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Space systems for Europe: observation, communications and navigation satellites – reply to the annual report of the Council

REPORT

submitted on behalf of the Technological and Aerospace Committee
by Mr Díaz de Mera, Rapporteur

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TABLE OF CONTENTS

[1] Adopted unanimously by the Committee.

[2] *Members of the Committee*: Mr *Marshall* (Chairman); Mr Atkinson (Alternate: *Brand*), Mr *Maass* (Vice-Chairmen); Mrs Aguiar, MM Arnau Navarro, Cherribi, *Cunliffe*, *Diana*, Dolazza (Alternate: *Speroni*), Etherington (Alternate: *Wray*), MM Jung, Kolb, Le Guen, *López Henares*, Luís, Martelli (Alternate: *Turini*), MM *Neuwirth*, Nothomb, Olivo (Alternate: *Lauricella*), Mr Polydoras (Alternate: Mrs *Katseli*), MM Ramírez Pery, *Staes*, *Theis*, Thönnes, Valk, *Valleix*, Wodarg, Mrs *Zissi*.

N.B. *The names of those taking part in the vote are printed in italics.*

IV. Which projects in Europe?

A. Observation satellites

1. The role of observation satellites
2. Types of observation satellites
3. Programmes

(a) Military optical programme based on the Helios-2 heavy satellite
(b) The CNES programme: 3S-Spot follow-on system
(c) Germany and the United Kingdom: TerraSAR
(d) Italy: programme based on a cluster of mixed optical/radar satellites: SkyMed/COSMO
(e) Future national programmes

(i) Germany
(ii) Spain

(f) ESA: the desire to coordinate European civil-military programmes
(g) NATO

4. Which partnerships can be envisaged in Europe?

B. Communications satellites

1. The role of communications satellites
2. Programmes

(a) Bimilsatcom, a Franco-German programme
(b) National programmes

(i) United Kingdom
(ii) Italy
(iii) Spain

(c) NATO

C. Positioning satellites

1. The issues
2. Global Navigation Satellite System programmes

V. Conclusions

APPENDICES:

I. The WEU Satellite Centre: missions and mode of operation

II. Presentation of the EUCOSAT report on "The end of European satellite-based earth observation?" by Mr Jean-Pierre Fourré, Chairman of EUCOSAT, former Vice-President of the French National Assembly and also of the Assembly of WEU

Draft Recommendation

on space systems for Europe: observation, communications and navigation satellites – reply to the annual report of the Council

The Assembly,

(i) Considering the need for Europe to acquire its own satellite systems with a view to developing the emerging European satellite industries and enhancing their competitiveness;

(ii) Noting that it is particularly important to fulfil that need in the field of space-based observation, in order to increase Europe's decision-making autonomy;

(iii) Considering that in the communications sector Europe must also acquire the necessary means for managing information warfare, given that communications satellites can be used for the coordination of forces, which is essential for any military operation, particularly one conducted by a coalition of states;

(iv) Bearing in mind that in the navigation field, Europe is involved in the Global Navigation Satellite System programme (GNSS), which represents a political and industrial challenge and will provide European military and civilian users with a reliable, efficient and very high-precision positioning system;

(v) Recalling that WEU must pursue the task given to it by the Council of Ministers of evaluating the possibilities for its participation in a developing multilateral European programme;

(vi) Stressing that WEU must, in this respect, take into account the industrial mergers currently under way and the new programmes arising out of them, as well as its own interests, which should induce it to participate in a satellite programme in which it has access to the programming of the satellite;

(vii) Noting that the Space Group is conducting a feasibility study on the direct reception of satellite images;

(viii) Welcoming the work of the Satellite Centre both in general and, more specifically at the present time, in connection with the events in Kosovo;

(ix) Welcoming in addition the ongoing development of technologies and procedures that will enhance the performance of the Satellite Centre (efforts to reduce image acquisition time, new analytical tools etc.) despite budgetary constraints;

(x) Taking the view that the Satellite Centre has a major role to play both for defining European requirements and with regard to the acquisition, centralisation and analysis of satellite data;

(xi) Recalling that Europe is fully competitive from the industrial and technological points of view, all the more so in light of the current industrial mergers;

(xii) Emphasising the importance of striving for interoperability of satellite systems;

(xiii) Deeming that Russia's experience in the space sector constitutes an important asset in terms of European know-how;

(xiv) Noting that there is real resolve in Europe to acquire efficient satellite systems,

RECOMMENDS THAT THE COUNCIL

1. Consider the central, coordinating role of WEU in the European military space sector (observation, communications and navigation), taking into account the following factors:

- the need for an autonomous European capacity for decision-making;
- industrial mergers in Europe;
- the importance the space sector has acquired in Europe;
- the importance of having Europe's operational needs defined by WEU, a political entity;
- the involvement of WEU in European satellite programmes;
- the quest for interoperability;
- the need to take due account of Russian expertise;
- the need in Europe for an institution to manage satellite data;

2. Assist the Satellite Centre, bearing those requirements in mind, in its development and its efforts to reduce satellite data acquisition times, taking due account of the following factors:

- participation of WEU in a developing European observation satellite programme which gives the Satellite Centre access to the programming of a satellite, in accordance with its requirements;
- procurement of a system for the direct reception of images, which is a necessary factor in reducing acquisition times;

3. Enable the Satellite Centre to become a body responsible for centralising European skills and know-how in the field of space-based earth observation, by virtue of the experience it has acquired in the following fields:

- European cooperation;
- meetings with representatives of industry for the presentation of their programmes;
- collection of images;
- analysis of satellite data;
- training of analysts;
- development of analytical software, databases and geographic information systems (GIS).

Explanatory Memorandum

(submitted by Mr Díaz de Mera, Rapporteur)

I. Introduction

1. The purpose of this report is to reaffirm the need for European systems:

- to develop and enhance the competitiveness of the emerging European satellite industries;
- to increase Europe's decision-making autonomy in the field of space-based observation;
- to respond to the crucial need in the communications field for Europe to acquire the means of managing information warfare. Communications satellites can be used to coordinate forces, a crucial factor in any military mission conducted by a coalition of states;
- to acquire a European positioning system (GNSS programme) providing both civilian and military users with access to a reliable and efficient high-precision system. Europe must rise to this challenge which is both political (the American GPS system, to date, being a dual-precision system) and industrial in nature.

2. WEU must take account of:

- ongoing industrial mergers and the new programmes arising out of them;
- its own interests, requiring it to achieve access to satellite images by participating in a European space-based observation programme, rather than by simply purchasing images, as it does at present. With a view to reducing acquisition times and enhancing quality, when considering participation in any satellite programme, WEU must think in terms of access to the programming of the satellite.

3. This report defines the categories of satellite systems currently available in Europe, with a view to WEU's becoming involved, in the near future, as a fully-fledged partner in those systems which it considers will best serve the development of a European Security and Defence Identity.

4. WEU must act as a central, organising body with an interest in the industrial mergers currently under way in Europe. To do so, it must, like ESA, state its requirements and assert itself as a potential customer.

5. The essential purpose of observation satellites is to provide information. However, the most valuable information is worthless unless it is analysed and disseminated at the right moment. Information these days is disseminated by means of sophisticated communications tools, including satellites. That is why it is important for WEU to keep abreast of European studies in the field of communications satellites.

6. Reference will also be made to Europe's progress in the field of navigation satellites and to the advantages for Europe of developing such a system.

II. WEU's space activities

1. Activities of the Space Group

7. On 18 November 1998 the Council of Ministers of WEU, meeting in Erfurt, called on the Permanent Council to actively pursue the task, agreed in Madrid in November 1995 and reaffirmed in Ostend in November 1996, of evaluating the possibilities for WEU participation in a developing multilateral European programme. The Space Group submitted a progress report on the subject to the Council of Ministers at its meeting in Rhodes. It was indicated in the conclusion of that report that before any recommendations could be submitted to the ministers, the advantages for WEU of more direct access to satellite imagery needed to be balanced against other considerations, such as the Organisation's operational requirements and the cost of providing such access.

8. Furthermore, the Space Group is currently engaged in a feasibility study on a system for the direct reception of satellite images.

2. The Satellite Centre

9. The Satellite Centre operates with an annual budget of some €8.7 million (30% of the

WEU budget). It analyses satellite information to provide answers to questions put to it by the Council. It trains satellite image analysts and provides interpretations of satellite imagery to international organisations and WEU countries. It carries out general surveillance of European zones of interest and makes a contribution to the process of verification of arms control and disarmament treaties. In parallel, it provides support for Petersberg missions. And finally, as part of its crisis-prevention mission, it is engaged in environmental monitoring[1].

10. The Centre's Research Division is working on the development of new tools for analysts designed to meet the operational needs of the Centre and compatible with existing interfaces. These include, *inter alia*:

- data integration systems;
- systems for the complementarity and merging of data (e.g. of optical and radar images): PAIRS (Professional Automatic Image Registration System);
- support tools for automatic analyses: AIMI (Automatic Interpretation of Multispectral Images);
- geographic information systems (GIS).

11. It is continually upgrading its technology and procedures in order to improve its performance. For operations in Kosovo it can supply precise analyses in less than four days. However, its scope is currently limited by the fact that it is not involved in the programming of the satellites on which it relies for its images. Images are currently purchased from a number of suppliers including: Spot Image (France), Landsat (US), IRS-1C and IRS-1D (India), Radarsat (Canada), ERS-1 and ERS-2 (Europe), KVR (Russia), Helios-1 (France, Italy and Spain).

12. In view of its budgetary constraints, the Satellite Centre must acquire images which give good value for money. Helios-1 images, for example (FF 200 000 per image), may seem expensive, but they offer guaranteed quality of imaging performance.

13. The drawback of this system of purchasing images is that the Centre is unable to participate in programming the satellites. The Satellite Centre is currently studying future satellite observation systems with a view to identifying the ones which will provide the images best suited to its requirements (for example, in terms of the cost and the possibility of programming the system). Commercial high-resolution imaging systems currently under development (cf. Chapter III.4*(b)* Political situation: United States) are financially attractive for the Centre. However, the quality of those images must be fully reliable if Europe is to retain its autonomous capacity for analysis.

14. The possibility of purchasing commercial high-resolution satellite images will, for obvious reasons of cost, be highly advantageous for the Satellite Centre, provided that the quality of the images supplied is totally reliable. The Centre is trying to reduce the time needed to access images (study of possible participation in a developing European multilateral programme, testing of a mobile data-receiver station). It is currently in the process of looking into the different solutions available to it in the field of imagery, in order to further upgrade its performance. To reduce image acquisition times, access to satellite images must be improved. The observation programmes presented in this report, with the exception of SAR Lupe, are open to participation by WEU and offer a choice of at least three options:

- participation by WEU as a fully-fledged partner in a cooperation programme;
- contribution by WEU to operational costs in exchange for an appropriate percentage of the system's resources;
- signature by WEU of a memorandum of understanding granting it a preferential customer status on a commercial basis.

III. Current situation in the field of satellites

1. A new world space order

15. Space is the focus for tomorrow's technologies. Increasingly, these technologies are being geared towards the civilian sector (scientific programmes and general commercial applications), leading to the emergence of satellite constellations dedicated to all forms of com-

[1] See Appendix I: The WEU Satellite Centre: missions and mode of operation.

munications (TV, the Internet, telephony etc.) High-resolution imaging has so far been confined to the military sector, but already commercial projects are emerging for the supply of high-resolution images (1 metre resolution optical and radar images, hyperspectral images etc.). The commercial development of a sector hitherto reserved for military customers does, of course, raise numerous questions (regarding, for example, whether there really is a market for such images).

16. In Europe, a considerable number of programmes are being developed, more or less in competition with each other, and in parallel to that a process of consolidation is under way in the industries concerned.

2. Technical developments: different systems

17. There is a growing trend towards clusters of small satellites which provide redundancy in the case of failure of one of the satellites, entail lower production costs and allow combined use of several types of sensor (one satellite may be equipped with optical sensors, another with radar sensors, for instance).

18. The satellite field is an area in which Europe is competitive. Given the dual-use nature of several space-related technologies, a consortium's involvement in a military satellite programme may give it a competitive edge in the field of commercial (scientific earth observation, communications, positioning) and/or military satellites.

3. Industrial mergers in Europe

19. Europe's satellite industry is composed of two groups, each of which plays a major role at international level:

- firstly, the European group resulting from the merger of Daimler-Chrysler Aerospace (DASA) and Matra Marconi Space (GEC: 49%; Lagardère: 51%). This group, which is the world's third satellite group behind Lockheed and Hughes, is responsible for the programmes known, before the merger, as TerraSAR, EagleEye and Bimilsatcom. Dornier's subsidiary Daimler-Chrysler Aerospace is currently competing against OHB-System GmbH for the German SAR Lupe project. Alenia Spazio could join this group in a few months' time;
- secondly, Alcatel Space, resulting from the merger, among others, of Alcatel Espace, Aerospatiale Satellites, Sextant Avionique and Thomson CSF, which ranks fourth at international level in the satellite field. Alcatel Space is currently working on Helios-2.

20. The mergers which gave birth to these two industrial giants took place recently. When referring to the programmes dating from pre-merger days it is difficult not to imagine that some of them may be abandoned in favour of others.

4. Political situation

(a) Europe

21. WEU's long-term objective of becoming involved in a European programme may be advantageous for Europe for at least three reasons:

- it will bring about further progress towards a European space defence policy through WEU (following Helios-1 and the creation of the Satellite Centre);
- it will involve participation in the development and pooling of industrial resources in the satellite field (since WEU promotes the setting-up of joint or complementary programmes in Europe);
- it will encourage the development of interoperable systems (in the field of communications satellites).

22. The Saint Malo Franco-British Summit was a watershed in the field of European defence. New opportunities for satellite programmes have emerged following Mr Blair's initiative. "Europe needs strengthened armed forces that can react rapidly to the new risks, and which are supported by a strong and competitive European defence industry and technology[2]". Mergers between European defence companies will lead, *de facto*, to the development of truly European industrial programmes.

23. A possibility for WEU would be to participate in a European programme geared to co-

[2] Saint Malo Declaration, 4 December 1998.

operation, among others, with Japan and the United States, for reasons of interoperability. Furthermore, it seems essential to cooperate with Russia in the satellite field. Russian space know-how is an important asset for Europe.

(b) United States

24. US policy on space, and satellites in particular, seems to be very aggressive. A knowledge of this policy will help us understand the challenges we face in the satellite field.

25. It has to be admitted that the United States, given the history of its space activities, enjoys a considerable lead, formerly in the field of military and now in that of both military and civilian satellites. Efforts are in progress to define standards for the future, with a view to achieving interoperability among the major allied powers. The United States is keen to assert its leadership in the space and satellite sector[3], as can be seen from various official declarations and in the way its space-related sector is organised. Directive PDD-23 of August 1994, concerning the authorisation of the commercial sale of high-resolution images, is a good example. The American approach has an influence on the policy of other European countries as regards high-resolution satellite imagery. Germany, for instance, seems to be following in the Americans' footsteps by developing observation satellites which could supply images abroad. Dornier Satellitensysteme GmbH (DASA), for example, will be supplying an $80 million 500 kg satellite with a resolution of 2 metres to Taiwan, provided that the deal is approved by the German Government. This approach is conducive to the development of observation satellite systems, since it offers the prospect of a return on investments. France appears to be reticent about disseminating its high-resolution images (problem of digitilising terrain for cruise missiles). One solution, which the United States will certainly adopt, would be to control the sale of images and sensing equipment.

26. Directive PDD-23 will doubtless enable the United States to overrun the market for high-resolution satellite imagery. Thus it will control that market and the risk of competing satellite companies emerging will be reduced. We must emphasise the state of dependency engendered by this 'all-American' approach – will the images be reliable, for example? Several programmes are currently being developed in the United States for the supply of high-resolution images (Ikonos from Space Imaging, Early Bird and Quick Bird from Earthwatch, Orbview from Orbimage). The American objective is clear: if these projects come about, they may constitute a serious threat to an independent capability not only for Europe, but for the rest of the world.

27. The creation of the National Imagery and Mapping Agency (NIMA)[4] in October 1996 is another development, following the directive, which illustrates the American Government's support for private programmes for the supply of satellite imagery. The aim of this imaging agency is to centralise orders for and deliveries to customers using the various sources that are available (national and foreign, public and private). What this means, at the end of the day, is that NIMA and its principal shareholder – the American State – support and control the satellite imagery market. The creation of NIMA is an example of the "global information dominance" that the United States authorities are establishing. NIMA is a body capable of providing financial support to private satellite programmes. It is in itself a source of funding for private American projects through the contracts it awards. It cooperates with private suppliers of high-resolution images, not only on setting up the means of image acqusition, but also on the development of software and interfaces to simplify the use of satellite data. By facilitating access to the interpretation of satellite images, the United States is preparing to conquer new markets. Indeed, the creation of facilities for the processing, analysis and dissemination of satellite data will be conducive to exports of those data.

28. It seems essential to study the possibility of developing a European system equivalent to NIMA in order to coordinate all European activities in the field of satellite imagery. The recent EUCOSAT report on "The end of European satellite-based earth observation?" published in

[3] See Xavier Pasco, *Fondation de Recherche Stratégique*, "Changement de politique, changement de perception" (Change of policy, change of perception).

[4] See Xavier Pasco, *Fondation de Recherche Stratégique*, National Imagery and Mapping Agency – NIMA.

March 1999 stresses the need for a European body similar to NIMA[5].

29. According to EUCOSAT, such a body should carry out missions in the field of security (crisis prevention and management, verification of international agreements, surveillance of proliferation), the environment (prevention and management of natural and industrial disasters, verification of environmental agreements) and the management of land and resources.

30. These different tasks are already being carried out by the WEU Satellite Centre. It is interesting to note that, thanks to current developments, the Centre is in the process of establishing a good position for itself as a future coordination body. As we have seen, it liaises with its users and suppliers, analyses satellite data, optimises its operations (study of possible acquisition of Helios images through a mobile receiver station, optimisation of the ground segment) and is developing tools for optimising the merger, analysis and dissemination of satellite data.

31. The Satellite Centre trains image analysts from WEU member countries. It works on security and defence-related issues and questions of general interest (studies on the effects of Hurricane Mitch, pollution of the Doñana region etc.).

32. NIMA's essential function is to coordinate the requirements of the different American bodies that use satellite imagery. It manages the purchasing and archiving of imagery in order to avoid duplication. Duplication can be avoided in Europe by organising coordination at European level through the WEU Satellite Centre. If a completely new European institution were to be set up for the management of satellite images without building on the Satellite Centre, this would actually amount to duplicating existing structures!

33. Indeed, the WEU Satellite Centre has not only the requisite experience, but also necessary management, analytical and training skills in the field of satellite-based observation. Moreover, we must once again stress that as far as the public at large is concerned, not much is known about the commercial market for high-resolution satellite imagery.

34. As regards GPS, the United States decided in 1996, through the National Economic Council, to abandon its dual-precision system (i.e. where the degree of precision depends on whether the system is used for military or civilian purposes) by 2006. Indeed, there are major commercial outlets for the GPS technology, in particular in the field of vehicle navigation systems. The aim of this new measure, which was imposed on the Pentagon, is to challenge the European satellite positioning system (EGNOS) which will soon be on the market. If the American GPS system is no longer a dual-precision system, European satellites will have less reason to exist, except as a tool for checking the integrity of GPS data.

5. Funding of programmes

35. Europe, it has to be admitted, does not yet possess a satellite capability on a par with that of the United States. This shortfall can be explained by the high cost of developing satellite programmes. The United States has the political will to engage in this activity, which is why it invests an annual €11.4 billion in the military space sector, 30 times more than the €0.4 billion invested by France.

36. Indeed, the development of military satellite systems calls for firm political resolve and a sound funding capability. There is a growing desire in Europe to develop such programmes. The UK, France, Italy and Spain have all developed a military satellite sector. Their ranks have now been joined by Germany, through its participation in the development of European capabilities in the field of observation (for radar systems) and communications (Bimilsatcom). The technical capability already exists, but there is no coordinated approach to satellite issues. A whole range of satellite programmes are under development, as we shall see below, and indeed there is a case for suggesting that there may be too many. The fact that there are so many is certainly proof that Europe now has the political resolve to acquire a high-performance satellite system (including not only the satellites themselves but also the requisite industrial capacity). That is a step forward as compared with the situation ten years ago.

37. However, the problem of programme funding, which we will consider in greater depth

[5] See Appendix I: Presentation of the EUCOSAT report by Jean-Pierre Fourré, former Vice-President of the French National Assembly and former Vice-President of the Assembly of WEU.

below, remains. Indeed, although the price of satellite systems has gone down as a result of miniaturisation and technological progress, space remains a costly business. There are two solutions for Europe:

(a) Cooperation

38. Quite naturally, collaborative programmes at European level are envisaged as a way of making the cost of systems affordable and avoiding a fragmentation, among other things, of the research and development effort among a number of similar programmes. The industrial mergers that have taken place in Europe are conducive to multilateral cooperation.

(b) Private funding

39. In the framework of private funding schemes like the UK's Private Financial Initiative, governments pay industry for a service. The UK's Skynet system is run on a commercial basis. This works for communications satellites, for which there is a civilian market. Moreover, it is a safe market for companies, in that it guarantees a return on their research and development. As regards observation systems, however, there is no proven market for high-resolution satellite images, which means that the cost of the satellite has to be borne by states and companies. One cannot expect any significant return on investment, since the system would not normally be sold to private customers. The commercial systems set up by the Americans are only possible because the companies concerned have long since fully mastered observation technologies and because the US Government has the determination to make commercial use of its technological lead (NIMA). The financial risks for the US companies concerned are minimal (off-the-shelf systems, the fact that NIMA as a government agency is a solvent customer, etc.).

IV. Which projects in Europe?

A. Observation satellites

1. The role of observation satellites

40. Observation satellites are used, *inter alia*, for:

- environmental monitoring;
- monitoring of potential crisis areas;
- anticipation of crises;
- planning of operations;
- monitoring the implementation of treaties.

2. Types of observation satellites

41. There are radar and/or optical programmes, using one or several satellites. Some programmes are exclusively military, while others are designed for both military and civilian applications.

42. Let us recall that while optical satellites offer good image definition (Helios-2 will have resolution of less than one metre), they are at the mercy of the weather, in other words, of cloud cover. Conversely, radar sensors can pierce the cloud layer and also distinguish among different materials (microwave radiometry reveals contrast[6]), making them more effective than optical systems despite resolution that is often lower.

43. The most recent programmes are less costly than those of a decade ago, because they are based on satellite platforms which can be produced in small series and then adapted to specific payloads (varied nature of space activities).

44. In parallel, there is a trend in industry, for obvious reasons of cost, towards clusters of mini-satellites which can be produced in small series, are lighter and provide redundancy should one satellite fail.

3. Programmes

(a) Military optical programme based on the Helios-2 heavy satellite

45. The Franco-German Horus programme has been abandoned. Helios-2 is under development by France and Spain (Matra Marconi and Alcatel Space).

46. France takes the view that the satellite sector is essential for Europe. During the operation launched in 1991 against Iraq by the US-led coalition of allies, the Europeans often complained about being "blind and deaf". Since then

[6] See article by Isabelle Sourbès and Bernard Cervelle on "The role of civil satellites in the verification of disarmament agreements", *La Vie des Sciences, Comptes rendus*, General Series, Volume 8, 1991, No. 1, page 31.

they have acquired Helios, which gives them a degree of autonomy in their assessment of developments, for example in Kosovo. However, Helios does not put European capabilities on a par with those of the Americans. Hence Helios-2, with an estimated lifetime of 10 years, is due to come on stream in 2003.

47. Helios-2 is an optical satellite programme with resolution which will certainly be less than one metre (an estimated 50 cm) and for the moment it is funded by the French Government. Spain has a 3% to 6% participation in the total budget (approximately 75 million euros, including the ground station). 2.5% to 3% is the threshold for any worthwhile participation in Helios-2, since at that level a daily average of three to four images can be acquired. This threshold is somewhat high, since Belgium is willing to contribute to a European programme but cannot for the moment exceed 1% (roughly one image a day).

48. The design of Helios-2 seems at first sight to be less attractive than that of other programmes presented further on in this report. Indeed, the programme is based on a single heavy satellite (some 2 500 kg), while competitors are moving towards small clusters of lightweight satellites. Helios-2 owes its large size to the numerous improvements it offers compared to the first generation of satellites (Helios-1A and 1B, scheduled for launch in November 1999), such as the two telescopes it will carry in order to increase the number of frames and an infrared channel. Moreover, in addition to its considerably enhanced resolution, it will offer an optimised image acquisition and processing system in order to reduce lead times.

(b) The CNES programme: 3S-Spot follow-on system

49. The Spot family of satellites was developed by France's *Centre National d'Etudes Spatiales* (CNES). Spot is a commercial observation satellite programme (the equivalent of Landsat in the US). The latest satellite, Spot-4, was launched on 23 March 1999. CNES is currently working on the next generations, Spot-5 and 3S (Spot follow-on). The ground resolution of Spot-5 will be some 4 metres in panchromatic mode and 10 metres in multispectral mode. It is due to be launched in late 2001 or early 2002. While Spot-5 will offer much higher resolution than Spot-4, it will still not be sufficient for a precise analysis of materials, in the case of vehicles, for example.

50. The 3S satellite will certainly be of considerable interest to the Satellite Centre, since it will be the first new-generation satellite developed by CNES to have been designed to be less costly. A 3S satellite will cost approximately €30 million (compared to some €400 million for a Spot-4 or Spot-5 satellite). Two 3S satellites would offer an equivalent performance to that of one Spot-5 satellite. The mass of a 3S satellite will be only 500 kg, against 2 500 kg for a Spot-4 or Spot-5 satellite. The first 3S launch is scheduled for 2003.

(c) Germany and the United Kingdom: TerraSAR

51. The TerraSAR programme is being developed by Matra Marconi Space UK and Dornier Satellitensysteme GmbH (DASA). TerraSAR (SAR: synthetic aperture radar) is a sun-synchronous satellite orbiting at an altitude of 600 km. The prime contractors estimate its life span at five years. Its maximum resolution will be 1.5 metres and its launch is scheduled for 2004. The Satellite Centre would be a major client for the TerraSAR programme. Hence MMS and DASA are contemplating setting up a ground station in the Satellite Centre for direct reception of data, as well as a high bit-rate connection between the Centre and the TerraSAR HQ in Spitzberg, in order to provide redundancy in the supply of images and rapid access to archives. TerraSAR could not be programmed by the Centre, which means that in exchange for its investment in the programme, it will receive a service. It could nonetheless be one of this programme's most important customers.

(d) Italy: programme based on a cluster of mixed optical/radar satellites: SkyMed/COSMO

52. The SkyMed/COSMO (Constellation of small satellites for Mediterranean basin observation) programme is composed of three optical and four radar-sensing satellites and funded by the Italian Space Agency (ASI). Finmeccanica's subsidiary Alenia Aerospazio is the prime contractor.

53. Each satellite in the constellation will have a mass of some 600 kg. The orbit will be sun-synchronous (480 km altitude for radar satellites,

500 km for optical satellites). The maximum resolution of the optical component will be 2.5 metres. According to ASI, the high-resolution radar images provided by SkyMed/COSMO would be an excellent complement to the optical images from Helios. The estimated cost of the programme is about €565 million for ASI. The first satellite is due to be launched in 2003 and the constellation should be operational by 2004.

54. Thus SkyMed/COSMO is particularly noteworthy for the performance of its radar component. Indeed, Alenia is currently working on the development of the SAR-2000 radar to be flown on four of the satellites in the constellation. It should offer metric resolution, making it a very effective tool for the Satellite Centre as a complement to the high optical resolution of Helios. ASI is exploring the possibility of collaboration with Germany for the development of SAR-2000, given the similarities it bears with the latter's SAR Lupe project.

55. Italian officials are seeking partners in Europe. As we have seen, SkyMed/COSMO's radar component would be complementary to the Helios optical satellites. Cooperation with France on SkyMed/COSMO would certainly be useful. Indeed, with the Helios optical systems and the SkyMed/COSMO radar systems, all the advanced satellite imaging technologies would be available in Europe. Spain and Greece have shown an interest in this programme, but do not seem for the moment to be contemplating financial participation.

56. It was envisaged from the beginning of the SkyMed/COSMO programme to open it up to other European partners. Each partner would exercise independent management. The constellation system would give each party in possession of a receiver station direct access to images.

57. As far as potential customers for SkyMed/COSMO are concerned, Italian officials are realistic, pointing out that there is no proven market for this type of earth observation programme[7] which is destined essentially for government administrations.

[7] See European Union report on the applications of SkyMed/COSMO.

(e) Future national programmes

(i) Germany

58. EagleEye is a high-resolution optical sensor programme developed by Dornier Satellitensysteme GmbH (a DASA subsidiary). It will offer resolution of about 1.5 metres from an altitude of approximately 500 km. It developed directly out of DLR's VHRC (Very High-Resolution Camera) programme designed for the Mars 96 mission. It will become operational in 2002 and will certainly be flown on some of the satellites of the RapidEye programme described below.

59. The prime contractor for the RapidEye programme is Kayser Threde GmbH. RapidEye AG, a legal entity in its own right, has been set up to promote this programme. Like SkyMed/COSMO, it involves a constellation of small satellites (8-10 satellites with a mass of less than 500 kg) which communicate with each other so that each is able, at any moment, to receive images from any of the other satellites and relay them to the nearest ground station without having to wait for the satellite to pass over the ground station (ring concept). For the moment there has been no firm decision concerning the sensors to be flown on the RapidEye satellites. Some of them will certainly be EagleEye sensors, although no precise information is as yet available. However, whether or not this is the case, RapidEye should not offer resolution of less than approximately 5 to 8 metres.

60. The German Defence Ministry has isued an invitation to tender for a small radar satellite programme called SAR Lupe. The SAR Lupe study project is not for the moment open to other countries. The German Government will contact foreign firms once the results of the study are available (end 1999). The aim of the study is to prove that the new satellite technologies (small, series-produced satellite platforms) make for considerable savings as compared, for example, with the estimated cost of the Horus programme based on a large, customised platform. The two German companies carrying out the SAR Lupe study are Dornier Satellitensysteme GmbH (DASA) and OHB-System GmbH.

(ii) Spain

61. The ISHTAR programme developed by the Spanish Space Agency (INTA) uses the plat-

form developed for MINISAT 01. ISHTAR is defined as an optical satellite programme dedicated to defence missions in a national and international framework. The satellites will have an approximate mass of 450 kg. ISHTAR will fly in sun-synchronous orbit at an altitude of 500 km. The sensors installed on the satellites will pick up optical images with metric resolution and infrared images with a resolution of 10 metres. Access to ISHTAR images will be available in a maximum of 12 hours. According to INTA, the system should be operational in 2003 and cost less than €95 million.

(f) ESA: the desire to coordinate European civil-military programmes

62. In the framework of its Earth Observation Envelope Programme (EOEP: €1330 million for the period 1999-2003), ESA will be promoting a satellite platform (Earthwatch, essentially a commercial project) which will certainly also be able to fly military payloads.

(g) NATO

63. Use of images and analyses provided by the Americans (from the Keyhole and Lacrosse satellites).

4. Which partnerships can be envisaged in Europe?

64. There is a possibility of agreement between France and Italy on the SkyMed/COSMO programme. The advantages of this programme are its modularity and radar capability. It could therefore function initially in a radar configuration, thanks to its complementarity with the Helios-2 system that has already been developed by France. The radar technologies developed by Germany (TerraSAR and SAR Lupe) could be used on SkyMed. The Italian Government intends to allocate considerable funds to the development of this programme.

B. Communications satellites

1. The role of communications satellites

65. The role of communications satellites is to provide forces with communications (data, conversations) that are secure (protection against jamming). It might be useful to jointly develop a military communications satellite in order to ensure interoperability of communications systems during a joint operation.

2. Programmes

(a) Bimilsatcom, a Franco-German programme

66. The Bimilsatcom programme involves Alcatel, Thomson CSF, MMS and DASA. This Franco-German programme is the follow-up to Trimilsatcom, in which the United Kingdom was also a participant. The UK abandoned Trimilsatcom because of its need to acquire an operational system of communications satellites before the end of the current Skynet system. Indeed, the first of the five or six satellites in the European programme would not be launched until 2005, which was not soon enough for London. Bimilsatcom is composed of geostationary satellites which will give Europe global coverage in the field of military communications. The cost of the programme, including the ground stations, is estimated at €2 billion.

(b) National programmes

(i) United Kingdom

67. A Skynet follow-up system must be found (since the UK withdrew from Trimilsatcom): MMS UK and Lockheed Martin/Alcatel are competitors and will each be proposing a Skynet-5 programme.

(ii) Italy

68. SICRAL (Satellite Italiano per Comunicazione Riservate): Italy has made a major financial investment in the design and development of this programme, consisting of a space segment with one operating and one back-up multifrequency satellite, (VHF, SMF and EHF wavebands) in geostationary orbit, and a ground segment comprising the satellite's TT&C and fixed and mobile communication terminals. The satellite weighs a total of 2.5 tonnes at launch and can carry a payload of 330 kg. Finally, SICRAL is interoperable with the NATO IV, Fltsatcom, DSCS and Skynet systems and most of the channels of the Syracuse and Hispasat systems.

(iii) Spain

69. Hispasat: This telecommunications satellite serves the Spanish programme Ccom Sat. Hispasat 1A (1992) and 1B (1993) were built by MMS and Hispasat 1C by Alcatel. The invitation to tender is under way for Hispasat 1D. The Hispasat system is compatible with the Syracuse (France), Skynet (UK) and NATO IV (NATO) systems.

(c) NATO

70. The NATO programmes (NATO 3D, NATO 4A, NATO 4B etc.) are being pursued.

C. Positioning satellites

1. The issues

71. The creation of a European satellite positioning system would give Europe a system that would be both technically and politically reliable.

72. From the technical point of view there is a risk with the American GPS system, as underlined in Mr Atkinson's report on the millennium bug[8]: "according to the experts ten types of different problem have been identified in the GPS computer programme and (...) in the case of some of them, it will not be possible to pinpoint them in more detail until three months before the Year 2000".

73. From the political point of view, in spite of the decision to abandon dual precision, the system remains under the control of the United States and is therefore at the mercy of unilateral decisions (jamming) in the event of an international crisis, although such an eventuality is unlikely these days because of the implications (navigation in the civil aviation sector now relies on the GPS system).

74. In economic terms Europe could, by acquiring a system to compete with GPS, participate fully in the positioning-related industry. Indeed, satellite positioning is a generic technology which, increasingly, is being incorporated into all kinds of systems (vehicle navigation, tourist information systems etc.) There are numerous outlets for the GPS technology, both in the civil and military spheres. An estimated nine out of ten positioning systems (GPS or GLONASS) are sold for civil or commercial purposes. And this is just the beginning, because the price of receivers continues to fall and the variety of possible applications is growing all the time.

75. Under no circumstances would it be enough for a European system to be used merely as a means of checking the integrity of GPS data. Europe needs its own system in order to be present on the emerging satellite positioning markets.

[8] Assembly Document 1622, 5 November 1998.

2. Global Navigation Satellite System programmes

76. The GNSS programmes are managed by the European Tripartite Group composed of Eurocontrol (European Organisation for the Safety of Air Navigation), the European Space Agency (ESA) and the European Commission. The Commission has given strong impetus to the development of the GNSS programmes.

77. GNSS-1 or EGNOS (European Geostationary Overlay Service) groups together the first generation of European positioning satellites. The aim of EGNOS is to enhance the performance of the GPS and GLONASS satellites by guaranteeing their integrity and improving their precision. Thus, like the American (Wide Area Augmentation System – WAAS) and Japanese (Multi-Function Transport Satellite – MTSAT) programmes being developed for the north American, Pacific and east Asian zones, EGNOS will provide corrections for its users in Europe. Eight European countries have signed an agreement on the development of the EGNOS system, which will become operational in 2002.

78. GNSS-2 or Galileo will be a full positioning system which will work in parallel and be interoperable with the American GPS and Russian GLONASS systems. To enhance its reliability, the system will be composed both of satellites in middle earth orbit (MEO: at an altitude of about 1300 km) and of geostationary satellites. The Russian experience gathered through the GLONASS constellation has provided valuable input for the development of Galileo. The development programme should begin in autumn 1999 and the constellation should be operational by 2008. The global cost of Galileo is estimated at €2.5 to 3 billion.

V. Conclusions

79. No truly multilateral European observation programme appears to be under development for the moment. Yet numerous programmes are candidates for cooperation, in order to reduce the burden of their costs (Helios-2, SkyMed/COSMO etc.).

80. In parallel, the industrial mergers currently under way will inevitably lead European governments towards more cooperation. They will move away from a system of national preference towards one which favours the emerging European industrial pole. Soon, in the satellite field,

protection of national industries will no longer be the order of the day, since the major industrial players in Europe will be pooling their expertise in order to remain competitive vis-à-vis their American counterparts.

81. The main problem confronting us today is not the same as a decade ago, which proves that attitudes have changed. These days, in Europe, the need to develop observation satellites is taken for granted. France, Italy and Spain, as well as Germany and the United Kingdom, have recognised the importance of the satellite sector if Europe is to acquire any degree of strategic independence. However, opinions diverge as regards the policy to be followed for the development of satellites in Europe, and it is here that we must work to narrow the differences. The shortage of funds for the development of exclusively military satellites in Europe (shrinking defence budgets) has prompted some partners to consider developing satellite systems which can also be used for commercial applications (sale of images or off-the-shelf satellites). If satellites can be produced in series, the costs go down. This solution would be advantageous to Europe's defence industry, since there would be a guaranteed return on investments without it being necessary to increase defence budgets. Not all states are willing to adopt such a solution (problems of the proliferation of satellite capabilities, of the means to digitalise terrain). Moreover there are political differences as regards the use which should be made of any satellites that are built (the issues at stake are industrial and commercial and/or strategic). European states are, however, keen to take up the challenge launched by the United States.

82. Whatever the case may be, the choice of programme for WEU participation will most certainly have an impact on the development of the other programmes. Most of the observation programmes presented in this report are in need of funding. It will not be possible to develop all of them. The role of WEU is to rally the support of its members for a mixed (radar and optical) constellation. This would enable each participant to receive images quickly (several satellites and the ring concept which enables data to be transmitted from one satellite to another and down to the ground station). The availability of several satellites means a greater number of opportunities for acquiring images. Finally, quality and diversity of data are assured by the system of a mixed – radar and optical – constellation. From an industrial point of view, a mixed constellation allows each country to participate according to its particular field of expertise. There must be no duplication within Europe.

83. WEU will focus investments on the programme in which it decides to participate. A programme which draws on the particular expertise of each country would be the best possible solution. Each of the participants would reap the benefits of such a multilateral programme in terms of the return it would gain on its industrial, political and strategic investments. For cooperation to be fruitful, it must be to the advantage of each participant.

APPENDIX I

The WEU Satellite Centre: missions and mode of operation

Missions

The Satellite Centre's mission is to analyse imagery derived from observation satellites for security and defence purposes.

The imagery is acquired to answer questions put by the WEU Council, the WEU member states, its associate members and any other user designated by the Council.

The areas of application include:

- General security surveillance:
  - general security surveillance of areas of interest for WEU on the basis of a mandate of the Council defining the conditions of the surveillance mission;
  - support for treaty verification;
  - support of arms control and a proliferation control;
- Support for "Petersberg" type missions[1];
- Surveillance in more specific spheres:
  - maritime surveillance;
  - environmental monitoring.

The Centre has been given two other missions:

- to train specialists in the interpretation of digital imagery;
- to develop new techniques and procedures which will put the Centre on a more effective operational footing.

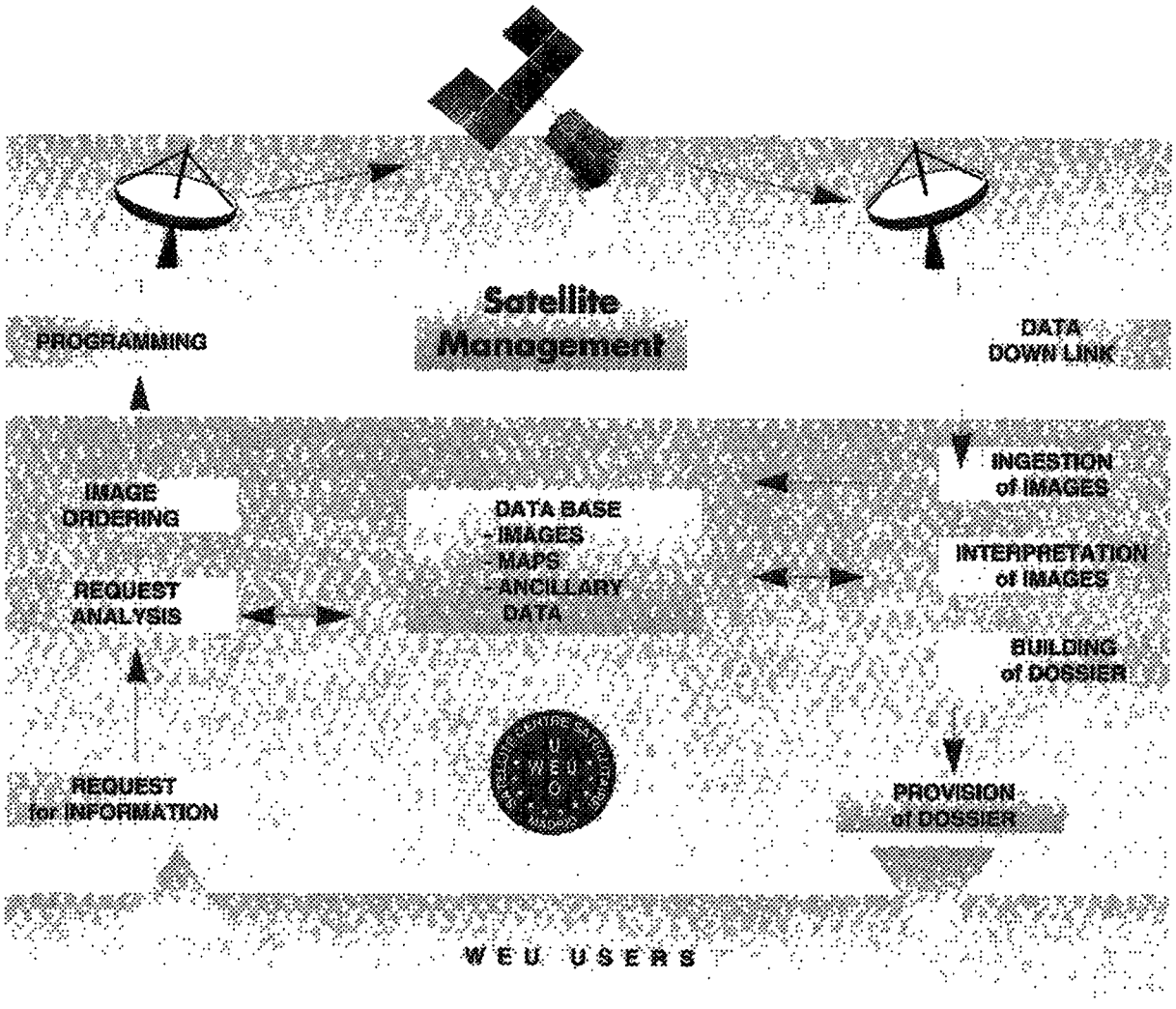
Once a question has been raised, the reply takes the form of a "dossier".

This document contains the space imagery and maps used for the mission and above all maps with information and notes provided by the image interpreter, together with his analytical report.

The complete dossier is sent not only to the requesting body but also to the WEU Headquarters and each of the thirteen member and associate member states.

[1] In 1992, the WEU Council of Ministers meeting at Petersberg near Bonn, envisaged the use of military units, acting under the authority of WEU, for humanitarian and rescue tasks, peacekeeping and crisis-management tasks, including peacemaking operations.

How does the Satellite Centre work?



APPENDIX II

Presentation of the EUCOSAT report on "The end of European satellite-based earth observation?" by Mr Jean-Pierre Fourré, Chairman of EUCOSAT, former Vice-President of the French National Assembly and also of the Assembly of WEU

Power resides in the control of information ...

If the place a state, or collection of states, has been able to claim on the international stage has traditionally been conditioned directly by the *concept of power*, this concept is today undergoing a perceptible evolution in its basic elements. To consider it as a triangle uniting the capacity for innovation, the economic dimension and a *proven knowledge of one's environment*, it must be accepted that the latter has begun to *take on a major, if not prominent dimension in this concept of power.*

So, whilst the history of man's conquests up to the present has shown us a continual desire to aspire to the first two vectors, which can be evaluated quantitatively, *new conquests*, of a more qualitative less visual content, *crystallise around the control of information*, whatever its nature or destination. In effect, this control, as much through its ability to command a reaction in purely tactical terms as through its ability to influence decisions of a strategic nature, shows itself to be the indicator of what today is regarded as the ultimate stage of power, namely the *pure and simple domination of culture and thought.*

... which finds in satellite-based Earth observation, a special tool ...

In this perspective, it is widely acknowledged that *satellite technology places itself as the main vector in the acquisition of this dimension*, both as a source (remote sensing, navigation, meteorology...) and as a relay of this source (communications). Satellite technology allows this dimension to address a series of applications, either of a governmental or commercial nature, even if a number of them are still in a state of evolution.

Indeed, the *technology of satellite-based Earth observation has proved to be the key element of all in situ information systems*, even if today exploiting the information still comes up against the operational limitations of the systems.

... even if this tool must still reinforce its operational capacity and reach its economic maturity.

These limitations or obstructions are mostly due to the infancy of a sector which is today entering a new phase, characterised by a series of major changes which will have an influence in the long term. They appear to be especially frustrating for the main users of the different fields of application who are starting to be aware of the amazing capabilities of spatial remote sensing. Added to this there is a *structural deficit in coordination between the different existing international systems*, resulting from specialised development and exploitation throughout the entire process of the development of information. The direct consequence is that the final offer is not very attractive to potential users. This is particularly evident for sectors as important as, for instance, Geographic Information Systems (GIS), pollution control or even applications linked to precision farming.

However, the intrinsic capabilities of the technology, those associated with new factors of growth in the sector, allow a glimpse of *very promising medium-term perspectives of development.* The economics corresponding to the whole of the sector's activities will have nothing in common with the situation of the last few years, and will settle at a global volume of US$ 30-40 billion (over the next ten years).

Whilst reference is often only made to the sale of images (which represents just 5% of the total economic value), it must be noted that the economic stakes are situated further downstream, at the level of information handling and diffusion services (50% of the global volume).

The United States are engaged in a course of action aimed at the domination of the world market for information which ...

In this context the United States, conscious of their role of super-power, with no real counterweight at an international level, and desirous of setting-up a real policy of planetary surveillance through the concept of 'Global Information Dominance' have rapidly identified, through strategic and economic potentialities of satellite-based Earth observation, the privileged vector for the establishment of their desire to *conquer the world market for information.*

They have therefore, during the last few years, engaged in an unprecedented effort of restructuring of the sector, particularly stressing the *civilian/military synergy.* They have understood the importance of this duality; more specifically that:

- the source of the information is relatively unimportant provided that one has the information itself and that it should be controlled and validated;
- the richness of the information and the speed of its delivery to the final user must prevail over the old traditions of self-sufficiency and secrecy;
- civilian systems, for functions which are not specifically military, should be usable at the least cost.

This new policy encourages, therefore, the commercial development of high-resolution satellites and the sale of remote-sensing technology; in order to improve US industrial competitiveness whilst protecting national security and foreign policy interests.

... through the "National Imagery and Mapping Agency" ...

However, this concept of "Global Information Dominance" could not be carried out efficiently without the setting up of a *unified structure.* This structure must be *capable of optimising existing capacities* to satisfy the needs of all the users, to exploit to the maximum the new digital technologies and to coordinate activity in the field of data-merging and of exploitation of geo-spatial information, in order for it to become a truly operational tool.

Thus, the creation at the end of 1996 of the new US imagery agency: The National Imagery and Mapping Agency (NIMA) must be seen as one of the most important elements in the field of imagery handling and utilisation – therefore of information.

A closer examination of this organisation leads us to consider it as a real player, not only in charge of a national protection mission but also to stimulate new behaviour in the organisation of image flows. The way it is conceived *NIMA appears to be a political tool which is all the more efficient because it is fundamentally open and integrating.* This concept of integration appropriately describes a mechanism which is both outward-facing and capable of satisfying all demands, taking account of the considerable means of handling and distribution a its disposal.

In line with its more industrial-economic approach, *NIMA is also tasked with working alongside or even galvanising the development of industrial initiatives.* This policy of support extends equally to the producers of data management computer and software tools in an attempt to harmonise procedures and technical standards, even if care is regularly taken to challenge any amalgamation, with the idea of 'preferential state-controlled client', allowing the funding of private companies...

Furthermore, beyond its effective results as coordinating institution of the American effort, there is no doubt that the *capability of NIMA to structure, even to create the market for geo-spatial information will not be without consequence*; not only with regard to national or foreign suppliers of images collectively, but also *with regard to inter-State relations in the field of the control of this information.* This development has the effect of giving the initiative to the US to propose the regulation that is needed in the international data market, and to allow them to have their approach accepted in the fight against proliferation. Following on from this analysis, the importance of NIMA for the American political authorities rests, perhaps, less in its short-term role of unifier but more in its capacity, less

directly obvious, to be the vector of new modes of regulating the role of satellite imagery in the international strategic arena.

Of course, such fundamental changes will certainly not be without consequence for the future of the other players, governmental and commercial, already present in this sector.

... allowing them to take a dominant position over Europe ...

Based on this initiative, which some would describe as well considered, the US are taking the lead in a field where, up to now, they did not have the dominant position. Thus, *it is Europe's place, and that of its partners on the international stage which is directly compromised.* This is true not only regarding its own control of information but also vis-à-vis an entire sector of important economic activity with a more than promising potential.

Faced with the not inconsiderable size of these stakes, it would appear vital to take a decisive step, at the very least to attempt to preserve a hard-won position or event to retake the lead.

Indeed, as it has been possible to observe in other fields with similar factors (radio broadcasting...), the risk of delay, which is virtually irreversible, or even the risk of a complete exclusion from the field, is very real. This is even more worrying when one considers that *Europe now has available*, at its own level or through its members, *the collective technical means* (from the space segment to the software which makes the information available to the final user) *to allow such a step, by its very nature, a uniquely political one.*

... unless Europe decides to make a bold and rapid reply.

Given the considerable size of the stakes, as well as that of the means of intervention, Europe collectively and, through it, the constituent European institutions, should really take up this issue as quickly as possible in order that a rapid and bold initiative can be materialised.

This report, result of work started at the time of the creation of EUCOSAT in 1991, and in line with the parliamentary initiative of the WEU, is the product of two years of preparatory meetings among the principal institutional and industrial European players in the field of satellite-based Earth observation. It has allowed the Committee of Ministers to reach the decision aiming for the creation of the Torrejón Centre for Interpretation.

It proposes the response which seems today the best way of dealing with the major issues of this new conquest of information. This response, which is above all pragmatic and concerned with the respective interests of each player in the field, should soon become reality with the setting up of the 'European Space based Information Organisation' (ESIO).