A New Perspective for Earth Observation: The Oxygen (O_2) Project

Introduction

Europe has achieved worldwide leadership in many scientific areas of Earth Observation with SAR imagery, interferometry, oceanic altimetry, atmospheric chemistry, to name just a few. On the other hand, Earth Observation has failed to evolve into a mature and self-sustainable operational or commercial activity. Hence, it has not allowed the development of a service industry of any economic significance. We believe that the causes for these drawbacks are rooted in a number of characteristic features of the current approach to operational Earth Observation. Drawing lessons from the failure in Edinburgh to coordinate national initiatives, we propose, in this document, a new implementation strategy for the Earth Watch missions, which shifts from the current technology-pushed to a market-pulled, user-oriented approach. In the mid term, this strategy would provide the full interoperability of all European Earth observing space systems. In the longer term, it aims at building up the necessary rationale, momentum and resources for the definition, deployment and operation of the next generation of European operational satellites. This strategy calls, in the short term, for the complete overhaul of current policies and the introduction of advanced technologies for distributing Earth Observation data from existing space infrastructure. We believe that the fostering of operational services requires the development of an integrated, transparent and user-friendly infrastructure to access information from Earth Observation missions in Europe. In this new paradigm, easy and inexpensive access to Earth Observation data is seen as the critical element and should be granted to any partner willing and capable of developing new applications and services. This strategy is perceived as an enabling mechanism to allow the development of a powerful service industry in Europe which would facilitate and encourage future investments in Earth Observation satellites. It is also considered critical for the implementation of GMES. The proposed approach is finally also intended to provide opportunities for turning one-off Explorer missions into operational systems and replies to requirements expressed in the Living Planet Programme for long-term scientific observations.

1 Earth Observation today

1.1 Europe's successes

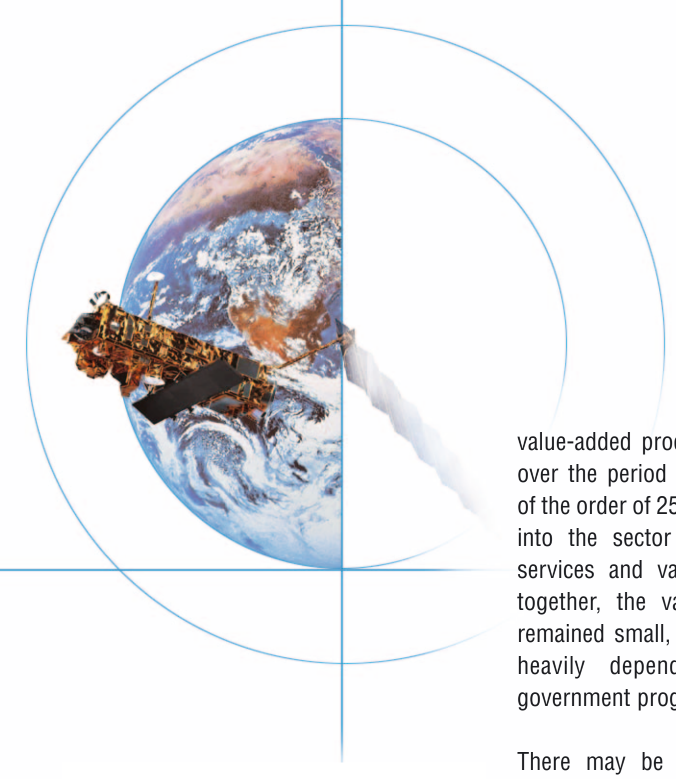
Europe has gained clear leadership in several critical technologies and in the scientific use of Earth Observation. The last 25 years have seen substantial, often unique, European contributions to such different sectors as operational meteorology, radar imaging, radar altimetry, oceanography, glaciology, radar interferometry, climatology, atmospheric chemistry, geodesy and others.

From the very beginning, the Meteosat series has put Europe at the forefront of operational meteorology. The recent launch of MSG provides the most advanced capability from geostationary orbit. The forthcoming EPS/MetOp will offer unique capabilities in advanced atmospheric sounding (IASI,GRAS). Europe has gained undisputed worldwide leadership both in technologies and applications of SAR (C-band in ESA and Canada, X-band in Germany and Italy). The best-known SAR applications include ocean and ice monitoring and the most sensational results are associated with the use of interferometry. Displacements associated with earthquakes, inflation of volcanoes before eruption, subsiding areas in urban environment as a consequence of major works or water/oil/gas extractions: these are just a few examples of the extraordinary potential of SAR interferometry.

Europe is also at the forefront of Earth Observation from space in the optical/multispectral imaging domain thanks to the Spot family. MERIS on Envisat is internationally recognized as providing unprecedented spectral resolution in support of land and ocean science and applications.

Ocean altimetry is another major European achievement thanks to Radar Altimeter instruments on ERS-1/2, Topex-Poseidon, Envisat, and Jason. The extraordinary accuracy achieved with this technique has been inherited from the expertise developed in geodesy/orbitography, which also led to a number of advanced geodetic missions (Grace, Champ, GOCE).

Envisat is carrying the three most advanced instruments to date to study atmospheric chemistry (MIPAS/GOMOS/Sciamachy). The international Earth science community will access the data from these instruments to better understand and model the complex processes taking place in the atmosphere which are believed to be critical in understanding increases of the greenhouse effect. It is also worth recalling that ATSR on ERS-1/-2 and Envisat is the most accurate source of sea surface temperature from space and the only one available which has the potential required to study long-term climate change by virtue of its accuracy and continuity over up to 18 years in orbit.



A new strategy should capitalize on available assets and maintain the world-leading role of Europe in the development of operational environmental and security services based on Earth Observation.

1.2 Earth Observation business: a disappointment?

An Earth Observation service industry came into existence (thanks in particular to the efforts of the French company SPOTIMAGE) in the late 1980s and grew steadily in the 1990s, riding a wave of optimism resulting from the initial availability of data from the first commercial high-resolution satellites. The total annual revenue of the European Earth Observation industry at the end of 1997 was 207 MEuro, representing an annual growth of 6% over 1995-96. While the private market has been continuously strengthening, it still remains much smaller than the public sector market, mostly defence, still representing 64% of the total market. The private sector growth benefited mainly from the telecommunication sector (infrastructure deployment for cellular phones), followed by oil and gas exploration.

In 1998, the industry itself forecast that its revenues would rise to between 245 MEuro and 340 MEuro by 2000. In the event, by 2000, the total European revenues had reached only 216 MEuro. This is equivalent to an annual growth of only 1.4% over 1998-2000, which represents a decline if annual inflation is taken into account. Revenues are coming from the sale of data and data rights (20%), sales of ground segment equipment and software (26%) and sale of services and value-added products. It is estimated that over the period 1998-2000, public money of the order of 25 MEuros/year was injected into the sector for the development of services and value-added products. All together, the value-adding industry has remained small, dispersed and fragile and heavily dependent on income from government programmes.

There may be several reasons for this disappointing performance. One is, possibly, the fact that space agencies worldwide have put their focus on the development of space hardware rather than the development of services. This lack of substantial public investment in the downstream sector was matched by industry, given the bleak perspective and the disappointing market pull by the user community. Indeed, users, customers and market owners have been reluctant to express requirements and to integrate Earth Observation information sources into their business practices. The validation of new information sources and of new services is not a one-off operation and needs to be supported over a sufficient term to encourage users to adopt new business practices. Finally, many potential users and customers of space information are simply not aware of the benefits they could accrue from using Earth Observation.

In this context, the two major causes that can be identified are the barrier of data cost and the hurdle of data access. We have daily reports of academic groups and small private service companies developing prototype applications using SAR and MERIS data. The validation at full scale of these services would require amounts of data that they just cannot afford under the current ESA data policy conditions. These actors are left with the alternatives of either giving up their spin-off projects or using US scientific data which are available free of charge. It should be recalled that GPS and Internet applications could be developed by millions from academic spin-offs and private initiative because the system was freely and easily accessible. Inexpensive, or even free access to data is certainly a necessary, if not sufficient, condition for the development of a mature service industry.

1.3 A need for information and services, not for data

Services, whether commercial or public, are about the provision of the right information at the right moment to the proper person. High-level operational information services are needed, and not simply space data or satellite images. Scenarios, estimates of socio-economic impacts, quantitative statistics, trends and forecasts are demanded at various geographical and temporal scales in support of European policies and this will be the purpose of GMES. Quantitative assessment and control are required in support of industrial and commercial activities (agriculture, insurance, construction, tourism).

Future information services will be characterised by a stronger integration of space data with all kinds of other data and information and require a knowledge-based approach making full use of European expertise in Earth sciences, information technologies, economics and social sciences. The complexity of this next generation of integrated services may also require a network of partners who will contribute to the production of information services. This will also require that Earth Observation data reach out as far as possible away from the space community.

It is currently very difficult and expensive to access and integrate Earth Observation data from several different sources. It is therefore necessary to develop tools to allow operational data acquisition and handling in coherent formats and through a coordinated access chain.

The successful, mature uptake of Earth Observation will require the integration of European capabilities in modelling, data management and service delivery to describe the state of our environment and to predict responses to actual and potential change.

1.4 The potential for synergy of Earth Observation missions

Amongst the inadequacies of existing Earth Observation systems that are often cited, one of the most important is the lack of timeliness and the insufficient frequency of observations. For example, in order to provide useful information to support prevention, assessment and support in case of natural disasters, frequent coverage and near-real-time access to information, not data, are crucial requirements, a must. Today, after thirty years, Earth Observation still remains largely an R&D tool. Despite the many Earth Observation satellites in orbit, it is not yet possible to get "the right information at the right time". When used separately, few if any of the current in-orbit systems can provide operational information to a wide community of users, whereas used in a cooperative way, as a single interoperable system, they could.

Therefore,without waiting for large dedicated satellite constellations, the situation can be improved significantly by better integrating existing satellite sources even of different resolution, quality, etc. Currently, more than 50 Earth Observation satellites are in orbit worldwide, carrying more than 150 instruments, of which approximately 20% are operated by European space agencies (ESA, Eumetsat, CNES, DLR, SNSB). Among those, there are about 15 civilian Earth Observation satellites available, which provide imaging data in the 3-30 metre resolution range using optical, infrared or radar sensors. Each of these instruments has its own specific purpose, but there is a clear lack of an integrated and synergistic approach to fully exploiting the very large volume of available measurements. The Executive believes that there is a major opportunity within reach at this moment in time to overcome the individual shortcomings of each mission by jointly operating and exploiting this multitude and variety of instruments and thus easing the task of building and providing operational services.

This benefit has also been recognized by the WMO community which states that "space agencies will continue to be encouraged to make their observations available to the Global Observing System (GOS) without restriction. This will include data from R&D satellites which are deemed to be relevant to the GOS" but should also include "high resolution optical and radar space imagery [for which] access to data remains an issue."

"The aim is to bring about a very significant increase in the availability and utilisation of data, products and services, not only in terms of volume and variety, but also in the geographical spread of the users. The increases which are already promised by the upcoming satellite systems in terms, for example, of higher spatial resolution, more frequent observations and the availability of more spectral bands, are not simply minor improvements, but represent in many cases step changes. Making these significantly improved data, products and services available and at the same time aiming to increase the number and geographical spread of the users, will represent the major challenge for the WMO Space Programme in the next decade." The proposed new approach to the Earth Watch programme should bring the necessary coordination of existing and future capacity.

1.5 Duality is everywhere in Earth Observation

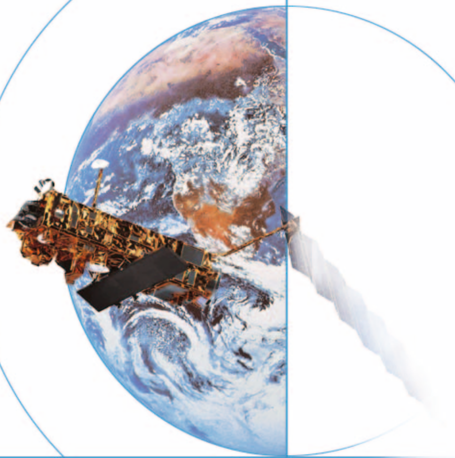
Use of civil space data and services by security/defence customers is common practice in Earth Observation. As an example, meteorology, which relies extensively on space assets, and has a wide range of well known civil applications, has been supported and used by the military sector in Europe from the very beginning in a wide number of applications ranging from air-traffic management to maritime navigation support, and even to forecast battlefield weather conditions. The United States is phasing out the dedicated civilian-only (POES) and military-only (DMSP) meteorological satellite systems, converging towards an integrated civil/dual use system (NPOESS).

The same scheme existed for altimetric applications (Geosat), which is now being supported by civil sensors (Topex/Poseidon, Jason, ERS-1/2 RA and Envisat RA-2). Cartographic applications cover both civil and part of military needs: the extensive use of Spot data during the 1991 Gulf crisis as well as the Afghanistan campaign are other well documented examples.

The use of space-borne SAR to support navigation in ice-infested waters or to control maritime traffic in specific areas are additional examples of dual use. On the one hand, civil authorities want to control fishing activities in European Economic Coastal Zone or illegal oil discharges at sea, while security authorities would use the same technique to monitor maritime traffic in strategic areas.

Derivation of Digital Elevation Models (DEM) from civil optical or SAR sensors is exploited for civil but also security applications. The idea that defence customers should make use of civilian space Earth Observation data whenever available, while developing dedicated systems only where the requirement cannot be met by civilian systems, is becoming common practice and is being presently formalised as US policy.

The United States has developed this approach to the extent that it charged a military agency, the National Imagery Mapping Agency (NIMA) with providing anchor tenancy for a number of initiatives (Space Imaging, Digitalglobe, Orbview). This policy has not been sufficient to bring these initiatives to a sustainable level and the recent Clearview contract demonstrates that, in the absence of a significant civilian service industry, the institutional role is essential for guaranteeing the availability of the infrastructure. A single integrated dual approach is practical and the only affordable solution to European needs.



2 Sustainability

2.1 A need for long-term continuity

The UNFCCC (Untied Nations Framework Convention on Climate Change) Report on the Adequacy of Global Climate Observations, the GMES Forum and the WCRP (World Climate Research Programme) are all advocating the need for continuity of Earth Observation sensors for climate observations. Even short-term applications, such as disaster monitoring, require a long-term perspective of data provision to justify the adaptation of the institutional and technical infrastructure in favour of using space technology. For Earth Observation to be a viable information source for policy implementation, continuity should be guaranteed. But continuity cannot be guaranteed until a community of users has expressed a sustainable demand and a mechanism to support the provision of information. This chicken and egg situation has been solved in the cases of meteorology and defence. With a few exceptions, Earth Observation missions are one-time R&D missions with lifetimes of around 5 years.

For WCRP, the value of space missions comes mostly from the capability to produce globally integrated, high quality and reliable climate data products, requiring the merged analysis of measurements from the whole constellation of operational and research/ demonstration satellites.

The WRCP "space strategy" relies upon the availability of long-term, stable and high quality observations as currently provided by operational satellites (such as the meteorological series) complemented with innovative, process-oriented observations as provided by research satellites using new technologies.

Long-term continuity is linked with sustainability and requires the setting-up of institutional and/or commercial funding frameworks, transferring the maintenance of operational systems outside the R&D institutions and budget lines. This requires the extension of existing mandates of organisations or the establishment of new ones. It also requires the introduction of new schemes for the relationships between institutions and industry (both manufacturing and service industry). Sustainability is a key issue in establishing operational services. It is recognized as such by the current Earth Watch Strategy and Earth Watch Declaration.

The following paragraphs provide a short analysis of the most popular models and schemes considered in the attempt to achieve sustainability. None of these models is the universal solution, and a suitable mix will have to be developed.

2.2 The "Eumetsat" scheme

An Intergovernmental Conference in the early 80s agreed to establish a new meteorological organisation. The Eumetsat Convention entered into force in 1986, with Eumetsat inheriting the Meteosat programme from ESA. In 1991, it initiated a new programme, the Meteosat Second Generation Programme, in order to ensure continuity of observations from geostationary orbit into the second decade of the 21st century. In a decade, Eumetsat had become a mature organisation with direct responsibility for the operation of its satellites in orbit and with new programmes to ensure the continuity of observations.

In such a scheme, public funding comes from sources not necessarily of an R&D nature. The institutional users are the national meteorological offices, which fund the procurement of new fleets of satellites which are tuned to respond to their specific needs through an operating agency, Eumetsat. ESA, in agreement with Eumetsat, takes care of research and technology activities and is charged with the development of the spacecraft.

It should be investigated whether such a scheme can be extended to other major institutional users of space data such as environmental or civil security agencies.

2.3 The "Utilities" scheme

Earth Observation data are a necessary condition to the provision of a large number of information services which provide economic benefit.

The European Union and its member states have signed a large number of agreements, both at European and international level. Many of them address environmental topics, an area which Europe has identified as a policy priority among its global partners. Examples where monitoring of EC legislation is required are the Common Agricultural Policy, the environment and development policies, or specific legislation within these such as the Water Directive, the European Spatial Development Perspective, or the 6th Environmental Action Plan.

The space contribution varies from minor to essential, but there is no question about its added value, in particular in support of institutional and public benefit uses. The information derived is addressing several areas of institutional responsibility (from weather forecasting to disaster monitoring and prevention, to aid to developing countries, to monitoring the implementation of treaties).

The satellites and the ground segments providing these data can be considered as essential infrastructures, like roads, motorways, electrical distribution networks, etc. Procurement and operation of these infrastructures is a public responsibility, better coordinated at European level, leaving to industry the role of developing and providing services and deriving commercial benefits.

2.4 Still a chance for PPP?

In Public-Private Partnership schemes the business case becomes a critical element of the entire programme, including space segment, ground segment and service sector. Industry is committing to invest in the programme at the forefront, in anticipation of future revenues.

This was made possible in the United States because major institutional customers have been open to underwrite “anchor tenancy” agreements with private sector providers. This approach has not been very successful, as these entities (IKONOS, QuickBird, etc.) have failed to reach other customers. The recent Clearview contract and the refusal of some of the private investors to support further development, provides evidence of the inherent weakness of this scheme.

The lack of commitment of public authorities to rely upon information services that include Earth Observation data sources, has not encouraged industry to engage in this process up to now. Industry will continue to be reluctant in the absence of reasonably guaranteed revenues in the short to mid term, and the role of institutional sponsor/customer is central to this scheme, as in the previous ones.

It is worth noting that the successful development of new services would bring benefits to the service industry and to market owners. It is therefore this industry which should be targeted in the future for a PPP scheme, and not only the space manufacturing industry.

3 An end-to-end long-term strategy

3.1 Introduction

The strategy presented here is intended to provide an alternative approach to developing the future Earth Observation operational infrastructure. While capitalizing on previous investments and successes, it should respond to the questions raised in the previous paragraphs regarding the sustainability of Earth Observation initiatives and overcome the current fragmented approach. The present lack of offers of operational services justifies the absence of long-term commitments from governments and private investors.

Over the long term, this strategy aims at the creation of a sustainable space infrastructure providing information in support of institutional and commercial services in Europe. This infrastructure should be tailored to the exploitation requirements expressed primarily by value adding companies and service providers. Therefore, the preparation of a future operational infrastructure relies initially upon the successful exploitation of current missions.

The present strategy proposes to implement changes in the current management and exploitation of Earth Observation programmes in order to maximize the use of current and planned satellite capacity in orbit in the short to medium term and to establish satisfactory operational services in a number of strategic sectors. It rests on three pillars which should be built in parallel over the next three years.

3.2 Pillar “S” : Developing services

This phase was initiated after the Council at Ministerial Level in Edinburgh and covers the development and the making operational of services. It will be accelerated. A number of instruments have been implemented following the decisions taken in Edinburgh both within ESA and the European Commission (GMES Service Element (GSE), Earth Observation Market Development (EOMD), Data User Element (DUE) and the EC 6th Framework Programme). The activities initiated through these instruments will receive increased support in order to generate rapidly representative forerunners of operational services. Access to new data sources will allow an improvement in the services provided and/or enable new services.

3.3 Pillar “C”: Providing access to current data sources

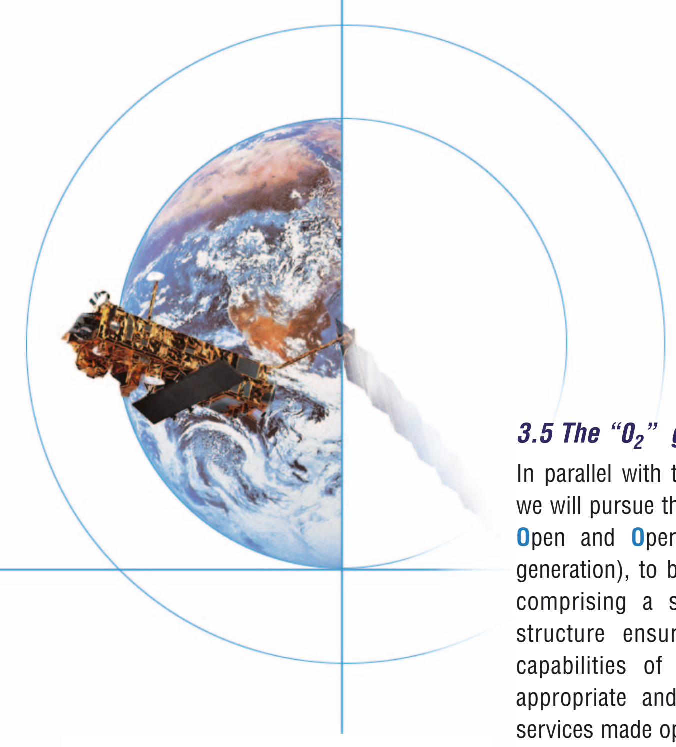
Information about Earth Observation services, data availability, project results and applications is currently accessible only in a very scattered way through different mission operators, scientific institutes, service companies, data catalogues, etc. Accordingly, only a limited community, knowing what to search for, is today in a position to collect and compile the necessary Earth Observation information. Easier and timely access to large quantities of primary data is a condition for delivering effective services.

The objective of this phase is therefore to offer European value-adding service industry straightforward, fast and economic access to data from the largest possible range of satellites. It is intended to primarily provide this service from ESA satellites and to progressively enlarge it to include other European satellites and, later on, non-European partners.

The current ground segment created for ERS, Envisat and the Multi-mission user services will require upgrading and streamlining in order to offer users a single interface and a coherent environment for programming observations from several satellites and delivering combined products and organized data sets.

Access to non-ESA satellites will require the establishment of agreements with the respective satellite operators. They should be negotiated and implemented in order to preserve existing national and European capabilities and assets. In addition to ERS and Envisat, such a system could provide access to Spot, DMC and Radarsat imagery, to other European scientific missions and possibly to non-European scientific and operational satellites.

These activities are a natural extension of the mandate ESA has received through the Earthnet programme, the Envelope and the Earthwatch programmes. They will be implemented within already allocated



funding, in the period 2003-2004. The deliverables from this activity will consist of an integrated interface to service providers and value adders for accessing satellite data and programming functions.

3.4 Pillar "N": Integrating upcoming Earth Observation national projects in Europe

A set of Earth Observation missions are planned at European and national level in the next 2 to 8 years. Most of these missions provide high-resolution imaging data from radar and optical instruments, for civilian and defence applications: Terrasar X, Cosmo-Skymed and Pleiades. In addition, Terrasar L and, possibly, Rapid Eye will be considered.

The ground infrastructure introduced in pillar "C" should be naturally extended to support these missions. Again, specific agreements will need to be set up with the relevant non-ESA programmes. The mission control and planning function will, for several reasons, remain specific to each mission or family of missions.

The resulting landscape, in the timeframe 2007-2008, should present the following picture:

- A set of institutional and commercial services including, but not limited to, a response to GMES requirements.
- A data distribution mechanism common to all these missions, including processing, archiving and distribution and allowing easy and coherent access to a wealth of intercalibrated data sets.
- A complex constellation of satellites in orbit, resulting from a set of more-or-less independent initiatives.

3.5 The "O_2" generation

In parallel with the previous three phases, we will pursue the preliminary design of an **O**pen and **O**perational system (the "O_2" generation), to be deployed as from 2010, comprising a space and ground infrastructure ensuring continuity with the capabilities of current systems, where appropriate and justified by the set of services made operational within pillar "S".

4 A Precedent: The International Charter on Space and Major Disasters

The International Charter on Space and Major Disasters is a first answer from the space community to face some of these challenges. The Charter is working successfully and provides civil protection agencies with access to data from a range of satellites. For example, during 2002, 7 major disasters were covered by the Charter. This was supplemented by another 8 activations for minor disasters, out of the about 100 which occurred worldwide. In the case of the Prestige oil spill, where all countries concerned made extensive use of ERS, Envisat and Radarsat data, the first image was acquired after three days. Today ERS and Envisat follow the event at the rate of two images every three days. The mechanism of the Charter, although successful in giving access to data, suffers evident shortcomings owing to the lack of data integration and of association with an operational service provider.

5 Benefits and challenges

The proposed initiative addresses directly the way information is elaborated and distributed in Europe. It needs to rely upon an efficient network for the circulation of data and information. It requires the development and improvement of information processing technologies. It requires the education and training of adequate personnel for analysing data and interpreting results. It requires a drastic expansion in the use of models for interpretation and forecasting in several domains. The links between the operational users, the aerospace industry and SME service provider industry at large and the science community will need to be reinforced. In short, when pursued in its entirety, the proposed initiative will have a substantial impact on the evolution of Europe as an information society.

The present strategy raises a number of significant challenges. The main ones are the design and implementation of the exploitation segment, the definition and the role of distributing entities, the creation of operational entities for the provision of institutional services and the coordination of civilian and defence requirements.

5.1 Commercial and policy issues

Each operator and/or distributor will retain its own rights for exploitation but, by licensing to ESA the access to its services and data, will have access to a larger and integrated market. The development risk for new missions' ground segments will be reduced, and the synergy between the various missions will be enhanced. The definition and implementation of integrated multi-mission products will be encouraged and supported, financially and technically, reducing the final operations cost for all partners.

Clear rules for accessing data and services are a key issue for this approach to succeed. In pillar "C" the individual policies of the various mission operators will obviously apply. They may be modified, at the user end, by financial or technical compensations negotiated by ESA with the operators. The forthcoming imaging missions, integrated in a European exploitation approach in the course of pillar "N", should offer a coherent access policy, to be negotiated.

5.2 Technical challenges

The implementation of this programme will pose a number of technical challenges in terms of information access and presentation tools, archiving and distribution, information extraction, and mission planning.

An Earth Observation access portal linking information, service providers, data and results both on a global and regional scale will be set up. Previous experience (e.g., Infeo, CEOnet and EOSDIS should be reviewed) and developments shall be enhanced.

Traditional inventories and user catalogues, even multi-mission ones, provide information on availability and quality of data. Earth Observation data and other geographic information need to be presented to potential users in a complete, coherent and consistent form. Current and future GIS and Web-mapping technology and interfaces can ensure immediate composition of different information layers (Earth Observation data sources, in-situ data, maps, results, meteo data, etc.)

Maintenance of the rapidly increasing Earth Observation data archives is a technical challenge in itself. An even bigger challenge is the cost efficient maintenance of a processing capability (hardware, operating system and adaptation of software to the modern languages) for these historical data. Data will have to be re-processed at regular intervals. GRID-based distributed processing technology can be applied for such individual, but resource intensive, requirements.

An increasing amount of data is stored on-line and can be distributed via ground- or satellite links. Network capacities are increasing and rapidly allowing the improvement of data access methodologies.

Similar geophysical or environmental parameters are extracted from many different Earth Observation data sources. Initially comparable, later standardised methods, algorithms and even tools will improve and facilitate cross calibration and long-term environmental trend monitoring. The development of multi-mission products as a basis for more reliable information will be supported and accelerated.

GMES, but also disaster management, requires immediate action from many different satellite and ground segment operators. An initial coordination of this type has been established through the Charter activities. Such a process can be enhanced by the operational availability of coherent mission planning tools displaying for each mission operator the foreseen and later the actual acquisition plan of other missions.

Finally, service developers in many cases do not have the technical and financial resources to maintain their services operationally. A framework infrastructure for the support of developments and operations to service providers will facilitate the utilization of Earth Observation data and the acceptance by users of improved services.

5.3 The challenges and benefits for industry

This strategy and the resulting implementation approach should be beneficial to European industry in at least three domains: satellite manufacturing, ground segment and data processing software developments, and service provision.

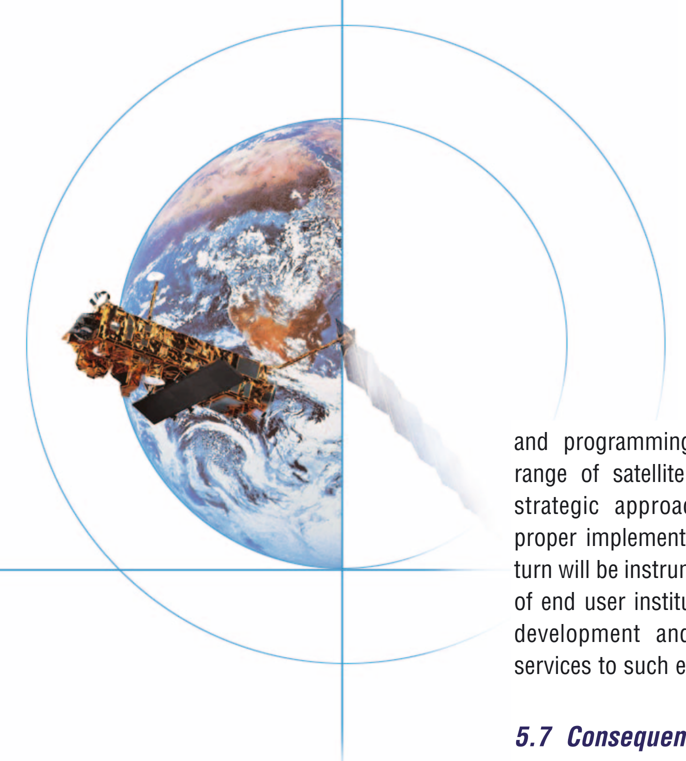
This initiative will have a long-term impact on the satellite industry. The building and maintaining of a satellite infrastructure, with high technology content, will ensure the survival first and the technological progress later of European satellite industry. In the short term, this initiative will offer augmented justifications to currently weakening national initiatives, ensuring their implementation and continuity. The satellite industry relies heavily on these projects. If successful, such a long-term plan for operational Earth Observation will create the need for the replacement of at least one satellite per year. This will add to the workload already ensured by ESA with the Earth Explorers and by Eumetsat with the operational meteorological satellites. The combined support of the current initiatives (GSE, EOMD, DUE, 6th FP) will provide European service industry with a level of funding never experienced before. More straightforward and cheaper access to basic data and products will help the industry to develop and provide more effective and economic services. An organized approach to exploitation, in particular in the interface to institutional users, will offer this industry an enlarged market and a better, less fragmented, vision of the user requirements.

5.4 Benefits for national programmes

National initiatives will benefit from the proposed approach in a number of ways. First of all, by saving in the deployment of the ground segment: the initiative proposed here offers to the national programmes the implementation of an integrated ground segment, with direct savings on the ground segments foreseen as part of each national programme and more potential savings on the parts currently not envisaged, but necessary (data distribution, user services, long-term archiving, near-real-time services, etc.).

Second, by reduction of operation costs: it is not foreseen at this stage to integrate the individual mission control facilities, but the common approach to ground segment development and operations will result in substantial savings in the operating costs of the individual missions. An improved exploitation segment, with an augmented delivery of services, might, depending on the economic scheme selected, result in an improved economic return for satellite operators. This approach will also provide substantial support to exploitation: focusing the various missions on a common set of services will result in a more effective distribution of resources in support of the exploitation of the missions.

Finally, the proposed strategy will provide a major justification for the mission itself and for its continuity: the continuity of some of the national initiatives is in question, beyond



the initial deployment(s). The creation of a unified approach to exploitation of these initiatives and the consequent development of long-term operational services will justify the continuity of the various data sources, if not of the individual missions.

5.5 Benefits for the scientific community

Some scientific issues require operational data series and are themselves a justification for operational satellites and operational information services. Anything that facilitates the generation and circulation of information will foster the development of Earth Sciences and the better understanding of Earth's phenomena. This will have an immediate impact on the development of services since scientific mastering of phenomena is a prerequisite to the development of reliable applications. Data from operational satellites should be made available to scientists.

5.6 Benefits for GMES and ESA/EU relationship

Environmental monitoring, sustainable development and resource management are beginning to benefit from Earth Observation as an information source. The requirements in these domains emanate from a wide range of institutional entities at national and European level.

With the GMES initiative, Europe is sending a strong signal that it has recognised the need for integrated operational information services to support European policies. These services will certainly benefit from smoother and more integrated access to data and programming functions for a wider range of satellite resources. The present strategic approach is essential for the proper implementation of GMES. GMES in turn will be instrumental to the identification of end user institutional entities and to the development and the early delivery of services to such entities.

5.7 Consequences for defence and security

Defence authorities are intensive users of Earth Observation data. They are currently the largest customers for commercial civilian imagery. Security also has a number of implications and constraints, including shutter control rules and restrictions on the timely diffusion of high resolution data. Although it is not in the mandate of ESA to serve the defence community, we believe that the proposed approach should be designed to remain compatible with the requirements of the defence community and to accommodate the necessary constraints. The restrictions imposed for security reasons are well known, have found solutions in the past with other satellite operators and will be taken into account in the setting up of pillar "C" and "N" and in the deployment of the "O_2 generation".

6 Conclusion

The strategy presented here should encourage a more effective use of information in many domains. It should favour the improvement in Europe of all technologies addressing the processing, management and circulation of information, regardless of origin. It should contribute to bringing together European capabilities in creating measurement instruments, generating data and information and delivering them. Synergy with European scientific teams will be fostered. The concept of a network of competences and the associated centres will be brought to reality. The approach set out here complements ongoing ESA Earth Observation programmes to ensure a comprehensive approach, including the understanding of Earth system processes, relevant technology development, transition to a sustainable service implementation and subsequent long-term continuity of data availability.

The initiative proposed requires a high level of political support. It requires the recognition by Member States that independent and uncoordinated initiatives, in particular if targeting global issues and institutional services, lack justification and are doomed in the short to mid term. It requires the recognition that even current programmes and existing infrastructure need to come to a higher level of integration in terms of offerings (data, services) in order to exploit synergies and to meet requirements for effective information. It requires the recognition that the current business model has failed to deliver a dynamic industrial service sector and that a different open-access approach provides a second chance for operational Earth Observation.

Political authorities should recognize that only an initiative of this size and scope can sustain European industry in both the manufacturing and service domains and transform the information and data handling industry in Europe.

Coherent and constant support from both of Member States and the European Commission is required as the initiative takes several years and is based as much on an integration of the offerings as on the coordination of the demand side: the requirements for information from institutional users across Europe.

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