that remote sensors and stations are able to communicate using IP.

This kind of services can be very important for GMES security applications, as well as for early warning services and alert broadcasting to several final users at the same time (i.e. local, national authorities, decision makers etc…) in case of crisis.

- Multicast

One service characteristic is to allow multicast of content to PCs,

In the case of GMES, the system can be used to distribute many different files to the user's PC, like video, multimedia, map and documents. Another use could be to stream video content in real time; in this case the users can only see what is on air.

This can play an important role for GMES in case of transfer of high amount of data to areas where terrestrial infrastructure is limited, damaged or inexistent.

- Regular TV

Low cost terminals and their easy installation are key to allow the deployment of high number of terminals in the frame of GMES services, usually needing to be installed in areas without terrestrial telecommunication infrastructure. A terminal can be delivered in the field and installed locally without requiring an specialist installer travelling to the site.

Today, this service is provided through the Astra 1D satellite, with pan-European coverage, but the service could be extended to the global ASTRA2Connect network, as presented in Figure 12 As the service address residential market, oceans are not covered, and this solution would not be adapted to provide broadband internet access on board vessels for maritime applications.

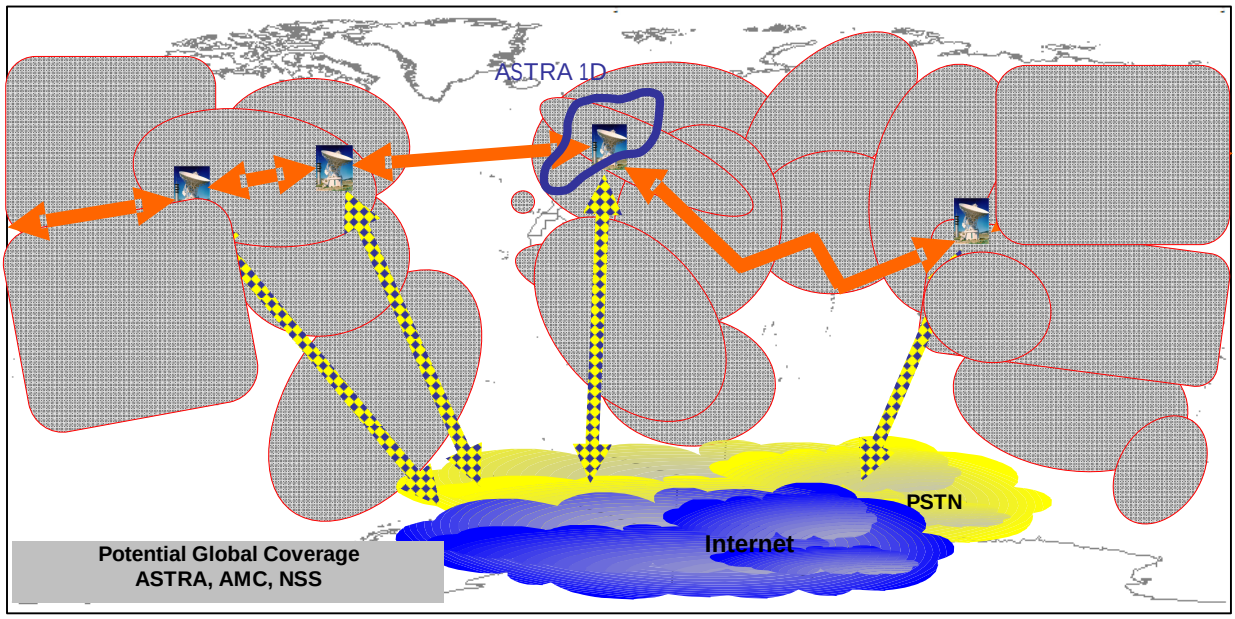
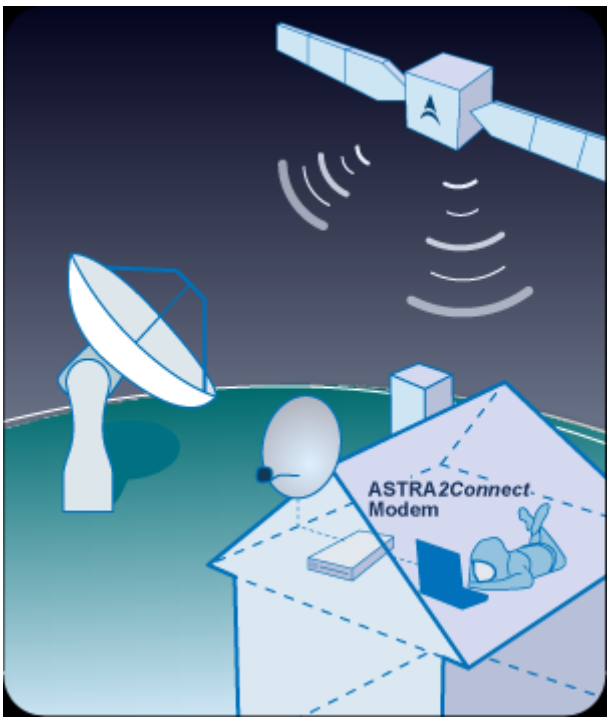


Figure 12: Potential Long Term Coverage



ASTRA2Connect System

ASTRA2Connect Equipment

The interface of the Astra2Connect system platform to the TANGO CTSP has been developed and successfully tested, in order to fully integrate this service into the TANGO Offer platform.

Astra2Connect is a commercial solution from SES which is in use in more than 12 countries to provide fixed satellite broadband services.

Services supported by this solution are suitable for GMES applications, in particular to provide access in areas with poor terrestrial infrastructure for data transport and dissemination, alarms distribution, early warning and to provide satellite backhaul to deploy ad-hoc terrestrial networks cells to ensure voice and data communication on crisis and disaster areas.

5.5 WORLDSPACE AND SPACECHECKER SYSTEM SOLUTION

WorldSpace satellite network is composed of 2 operational L-Band geostationary satellites:

- Afristar, located at 21E, launched on 10/1998,
- Asiastar, located at 95W, launched on 03/2000.

Having a life expectancy of about 15 years, these two satellites cover 2 large geographic areas as shown here below. Each of existing satellites has three beams, each one carrying up to 80 128KBits/s data channels.

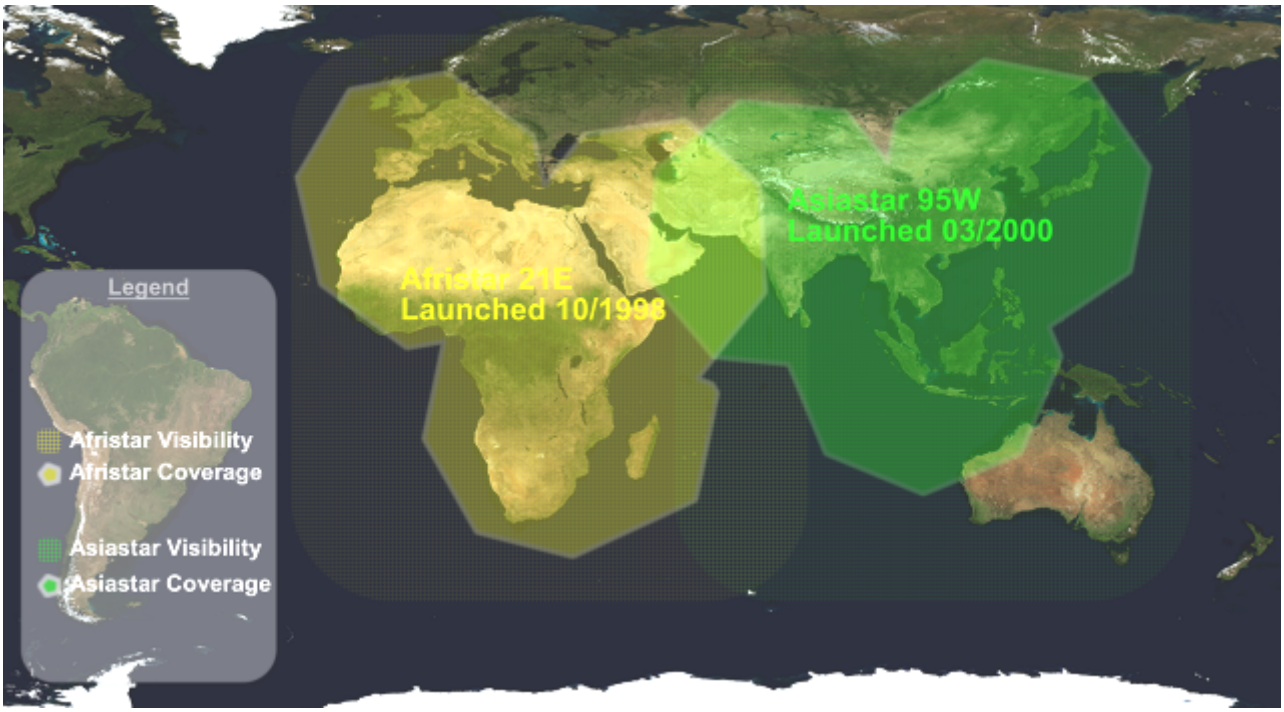


Figure 13: WorldSpace system coverage

Among the satellite services provided by WorldSpace system, following ones are of particular interest for some GMES services in areas where other terrestrial communications solutions are available:

- Alert delivery

  Alert delivery service can be provided in more than 100 countries. Alarms can be addressed by country, groups of terminals or location of the receivers.

- Data delivery with low data rate

  This service allows to broadcast data to areas without terrestrial infrastructure.

The technical adaptations of the WorldSpace solutions in TANGO were to modify and to improve the Alert Distribution system developed by WorldSpace. This system allows to broadcast alert messages on a large scale, based on satellite infrastructure, with cost effective portable equipments. This makes the system independent from terrestrial networks and suitable for Alert distribution services in the frame of GMES applications for emergency and crisis management in case of disaster, when terrestrial infrastructure is damaged or inexistent.

The purpose of the adaptation and integration work in TANGO was to develop an end-to-end alert service using WorldSpace and SpaceChecker satellite-based infrastructures. The service can access two types of terminals :

- One-way terminals, where no return channel is available. Alert broadcast is performed through the WorldSpace infrastructure. A GPS receiver is included for geofiltering. Bluetooth is available as interface to disseminate locally the alert textual information. The one-way terminal is using the so-called WorldSpace legacy (and proprietary) satellite broadcast technology.
- Two-way terminals, where SpaceChecker is used as return channel in order to allow acknowledgement of the alert. In this case, a user interface is developed to allow the operator to visualize and acknowledge alerts.
- In addition, a Web portal has been developed to allow authorities to manage recipients and alerts
- Developments have been carried out to implement the interface of WSP system to the TANGO CTSP.

Alert distribution services with return channel for alert acknowledgement is one of the most recurrent requirements from GMES community for Risk& Crisis and Humanitarian Aid services, in order to allow authorities to confirm the responsibilities transfer in the frame of the emergency management procedures.

5.6 SATELLITE + PMR SERVICES

PMR (Professional Mobile Radio) services are key for enabling connectivity between security forces. The PMR solution studied in TANGO is TETRAPOL IP technology.

All civil and military organizations, whether public or private, national or local, need completely reliable and fully secure radio communications systems to coordinate their actions and increase their operational efficiency. Whereas GSM services can be used by different types of end users in the frame of emergency management situations, the PMR services are more dedicated to the Public Safety organisations, with a focus on ensured and encrypted communications through dedicated PMR networks.

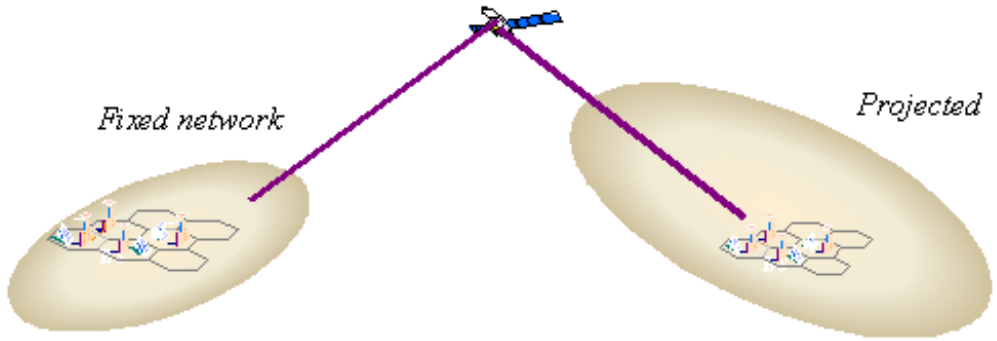


Figure 14: PMR TANGO solution basic architecture

The solution developed in TANGO is the extension of an existing PMR TETRAPOL IP network by satellite, to allow its connection to an existing PMR TETRAPOL IP network from any place, even when PMR coverage is not available (e.g. disaster relief, peacekeeping). This will allow to provide temporary PMR services in areas without PMR terrestrial infrastructure, or if infrastructure is overloaded or damaged. In these situations, the PMR by satellite extension system will allow to access the GMES services and products from the on field area, as well as to ensure secured voice communications between teams in the field and the main site (headquarters).

The lists of services that could be offered are:

- Secured voice calls, mainly group communication:
- Data services (low data rate) for geolocalisation, SMS and data base query.

The architecture of the PMR/satellite subsystem will be made of a satellite link between a “fixed” PMR network and a projected PMR network.

The innovation brought by TANGO in this crisis scenario are:

- The use of containers PMR solution that is modular and compact enough so as to be transportable in helicopters, boats, different van etc. It shall therefore comply with requirements such as compactness, autonomy, ease of use, ease of interface with IP networks

- The capacity to interconnect PMR cells by using a satellite link.
- The software adaptation and validation of the PMR solution to satellite constraints.

The added values of this solution for GMES services in the frame of Risk & Crisis management are:

- To offer the continuity of PMR services on the field crisis area, with communications link by satellite to the PMR network at the headquarters.
- Establish a communication cell allowing wire and wireless access through satellite to Internet and to GMES services and products, using easily man portable equipments.

5.7 SATELLITE + VOICE OVER IP SERVICES

Within TANGO project, specific developments and adaptations have been performed to provide Voice over IP services coupled with satellite:

- Adaptation of existing vehicles TRACKS MOBIDICK providing satellite backbone links for deployment of local VoIP communication cells (GMS and DECT)
- RECOVER transportable telecom solution has been designed and manufactured in the frame of TANGO

These three mobile stations are transportable and rapid deployable, providing a Ku band satellite access coupled with for Voice (GSM and DECT) and Ethernet/Wifi terrestrial networks, allowing to built and operational network at any place in the world, even if terrestrial infrastructure does not exist.

The Voice over IP service developed in TANGO is composed of:

- The extension of GSM network by satellite. The extended network can be part of an existing GSM network which infrastructure is damaged in the area of crisis, or it can be a standalone GSM network installed in the crisis area. In the second case, the network will allow rescue teams, local authorities and population to communicate among themselves and also with external world
- VoIP using a private DECT cell or a private WIFI cell with dedicated terminals.
- Internet services in the crisis area where the terrestrial infrastructure is damaged.

The following main characteristics of the solution are of high importance for GMES services:

- Easy to deploy, install, use, dismount
- Reliable and available communications
- Autonomous in terms of energy
- Deployment of local cell for voice and data communications as well as provision of satellite backbone for broadband communications and Internet connexion.

These solutions ensure communications means in areas where terrestrial infrastructure is damaged or inexistent, so they are of particular interest for emergency management situations, Humanitarian Aid and Security applications.

RECOVER is a R&D solution developed within TANGO that consists of a set of containers which providing the following types of links:

- Internet connexion by satellite through Ku band satellite broadband links (DVB-RCS or SCPC), which is locally distributed by a Wireless network (WiFi)
- GSM extended private cell (with a radios of about 3 km), which allows local people to be connected with each other. It is also connected to the rest of the world by a GSM backhaul over satellite.

This solution is modular and compact enough so as to be transportable in helicopters, boats, different van etc… It provides full autonomy (concerning transport, energy and telecommunications) for a minimum of 24 hours.

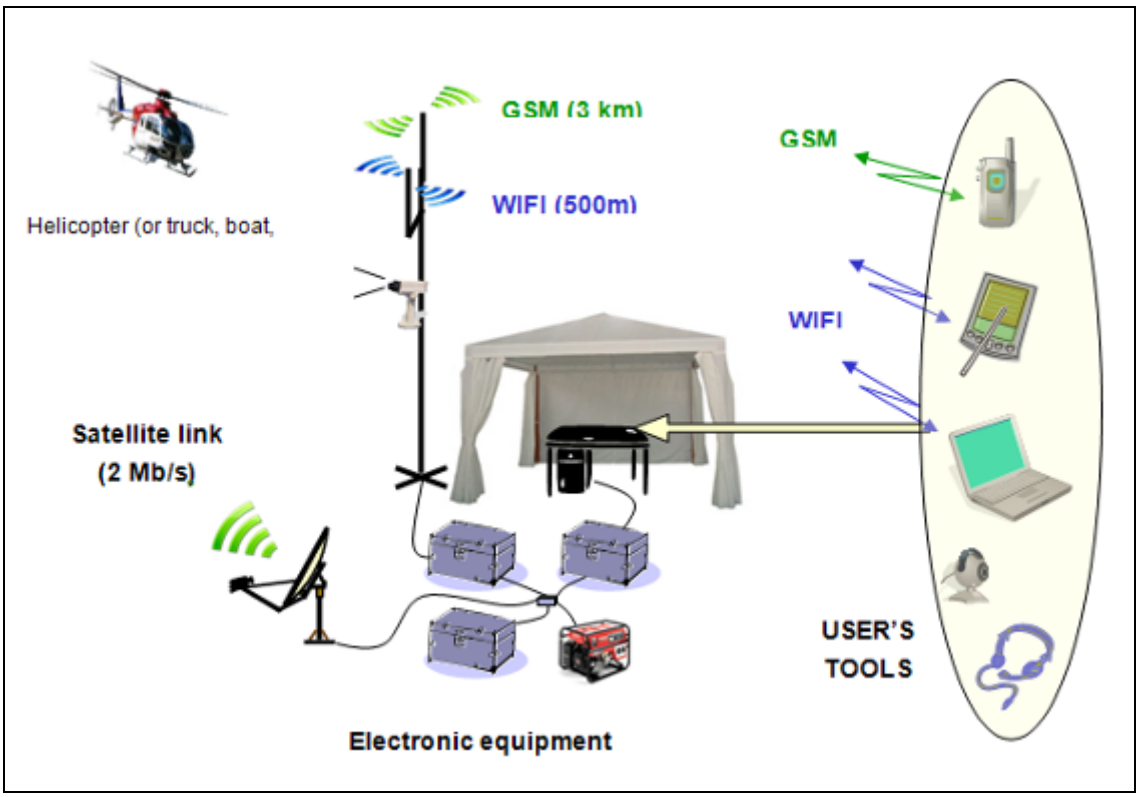


Figure 15: RECOVER solution

RECOVER is a solution for deploying an advanced relief and telecommunications station for different kind of situations like:

- emergency situations
- isolated sites requiring short-term, long-term or even permanent telecoms support.

It allows to share the communication resources between actors in the crisis area such as civil protections, local authorities etc…

The main advantage of the satellite backbone on mobile stations is that they can be used anywhere in world, by modifying the satellite link provider depending on the area to be covered.

In terms of licenses, before using a Fixed Satellite Service antenna or VSAT, the end users needs to request to national authorities for licenses to use this service. Some satellite operators negotiate in advance with national authorities global licenses for operation, exempting the final end user of doing the request.

Particular authorisation from the National Regulations Authority will be also necessary for deploying the GSM local cell around the mobile station.

6 THE TANGO COMMON TELECOMMUNICATION SERVICE PLATFORM (CTSP)

6.1 INTRODUCTION

TANGO aims to facilitate GMES community access to telecommunications solutions, in particular through the development of the TANGO "Common Telecommunication Service Platform". The TANGO platform offers a privileged interface to the GMES service providers to get fast access to the telecommunication solutions and to optimise the satellite capacity utilisation as a complement to terrestrial solutions. 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.

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.

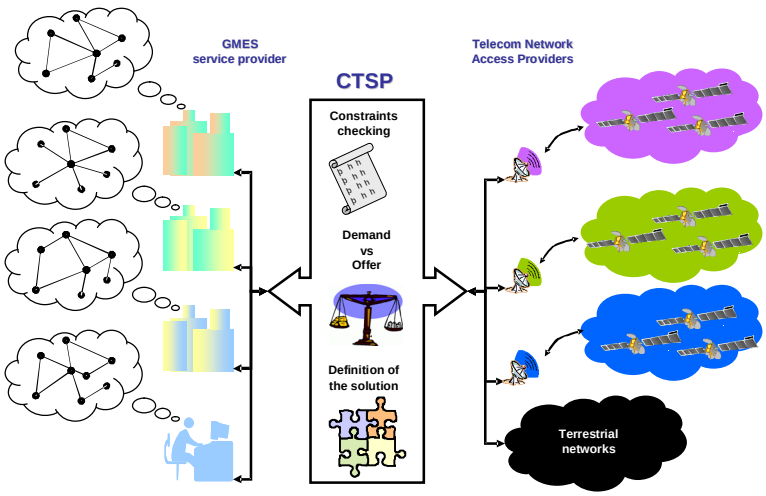


Figure 16: CTSP Network Definition

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.

The platform developed by Avanti Communications Ltd in the TANGO project frame integrates dedicated interfaces to 3 of the TANGO project Telecommunication Solutions. The current CTSP Catalogue includes offers from TANGO satellite providers partners mainly related to TANGO demonstration exercises. It will be extendable in its specification and design to integrate other satellite and terrestrial telecommunication solutions and to enable access to increased satellite capability in a future operational system.

TANGO Common Telecommunication Platform link: http://ctsp.avantiplc.com/ctsp/

6.2 THE CTSP

The CTSP is a website which allows GMES Service Providers (SP) to identify order and manage satellite communication services (telecommunication links and associated end-user terminals). It is particularly suited to address urgent or short term procurement needs where location or bandwidth requirements may not be known in advance.

It enables efficient comparison and evaluation of different telecom alternatives and can cover the entire communication chain from collection of Earth Observation data to transport of GMES products, dissemination of those products to end-users and deployment of ad-hoc and on-the-field networking.

Several key factors uniquely distinguish the CTSP from existing operator specific systems.

- It can gather together on one website "Offers" from a range of (satellite) Telecom Operators
- It allows comparison between different types of Offers according to user selected criteria
- It incorporates the latest Web technologies to provide an interactive user experience
- It allows management (via a single website) of services provided by multiple Telecom Operators

6.2.1 Functional Concept

In functional terms the CTSP Web Interface provides access to 4 main capabilities:

- Information (catalogue of Telecom Offers, satellite telecom services, terminals etc.),
- Evaluation (a selection mechanism to identify Offers which meets user needs, a forum where the community can share experiences and expertise etc.).
- Procurement (ordering services, terminal provisioning (at least location & type identification), the choice of available CTSP resources or procurement from a Telecom Provider).
- Management (of active services – in practice for V1 this amounts to Terminal management)

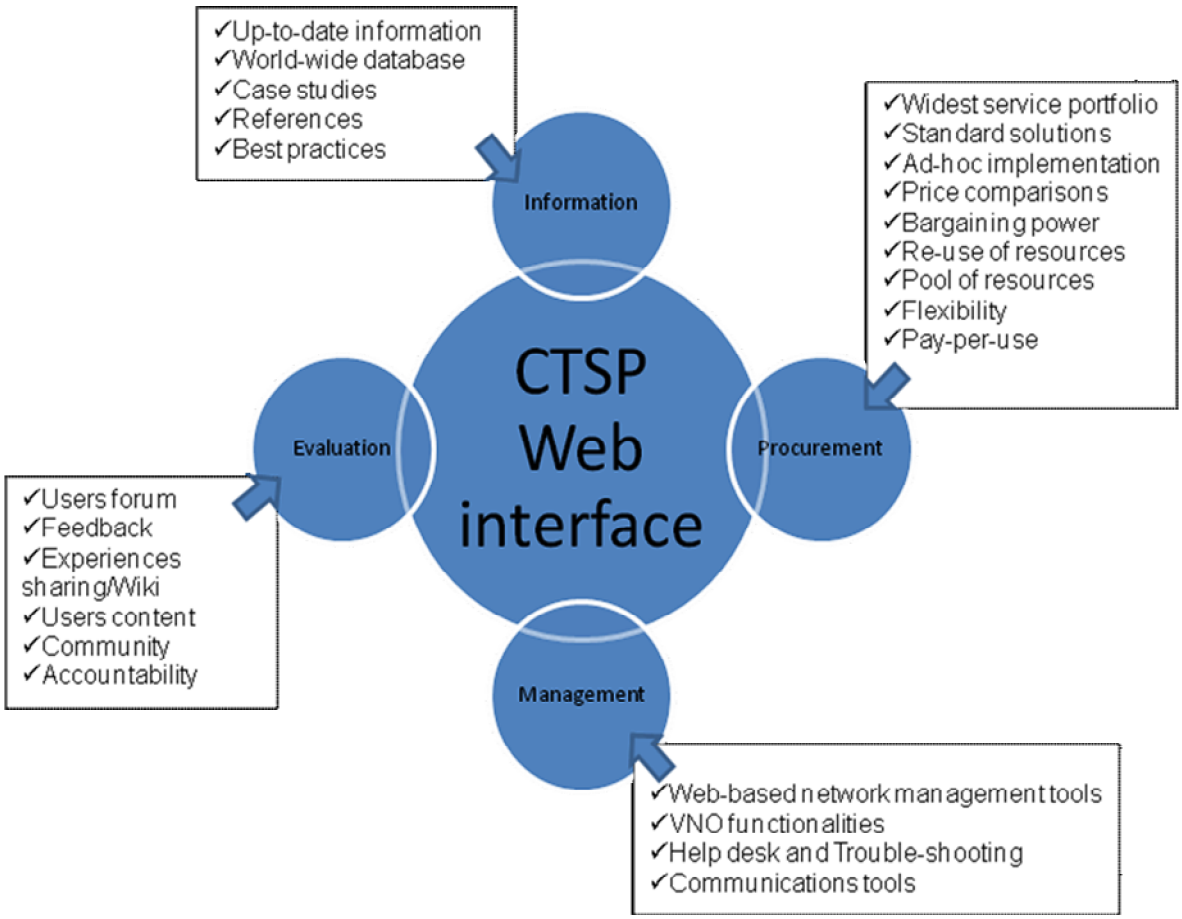


Figure 17 : Functional model of the CTSP

6.2.2 Logical Concept

The purpose of the CTSP is to act as a broker, thus enabling service provisioning & management, between the two main entities: GMES SP, acting as CTSP customers, and the Telecom Providers (TP), acting as CTSP suppliers. The CTSP requires an operator for the maintenance of the platform and to support the users. It is referred as CTSP administrator.

In logical terms the various "actors" – Service Providers, Telecom Providers & GMES "End-Users" (to whom service is provided via the satellite telecom links & terminals) interact with the CTSP as shown below (note: End-Users do not directly interact with the CTSP).

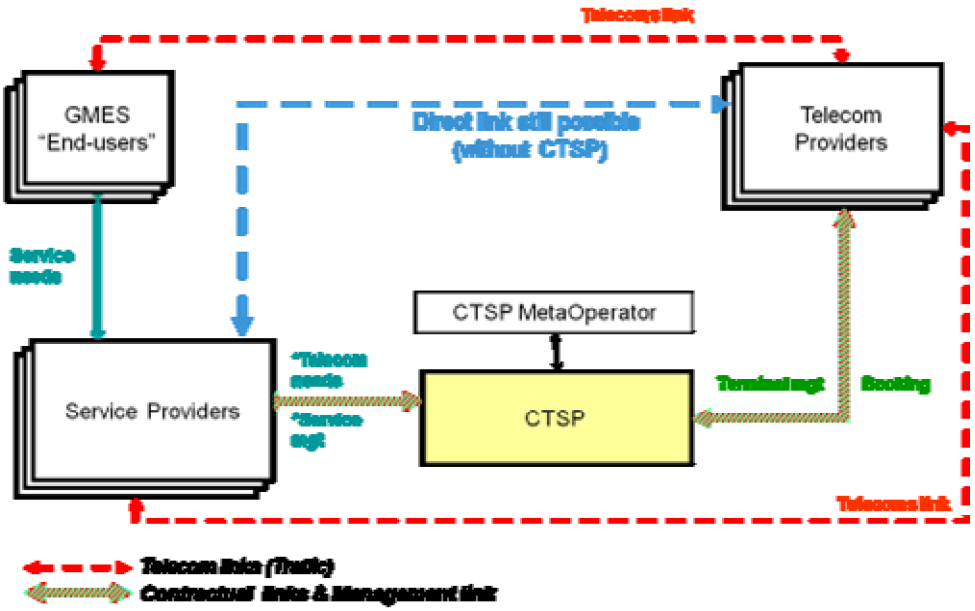


Figure 18: CTSP Actors & roles

From the perspective of the CTSP platform Service Providers (SP) also encompass GMES DP (Data Providers). The GMES end-users will benefit from services provided through the CTSP, but they are not considered as direct customer for CTSP. The GMES SP will interact with the CTSP on their behalf.

The principle of this model is that the GMES SP will have to register/subscribe to the CTSP, in order to be served by the platform. There will be a peer relationship with the CTSP to request and co-ordinate the procurement and set-up of the various telecommunications services, required to exchange the EO-data, GMES products, or any data between the GMES entities (Meta-GMES SP, SP, DP, end-users), in support to their operational activities.

The CTSP will provide and manage "high-level" telecom services (called "Meta-Services"), based on TP communication services. Before such procurement is possible, business and contractual relationships need to be set-up between the meta-operator and the TPs, which supply the underlying communication services. The definition of the CTSP high level services (based on TP service integration/customization), up to the contract establishment, is not supported by CTSP software. This is an off-line activity, achieved thanks to Meta Operator/TPs exchanges (discussions / negotiations). The telecom services will be registered in the CTSP, with the attached contracts, by the CTSP administrator. The GMES SP will then have access to those services, for provisioning and operational usage (network management).

To improve access to the telecom services, and to bring relevant support, the CTSP will provide adequate classification on top of the telecom services catalogue. The structure of the classification will be configurable by the CTSP administrator, according to the nature of the service the meta-operator intends to propose. The way to present the services, the level of details given, as well as the criteria used to characterize the services will be chosen by the meta operator, and configured in the CTSP, through the administrator.

Figure 19 here after illustrates the high level function groups of the CTSP as defined by TANGO. To facilitate and accelerate the setup of communication links, the platform should provide the following functionalities:

§ Telecom Service Cataloguing: catalogue the telecom offers based on classification model

§ GMES SP Management: support SP access, and provides support to the scenario requirement definition inside CTSP (formalized interface with GMES providers)

§ Telecom Service selection & provisioning

- Selection of the relevant telecom service class
- Optimisation of telecom needs (formalization)
- Automatic resolution of the solution (demand vs offer)
- Service provisioning & subscription

§ Service Management :Service Configuration, Service Monitoring & Reporting (Statistics collection), Service Accounting

Figure 19 illustrates as well the main interactions of the various actors around the CTSP function blocks. This includes both:

- "automated" interactions (handled by the CTSP software platform),
- and "non-automated" ones (dashed arrows in the figure), that mainly occur at the meta-operator level, as off-line operations.

As shown, the GMES SP interfaces and the CTSP Administrator are handled on two orthogonal planes. They have different/complementary roles, distributed around the same data objects (database).

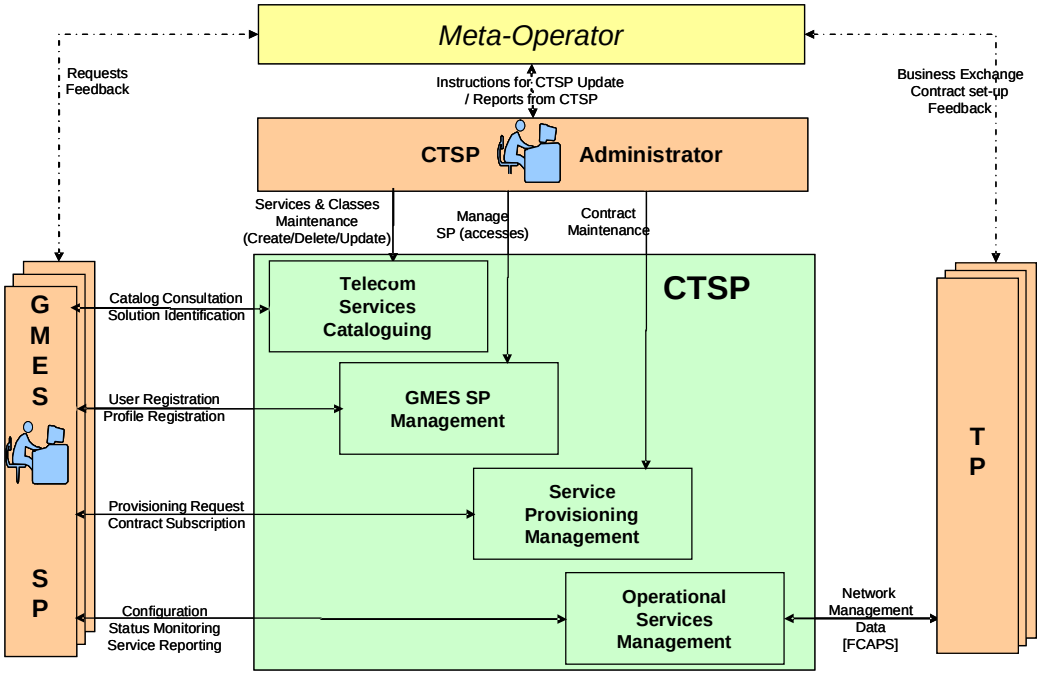


Figure 19: CTSP Operational overview

6.2.2.1 CTSP Benefits versus Objectives

The following table details the expected benefits with regards to the main CTSP objectives. For each objective is listed the attached hypothesis that are to be met to get the stated benefits.

	Objectives	Benefits	Hypothesis
1	***Improve access to dedicated telecom solutions, thanks to a unique interface***	1- CTSP = Central P/F accessible to the whole GMES community 2 - Telecom Provider Service promotion	Role Model : 1- CTSP acts as broker, 2- GMES SP / CTSP adhesion 3- CTSP / TP agreement
2	***Dedicated support to telecom service provisionning***	Deliver the relevant information on the telecom services while hiding technicals aspects	Telecom services description is available in the CTSP database
		Collection of formalized user requirements for an improved service selection	Telecom Service characterisation in the CTSP (synthetic description of service features)
		Automated Service Subscription	Role Model : - CTSP acts as broker, - CTSP/Telecom Providers contractual agreement
3	***Provide Cost-effective, competitive telecom services***	Improved price/performance ratio per individual user	Telecom Service Offers : - Reduced priced due to scale factor (grouped user needs) or/and - Shared resources (e.g : bandwith sharing) in the service or/and - Dedicated GMES telecom services (customized SLA, High level Qos ...)
4	***Provide service reporting & accounting***	1- Bring relevant info status on the services (performance, status, fault, etc..) 2- User feedback management 3- Traffic/service prevision plan 4- Service Accounting	.- TPs open their SML/NML relevant functions to the CTSP .- Role Model (contractual relationships between actors for billing policy)
5	***Provide consistent management of the "end-to-end telecom services" attached to a scenario***	Efficient set-up / usage/ desactivation / accounting	.- TPs open their SML/NML relevant functions to the CTSP

Table 2: CTSP Benefits versus Objectives

7 TANGO DEMONSTRATIONS

The following table presents an overview of the full TANGO demonstration plan including the satcom solutions tested in each exercise.

Demonstration scenario	Place	Date	Satcom solutions
On-field crisis management	Elancourt	September 2008	PMR satellite transportable solution
On-field crisis management	Cahors	December 2008	Transportable stations RECOVER, MOBIDICK and TRACKS trucks – Hybrid terrestrial satellite solution GSM/DECT/IP over DVB-RCS SES ASTRA2Connect
Fisheries monitoring	Comoros	April 2009	SES ASTRA2Connect
Fisheries monitoring – UAV	Italy	September 2009	Iridium
Fisheries monitoring Azores	Azores	May 2009	Simulated Swift Broadband - BGAN
Maritime Surveillance (Ship tracking)	Ocean Atlantic	March to June 2009	LRIT / Iridium, AIS
Maritime Surveillance (Met-ocean observation)	Baleares	August 2009	ARGOS 3
Humanitarian Aid Vulnerability Mapping RESPOND	Vietnam	May 2009	BGAN, ELISEO (Iridium)
Security (Evacuation from a crisis area)	Madeira	May 2009	RECOVER, BGAN, ELISEO (Iridium)

Table 3: TANGO demonstrations overview

7.1 RISK & CRISIS

7.1.1 Crisis Management Demonstration in Cahors/Lalbenque

EADS Astrium and their partners ran on the 11th December 2008 in Cahors/Lalbenque a demonstration showing the added values of satcom solutions in crisis management. The demonstration made a specific focus on the adaptability and scalability of satcom solutions in:

- the management of evolving crisis,
- the dissemination of GMES services (Global Monitoring for Environment and Security).

Practically all the satcom solutions as well as the crisis management applications developed/adapted in TANGO were used for the demonstration purpose. Among them are:

- Transportable stations RECOVER, MOBIDICK, TRACKS implementing hybrid terrestrial-DVB-RCS solutions,
- Fixed stations ASTRA2connect,
- Solutions and applications dedicated to crisis management: ELISEO, RISKFRAME,
- Common Telecommunications Service Platform (CTSP).

The demonstration had different objectives:

- Show the adaptability of TANGO satcom solutions to the evolutions of crisis needs. This is possible owing to their scalability and modularity characteristics.
- Illustrate the added value of satcom solutions to the enhancement of GMES emergency services. This covers all phases from the Preparation, Response to the Recovery.

A comprehensive crisis management scenario was deployed. Starting from a fire in a spotted area, the crisis spread and raised risks of contamination over several areas. Fire brigade team organisation evolved with the dynamic situations. The use of different satcom solutions according to the evolution of crisis was shown. The purpose of satcom solutions was both to offer communications to on-field areas as well as to disseminate GMES emergency services.

The use of CTSP to tailor satcom solutions to on-field needs was shown. This was part of TANGO risk & crisis demonstration specificity.

The demonstration was a success. This was possible owing to

- The strong involvement of the Fire Brigade of Lot (SDIS 46 – Service Départemental d'Incendie et de Secours du Lot) both in the scenario definition, scenario run and feedback.
- The attendance and feedback from the end users such as
  - Cahors local authority,
  - Humanitarian aid NGO and GMES service provider such as MapAction,
  - European Public Safety organisations.
- The GMES services kindly made available for the demonstration by GMES service providers such as: CNES, Infoterra, GMV, Sertit, MapAction.
- The logistics and the support provided by the aerodrome of Cahors/Lalbenque.

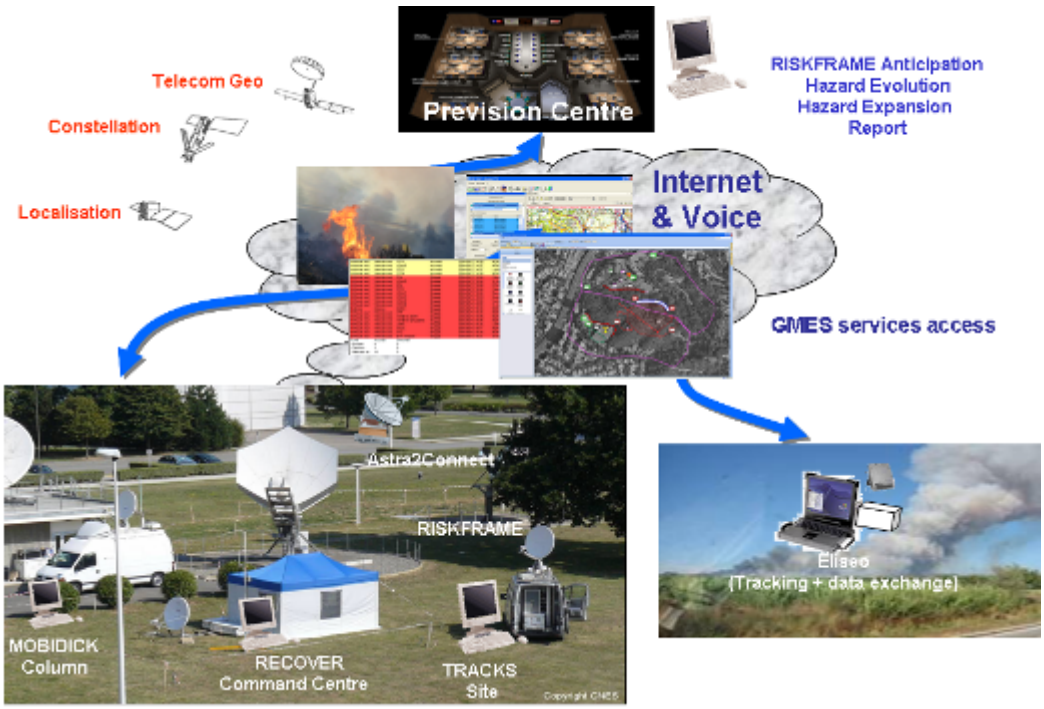


Figure 20: Overview of satcom solutions role and use in the demonstration

Figure 21: Fire Brigade team of SDIS 46 in preparation for the demonstration run

Figure 22:Overview of different transportable stations: MOBIDICK, RECOVER, TRACKS in the aerodrome of Cahors / Lalbenque

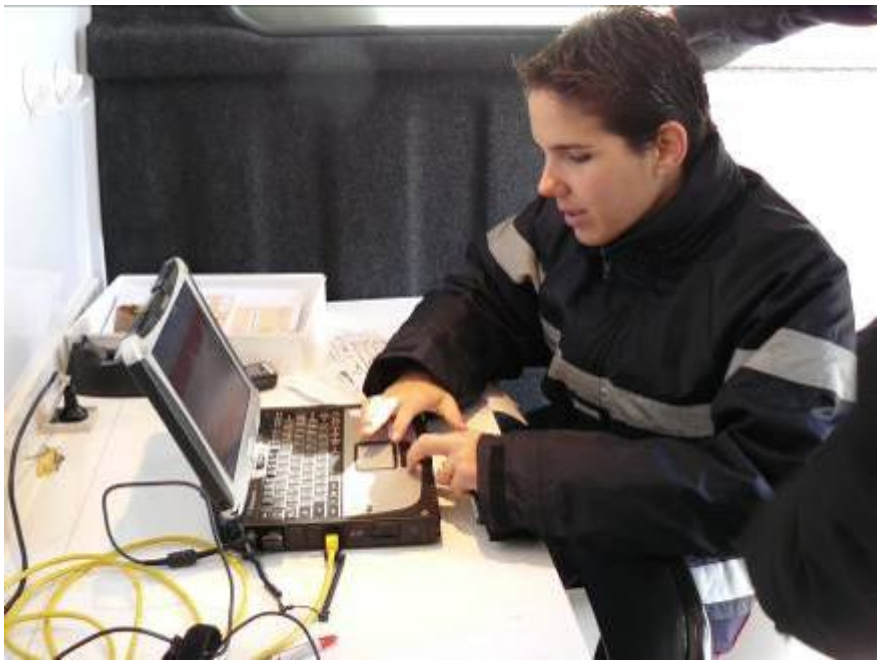


Figure 23:Use of satcom solutions for communications and for GMES service dissemination

Figure 24: Use of CTSP to select satcom solutions adapted to crisis management needs

7.1.2 Risk & Crisis demonstration run in Elancourt

The first Risk & Crisis management demonstration was performed in Metapole, EADS SN premises in Elancourt, France, on the 15th September 2008. The PMR by satellite solution was developed in the frame of the TANGO project to answer to collected user requirements in the domain of crisis management and public safety: secure and robust voice communications for rescue team management, interoperable system to keep contact with other rescue forces, efficient data information system to collect and transmit information of current situation and evolution of mission. The hybrid solution combined a Tetrapol Projectable Telecommunication Network Solution, to be autonomous as much as possible and to satisfy quick deployment and transportation constraints, and satellite telecommunications solution to ensure rapid deployment of links between two points when terrestrial telecommunications are not available or out of service.

The demonstration of the solution was conducted on a typical crisis scenario in presence of OTAN, French Gendarmerie and French Civil Security, who provided positive feedback and were convinced by the technical solution.

Figure 25: Elancourt demonstration - PMR by satellite equipments

7.2 FISHERIES MANAGEMENT

Three demonstrations exercises were held in the frame of fisheries management. Their were complementary, in order to show the benefits of different satcom solutions covering the needs of segments of the GMES architecture (data transport, data dissemination and communications on the field).

Comoros Demonstration: Comoros IUU Fisheries fight, Moroni Comoros, 27 March-8 April 2009

The objective of the demonstration was to help the Comoros Fisheries Monitoring Centre (FMC) to fight against unreported fisheries. The vessels over 15 meters are obliged to report every 2 hours their positions according to the International Maritime Organisation VMS regulation. However in many ways the VMS can be spoofed or just simply switched off. Remote sensing is an element to fight this kind of fraud. In Comoros, the poor telecommunication infrastructure does not allow traditional means to fight VMS spoofing. Using satellite communication can highly improve Fisheries Management bringing GMES services in such remote areas.

Azores Demonstration: Improving patrolling communication system, Lisbon, 4 May 2009

Fighting VMS spoofing in Azores Area is improved with ability to communicate fast the key information. Being able to reliably send back and forth latest point of interest during an aircraft patrol will enhance the fight against unregulated fisheries. Inmarsat BGAN has been successfully tested letting the possibility to use Inmarsat SwiftBroadBand services for operational use.

UAV Demonstration: Enabling new means for fisheries control, Tarquinia, Italy, 9 September 2009

A flight demonstration was carried out by the TPU scaled Solar Powered UAV (SESA) to monitor boats and ships prior to boarding in port. It was carried out from the S. Giorgio airfield (about 5km south Tarquinia Lido, 10 km north Civitavecchia). An autopilot system was installed on board of the aircraft and was connected by a Iridium SBD service to the Ground Control Center. The onboard Camera was able to take a picture of the boats along the flight path.

7.2.1 Fisheries Surveillance Demonstration in Comoros

The European Commission's Joint Research Centre (JRC) and Navigs Sarl successfully tested with their end-users, the Fisheries Monitoring Centre of the Comoros in Moroni, a new architecture developed in the framework of the TANGO project aiming at providing cost efficient near real time fisheries monitoring capability to remote and isolated areas of the globe. The TANGO demonstration held in the Comoros from 30th March to 8th April 2009 was designed to test the feasibility of bringing real-time vessel detection system (VDS) capabilities to a country that is physically remote, suffers from a rudimentary infrastructure and weak telecommunications services. Because the exclusive economic zone (EEZ) of the Comoros is one of the Indian Ocean's key tuna fishing grounds, and because the country, one of the poorest on Earth, has no monitoring, control and surveillance assets in the form of patrol vessels and patrol aircraft, VDS could be the key to determining the level of illegal fishing in the EEZ.

The demonstration aimed at evaluating the benefits of satellite telecommunications means in complement to the already mature VDS (Vessel Detection System). The TANGO fisheries team has worked together with SES ASTRA TechCom, Newtec and EADS Astrium to implement the telecommunications part of the VDS architecture. The architecture relied on the provision of dedicated satellite communication means to transport near real time satellite imagery scenes from a data relay ground station in Europe to the FMC, thus enabling a local VDS capability which would have not been possible with the limited capability of Comoros local telecommunication infrastructure.

Though the demonstration was originally designed to take place in two phases, difficulties in supplying required equipment on-site necessitated a scaling-down of the effort to a single phase. In early March, Newtec installed and put into operation an antenna and receiver of the ASTRA2Connect telecommunications system. During the same period, JRC ordered satellite images of the Comoros EEZ covering the demonstration period, making use of a number of satellite image suppliers. The planned operation was to download satellite images and to compare the data extracted from them so as to compare it with vessel monitoring system (VMS) data. This could yield a preliminary assessment of the presence of illegal vessels.

The Astra2Connect antenna

One of the reasons for the choice of the Comoros was to test the possibility of realizing a VDS in difficult conditions and this, indeed, proved to be the case. The Comoros is notorious for frequent power outages, and these were exacerbated by torrential rains during a significant period of the demonstration. Furthermore, an auxiliary diesel generator was not in operation during the period, thus limiting execution of the demo to periods when the normal power grid was operational. Despite these setbacks, direct access to the satellite images to the Fisheries Monitoring Centre was successfully achieved, through the Astra2connect satellite communication capability. The largest files, which came from Radarsat 2, were typically 213 MB in size and were downloaded at a speed of from 80 to 85 KB/s, for a total time of just over 40 minutes. This performance is consistent for requirements of a quasi-real-time VDS. The performance in acquiring and downloading the images attests to the fact that the technical capability was successfully demonstrated and that such a tool could be used advantageously in the future.

The satellite solutions

For the three demonstrations (Comoros, Azores and UAV) the following Satellite Communications services have been used:

- Astra2Connect for broadband internet connection in weak telecommunication infrastructures in remote areas
- Artemis Near Real Time data relay to perform fast Envisat images delivery
- Inmarsat BGAN to achieve fast communications to and from patrol aircraft in Azores demonstration
- Iridium SBD to interact in real-time with the TPU SESA autopilot.

7.3 MARITIME SURVEILLANCE DEMONSTRATIONS

7.3.1 Ship tracking

Contents of the exercise:

The demonstration consisted in ship tracking exercises, based on real ship tracks and dedicated actions to track the ship (assuming the ship could be involved in illegal actions, which was of course not the case). The Ship Tracking demonstration consisted in tracking two voluntary ships provided by the French ship operator Louis Dreyfus Armateurs, from Hamburg (Germany) to France, England, Spain and Italy.

The ships were tracked daily using the new mandatory LRIT (Long Range Identification & Tracking) system. To do that, CLS installed one LRIT terminal on each of these ships. In addition, CLS had already installed an ARGOS transmitter on each of the ships for company purposes. These two terminals reported the ship position automatically. The ships were also tracked with their AIS (Automatic Identification System). To complement the cooperative position reports, the ships were detected on SAR satellite scenes programmed and analysed by CLS and EUSC.

CLS has installed the SitCen supervision systems in 2 CROSS (belong to French Affaires Maritimes) and in EUSC.

The chronology of the demonstration was made of three phases:

- a routine phase for traffic surveillance (365 days a year),
- a “event-triggered” phase starting when a ship has been identified as part of a potential illegal transshipping,
- and a “time-trigerred” phase for seasonal pollution monitoring prior to the touristic season.

Demonstration day:

The Maritime Surveillance demonstration day of the TANGO project took place on 23rd June 2009 in the French Maritime Rescue Coordination Centre (MRCC) for the Mediterranean sea, known as CROSSMED, located in Toulon (France).

Figure 26 : View from CROSS MED

The demonstration day combined a presentation of historical data and a workshop with near real time acquisition and analysis, related to ship and oil spill detection. The objectives were to summarize the use of satellite technologies for telecommunications and observation, and highlight areas where TANGO could contribute in improving access to time-critical data.

Missions of the states at sea supported by TANGO

While the national organizations may vary from one state to another, the EU Member States have in common to cover the following missions at sea:

- Vessel traffic management
- Search and Rescue and safety at sea
- Security and surveillance of illegal activities
- Marine Environmental protection
- Fisheries monitoring
- Broadcast of information to seafarers

These maritime missions for safety and security have to be efficient at a regional scale (most of search and rescue operations are issued by small boats, sailing close to the coast) and in the high seas, as shown in recent piracy attacks in the Indian Ocean. These missions are demanding always greater capacities in satellite systems, in particular for sea surface observation and detection of ships by radar satellites.

Why choosing the Mediterranean sea for the TANGO demonstration?

The vessel traffic in the Mediterranean sea is one of the most crowded in the world. According to 2006 REMPEC figures, 15% of the port movements in the world are in the Mediterranean ports and more than 13,000 merchant ships are passing every year, including 4,000 tankers. The Mediterranean coasts are also places with high densities of population and ecologically sensitive areas. A pollution may rapidly affect fragile ecosystems and hundreds of thousands people. The Mediterranean sea also faces sensitive border protection issues.

Actors involved and audience

The TANGO maritime surveillance demonstration was coordinated by CLS, Collecte Localisation Satellites, company specialized in ship tracking by satellite, and environmental observation. Also involved in the demonstration are the EUSC (European Union Space Centre), which has performed some of the satellite image analysis, and TNO, the Dutch marine security research centre.

Figure 27 : Some of the participants to demonstrations day in CROSS MED

For the demonstration on 23 June in CROSSMED, the audience was composed of about 25 people representing various governmental services. The exercise was monitored by the French Affaires Maritimes CROSSMED officers. In the audience, we find the Prefecture Maritime, which coordinate the state action at sea and may prosecute a polluter or instance, the French navy Operation commander for the Med sea, with search-and-rescue and police specialists, the French customs air patrol involved in pollution watch, and the European agency FRONTEX, specialized in border surveillance. A superintendent of the company Louis Dreyfus Armateurs is present to represent the point of view of the shipping industry.

Figure 28 : The company Louis Dreyfus Armateurs allowed two vessels to be volunteers to be tracked by LRIT (left photo © Mer et marine, other photos: ©CLS)

The TANGO ship tracking scenario

The scenario invented for the exercise is the following: a governmental agency has to perform several types of tasks. It relies on one or two GMES Service providers (CLS and EUSC, based in France and Spain) for the analysis of data and uses the THEMIS software system to merge all data in one map. The sequence of tasks was the following one:

1. Routine tasks such as vessel traffic and pollution monitoring. The vessel traffic tracking usually relies on governmental infrastructure like coastal radars and AIS receive stations connected to a single point, generally not using satellite telecommunications. TNO demonstrates the use of combined real time coastal surveillance on which the Louis Dreyfus ship tracks have been observed:

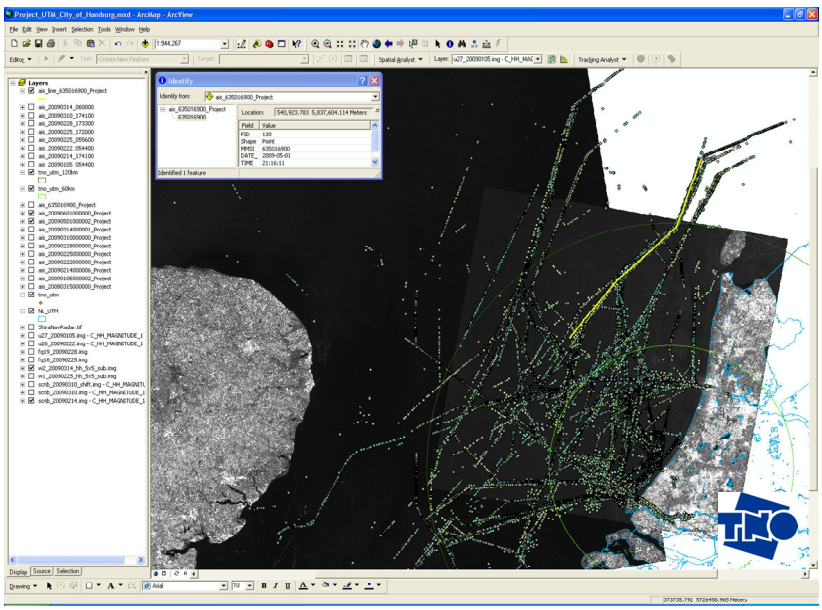


Figure 29 : Vessel traffic displayed by TNO. The voluntary ship appears in yellow

2. As part of routine tasks to monitor the traffic lanes in long distance, the agency acquires low resolution/wide coverage satellite radar scenes from Envisat and ERS2, two satellites from the European Space Agency. This part of the exercise has last from 1st March to 1st June 2009.

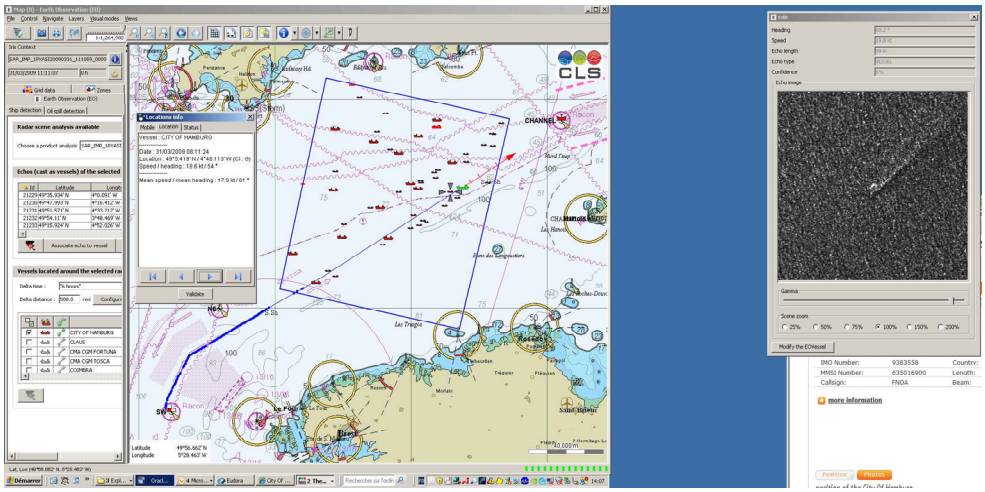


Figure 30 : Vessel traffic displayed by CLS, combining AIS and LRIT (blue track) and low resolution radar detection (©: imagette made from ERS image provided by the European Space Agency)

3. On the 31st May 2009, the agency is informed by another intelligence agency that a suspicious boat (a sailboat fitted with a satellite transponder) has been detected while stopping in the English Channel, maybe for a rendez-vous at sea. The agency needs to identify all ships in the vicinity, using available technologies. The agency accesses to LRIT (Long Range Identification & Tracking) position reports, under its Coastal State profile. In pre-defined LRIT custom coastal areas, the agency receives a list of ships position reports. The agency starts tracking a merchant ship of interest. The agency asks CLS to program high resolution satellite radar scenes from Radarsat2, in order to confirm that the LRIT position report corresponds to the ship. The scenes allow to detect a 160-meter long ship (ship identification is not possible):

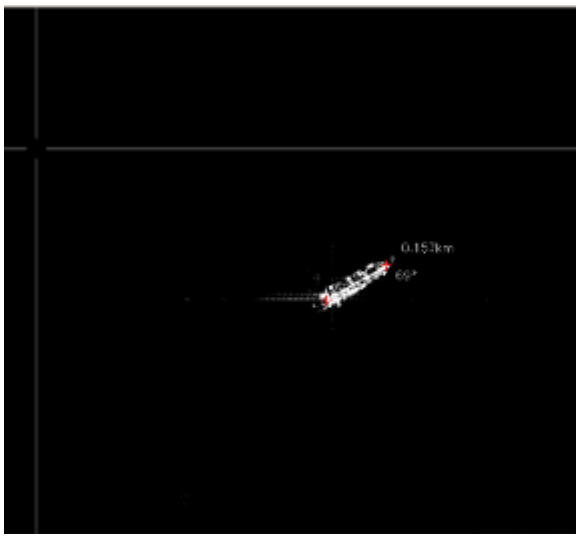


Figure 31 : Ship detected in June 2009 in Gibraltar Strait, Radarsat2 Ultra Fine mode image, displayed in SARTool © MDA

4. On the 1st June 2009, the agency starts its annual "clean coast" campaign, and increases the level of surveillance of the potential pollutions. The agency asks the GMES Service Provider (i.e. CLS) for some high resolution ENVISAT and Radarsat2 satellite images .

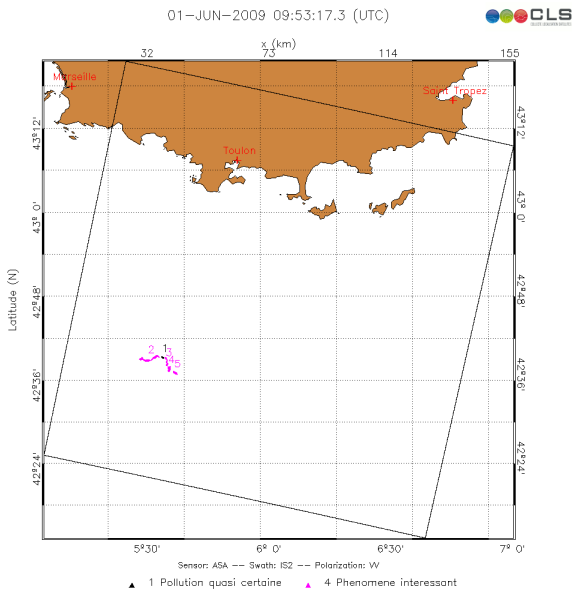


Figure 32 : Pollution detected in June 2009, French ZPE,

Low incidence high resolution ENVISAT image provided by the European Space Agency,Processing : SARTool by CLS

Specific added-value of TANGO

The first advantage of TANGO was to give access to a catalogue of various satellite solutions to solve every mission thanks to the Common Telecommunication Service Platform. In this present exercise, TANGO would have helped in choosing to technology to track the boats and the merchant ships.

Few high data rate satellite telecoms were used. Unlike the other demonstration supported by TANGO, the Maritime Surveillance exercise relies on existing telecommunication infrastructure:

- In the Netherlands, the ships were tracked by TNO, using radar and AIS, and the AIS data were sent to CLS via FTP for integration into THEMIS. Satellite communications could be useful to do that if the AIS antenna is located in a remote area.

- In second half of 2009, the merchant ships started using a new mandatory ship tracking system, called LRIT. CLS will be the operator of the European LRIT data Centre which will track all EU ships on a global scale, and other ships within European regions. CLS has installed 2 THORIUM LRIT transponders, based on the IRIDIUM global constellation, on 2 voluntary ships from Louis Dreyfus Armateurs. These ships operate between the AIRBUS factories to carry the Airbus A380 components. The THORIUM LRIT transponders are providing position reports every 6 hours, sometimes every 1 hour or every 15 minutes, during all the duration of the exercises.

- In addition, we were expecting to use prototype Satellite-AIS data, supplied by LUXSPACE. We presented some data samples obtained via the MARISS project in January 2009, the period covered did not fit in our scenario.

- The data links between the Envisat, ERS, Radarsat2 and the GMES Service Providers are using terrestrial networks. Should a similar scenario take place in non European regions, satellite telecommunications could have been used between data providers and GMES service providers (broadband access through fixed satellite networks or BGAN), or to improve fast access to satellite imagery through geostationary data relay.

7.3.2 Met-ocean buoy deployment in the Baleares by IMEDEA

A second set of TANGO maritime demonstrations were the met-ocean instruments' deployments, using the new generation of Argos-3 Platform Messaging Terminals. These demonstrations are independent of the ship tracking demonstration, they are performed with met-oceanographic institutes to contribute to Mediterranean sea forecasts.

The deployments are part of a wider experiment called SINOCOP, and coordinated by IMEDEA, the Mediterranean Institute for Advanced Studies, based in the Baleares islands. IMEDEA is a research center jointly governed by the Consejo Superior de Investigaciones Científicas (CSIC) and the University of the Balearic Islands (UIB).

The specific objectives of SINOCOP are to investigate the limitations and potential improvements of altimetry data in the coastal area, test new technologies (gliders, ARGO profiling floats, Argos-3 surface buoys), and inter-calibrate in-situ data with remote sensing and altimetry.

During this experiment, the first-ever Argos-3 buoys provided good results, showing an increase of the amounts of data transmitted while reducing the transmission time, a key benefit to extend the lifetime of the buoys.

7.4 HUMANITARIAN AID

7.4.1 Vulnerability Mapping demonstration in Vietnam in collaboration with RESPOND

The Humanitarian Aid demonstration performed in Vietnam by UNITAR/UNOSAT and their partners during the first week of May 2009 simulated Vulnerability mapping services in case of crisis.

The purpose of the exercise was to evaluate the support of TANGO solutions for telecom equipment and services in a typical RESPOND project scenario (GMES services supporting humanitarian relief, Disaster Reduction and reconstruction - www.respond-int.org) dealing with preparedness and crisis response in the case of floods disaster event. TANGO provided support to field team activities with portable Satcom equipments integrating technologies for voice and data communications, and providing also GIS capabilities.

The team was composed by UNOSAT experts in charge of the coordination of the demonstration, Infoterra France, in charge of the Eliseo tool, and EADS Astrium, the TANGO project coordinator. Tasks carried out within the demonstration in Hue were also efficiently supported by the Vietnam National University, Hanoi, as well as the Bureau of Government, Ministry of Science and Technology, Ministry of Defense, People's Committee of Thua Thien Hue Province, Science and Technology Service of Thua Thien Hue province, Hue University, Hue Center of Information Technology, without which the demonstration would not have been such a successful.

Two "operational" crisis scenarios were used for the demonstration. In the first scenario, the Hue city area is flooded due to monsoon rains and the team has to identify flooded areas, safe areas, and ways to evacuate the affected population. In the second scenario, the landfall of a typhoon causes the flooding of the lagoon area in the Hue region and the team has to identify the flooded areas and status roads. Two teams were established, one for each scenario.

Participants worked for two days on a geographic area confined by the sea, river, mountains and the beach to identify the areas potentially flooded, the safe areas nearby, and how to evacuate the affected population. The boundaries of these areas were drawn including the road network using the Eliseo tool and the information was transmitted to the Command Center located in the Hue City. The Command Center, after coordination of data collection, retransmitted the filtered data to RESPOND HQs located in Europe through satcom links. After processing the data available, the RESPOND team in Europe sent back to the field the maps necessary to coordinate the operations of rescue teams.

The results of the demonstration were highly appreciated by the Vietnamese authorities during the debriefings in Hue and Hanoi, opening the concrete possibility of future collaborations. The Vietnamese

authorities underlined that satellite telecommunications associated to geospatial data as in the case of the TANGO project play an important role in monitoring risk, responding to crises and bringing more efficiency in disaster management.

The demonstration team benefited from support from Inmarsat for the satellite bandwidth service provision and from Ansur Technologies of Norway for the ASIGN Image Communications Solution. The BGAN and ELISEO telecom equipments have worked without failures including under torrential rain in Hanoi.

Figure 33: European HQs final GIS products for the second scenario (flood occurring in Tam Giang Lagoon)

7.5 SECURITY

7.5.1 Evacuation of civilian people from a crisis area

The security demonstration of the TANGO project was successfully performed on 27th-28th May 2009 in the Island of Madeira.

The exercise was organised and coordinated by the European Union Satellite Centre (EUSC) in collaboration with several partners from different technical areas, among which EADS Astrium (TANGO project coordinator), CNES (Centre National d'Etudes Spatiales), Infoterra France, Charles University (Czech Republic) and Avanti.

The demonstration was hosted by the Madeira Operational Command, who kindly offered access to their premises, provided organization support and actively participated in the demonstration. The exercise simulated an evacuation of EU nationals affected by a crisis situation in "Alania" outside EU borders. The scenario was integrated in the framework defined by the European Union and benefited from the support, guidance and implication of representatives from the EU Situation Centre (Brussels).

The existing telecommunication networks were ignored during the exercise to simulate the lack of terrestrial communication infrastructure during a crisis.

The exercise allowed to highlight the benefits of providing near real time satellite imagery plus advanced telecommunication services by the bidirectional linking of the three sites participating in the exercise: the actors in the field (SitCen-A plus Mobile Unit), EUSC providing data and information updates and the headquarters managing the operations (SitCen, Brussels).

Transportable and easy to deploy satellite communication solutions adapted for crisis management situations were demonstrated. These solutions successfully provided stable and reliable communications between actors involved in the scenario to allow voice, data and internet communications, the transfer in real time of geospatial data as well as GPS positions collected on the field, and to provide access to near real time earth observation satellite imagery information. The geospatial information was efficiently shared between different actors of the scenario in the three sites, providing an optimised support for decision making.

During the demonstration both operational satellite telecommunication solutions like ELISEO from Infoterra France, and innovative solutions such as RECOVER, developed in the frame of the TANGO project under CNES leadership, were brought into service for the benefit of the evacuation scenario. ELISEO combines geomatics GIS and GPS applications with satellite communications adapted for field mapping services, integrating cartography, positioning and communication. It allowed a permanent connection between the Mobile Unit on the field and the local command centre for communication and tracking of the evacuation routes in the field. The RECOVER (Risk and Emergency COntainers for Valuable and Essential telecom Recovery) is a modular and compact solution composed of a set of containers providing the following types of links during the evacuation exercise:

- Internet connexion by satellite through a SCPC link, which was locally distributed by a Wireless network (WiFi)
- Voice communications extended private cell, which allowed people in "Alania" to be connected with each other. They were also connected to the rest of the world by a backhaul over satellite.

In order to ensure internet connexion with the EUSC and EU SitCen in Brussels, RECOVER was installed at the local command centre (SitCen-A). RECOVER provided permanent connexion to the ELISEO platform through satellite internet connexion to facilitate communications with the Mobile Unit. Telecom solutions were selected from the offers provided by the Common Telecommunications Service Platform (CTSP). These solutions were successfully tested in the security demonstration. The exercise benefited also from the highly appreciated support of Inmarsat for the provision of the satellite bandwidth for BGAN communications. Operational activities developed during the demonstration were supported by products generated from a geographical information system (the Evacuation GIS), based on satellite images and aerial photographs of high-resolution in which route analysis was performed to determine the best evacuation routes from specific evacuation areas. The system enabled demonstration actors to obtain essential information for a fast and efficient evacuation of EU citizens such as the selection of the most suitable or the fastest route, estimated travel time, location of evacuation points, hospitals and other important facilities, etc.

Figure 34: GIS product with evacuation routes

To comply with the security requirements of the end users collected during the first phase of the project, communications and data were encrypted/decrypted during the exercise using dedicated hardware and software.

The evolution of operations was accompanied by access to servers located at EUSC in Torrejón and at Charles University in Prague.

The demonstration was attended by civil and military authorities of the EU, the Regional Government of Madeira and the Madeira Operational Command who highly appreciated the demonstration. Running in parallel with the exercise, there was a programme of presentations and briefings by the project partners about the technologies being used in the demonstration.

This event provided an excellent opportunity for networking and awareness on the status of EU operations and the benefits of using satellite telecommunications in international crisis.

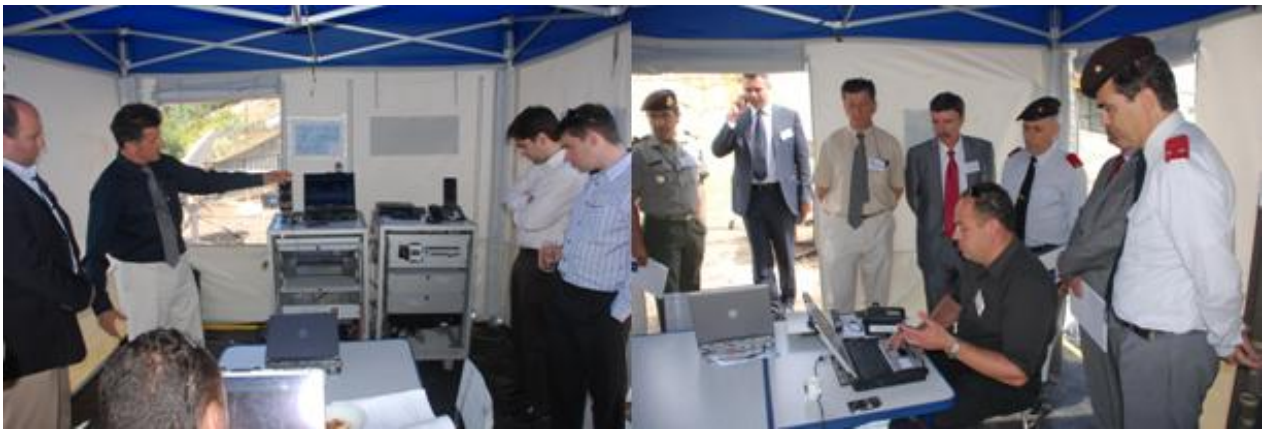


Figure 35: RECOVER and ELISEO solutions at Field Base (SitCen-A)

8 SYNTHESIS OF DEMONSTRATIONS

The objectives of these activities were to summarize the results obtained during training and demonstrations, in particular to gather and analyse the different feedback obtained from end users and GMES service providers about demonstrations and TANGO solutions.

Technical activities included the study of the telecom needs from end users involved in demonstrations versus initial requirements. For that, telecom benefits were presented according to parameters used for the requirements synthesis: speed of service delivery/time to access to the information, data volume and transmission time, portability, transportability, coverage area, security, reliability, easy to use and interoperability.

8.1 TANGO DEMONSTRATIONS BENEFITS

The following Table 4 summarises the most characteristic benefits brought by satcom solutions for each segment of the GMES chain for the implemented TANGO scenarios.

The table shows that TANGO solutions brought benefits to meet the key user needs expressed by GMES community:

- Faster and optimised collection of observation data
- Reduction of time for service delivery
- High resolution & high volume data transport everywhere
- Better coverage
- Optimised GMES products dissemination down to the on field area
- Fast, easy to deploy, robust equipment & communication for better operations to improve situational awareness and communications on the crisis field area.

Demonstration scenario	Data collection	Data transport	Data dissemination	On the field coms
On-field crisis management Elancourt				Portability Mobility
On-field crisis management Cahors	Service time reduction	Higher data rates	Global coverage, Higher data rates	Portability Mobility
Fisheries monitoring in Comoros		Global coverage, Higher data rates	Global coverage, Higher data rates	
Fisheries monitoring – UAV	Service time reduction			Global coverage Mobility
Fisheries monitoring Azores				Global coverage Mobility
Maritime Surveillance (Ship tracking and Met-ocean observ.)	Service time reduction Higher data rates Global coverage	Service time reduction Higher data rates		
Humanitarian Aid Vulnerability Mapping RESPOND			Global coverage Service time reduction	Global coverage Mobility
Security (Evacuation from a crisis area)	Service time reduction	Higher data rates	Higher data rates	Global coverage Mobility

Table 4: Most characteristic benefits versus TANGO segments

Table 5 provides a summary of main benefits brought by TANGO satcom solutions and the GMES service improvement for the full TANGO exercises.

Demonstration scenario	TANGO Benefits	GMES service improvement
On-field crisis management Elancourt	Voice & data access in the field everywhere	Better operations during crisis
On-field crisis management Cahors	Voice & data access in the field everywhere	Better operations during crisis
Fisheries monitoring in Comoros	Faster access to satellite imagery in areas with poor terrestrial telecom infrastructure	Better autonomy in fisheries management service
Fisheries monitoring – UAV	Faster data collection in the field	Better reactivity in fisheries management service
Fisheries monitoring Azores	Real time communications on board patrols	Better reactivity in fisheries management service
Maritime Surveillance (Ship tracking and Met-ocean observ.)	Faster and improved data collection	Better efficiency and reactivity
Humanitarian Aid Vulnerability Mapping RESPOND	Optimised GMES product dissemination and real time data collection on the field	Better coverage and efficiency in crisis coordination
Security (Evacuation)	Secured Telecoms for real-time situation awareness	Better coverage and reactivity in crisis coordination

Table 5: TANGO solution benefits and GMES service improvement

8.2 CONCLUSIONS

As a conclusion, the whole TANGO demonstration plan showed how satellite telecommunications can bring benefits to end-users and citizens at each step of the GMES value chain:

- Satellite telecommunications can be considered as an enabler for the development of GMES services, in particular in isolated regions with extended needs but relatively poor infrastructure to have access to new technologies and services (i.e. Fisheries management in Comoros). Combination of real-time information is made available the closest to the end-users providing them autonomy, decision and operation.

  - Better coverage, to provide communication means in remote areas where terrestrial infrastructure is damaged or not existing.
  - Higher data rates to transport high amount of information and disseminate GMES products to the end users.
- Time is critical at each step of the GMES chain:
  - Telecommunication solutions to reduce the time to access to information (faster data collection (i.e. Maritime surveillance, fisheries management)
  - Telecommunication brings real-time access to information for situational awareness (i.e. Field mapping applications like for humanitarian aid, risk & crisis and security demonstrations)
- Satellite solutions are rapidly deployable, robust, reliable and therefore particularly suitable to provide mobile communications on the field between several actors, integrating several functionalities (voice, data and geolocalisation services), able to work everywhere in the world (global coverage).

TANGO has proved that efficient operational technologies are available to meet GMES requirements and that telecommunications should have a key role in the future GMES model.

9 ROADMAP ACTIVITIES TOWARDS OPERATIONAL PLATFORM IMPLEMENTATION

Objectives of these activities were twofold:

- Firstly, to define a set of technical recommendations for future R&D activities for the integration of improved operational satellite telecommunication services into GMES capabilities.
- Secondly, to identify the different candidate role models for the TANGO operational platform and to provide a set of recommendation to be considered for the implementation of an operational platform based on the CTSP concept developed in the frame of the project.

For technical recommendations, the work started from the results and lessons learnt from the TANGO telecommunication solutions and their integration in the TANGO demonstrations.

The study of CTSP role models and the elaboration of recommendations for an operational platform took as inputs the results of the CTSP development and validation on the one hand and the outcome of the set of TANGO demonstrations on the other hand.

The logic applied to this work is summarized in the following figure:

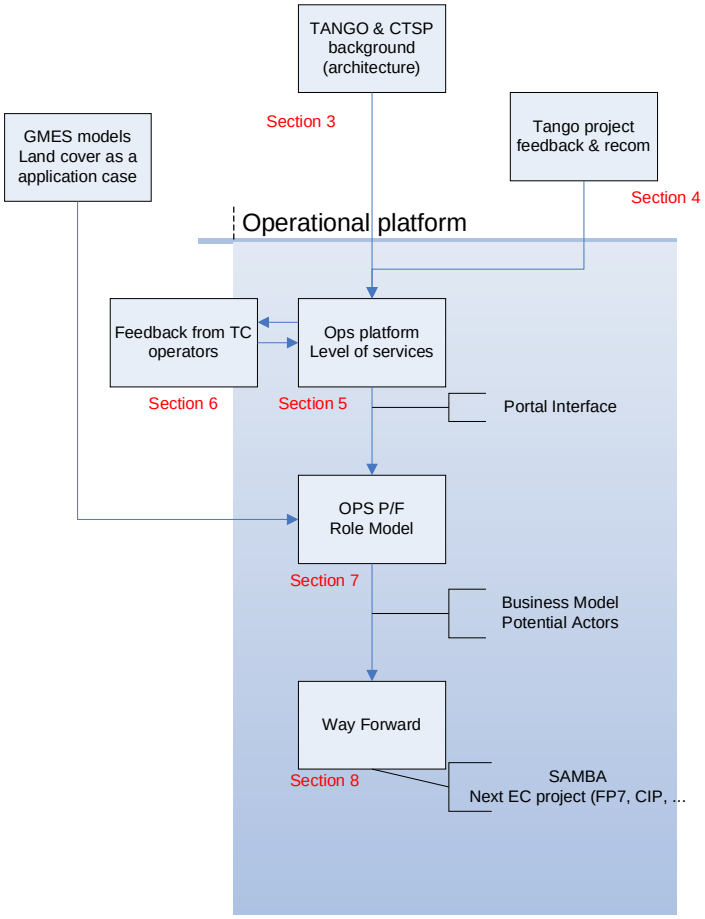


Figure 36: Operational platform definition study logic

- Firstly a set of level of services have been defined taking into account both the current TANGO CTSP architecture and the feedback acquired all along the demonstration phase
- This operational set of services have also been confronted with some telecom operator views through dedicated interviews.
- Then, starting from this platform configuration, and with a set of assumptions on the future GMES model, several role models for the future operational platform have been established
- Finally a set of recommendations and a way forward have been proposed

During the course of the studies, 5 level of services (for CTSP operation) were identified and their relative merits and demerits have been discussed. These models include:

- Catalogue : to provide current information of market offers
- Broker / one stop shop : to facilitate ordering of Telecom Provider Offers & equipment
- Auction / Exchange : to create a community based forum for exchange, or a more formal auction

- Aggregator : to aggregate customer demand to more efficiently use offers
- End to End network management where the platform may assume some/all contractual responsibility for QOS guarantees

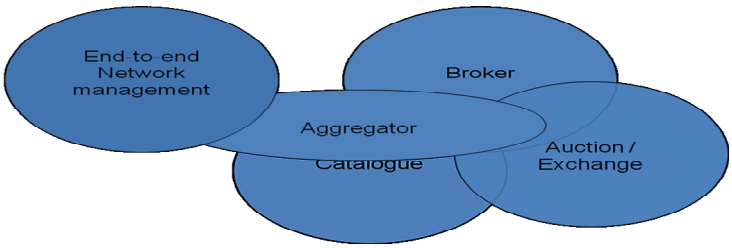


Figure 37: The 5 levels of service of the operational platform

Several options for the role models were studied and compared. For instance, options such as the opportunity to split the TANGO telecommunication segments in two groups were considered.

Finally a set of recommendations on the one hand and a way forward in the other hand concluded the study. The recommendations are recalled hereafter

Recommendation 1 : The Operational platform has to be developed in order to provide up to 5 levels of services from Catalogue up to an end to end management set of services

Recommendation 2 : The development of the platform has to be incremental

Recommendation 3 : A detailed business analysis of the platform has to be done in close relationship with GMES governance model in order to get a Telecommunication platform smoothly integrated into the overall GMES model

Recommendation 4 : the funding model of the platforms has to be deeply worked out, but should take into account the specific aspects of the different telecommunication segments. The funding scheme should also take into account the way images and data will be funded when the GMES will enter the operation phase.

Recommendation 5 : In the mean time (before to get an operation GMES), the Telecommunication dimension of GMES has to be clearly accounted for during upcoming projects.

The way forward deals both with long term and with mid term objectives. The long term approach aims at putting into operation a telecommunication platform integrated within the GMES overall operational structure. The work done identified some possible short/mid term opportunities to implement the way forward, relying both on EC and on ESA.

Technical recommendations for satcom activities are related to the future improvements to be done to the TANGO solutions, in order to better cover the needs expressed by the GMES community. Some lessons learnt from demonstrations were also considered for elaborating these recommendations Technical recommendations were organised as follows:

- Technical recommendations for R&D activities related to the CTSP platform, including recommendations for the update of the high level CTSP specifications, their impact of the role model and programmatic aspects, provided by Avanti.
- Technical recommendations for R&D activities related to telecommunication solutions studied in the project, from the point of view of TANGO telecom providers.
- Other recommendations for R&D activities for future use of telecommunications solutions and CTSP in GMES services related to TANGO demonstrations, and provided by demonstration leaders, providing the point of view of the GMES community based on their experience of TANGO exercises.

These activities enabled to consolidate and highlight the main outcomes and lessons learnt from the project.

10 COST AND BENEFITS ANALYSIS

One key objective of TANGO will be to "make it happen" through the definition of conditions and recommendations for an operational exploitation of the Common Telecommunications Service Platform.

A first step in economical viability was performed through Cost & benefits analysis, to evaluate the additional costs and additional benefits for GMES community to bring satellite communications and telecommunication service platform.

The applied methodology for the study is presented in the following figure:

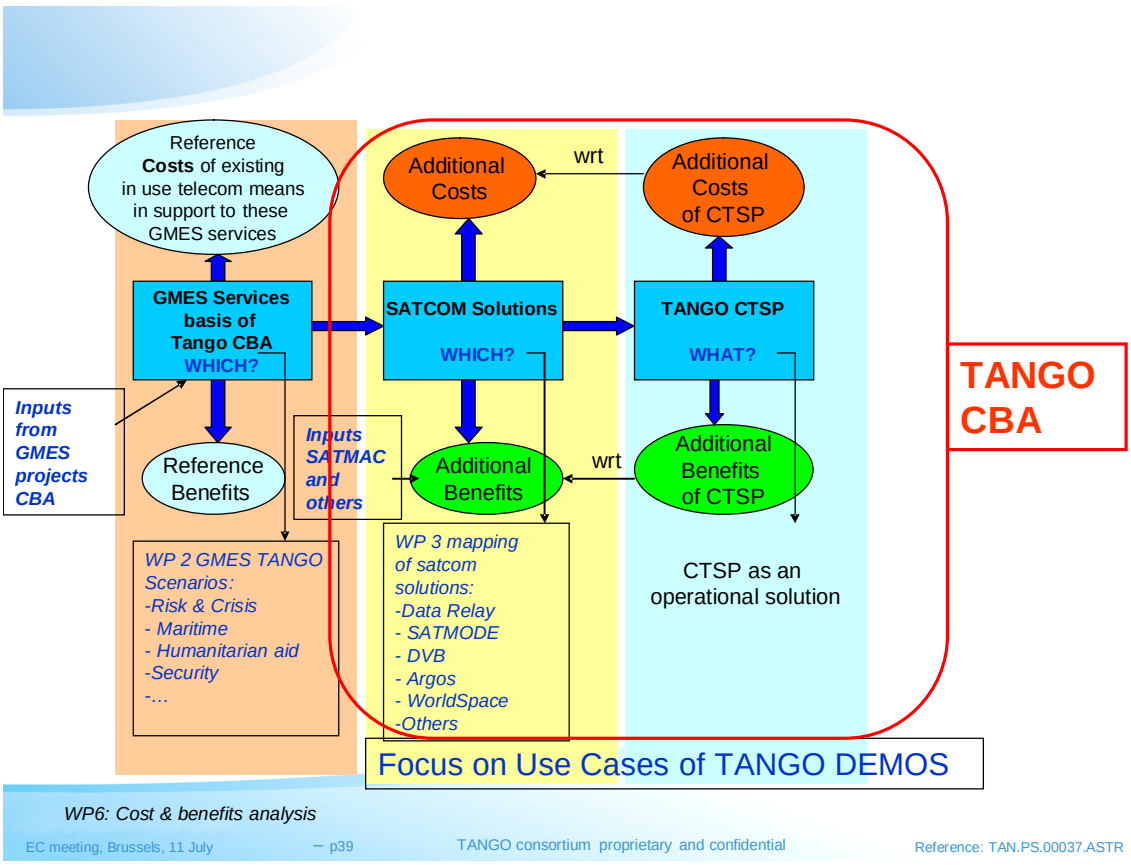


Figure 38: Methodology for CBA activities

11 DISSEMINATION AND USE

This section presents dissemination of knowledge actions carried out during the TANGO project. It provides a summary of dissemination activities for the three years of the project.

Main objectives of this activity are

- to contribute and participate to conferences and standardisation international bodies meetings, related to telecom as well as to GMES
- to contribute to the dissemination of results obtained during the TANGO project, including through a web page
- facilitating the dissemination of results of WPs within the project (FTP server and Internet web page)

Dissemination activities have been structured into five sections presenting dissemination objectives and activities by category of audience:

§ GMES projects

§ End-Users

§ Institutional organisations

§ General public

§ Future operators, in view of operational platform, in complement to current partnership.

11.1 LINKS WITH GMES PROJECTS

TANGO study logic includes strong cooperation with GMES projects, in particular during the GMES requirements collection phase performed in the first six months of the project, and during demonstration phase where specific cooperation with projects is defined. Cooperation activities have been driven by TANGO partners involved or having privileged interfaces with GMES projects. An important part of TANGO dissemination activities are addressed to these GMES projects, to provide them a better knowledge of project's activities and TANGO platform solutions (in terms of satcom services and Common Telecommunication Services Platform (CTSP)).

These tasks cover:

- Participation in GMES projects events, including communication on TANGO in various forms
- Participation in GMES projects coordination meetings
- Organisation and participation to dedicated meetings with GMES projects

Main objectives of these activities are to:

- Better understand the current and future GMES services and their associated requirements in terms of telecommunications
- Communicate on the TANGO solutions able to cover their needs, in terms of satcom solutions adapted and developed within TANGO and in terms of the CTSP.
- Establish or reinforce cooperation with projects by defining potential support from TANGO to provide telecom solutions, including through demonstrations.

The activities of cooperation with GMES projects carried out during the project are summarised in the following table:

RP1			
Date	Project meeting	TANGO Partner	Comments
November 2006	PREVIEW meeting and Forum	AST	TANGO presentation
8 February 2007	LIMES coordination meeting	AST, UNO, EUSC, JRC, SPOT	Fruitful exchanges with LIMES project and other represented GMES projects
8 February 2007	4th Geoland Forum	ITD	TANGO presentation
April 2007	GMOSS 36th meeting	EUSC, AST, JRC	TANGO presentation
April 2007	Dedicated meeting with AVV as MarNIS coordinator	AST, TNO, EUSC	Study of possible cooperation in the frame of demonstrations
June 2007	Dedicated meeting with RESPOND coordinator	AST, UNO	Discussion for cooperation in Humanitarian aid demonstration
September 2007	2nd dedicated meeting with MarNIS	AST, TNO, EUSC,	Discussion on potential cooperation in maritime surveillance demonstration
Continuous	LIMES	AST	Cooperation with LIMES project and contribution to LIMES deliverable "D5420.1: Technical note – Synergies with TANGO project" (September 2007)
RP2			
Date	Project meeting	TANGO Partner	Comments
22nd January	Workshop MARISS on Space	AST, JRC, CLS	Presentation of TANGO project,

2008	Systems for Maritime Security		with focus on activities related to maritime surveillance.
19-20 February 2008	Workshop GMOSS on "Remote sensing for international stability and security: integrating GMOSS achievements in GMES"	JRC, EUSC	Presentation of TANGO project, with focus on activities related to security.
27-28 May 2008	SeBoCoM "Secure Interoperable Border Communications" workshop	AST, EUSC	Presentation of TANGO project, with focus on activities related to security and risk & crisis management.
Continuous	LIMES and MarNIS cooperation	AST, TNO, EUSC, CLS	Preparation of TANGO Maritime surveillance demonstration
Continuous	RESPOND and GMFS cooperation	UNO, INFRAM	Preparation of TANGO Humanitarian Aid demonstrations
Continuous	PREVIEW and RISK-EOS cooperation	AST, Infoterra France	Preparation of TANGO Risk & Crisis demonstrations
RP3			
20 January 2009	RESPOND coordination meeting	UNITAR	Presentation of TANGO support to Vulnerability mapping RESPOND scenario
13 June 2009	GMFS training to corresponding Ministries personnel in Ethiopia	INFRAM with support of UNITAR	Presentation of potential TANGO support to Food Security in Ethiopia and description of intended demonstration
continuous	RESPOND and GMFS cooperation	UNITAR + INFRAM	Preparation of Humanitarian Aid demonstrations
continuous	LIMES	AST, EUSC	TANGO support to LIMES scenario about monitoring of a cargo vessel from Mediterranean sea (Aden Gulf) to Southern East Africa

15-17 December 2008	Final FP6 project PREVIEW meeting	Infoterra GmbH	Project partner and public users at PREVIEW final meeting; presentation of TANGO results for emergency applications
14 May 2009	TANGO presentation at the Geoland2 Forum in Berlin	Infoterra GmbH	FP7 Geoland2 project partners and invited "Land" users

Table 6: Dissemination activities towards GMES projects

11.2 LINK WITH END-USERS

TANGO objectives are to support GMES service providers in providing adapted telecommunications solutions to their needs, enabling them to enhance the service they offer to their own end-users. In the phases of preparation and realisation of TANGO demonstrations, direct contact with GMES service providers and end-users have been established. This was not made in contradiction but in link with GMES projects, thanks to privileged contacts with end-users through TANGO. The involved TANGO partners and associated activities are detailed in the "Final plan for using and disseminating the knowledge" included in the Final Activity Report for the last year of project.

11.3 LINK WITH INSTITUTIONAL ORGANISATIONS AND OPERATORS

One of the TANGO objectives was also the preparation of future infrastructure able to answer to identified GMES needs.

It answers to a two-steps approach: first step consisting in the development within TANGO of telecommunication solutions able to provide a short-term answer (within the three years) to GMES needs, and demonstrate these solutions through preliminary service implementation; second step consisting in defining the solutions and establishment of dedicated infrastructure for the future.

Some dissemination activities were orientated to convince institutional organisations and satellite operators (as Space Agencies) on complementary development or activity in a longer term. These kind of activities continue after the end of TANGO in order to prepare a potential follow-on of the project.

These communication activities were held through dedicated meetings and presentations.

All during the project, ESA (ESTEC & ESRIN) and EUMETSAT have shown their interest in the TANGO project in particular through their participation and active contributions to the second and third TANGO User Forum held in Ispra in April 2008 and in October 2009 respectively.

In the frame of TANGO Role Model activities and preparation of the roadmap for future implementation of an operational platform into GMES services, TANGO team has collaborated with several satellite operators.

During the Evacuation demonstration in Madeira, EUSC closely collaborated with ESA with the purpose of acquiring the latest Envisat ASAR and MERIS imagery over Madeira using the Artemis data relay.

EUSC was provided by ESA a password and a username to login to the ESRIN rolling archive wherefrom data has been downloaded.

Additional links were established with the Instituto de Meteorologia Portuguesa and Centro de Informacao Meteorologica that provided weather reports during the Security Demonstration.

In the preparation phase of the demonstration in Madeira, contacts have been established with the Portuguese Regional Institute of Cartography (DRIGOT) that kindly provided the aerial photography needed to generate the Evacuation GIS at no cost. After the demonstration DRIGOT showed interest in the Evacuation GIS produced in frame of TANGO so future collaboration with DRIGOT is foreseen.

On the telecommunications aspect, a close collaboration was established between TANGO partners and ANACOM (The National Authority for Telecommunications in Portugal) that kindly supported the logistical aspects of the setup of the telecommunications solutions.

The participation of the EU Joint Situation Centre was significantly important not only for its relevant input into the scenario and in the detailed script of the Security Demonstration but also due to the benefits that this organization has derived from the use of telecoms to improve in future its operational activities. In their feedback after the Security Demonstration, the EU Joint Situation Centre has indicated interest to keep contact with the activities of TANGO and its potential follow-on.

11.4 COMMUNICATE AND INFORM THE GENERAL PUBLIC

11.4.1 Flyers and poster

TANGO flyer was elaborated during the first months of the project providing key information about the project and main objectives.

In order to support first User Forum presentations, further flyers were also prepared to synthesise main results obtained during the collection of GMES telecommunication requirements for Risk & Crisis management, Security and Humanitarian Aid themes.

Another poster presenting TANGO activities related to Emergency communications was elaborated for the GMES Forum in Lille in September 2008 (see Detailed dissemination plan included in RP2 Activity Report).

EUSC prepared a poster presenting the TANGO security demonstration in order to communicate on it in future conferences and events.

In 2009 a new general TANGO poster was prepared to disseminate about the project and to be shown in the different TANGO demonstrations and communication events.

Four new flyers were prepared in order to present the performed demonstrations and their main results for the different TANGO themes: Risk & Crisis, Maritime Surveillance, Humanitarian Aid and Security. They were distributed to participants attending the third TANGO User Forum in October 2009.

Figure 39: TANGO poster

11.4.2 TANGO movies

A TANGO movie has been produced in order to communicate and disseminate the major outcomes of the project to a large public.

A second TANGO movie was prepared by EUSC describing the Security demonstration in Madeira.

11.4.3 Internet site

TANGO internet site (www.teladnetgo.eu) was created at the beginning of the project. It has been regularly updated with relevant information about the project like main events.

Continuous updates of the site were done in order to complete information on technical activities of satcom adaptations and Common Telecommunication Services Platform (CTSP) development, as well as to include information about project main events like demonstrations (announcement and summary of each demonstration results) and User Forums.

For each demonstration, the event was announced in the web site in advance. After each exercise, a summary of the results and the associated presentations and deliverable documentation provided to European Commission were also uploaded in the TANGO internet site.

The private zone of the website containing deliverables and presentation document information restricted to project use is protected for access only by allowed users.

Figure 40: TANGO internet site

11.5 CONFERENCES AND FORUMS

Detailed information about conferences and forums attended by TANGO partners as well as whole dissemination activities during the full duration of the project are included in the "Final plan for using and disseminating the knowledge" included in the Final Activity Report for the last year of project.