International Symposium on Space Policy and Coordination Framework
Technical Session 1

Organized during

Map Middle East 2010.

23rd March 2010, Abu Dhabi

Fundamentals of Earth Observation Policy: Examples for German and European Missions

Gunter Schreier*, Bernhard Schmidt-Tedd, Rainer Sandau,

DLR – German Aerospace Center
* DLR - German Remote Sensing Data Center
D-82234 Oberpfaffenhofen
Germany
Tel: +49 8153 28 1375
Fax: +49 8153 28 3444
Gunter.Schreier@dlr.de

Abstract

Several European countries have developed their national high resolution earth observation systems. Some of them are operated in close cooperation with industrial partners, others are dual-use missions earmarked to fulfil the needs of national security. In addition, the European Space Agency and the European Commission have initiated the Global Monitoring for Environment and Security (GMES) project. Therein, a fleet of satellites (SENTINELs) will deliver data for European wide information services, augmented by data from national and non-European earth observation systems.

This new scenario needs clear guidance and regulations. Besides the principles for operations of earth observation missions – as set out in UN principles on earth observation – the operators of very high resolution missions require clear governmental acts which international users can be served and which data might be restricted in distribution. For national science and the SENTINEL-missions, a policy for free and open access is being developed to guarantee a maximum use of the data.

Exemplified on the German national missions and the European GMES scenario, data policies and regulations for existing and new earth observation missions will be explained.

The European GMES Scenario

The nations of the European Union have strengthened their common policies in the treaty of Lisbon, which entered into force December 1st 2009. The treaty sets the common understanding of European nations to work together on issues of environmental protection and civil security on a legal binding basis. Article 189 of this treaty also calls for a European Space Policy and to take the "necessary measures" to implement it.

Apart from European independency in satellite based navigation (i.e. the Galileo Program), European member states recognized the suitability of space technology – including earth observation from orbiting satellites - to help to preserve the environment, to protect the climate and to safeguard the security of its inhabitants.

European plans and capabilities to meet this challenge are being brought together in the GMES program (Global Monitoring for Environment and Security). Its purpose is to establish satellite systems and related ground infrastructure in Europe for earth observation and to provide geo-information services for citizens of Europe and other nations.

The GMES program was first initiated in a European conference in Baveno, Italy in 1998. Since then it got momentum and was officially agreed to be implemented as a joint activity under the leadership of the European Commission, wherein ESA (supplemented by contributions from EUMETSAT) is taking care of the management of the space segment and the Commission is responsible – apart from the overall management – for the development and the sustainability of the geo-information services. On the Commission side, GMES – and specifically the five selected geo-information services (Figure 1) – is currently implemented with the 7th Framework Programme on Research and Development, whereas ESA member states contributions support the majority of the GMES Space Component (GSC) programme. The successful implementation of this ESA programme was highlighted at the ESA Ministerial in The Hague in November 25-26, 2008, with Germany being the biggest contributor to the GSC programme.

Figure 1: GMES Services Core projects and Primes of pan-European Teams

The GMES geo-information services will be supplied with earth observation data from a GMES fleet of satellites. The first component of this fleet will consist if five series of GMES SENTINELs, implemented under the ESA GSC programme:

Sentinel-1: a C-band interferometric radar mission, providing continuity to the ERS and ENVISAT Satellites, but with higher ground resolution and more capacity per orbit.

Sentinel-2: a multispectral optical imaging mission, providing improved continuity for SPOT and Landsat kind of multispectral optical data.

Sentinel-3: a mission with a dual band (Ku and C) microwave altimeter, a wide-swath optical imager (OLCI = Ocean Land Color Instrument) with 21 channels and a visible/infrared radiometer for sea/land surface temperature observation.

Sentinel-4, -5: two families of atmospheric chemistry monitoring missions, developed in close cooperation with EUMETSAT and operated as a dedicated payload on EUMETSAT geostationary (Sentinel-4) and polar orbiting (Sentinel-5) satellites.

These SENTINELS will be complemented by additional European national and non-European (3rd party) satellites to fill gaps in the data supply and to deliver information for high resolution mapping and security-relevant tasks (Figure 2).

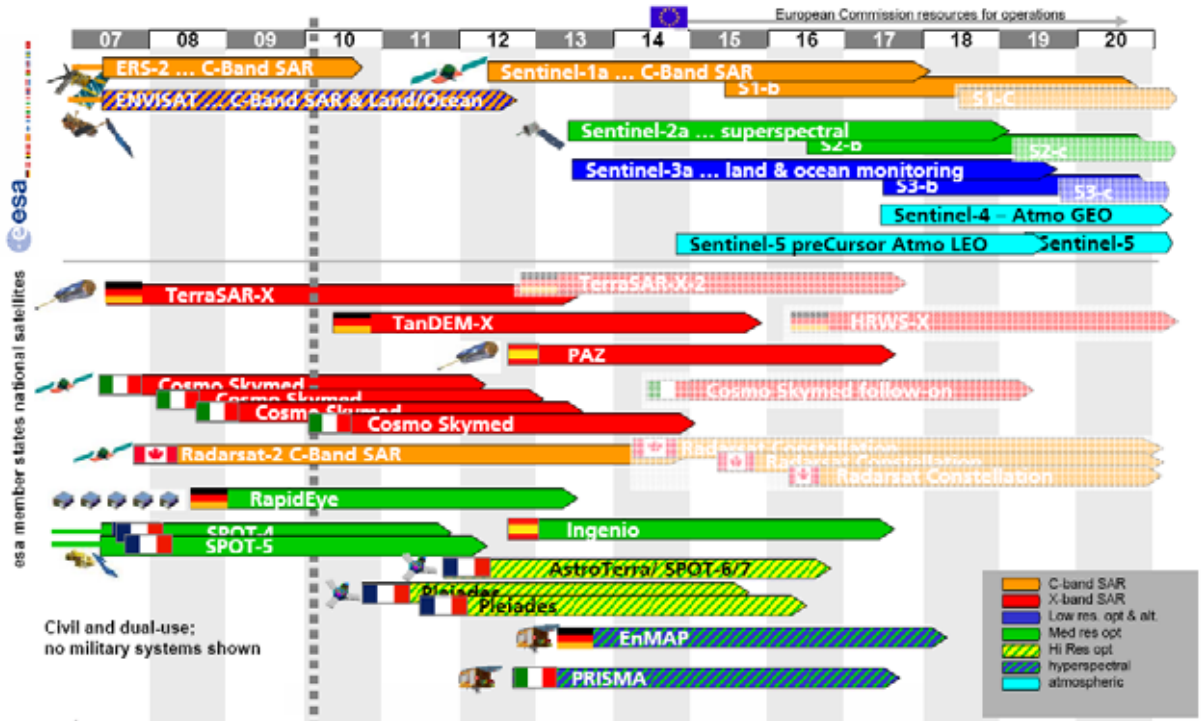

Figure 2: GMES SENTINEL and European contributing Missions

Baseline for the access to the orbiting satellites will be multi-mission ground segment, based on national facilities, data centers and near-polar acquisition stations. These stations are complemented by (at least two) geostationary European Data Relay Satellites (EDRS), allowing real time programming and data transfer to those SENTINELS (currently 1 & 2) and national missions (currently TerraSAR-X and post-TerraSAR-X missions) equipped with appropriate Laser Communication Terminals (LCT).

Apart from its financial contribution to the ESA and EC GMES programs, Germany contributes several earth observation systems – already in space or to be launched – to the GMES programme.

TerraSAR-X: launched in June 2007, this very high resolution multi-mode X-Band SAR satellite is operated as a Public Private Partnership (PPP) between DLR and the company ASTRIUM/InfoTerra. Its phased array X-Band SAR antenna and the precision of the geolocation of SAR pixels are already now subject to innovative applications such as moving object detection and repeat pass SAR interferometry.

TanDEM-X: By 2010 TerraSAR-X will be accompanied by a twin satellite. Manoeuvred in a unique helical orbit with TerraSAR-X, this TanDEM-X satellite will circle around TerraSAR-X just a few hundreds meter away and will form the first bi-static SAR interferometer in space in order to generate the most precise global Digital Elevation Model (DEM). (*DLR, 2009; Zink 2006*).

RapidEye: The constellation of 5 small satellites was successfully launched in August 2008 from Baikonur. Each of the five satellites carries a 5 band push broom scanner at 6,5 m GSD. The constellation enables a daily coverage of all land masses of the earth. RapidEye is owned and operated by RapidEye AG of Brandenburg, Germany (www.rapideye.de).

EnMAP: A DLR owned and operated hyperspectral imaging mission with >200 spectral channels at 30m ground resolution and 30km swath. EnMAP is scheduled to be launched in 2013 and will primarily serve science needs, whilst operational applications should be demonstrated.

ResourceSat and CartoSat: The company EuroMap; Neustrelitz, Germany, holds the exclusive European acquisition and marketing rights for the Indian Remote Sensing (IRS) satellites (www.euromap.de). The IRS-P6 (ResourceSat) is the current working horse for European land coverage. The IRS-P5 (CartoSat-1) with its 2,5 m in track stereo b/w capability is a unique source of Digital Elevation Model (DEM) information. EuroMap and DLR are teaming to downlink and process the data at the DLR facility in Neustrelitz.

IKONOS and WorldView-1/2: After having access to the IKONOS satellite, the company European Space Imaging (EUSI), Munich is now teaming with DigitalGlobe to have direct access to the WorldView-1 and -2 satellites (www.euspaceimaging.com). The latter has 0,5 m resolution and is tasked from and acquired by a station at DLR, Oberpfaffenhofen. All these very agile and responsive submetric satellites form the basis for many GMES applications such as emergency mapping and civil security.

GMES Data Policy

A pan-European approach to establish new earth observation capabilities and to use existing and planned ones, needs a clear understanding on how und under which regulations the raw and processed satellite data and the derived geoinformation is available to its users. As far as traditional “geoinformation” is concerned, the European Union established the INSPIRE directive (Infrastructure for Spatial Information in the European Community) in May, 15th, 2007. INSPIRE sets a regulatory framework to ensure that the spatial data (as defined in three annexes) and infrastructures of the Member States are compatible and usable in a community

and trans boundary context (*Duformont, 2009*). Annex II of the INSPIRE regulation includes orthorectified imagery from air-, as well as from space platforms. Though INSPIRE requires all data sets concerning environmental reporting obligations to be free of charge (to the European Union and its services), INSPIRE deliberately does not affect in principle already established data policies and eventual data fees. However, fees should be set to a minimum to guarantee access and the necessary quality of the data.

While INSPIRE is still under implementation, the supply with earth observation data for the actual GMES pilot services need to concern existing data policies and to establish interfaces to existing data catalogs.

In the implementation of the GMES pilot services within the 7th Framework Programme (FP7), the EC has denoted a significant amount of resources for ESA to establish contracts with the space data providers. Based on the data requirements from the major GMES projects, a complete list of data needs has been established. Challenged by changing or "not-clearly-definable" requirements (i.e. emergency response), data is now delivered from various sources, including commercial suppliers. In order to allow a transparent search and ordering of this data, ESA required the suppliers to implement a "Heterogeneous Mission Accessibility" (HMA) gateways, which allows ESA (and hence the projects) to be always up-to-date with existing and planned data in the various archives (https://earth.esa.int/hma). These data are then available to the GMES Service participants free of charge; however under a sub-license agreement, which does not allow to distribute the data beyond the Service and which has certain restrictions in the distribution of value added products generated from the data.

Whilst these restrictions may apply for data derived from missions financed outside the GMES regime, or even by private investment, it is clear that the access to the dedicated SENTINEL-satellites must be governed by a more liberal policy. This policy must be in line with international commitments such as the GEOSS data sharing principles (GEOSS, 2009) and the Principles Relating to Remote Sensing of the Earth from Outer Space, adopted by the General Assembly in its resolution 41/65 of 3 december 1986. Hence, ESA proposed a "free and open" policy (ESA, 2009) under which:

- Sentinel data is accessible via a generic on-line access mode and thru a registration by anybody without difference between public, commercial and scientific use and in between European or non-European users;
- The licenses for the Sentinel data itself are free of charge;
- Additional access modes and products subject to tailored conditions;
- Eventual security restrictions may apply to specific Sentinel data.

Especially the policy of "free data for all" from the SENTINEL missions was subject to discussions in the European framework, where some member states have invested in the commercialisation or public-private-partnerships in earth observation. The final data policy is based on the consensus, that the SENTINEL missions shall address the low and medium resolution data needs, whereas other (including commercial) suppliers shall care for the data from rapid coverage and very high resolution missions.

This change in ESA data policy will also affect the data distribution scheme of the existing ESA mapping missions (i.e. ERS-2 and ENVISAT). So far, ESA has

distinguished its data users in users for science and non-commercial application needs (CAT 1) and users with commercial objectives (CAT 2) and has appointed two commercial consortia (i.e. EMMA, lead by Telespazio, Rome and SARCOM, led by SPOT Image, Toulouse) to distribute the CAT2.

Recognizing the value of long time series of data for environmental observation, the last ESA ministerial in 2007 has launched the Long Term Data Preservation (LTDP) initiative. Therein, a compilation of the existing European data archives and investigations in long term archive technologies and policies are performed to allow implementing a permanent programme, in-line with the policies of ESA, its member states and international bodies, to take care for the growing earth observation archives. If not even directly implemented under the GMES, the GMES services and global data users shall take benefit from the availability of historic earth observation data.

Data Policies for German National Missions

As mentioned earlier, Germany contributes with several earth observation missions to the GMES data supply. One of these mission lines is based on the significant investment of Germany in the development of spaceborne X-Band SAR technology. One initial highlight was the1994 joint NASA-DLR mission Shuttle Imaging Radar (SIR-C/X-SAR), where Germany has contributed the X-Band antenna and the 2000 Shuttle Radar Topography Mission (SRTM), yielding the so far best global Digital Elevation Model (DEM).

Based on the experience in in-orbit technologies and the value of X-Band data, the first national SAR mission – TerraSAR-X – was realized as joint initiative between DLR (on behalf the German Ministry of Research and Education) and the lead industry in SAR technology in Germany, Astrium. The initiative was implemented as a “Public-Private-Partnership” (PPP) March 25th, 2002, under which DLR invests the larger part of the project costs, takes the project lead, the mission control and the ground segment development and operations for the new TerraSAR-X mission. The commercial partner ASTRIUM GmbH contributes to the mission costs and has the duty to develop the commercial market; moreover to invest the commercial revenue in data sales in a (then fully commercial) continuation of data supply based on follow-on missions. Within the PPP, DLR is responsible to distribute TerraSAR-X data to users with clear science objectives, evaluated in an “Announcement of Opportunity” (AO) process, where users describe their science projects, partners and data needs. On the other side, InfoTerra, Friedrichshafen, Germany, (a subsidiary of ASTRIUM) is responsible to sell TerraSAR-X data to commercial customers worldwide, including the public demand in and outside Germany. Marketing may include granting direct TerraSAR-X data acquisition (Data Access Terminal, DAT). The tasking share between science and commercial use of the data is about 50/50, but each partner has the right to get the full set of data, independent from the question who ordered those data.

Clarified In the post-launch implementation of the PPP, DLR can also serve non-science requests such as data need in natural disasters as declared thru the International Charter on Space and Major Disasters (www.disasterscharter.org). Also international non-commercial programmes such as the UNESCO Open Initiative to

help to preserve the World heritage sites by using earth observation data is supplied thru DLR with TerraSAR-X data (*Hernandez, 2005*).

The PPP with Astrium/InfoTerra is being extended to the TanDEM-X mission. Based on contributions from Astrium, InfoTerra retains the marketing rights for the global DEM derived from this TerraSAR-X twin satellite constellation, to be launched in 2010.

A second PPP, though with a larger role of industry and private investment, was created with RapidEye AG, Brandenburg, Germany. In return to financial contributions to the 5 satellite Rapid Eye constellation, respectively camera systems, DLR got rights to use and distribute a certain amount of RapidEye data for science use (RapidEye Science Archive, RESA).

EnMAP will be a mission with primarily scientific objectives and is therefore implemented as a full DLR national mission. EnMAP shall however serve as a precursor to exploit possibilities for operational use of spaceborne hyperspectral data. Implemented with a clear science perspective in mind, the EnMAP data policy shall also give room to encourage value adding companies to enter this new domain of earth observation. The EnMAP data policy will be adapted to both needs.

The availability and distribution of submetric, high quality SAR data over global terrain, required a clear regulation on how the national security interests of Germany and its partners are not affected by SAR based intelligence availability over critical areas. Considering the international regulations and the objective to develop the commercialisation with clear supporting guidelines rather than a restrictive case-by-case basis process, and taking a general approach beyond SAR observation technology, Germany developed the Satellite Data Security Act (SatDSiG) which entered into force December 1st, 2007 (*German Federal Gazette, 2007*).

The Act addresses only German satellites, operated by German citizens. Hence the acquisition and distribution of Indian and US satellite data by German companies/ entities is not affected and assumed to be regulated under corresponding Indian and US law. Further on, the Act does not concern governmental satellite systems, which work for military/intelligence services.

The regulations of the Act only apply to “high grade” earth observation systems. The definition of “high grade” is described in the Act and consists of defined limits of geometric and spectral resolution, amongst others. Whereas, TerraSAR-X is regulated under the Act, the optical resolution of RapidEye and EnMAP is regarded as uncritical under the Act.

This Act requires an operator license for the operation of a high-grade earth remote sensing system (Part 2, Section 3) and a dissemination license for the dissemination of data of such a high-grade system (Part 3, Chapter 1, Section 11). In practice the Act is clearly focussed on a clear and transparent procedure for the first time dissemination (both science and commercial) of earth observation data. “First time” here means that all data use/dissemination beyond the initial data distributors, directly responsible to German law under the Act, shall not be directly affected. For TerraSAR-X, two German entities have got appropriate governmental licences: DLR for the mission operations and distribution of data to science users and InfoTerra for the data distribution under the commercial scheme.

This license is only granted to entities, which demonstrate a significant degree of liability and have technical means to protect the access to the data. The latter includes that all commands to the satellite are generated in Germany and are encrypted by an admitted encryption scheme. A secure encryption mechanism applies also to the down linked data, as well as further secured archiving and distribution mechanisms. Commercial partners need also to show protection for foreign business takeovers.

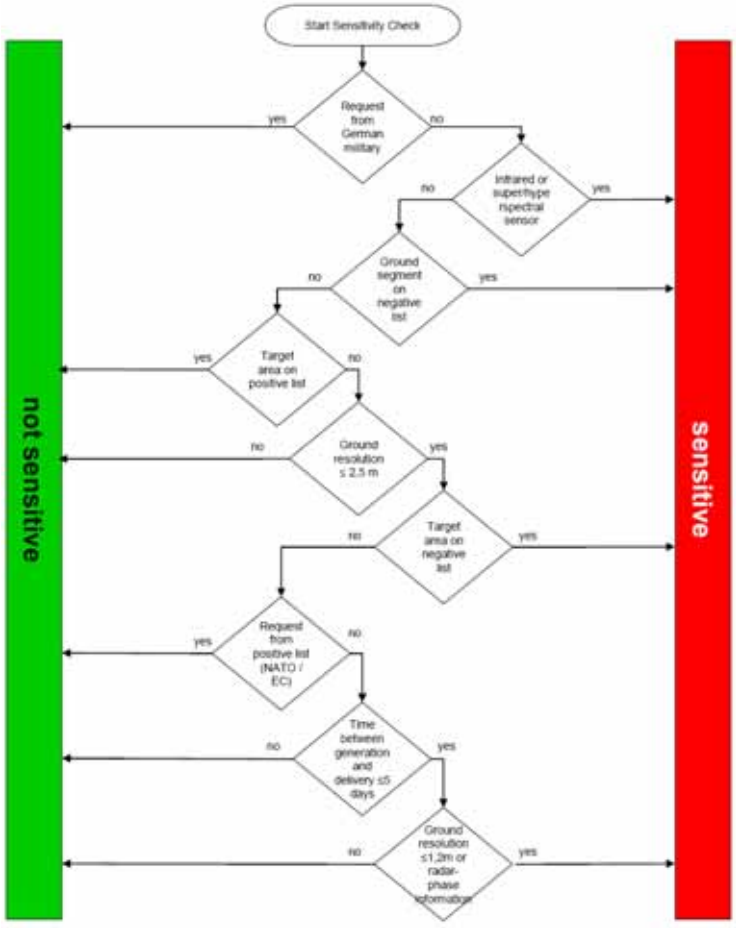

Figure 3: Decision Tree for German Satellite Data Secutity Act

The distribution of the data outside this secure perimeter to national and international users, is governed by a “sensitivity check” in a decision tree (Figure 3). Therein, the category of users, a positive and negative list of target areas, the geometric resolution and the timeliness from data sensing to product delivers (i.e. near real time applications), determine whether a product can directly be delivered to international users or the delivery needs a permission by the governmental authority in charge (here: Federal Office of Economics and Export Control, BAFA). The sensitivity check is under the full responsibility of the licensee. Demands from “critical customers” can be evaluated by BAFA in advance to allow transparent business cases.

Future Aspects for Earth Observation Data Policy

The European GMES programme require a clear policy on how to access, distribute and use the data and clear regulations what restrictions should apply, e.g. for security reasons. The various political partners in the GMES governance structure need to find clear policies for these objectives. Whether policies from other European operational earth observation programmes, such as the EUMESAT weather satellite constellation, could be used as a template need to be seen. Embedded in an international context of global programmes, such as GEO/GEOSS, GMES need also to find an answer on how to integrate the various data policies from its contributing entities. This includes defining the role of commercial data providers, and the market are they going to address. Not an easy question in the ebb and flow of opinions concerning earth observation data as a public or private good in the recent years.

This paper has highlighted how German earth observation missions contribute to these duties specifically in the GMES context and how DLR is supporting to define clear earth observation data policy guidelines in close cooperation with national aand international legal bodies and its international partners.

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Biography of the main author

Gunter Schreier is working as Head of Business Development at the German Remote Sensing Data Center of DLR (DLR-DFD) and is the coordinator for GMES initiative. He has served at DLR in several functions since 1985, among others as Head of the Technology Transfer unit and team leader for establishing the ESA-ERS „Processing and Archiving Center“. He has business experience as founding Vice President Geomatics for Definiens and has worked as national expert at the Joint Research Center of the European Commission. Gunter Schreier has a diploma in Geophysics from University of Munich. He is member of several international workgroups and organisations such as the International Policy Advisory Group of ISPRS.