Assembly of Western European Union
The Interparliamentary European Security and Defence Assembly

DOCUMENT A/1902 **15 June 2005**

FIFTY-FIRST SESSION

Arms control and non-proliferation: verification by satellite

REPORT

submitted on behalf of the Technological and Aerospace Committee
by Jean-Guy Branger, Rapporteur (France, Federated Group)

ASSEMBLY OF WESTERN EUROPEAN UNION
THE INTERPARLIAMENTARY EUROPEAN SECURITY AND DEFENCE ASSEMBLY
43, avenue du Président-Wilson, 75775 Paris Cedex 16
Tel. 01.53.67.22.00 – Fax: 01.53.67.22.01
E-mail: info@assembly.weu.int
Internet: http://assembly.weu.int

Document A/1902 **15 June 2005**

Arms control and non-proliferation: verification by satellite

REPORT[1]

submitted on behalf of the Technological and Aerospace Committee
by Jean-Guy Branger, Rapporteur (France, Federated Group)

TABLE OF CONTENTS

[1] Adopted unanimously by the Committee on 12 May 2005.

RECOMMENDATION 766[1]

on arms control and non-proliferation: verification by satellite

The Assembly,

(i) Considering that it was only as of 1980, at the time of the Iran-Iraq war, that proliferation once again became a major international issue, when the use of weapons of mass destruction (WMD), chemical weapons in this instance, gave new impetus to the fight against proliferation;

(ii) Recalling that Iraq − which, in addition to building up an arsenal of chemical weapons had engaged in a ballistic missile programme based on Scud missiles − was the central factor in those anti-proliferation efforts, and stressing that it had also shown the limitations of the Non-Proliferation Treaty (NPT) by launching a particularly advanced nuclear programme;

(iii) Recalling also that the A.Q. Khan network − named after the Pakistani scientist considered to be the "father" of Pakistan's nuclear bomb − although officially dismantled by the Pakistani authorities under pressure from the United States, would seem to be a veritable international grouping of proliferating states;

(iv) Stressing that North Korea continues to be one of the most worrying cases as regards ballistic and nuclear proliferation;

(v) Noting furthermore that the Iran crisis continues to unfold and that participation − with the EU Council's approval − by three European states (France, Germany and the United Kingdom) in the negotiations on nuclear weapons proliferation has proved to be symbolic of Europe's growing involvement in arms control and non-proliferation issues;

(vi) Noting that, as a consequence, arms control and non-proliferation have become key objectives of the European Union which, in order to fulfil its ambition of becoming a major global force, has drawn up a Security Strategy and a Strategy Against Proliferation of Weapons of Mass Destruction;

(vii) Taking the view that the European Union must for that purpose acquire means of verification in order to ensure compliance with the treaties, as well as in the interests of its own security;

(viii) Noting that satellite means are perfectly legal, since they do not violate the airspace of the country being observed, and that their ever-greater precision and growing numbers in orbit allow satellite images of acceptable quality to be produced of any spot in the world in reasonable timeframes;

(ix) Taking the view that the major developments these past few years in the field of European space activities − such as the Galileo programme, the increasingly close ties between the EU and the European Space Agency (ESA) and the EU White Paper on space setting out an action plan for implementing a European space policy − illustrate the EU's efforts to become a key player in this area;

(x) Stressing that although Europe, through ESA, has been present in the space sector for some considerable time, European cooperation in this area has been confined to scientific research, while observation for military purposes has been a matter for individual member states, France in particular, which so far is the only country − in cooperation with Belgium, Italy, Spain and soon Greece − to have developed military observation satellites (Helios);

(xi) Noting that the next generation of European observation satellites will be produced on a purely national basis, even though cooperation among states has been strengthened to allow those systems to function in a complementary fashion;

(xii) Welcoming in that respect Germany's SAR-Lupe and TerraSAR programmes as well as the Franco-Italian cooperation initiative based on France's Pleiades programme and Italy's Cosmo-SkyMed programme;

[1] Adopted by the Assembly on 15 June 2005 at the 5th sitting.

(xiii) Recalling furthermore the five types of threat identified by the European Security Strategy: terrorism, regional conflicts, state failure, organised crime and the proliferation of weapons of mass destruction (WMD);

(xiv) Noting that the European Defence Agency (EDA) was set up in response to the need to pool capabilities and that the European Capability Action Plan (ECAP) was launched in order to identify capability shortfalls and propose short- and medium-term solutions to remedy them;

(xv) Noting furthermore that the creation within the ECAP framework of a Space Group tasked with improving capabilities in the short term, developing them in the medium and long term and drawing up an operational concept and doctrine is of particular strategic interest for Europe;

(xvi) Considering that the inclusion of space-based assets in the ESDP guarantees a degree of strategic independence by providing continuous access to information;

(xvii) Stressing that satellite images are a crucial tool for the prevention of WMD proliferation and the verification of international treaties and that their interpretation is now the responsibility of the EU Satellite Centre (EUSC);

(xviii) Recalling that the EUSC provides support for Petersberg missions, general security, maritime and environmental surveillance missions and activities in the area of treaty monitoring, arms control and non-proliferation;

(xix) Noting, however, that although the EUSC provides information that is of undeniable strategic relevance, it does not for the moment offer a tactical intelligence capability, and that therefore, despite now being an integral part of the ESDP and involved throughout the decision-making process, its action will remain limited for as long as the European Union does not possess its own satellite capabilities;

(xx) Considering that from this perspective the ESA-Commission joint GMES (Global Monitoring for Environment and Security) initiative will strengthen the EUSC's image acquisition capacities and could therefore be the first step towards the creation one day of a European intelligence agency;

(xxi) Stressing that the aim of the GMES initiative is to group together all European earth observation activities;

(xxii) Considering that the Commission's interest in using the GMES system in support of the CFSP makes it necessary to clarify the respective roles of the Council and Commission in this area in order to avoid the duplication and tension that currently exists between the EUSC, which is answerable to the Council, and the Joint Research Centre (JRC), which is answerable to the Commission;

(xxiii) Considering that the Common Operational Requirements (known by their French acronym BOC) are the forerunners for a new European space cooperation architecture, possibly with a variable geometry;

(xxiv) Recalling furthermore the decision of the WEU Ministerial Council in 1995 to conduct a study in order to evaluate the possibilities for the participation, at the time, of WEU in a multilateral space observation programme,

RECOMMENDS THAT THE COUNCIL INVITE THE WEU MEMBER STATES AS MEMBERS OF THE EU TO:

1. Take up once again the idea put forward by the WEU Ministerial Council in 1995 and take the necessary steps for launching a genuine European military space observation programme;

2. Ensure that the European Union, through the European Defence Agency, groups together all those efforts by taking account of the need to:

– establish a European standard for the construction of observation satellites by encouraging European or intergovernmental initiatives such as GMES and the Common Operating Requirements (BOC);

– give the EU Satellite Centre the necessary means to implement the ESDP by:

(a) giving it access to both the commercial and non-commercial images of the EU member states;

(b) allowing it to participate in the programming of European observation satellites;

(c) enabling it in the future to acquire a tactical capability to support Petersberg missions;

3. Allocate sufficient funds to the framing of a genuine European space policy, in order to avoid being dependent in this sensitive area on governments or companies outside the Union;

4. Offer European companies outlets for technological innovation in the space sector;

5. Strengthen ties between the EU and ESA with a view to establishing a link between the EDA and the ESA Security Office;

6. Make use of permanent structured cooperation in the space field on the model of the Common Operating Requirements (BOC) or of ESA's optional programmes;

7. Give preference to the capacities of the Kourou Space Centre in Guiana for launching European satellites.

EXPLANATORY MEMORANDUM

submitted by Jean-Guy Branger, Rapporteur (France Federated Group)

I. Introduction

1. Complete and universal disarmament, the utopian ideal which the League of Nations at the time established as a dogma, is these days difficult to imagine. Following the Allied victory in the Second World War, two of the victors, the United States and the USSR, embarked on a process of building up their arsenals that dashed the hopes for disarmament that the return to peace had brought with it.

2. Indeed, after the war the two superpowers engaged in an arms race with nuclear weapons as the stakes. The Baruch Plan presented to the United Nations' Atomic Energy Commission on 14 June 1946 was never to be put into practice, paving the way for nuclear proliferation.

3. Today, in addition to the five official nuclear weapons countries (the United States, Russia, the United Kingdom, France and China) a number of other countries possess, or are presumed to possess, a nuclear weapons capability. These are India, Pakistan and Israel. North Korea also claims to possess nuclear weapons, although this claim has not been verified by the international authorities.

4. The question of proliferation, which had slipped to the back of peoples' minds during the cold war, cropped up episodically during international discussions. France, for example, caused concern when it conducted its first nuclear tests (1960), as did China, both countries being seen at the time as proliferating states. Nevertheless the Non-Proliferation Treaty (NPT), now the cornerstone of the fight against the proliferation of nuclear weapons, recognised the right for both states to possess nuclear weapons, since "for the purposes of this Treaty, a nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to January 1, 1967"[2].

5. Only three states − Pakistan, India and Israel - have refused to ratify the NPT since it came into force in 1970, while North Korea withdrew from the Treaty in 2003. The Treaty was drawn up in response to the superpowers' concerns about too many countries possessing nuclear weapons, fears which were voiced by President Kennedy when he referred to the risk of 25 countries or more acquiring such weapons in the short and medium-term future.

6. However, the NPT has given rise to a new form of proliferation involving the non-nuclear weapon states (NNWS). That proliferation is every bit as worrying as that involving India and Pakistan and seriously jeopardises the NPT, which remains one of the last remaining safeguards against the proliferation of weapons of mass destruction (WMD).

7. It was only at the beginning of the 1980s that proliferation once again became a major international issue, when the Iran-Iraq war (1980-1988) served as a wake-up call to the different powers. The use of WMD, chemical weapons in this instance, provided the starting point for the anti-proliferation efforts that culminated with the creation of the "Australia Group" composed of nations which possessed chemical weapons but refused to sell them to proliferating states.

8. Concern about Iraq's activities was a catalyst for those efforts. Saddam Hussein's Iraq, in addition to building up an arsenal of chemical weapons, had also engaged in a ballistic missile programme involving the adaptation of Soviet Scud missiles to increase their range[3]. Iraq also showed the limitations of the NPT when it secretly launched an advanced nuclear programme which was only discovered thanks to the weapons inspections imposed upon it in the aftermath of the first Gulf war (1990-1991).

9. Libya, although no other country was aware of its nuclear programme, decided of its own accord to give up its WMD programmes and indeed to accept IAEA inspections following

[2] Nuclear Non-Proliferation Treaty, Article IX, paragraph 3.

[3] The G7 countries set up the MTCR (Missile Technology Control Regime) in 1987 in order to restrict exports of missiles and missile components.

negotiations[4] with the United States and the United Kingdom. Although Libya is cited as an example to proliferating states, a number of grey areas remain. There are for example questions about whether P2 centrifuges (the most modern type) are being used to enrich nuclear fuel and about Libya's role in the A.Q. Khan network.

10. The A.Q. Khan[5] network, which was dismantled by the Pakistani authorities under pressure from the United States, would seem to be a veritable international grouping of proliferating states, supplying a range of products from fissile materials through to plans for nuclear weapons. It could easily arrange for the transport of centrifuges from Malaysia to Libya, via Dubai. Although it has been officially dismantled, doubts remain as to whether it has really ceased its activities, since the Khan network was a supplier of fissile materials not only to proliferating states but also to Pakistan itself.

11. North Korea, designated by President George W. Bush in 2001 as a "rogue state" and by US Secretary of State Condoleezza Rice in 2005 as an "outpost of tyranny" continues to be one of the most worrying cases as regards ballistic[6] and nuclear proliferation. Although it signed the NPT in 1985 under pressure from the USSR, it only ratified the IAEA guarantee agreement[7] in 1992. Since that time relations between North Korea and the IAEA inspectors have been strained, with North Korea refusing to grant them access to certain nuclear facilities before it finally withdrew from the Treaty in 2003. The risk that in addition to the problem of ballistic missile proliferation a second nuclear proliferation network could develop from North Korea cannot be ruled out, which is why particular attention is being paid to that country.

12. In September 2003, the IAEA Board of Governors passed a resolution setting a deadline by which Iran was to provide unrestricted access to complete information on its past programmes and suspend its uranium-enrichment activities. Although Iran refused to go along with that resolution, on 21 October 2003 it reached agreement with France, the United Kingdom and Germany on suspending the fuel cycle, strengthening cooperation with the IAEA and complying with the additional protocol on more intrusive inspections. Just as an investigation into the Khan network was beginning in January 2004, links between Pakistan and Iran came to light following revelations about P2 centrifuges supplied by the Pakistani network to Iran. In June 2004 the IAEA Board of Governors held another meeting at which it deemed that Iran's replies about the P2 centrifuges and the origin of certain types of enriched uranium were not satisfactory. On 22 June 2004 Iran announced in a letter to France, the United Kingdom and Germany that it had decided to resume tests on the centrifuges as of 29 June 2004, on which date the IAEA seals were broken. Nevertheless, a fresh agreement was signed with the Europeans on 15 November 2004, and in a resolution adopted on 25 November the IAEA Board of Governors acknowledged Iran's voluntary suspension of activities.

13. As the Iran crisis unfolded, the three European states' participation − with the EU Council's approval[8] − in the negotiations on nuclear weapons proliferation was a première that was symbolic of Europe's growing involvement in arms control and non-proliferation issues.

14. The European Union, through its member states, is now involved in all the non-proliferation agreements such as the NPT, the Chemical Weapons Convention (CWC), the Comprehensive Test Ban Treaty (CTBT) and the Treaty on Conventional Forces in Europe (CFE)[9]. Indeed, in the framework of its enlargement process the EU requires all new member states to be signatories to the major arms control and non-proliferation treaties.

---

[4] Those negotiations were launched following the 11 September 2001 terrorist attacks.
[5] Khan, a Pakistani scientist, is considered to be the "father" of Pakistan's nuclear bomb.
[6] One significant development was a test in 1998 in which a TaepoDong missile flew over Japan.
[7] The guarantee agreement needs to be ratified for the IAEA inspectors to be able to commence inspections in a NPT participating state.
[8] "The Council underlined its full support for the negotiating process and recalled its commitment to contribute to a positive outcome". General Affairs and External Relations Council, Press Release 15461/04, Brussels 13 December 2004.
9 See Assembly Document 1784, adopted on 5 June 2002: "Monitoring international discussions on arms control and disarmament", submitted on behalf of the Defence Committee by Lluis-Maria de Puig, Rapporteur (Spain, Socialist Group).

15. Arms control and non-proliferation have become key objectives of the European Union which, in order to fulfil its ambition of becoming a major global player has drawn up a Security Strategy and a Strategy Against Proliferation of Weapons of Mass Destruction.

16. The European Union must for that purpose acquire the means of verification needed to ensure compliance with the treaties, also in the interests of own security. Although on-the-ground inspections are the most effective means of verification, proliferating states are little inclined to allow inspectors onto their territory. Satellite means are perfectly legal since (unlike UAVs) they do not violate the airspace of the country concerned. Given their ever-greater precision and growing numbers in orbit, satellites can be used to produce images of acceptable quality of any spot in the world in reasonable timeframes.

17. European space activities have undergone a number of major developments these past few years as the EU has stepped up its efforts to become a key player in this area. The Galileo programme is undoubtedly the most striking illustration of the EU's space involvement, but other examples are its increasingly close ties with the European Space Agency (ESA) and its White Paper on space, which sets out an action plan for implementing European space policy[10].

18. While Europe, through ESA, has been present in the space sector for some considerable time, European cooperation in this area has been confined to scientific research. Observation for military purposes has been a matter for individual member states, France in particular, which so far is the only country (in cooperation with Belgium, Italy and Spain) to have developed military observation satellites.

19. That being the case, it is necessary to take stock of Europe's satellite capabilities in both the short and medium term. This will enable us to more easily apprehend the EU's approach to WMD proliferation and arms control within the CFSP and ESDP framework, and the tools it possesses, or is acquiring, in order to implement its policy in that area. Finally, an assessment of the EU's current and expected progress, both in technological and institutional terms, will help us identify the EU's possible future role on the international stage with regard to arms control and non-proliferation issues.

II. European satellite capabilities in the field of verification

20. On 4 October 1957 the launch of the first artificial earth satellite Sputnik 1 was a groundbreaking development that paved the way for the conquest of space. Fifty years on, there is considerable activity in space, including of a military nature, in the areas of verification, intelligence and communications. According to Xavier Pascoe[11] there are three major categories of military space activities. The first involves the use of dedicated satellites for surveillance and reconnaissance. The second area is that of telecommunications and the third is satellite navigation, enabling the use of precision-guided weapons and satellite positioning systems to guide troops.

21. Although the EU does not for the moment have any satellites of its own, it has access through its member states to two of the above activities, and is involved in the third through Galileo, a common programme currently under development. However, the only effective verification tools are surveillance and reconnaissance satellites, which are precisely the capabilities that are cruelly lacking in Europe at the present time, with France being the only state to possess them. However, in the next few years Germany and Italy too will be developing satellites that will contribute to EU capabilities for the monitoring of arms control and non-proliferation agreements.

1. Current capabilities

22. "To verify one must have the means of surveillance". This statement by Colonel Blin[12] is particularly poignant in the light of current European observation satellite capabilities. Indeed, France,

[10] European Commission, 2003, White Paper on "Space: a new European frontier for an expanding Union. An action plan for implementing the European Space policy", COM (2003) 673 Final, Brussels.
[11] Research Fellow at the US Foundation for Strategic Research and a specialist of US space policy. Interviewed by *Cyberscopie*, June 2002.
[12] Head of the Space Office of the French Defence Staff's Joint Forces Programmes Division, during an

in collaboration with Belgium, Italy and Spain, is the only country to have a military observation satellite. This being said, observation capabilities can be boosted by calling on commercial satellite operators, both within Europe (Spot Image) or outside it (essentially, American operators).

(a) Helios

23. On 18 December 2004 Helios 2A, the second generation of predominantly French military optical observation satellites, was placed in orbit by the Ariane 5G launcher. It was not the first, but the thirteenth military payload to be put into orbit by the European launcher, whose previous launches[13], included Helios 1A (1995) and Helios 1B (1999).

24. The Helios military satellite observation programme started in 1986 under impetus from the French Ministry of Defence. Originally purely French, it became a two-nation programme when joined by Italy in 1987, and a three-nation project[14] with the arrival of Spain in 1988. Although Helios is managed collectively, each nation uses the satellites on a confidential basis *pro rata* to its national participation.

25. For four years the Helios 1A satellite with its optical observation system was able to scan the whole globe on its own in 36 hours from its quasi polar (700 km) and sun-synchronous orbit. The performance of the system was enhanced when Helios 1B was launched in December 1999, enabling any spot on the globe to be revisited within about 24 hours. Now, Helios 1A continues to function[15], while Helios 1B had to be taken out of orbit in October 2004 after five years of operations.

26. The French Ministry of Defence decided in 1994 to launch the Helios 2 satellite programme to replace Helios 1 which was becoming obsolete. However, the cost of the Helios 2 project has had to be borne almost exclusively by the French authorities since the failure of the Franco-German Helios 2/Horus programme, although since 2001 Belgium and Spain have also been participating in the Helios 2 programme to the tune of 2.5% each. Greece is on the point of joining the Helios 2 programme with participation of 2.5%.

27. Helios 2A is located in the same type of orbit as its predecessors, but comprises a large number of technical improvements. For example, it has a very high resolution instrument which "thanks to a highly stable dimensional structure is able to produce high-definition optical and infrared images"[16]. The addition of an infrared capability enables both day and night-time observation, but its optical sensors remain dependent on weather conditions[17]. It offers the French, Belgian and Spanish authorities a high-resolution capability enabling civilian objects to be distinguished from military ones[18]. Moreover it has a wide-field sensor making it possible to produce medium-resolution images over large areas, for mapping purposes, for example[19]. That instrument shows the broad synergy that exists between civilian and military satellites, essentially between the Helios and Spot satellite families, since it was developed jointly with the Spot 5 satellite system. Moreover, the Helios 1A and 1B satellites were based on Spot 4, while Helios 2A was designed on the basis of Spot 5.

(b) Commercial operators

28. Space observation was a real military monopoly until the 1980s, but a major turning-point was reached when France decided to develop the Spot commercial imaging satellite in 1982. Indeed, the spatial resolution of commercial satellites is approaching that of military satellites and they are becoming increasingly attractive for arms control verification purposes.

---

interview on 25 January 2005.

[13] Essentially, military telecommunications satellites: Syracuse I, II and III (France), Sicral I (Italy), Skynet 4 (UK), Hispasat 1A and 1B (Spain), Türksat 1A, 1B, 1C and Eurasia Sat 1 (Turkey), as well as the previous two European military optical satellites Helios 1A and 1B.

[14] The financial break-down is as follows: France 79%, Italy 14% and Spain 7%.

[15] The Helios 1 satellites were designed to have a five-year lifetime.

[16] French Ministry of Defence, http://www.defense.gouv.fr

[17] Optical satellites are of limited use in cases of thick cloud cover.

[18] According to the French Ministry of Defence, Helios 2A can now distinguish a tank from a tractor. Its spatial resolution is estimated at between 50 cm and 1 m.

[19] French Ministry of Defence, http://www.defense.gouv.fr

29. Spot Image, the only European company to market satellite images, ranks among the major companies selling this type of service at international level. American companies use satellites with the highest spatial resolution on the market, but there are also Israeli, Indian, Japanese and Taiwanese commercial satellite operators worthy of mention.

− Non-community companies

30. Up until 1993 American companies were not allowed to invest in the highly strategic satellite images market, since the US authorities had decided very early on to control the dissemination of satellite images. However, as this market boomed, the Bush Administration in 1993 and then the Clinton Administration in 1994 decided to authorise the sale of images with 3 metres, and later, one metre resolution. That decision, known as PDD (Presidential Decision Directive) 23, also gives the US authorities the right to have a say in the activities of the companies concerned. They reserve the right, for example, to prohibit the sale of commercial satellite images to certain states or suspicious individuals, and to restrict access to certain zones in the event of a crisis. As far as Israel is concerned, no images of a higher resolution than that available from other commercial sources may be sold, in order to prevent them from falling into the hands of terrorists.

31. Although the US Government has never actually invoked PDD 23, it remains interventionist in its approach. In 2001, during Operation Enduring Freedom in Afghanistan, for example, the Pentagon acquired all the images taken by the company SpaceImaging[20]. Under an agreement signed on 5 October 2001 and extended for another month on 5 November, the company pledged, in exchange for a fee of 1.9 million dollars, to refrain from selling images of Afghanistan and the surrounding region (Pakistan, Uzbekistan) to customers other than NIMA (National Imagery and Mapping Agency)[21].

32. The arrival of two new players − Orbimage[22] and DigitalGlobe[23] − on the American market makes it unlikely that the NGA (National Geospatial Intelligence Agency, NIMA's successor) will be able to buy up all the images. Images were published during the Iraq campaign, for example, but only after the Pentagon had given the green light.

33. This dependency of US firms on their government[24] makes it difficult for the European Union to acquire images of high strategic interest through commercial channels.

− Spot Image[25]

34. The company Spot Image was set up in 1986 in order to market the images produced by the Spot 1 satellite, initially as a subsidiary of the French space agency CNES, which now holds only 41% of the shares. It still has strong ties with CNES, which has given it an operating licence for its Spot satellites. The only official rules to which it is subjected are those of a UN resolution[26] adopted in December 1986 authorising free observation from space.

35. Contrary to the situation in the US where the dissemination of images by companies is regulated by law, there is no reference in French legislation to satellite images. However, there is a compromise

[20] The only US firm in 2001 to have its own commercial observation satellite, Ikonos, with spatial resolution of 1 metre in panchromatic mode and 4 metres in multispectral mode.
[21] Laurence Nardon, 2002, *Le contrôle de l'imagerie commerciale : après la campagne d'Afghanistan*, IFRI, Paris, page 6.
[22] Orbimage owns the OrbView-3 satellite which has spatial resolution of 1 metre in panchromatic mode and 4 metres in multispectral mode. The next satellite, OrbView-5, will be able to produce images with a spatial resolution of 41 cm but, only for the US Defence Ministry; the images being sold on the market will have a resolution of 82 cm or more.
[23] Digitalglobe offers the services of its Quickbird observation satellite, with spatial resolution of 61 cm in panchromatic mode and 2.44 metres in multispectral mode.
[24] The two contracts granted to Orbimage and Digitalglobe in the *Nextview* framework were revealing of the close ties between those companies and the US Government. The future of the company Space Imaging looks somewhat uncertain as it was not chosen for one of the two *Nextview* contracts.
[25] From an interview with Philippe Munier, Deputy Director General of Spot Image, on 14 February 2005.
[26] Resolution 41/64, 3 December 1986, http://www.un.org

solution under which the French authorities supervise and provide a framework for the dissemination of images.

36. These days the space imaging market, estimated at a billion dollars, is essentially institutional, with defence ministries accounting for a large share of the images sold. Spot Image, making the most of its quasi monopoly at the beginning of the 1990s, among other things provided coverage of Iraqi territory for the benefit of the US armed forces during the first Gulf war. Since that time the number of companies supplying such services has increased, as has the spatial resolution offered by commercial satellites.

37. Although the spatial resolution of the Spot satellites[27] is lower than that of its main competitors, the images they produce still meet with military and intelligence requirements. There are two possibilities. The first is the supply of images from Spot satellites for general surveillance and mapping purposes. A Spot 5 image may cover an area of 60 by 60, or even 60 by 200[28] kilometres. Hence it covers a particularly large surface area (3 600 or even 12 000 km2) at a price of one to three euros per square kilometre, as compared with 15 euros for its main competitors. Alternatively, Spot Image may play the role of intermediary by acquiring higher-resolution images from other commercial suppliers. This offers a two-fold advantage to institutional customers, in that Spot Image acts as sole supplier[29] but also as a screen which conceals the customer's identity from the other suppliers.

38. These days the distinction between military and civilian satellite capabilities no longer obtains, given that commercial companies can offer intelligence services almost on a par with those from military sources. Since Spot Image has been authorised to market images from France's future dual-purpose (civil and military) satellite Pleiades, which offers spatial resolution of 70 cm, the EU authorities will have access at any time to both general and specific space images without the dissemination of images being hampered by legislation that is external to the Union.

39. The growing role of commercial operators will in future allow the European nations' defence ministries to make savings. Commercial operators could sign annual contracts with their defence ministries for the supply of a fixed number of images per day on the basis of an architecture which remains to be defined, using the medium- and high resolution sensors available to them. This would avoid having to incorporate those capabilities in military satellites and the duplication and extra costs that this would entail. Only a few dedicated systems with the highest performance levels, such as very high resolution and hyperspectral systems, would remain the monopoly of the armed forces, which would be able to concentrate their efforts on capabilities unavailable elsewhere.

2. Short- and medium-term capabilities

40. Although the next generation of European observation satellites will be developed on a purely national basis, cooperation among states has been stepped up in order to ensure that these systems function in a complementary fashion[30] that makes for "synergy among the national capabilities provided by each state with a view to their joint and optimised use"[31]. Moreover, that new generation of satellites brings with it enhanced cooperation among the civil and military spheres, thereby reducing production costs.

(a) SAR-Lupe and TerraSAR

41. SAR-Lupe is Germany's first military observation satellite, as well as the first satellite in Europe to gather radar images for intelligence purposes. The German Defence Ministry's choice of a

[27] Spot 1, 2 and 3 offer resolution of 10 metres in panchromatic mode and 20 metres in multispectral mode (3 bands). Spot 4 has the same characteristics but has 4 bands in multispectral mode. Spot 5 has spatial resolution of 2.5 metres in panchromatic mode and 10 metres in multispectral mode.
[28] In 2002, while American commercial satellites covered only 80% of Iraqi territory over an eight-month period, Spot 5 was able, at the request of the US authorities, to cover the whole area in two months, from September to October.
[29] Spot Image is a defence contact point for the French Military Intelligence Directorate.
[30] See Assembly Document 1881, adopted on 30 November 2004: "The space dimension of the ESDP", submitted on behalf of the Defence Committee by Mr Gubert, Rapporteur (Italy, Federated Group) pp. 10-11.
[31] French Senate Report No 443, page 5.

radar satellite was crucial in that, unlike optical satellites, it offers a day- and night-time as well as an all-weather observation capability.

42. The five-satellite constellation, due to be launched between 2005 and 2007, should provide the German authorities with images of less than one metre resolution. In addition to its all-weather capability, the radar sensor can detect the precise physical characteristics of the earth's surface, in particular roughness and humidity. With resolution of less than one metre, the SAR-Lupe satellite constellation allows the distinction to be made between different types of construction and hence to detect structures which may be linked with WDM proliferation. All the satellites in the constellation can operate on two different wavelengths − X and S − allowing an even more precise distinction between objects.

43. The German authorities' choice of radar satellites entails the need to train specialised photo-interpreters. Moreover, it is quite logical for Germany, as a specialist in radar observation, to work in cooperation with France, which is specialised in optical observation. Hence, under an agreement signed on 30 July 2002, France has pledged to give Germany access rights to Helios 2 in exchange for access rights to Germany's SAR-Lupe system[32].

44. The TerraSAR programme involves the construction of two dual-purpose and dual-funded radar satellites. Indeed, since the programme has both civil and military applications, it is to be funded on the basis of a public/private partnership between the DLR[33] and EADS Astrium GmbH. Both satellites, scheduled for launch in 2006, will be operated by a subsidiary of Astrium, Infoterra, which was set up for the commercial exploitation of the satellites[34].

(b) Cosmo-SkyMed and Pleiades: a Franco-Italian cooperation initiative

45. On 29 January 2001 the French and Italian governments signed an agreement formalising their intention to develop a dual-use system composed of optical and radar satellites, together with their ground segment[35]. Although the satellites will be developed at national level, the user ground segments for the two systems will be identical, enabling an efficient exchange of information. The system, known as ORFEO (Optical and Radar Federated Earth Observation) will comprise a radar component, Cosmo-SkyMed, developed by Italy, and an optical component, Pleiades, developed by France. The original idea of having a common user ground segment for the two systems, which would have made for even better interoperability, was finally dropped in favour of a distinct ground segment for each of them.

− Cosmo-SkyMed

46. Alenia Spazio is the prime contractor for the Cosmo-SkyMed constellation composed of four radar satellites enabling images of sub-metric resolution to be obtained using the X band. The launches are scheduled to take place between mid-2005 and mid-2007. This will be Europe's second radar satellite system, but its mode of operation differs from that of SAR-Lupe. The latter has a passive radar antenna to obtain better spatial resolution, while COSMO-SkyMed, like TerraSAR, will be equipped with an active antenna emitting its own radar wave which will be reflected back from the ground and picked up by the satellite[36]. This method has the advantage of conferring greater flexibility on the satellite, enabling it to gather images over a wider surface area.

− Pleiades

47. The two Pleiades satellites, whose development is being funded by the CNES, have been chosen to replace the Spot commercial satellites. The prime contractor is Astrium[37] and the launches are scheduled for 2008 and 2009. The satellites offer spatial resolution of 70 cm over a 20 km area and

[32] The two defence ministries will be able to acquire the user ground components of their partner.
[33] *Deutsches Zentrum für Luft und Raumfahrt*, the German Space Agency.
[34] Those satellites also offer spatial resolution of 1m. Each will operate on a different wavelength, respectively the X and L bands.
[35] French Senate, 2003, *op.cit* page 5.
[36] An active radar antenna functions according to the same principle as the sonar.
[37] Alcatel Space, for its part, is to develop the high-resolution instruments.

like Spot 5 they work in four spectral bands. Moreover, given the importance of the HRS (High Resolution Stereoscopic) instruments on Spot 5, enabling the acquisition of images in stereoscopic mode[38], the Pleiades satellites are to be equipped with the same capabilities.

48. Both Cosmo-SkyMed and Pleiades are dual-use satellites. The information destined for the defence ministries of the countries concerned will be encrypted differently using secure communications channels.

49. Initiatives like these, involving cooperation among individual states, nevertheless contribute to Europeanising observation satellite capabilities. Indeed, the information gathered by systems like Cosmo-SkyMed and Pleiades will be made available to the European bodies in the framework of initiatives such as GMES (Global Monitoring for Environment and Security), which is dealt with below. This will provide access to high-quality imaging at any time of the day or night and in all weathers, thereby contributing to the development of a space-based capability to serve the ESDP and its arms control and non-proliferation objectives.

III. Arms control: a special role for ESDP

50. The EU's assertion of its role on the international stage as an entity in its own right is a relatively recent development, for in the past the national policy of individual member states has often taken precedence over community policies. However, the terrorist attacks in the US in 2001 and Spain in 2004 contributed to the development of a common position on the key issues of arms control and non-proliferation. The European Union has drawn up a European Security Strategy and a European Strategy Against Proliferation of Weapons of Mass Destruction. It has set itself a number of objectives and engaged in a process of reflection on the ways and means of achieving them. This then is the context in which we must consider the role of space in the ESDP. A number of initiatives have already been taken which will help the EU meet its requirements in the field of arms control and non-proliferation. The EU Satellite Centre and the GMES are undoubtedly key elements in that respect.

1. ESDP, arms control, non-proliferation and space

51. The process of shaping the ESDP − launched with the signing of the Maastricht Treaty and reaffirmed by the Amsterdam Treaty − continues. Crisis management, confirmed as a key issue by the Cologne European Council in 1999, has become a crucial component of the ESDP. Weapons proliferation, as a contributing factor to generating crises, is among the concerns taken on board in the strategies adopted by the EU.

(a) The European Security Strategy and the EU Strategy Against Proliferation of Weapons of Mass Destruction

52. The European Security Strategy adopted by the European Council on 12 December 2003 in Brussels is a kind of "roadmap of the global environment, of its risks and threats and the measures for dealing with them"[39]. It identifies five threats: terrorism, regional conflicts, state failure, organised crime and the proliferation of weapons of mass destruction.

53. "The proliferation of weapons of mass destruction" is "potentially the greatest threat to our security"[40]. There are, in fact, several types of proliferation. It may be regional − the most worrying example is the Middle East − or concern a specific type of weapon, whereby key concerns are biological, chemical and radiological weapons, together with ballistic proliferation. Moreover the different threats cannot be dissociated from each other: "The most frightening scenario is one in which terrorist groups acquire weapons of mass destruction"[41].

54. The European Security Strategy, which constitutes a whole body of doctrine, proposes upstream action to counter the threats it identifies: "We need to be able to act before countries around us

[38] Three-dimensional imaging.
[39] Joanna Liponska-Hottiaux, 2004, "*Les nouvelles avancées de la politique européenne de sécurité et de défense"* in *Eipascope*, no 1, Maastricht, p.25.
[40] Javier Solana, "A secure Europe in a better world", European Security Strategy, IES Paris, page 8.
[41] *Ibid.*

deteriorate, when signs of proliferation are detected, and before humanitarian emergencies arise. Preventive engagement can avoid more serious problems in the future"[42]. It proposes in that context that the "systematic use of pooled and shared assets would reduce duplications, overheads and, in the medium-term, increase capabilities"[43].

55. The extraordinary European Council of 21 September 2001 identified arms control and non-proliferation as EU policy objectives when it adopted a plan of action to combat terrorism. Subsequently the question of WMD was systematically addressed in European Council conclusions up until the Thessaloniki European Council on 20 June 2003, which adopted a declaration on the subject.

56. The EU Strategy Against Proliferation of Weapons of Mass Destruction echoes the European Security Strategy, recalling that "WMD and missile proliferation puts at risk the security of our states, our peoples and our interests around the world" [44]. Since the EU is committed to ensuring compliance with the system of multilateral treaties and negotiations, it requires "verification mechanisms and systems"[45] to detect treaty violations and prevent the rules from being circumvented. Space-based sensors are an essential component of such systems used in support of the ESDP.

(b) The ESDP and Space

57. With the ESDP developing at a pace unparalleled by other areas of European integration, space policy is beginning to take on unprecedented importance in the framework of the CFSP. There have been crucial developments since the Amsterdam Treaty was signed in 1997, such as the creation of the post of High Representative for the CFSP, which has been occupied by Javier Solana since 1999, and the launch of the process for identifying shortfalls in the area of European security and defence, which is still under way. Much thought and effort has gone into strengthening the ESDP as an integral part of the CFSP.

58. The European Defence Agency (EDA) was set up in response to the need to pool capabilities and following a decision announced at the Thessaloniki Summit to create an "Agency in the field of defence capabilities, development, research, acquisition and armaments"[46]. The European Capability Action Plan (ECAP) was launched in 2002 in order to identify capability shortfalls and propose short- and medium-term solutions to remedy them. 42 shortfalls were identified, following which it was decided at a meeting of EU Foreign Affairs and Defence Ministers on 19 May 2003 to reform the ECAP process. Nineteen panels were set up, composed of experts provided on a voluntary basis by a number of member states and steered by one, or in some cases, several member states[47] with the task of finding solutions to remedy the identified shortfalls. Then 15 project groups were set up in order to implement the proposed solutions, among which a Space Group chaired by France. That Group is sub-divided into sub-groups responsible for improving capabilities in the short term, developing them in the medium and long term and drawing up an operational concept and doctrine, and is of particular strategic interest for Europe.

59. Since the ESDP is the responsibility of the EU Council, decisions in that area must be taken unanimously. Space offers a certain added value in that it guarantees access to reliable information that is available to all, reduces uncertainty and increases the chances of cautious and appropriate decision-making[48]. Space policy as an integral part of the ESDP guarantees a degree of strategic independence by providing continuous access to information through "autonomous instruments making it possible to assess the situation in an independent, precise and objective fashion"[49]. Since

[42] *Ibid.*
[43] *Ibid.*
[44] Council of the European Union, 2003, EU Strategy Against Proliferation of Weapons of Mass Destruction, 15708/03, Brussels, p.2
[45] *Ibid*, page 6.
[46] See Assembly Document 1842 adopted on 3 December 2003: "European defence: pooling and strengthening national and European capabilities − reply to the annual report of the Council", submitted on behalf of the Defence Committee by Manuela Aguiar, Rapporteur (Portugal, Socialist Group).
[47] *Ibid*.
[48] EU Council, 2004, "European space policy: the ESDP and space", 11616/3/04, Brussels.
[49] Thierry Coosemans, 2004, *"L'Union Européenne et le renseignement*", GRIP, Brussels, p.48.

satellite images can be used in the fight against the proliferation of WMD and to verify compliance with international treaties by providing proof of illicit action, the interpretation of those images has become crucial. That task is now the responsibility of the EU Satellite Centre.

2. The EU Satellite Centre

60. Given the growing importance of satellite imaging in modern-day conflict situations, WEU took the decision following the Gulf war to set up its own Satellite Centre. The project took a few years to materialise and the WEU Satellite Centre was declared operational in 1997. Although its prime objective was to supply information on the regions recognised by the WEU Council as being in crisis, its task gradually evolved into one of general surveillance.

61. As a logical consequence of the gradual process of transferring WEU's operational functions to the EU, the WEU Satellite Centre became the EU Satellite Centre (EUSC) in 2001, following a decision by the EU Council on 10 November 2000. The Joint Action establishing the EU Satellite Centre, which is located in Torrejón, Spain, describes its mission as follows: "The Centre shall support the decision-making of the Union in the context of the CFSP, in particular of the ESDP, by providing material resulting from the analysis of satellite imagery and collateral data, including aerial imagery as appropriate"[50]. The EUSC comes under the authority of the High Representative for the CFSP, but requests for information may also be submitted to it by the EU Council as well as individual EU member states, international organisations and third countries. All requests are subjected to a ranking system and hence the Centre's main "customers" are the EU Council (52%), the member states (45%) and NATO (3%)[51].

62. The EUSC's task is to support Petersberg missions, general security and environmental surveillance missions and activities in the area of treaty verification, arms control and non-proliferation. For those purposes its budget has continually been increased since it became an EU agency, going from 9 300 000 euros in 2002 to 10 210 000 euros in 2004, an increase of 9.8%. Thus between 2002 and 2004, although peacekeeping and humanitarian support constituted the bulk of its observation activities (26.8% and 26.5% respectively), treaty-monitoring and arms control were in third place with 15% of missions. Much of the EUSC's surveillance work in the area of arms control and non-proliferation is focused on proliferating states such as Iran and North Korea, with a view to its key objective of prevention.

63. The EUSC is currently engaged in continuous surveillance of several sites linked with Iran's nuclear programme. For example, as regards the Bushehr power station, built with Russia's assistance, its mission is to monitor the construction process in order to estimate when the power station will become operational. The Esfahan nuclear technology centre is also under surveillance. Indeed, since its construction at the end of the 1970s it has had two further structures added to it: a uranium hexafluoride (UF6) conversion plant and a zirconium factory[52]. Iran declared the two plants to the IAEA in 2000 but suspended the construction process under pressure from the international community and the IAEA. The EUSC's task is to check that construction is not being resumed. Recent images taken by Ikonos and Quickbird showed the uranium conversion plant to be partially operational and in the process of being militarised, with the installation of an air defence system. The most striking case, however, is that of Natanz where a clandestine uranium enrichment plant was built. Since its discovery in 2002 that site has been kept under regular surveillance, since it is clear from the EUSC's observations that it has a military purpose. Indeed, there are two large buildings (about 25 000 m2 each) that indicate the presence of a large number of centrifuges. By burying those structures to make satellite observations more difficult, the Iranian authorities only confirmed the suspicions concerning them.

[50] Council Joint Action of 20 July 2001 on the establishment of a European Union Satellite Centre, Document 20001/555/ESDP.

[51] De Neve Alain, Mathieu Raphaël, 2004, *"Développements capacitaires en Europe dans le domaine des activités spatiales liées à la défense et à la sécurité"* in *Sécurité et Stratégie*, No. 84, Brussels, pp.222-223

[52] These installations enable Iran to produce nuclear fuel.

64. Although the information produced by the EUSC is of undeniable strategic relevance, the Centre does not for the moment offer a tactical intelligence capability, due to its reliance on commercial satellites, which means longer image acquisition times[53]. Indeed, every time the Centre needs images it launches an invitation to tender, to which commercial companies respond according to the images they have available. However, the EUSC has signed an MOU[54] with France, Italy and Spain giving it access to Helios 1 military-quality images and is negotiating a follow-up MOU on Helios 2 images.

65. Although the EUSC is now an integral part of the ESDP and is involved throughout the decision-making process, from the request for information through to the actual decision, its action will remain limited for as long as the European Union does not possess its own satellite capabilities, for these are crucial to obtaining information quickly. GMES, the system for Global Monitoring for Environment and Security, will doubtless strengthen the EUSC's image acquisition capacities and will perhaps be the first step towards the creation one day of a European intelligence agency.

3. Global Monitoring for Security

66. The aim of this joint initiative launched in Baveno in May 1998 by the European Commission and the European Space Agency (ESA) is to group together all European earth observation activities in a "system of systems" to help Europe acquire the autonomous capacity to assess situations, trends and developments that have an impact on its environment and security. To achieve this, "GMES needs to make full use of data collected from space-borne, airborne and in-situ observation systems that is then delivered to service providers through an efficient data integration and information management capacity"[55]. The space component of that architecture as envisaged by the GMES Steering Committee[56] should comprise satellites operated both by ESA and the national space agencies. Those satellites will be divided into five categories of "sentinels": radar satellites; multispectral satellites of the Spot or Landsat type for earth observation, including vegetation; ocean observation satellites flying multispectral sensors and altimeters; geostationary satellites to observe the composition of the atmosphere and detect cross-border pollution and, finally, low earth orbit (LEO) satellites to monitor the composition of the atmosphere[57].

67. Above and beyond the problems of setting up such a system between now and 2008, the GMES reflection process is centred on the security aspects. While defence issues are the sole responsibility of the Council of the European Union, "security" as envisaged by the Commission is an "inter-pillar"' notion. The concept covers a particularly broad area embracing civil protection, rescue operations, humanitarian assistance, assistance with police, coastguard and customs operations, and the support of the CFSP for humanitarian operations, crisis management (including Petersberg operations), and the provision of emergency assistance both within and outside Europe.

68. The Commission's interest in using the GMES system in support of the CFSP makes it necessary to clarify the respective roles of the Council and Commission in this area. With reference to one of the conclusions drawn by the 1999 Helsinki European Council[58] to the effect that "a non-military crisis management mechanism will be established to coordinate and make more effective the various civilian means and resources, in parallel with the military ones, at the disposal of the Union and the Member States", the GMES initiative has a role to play within the CFSP. Nevertheless, there is a problem of possible duplication between the Council and Commission; indeed, this is an area in which there is considerable tension between the EUSC and the Joint Research Centre (JRC)[59].

---

[53] In some cases commercial images must be screened by the intelligence services, lengthening image acquisition time.
[54] Memorandum of Understanding.
[55] Commission of the European Communities,2004: "Global Monitoring for Environment and Security (GMES): Establishing a GMES capacity by 2008 − (Action Plan (2004-2008)) , COM (2004) 65 final, Brussels, p.3.
[56] GMES Advisory Council, 2004, "Reflection Paper: GMES Space Observation Component," GAC(2004)7_Fin, 5 pages
[57] For the system to be operational a satellite from each group has to be functioning at all times.
[58] Helsinki European Council, 10-11 December 1999, Presidency conclusions, http://europa.eu.int
[59] JRC is the equivalent of the EUSC but works for the Commission.

69. The JRC and DLR, with the assistance of 22 other public and private civilian[60] organisations, have set up a network of excellence called GMOSS[61] with the aim of making scientific and technological research available for the security aspects of GMES, by identifying and reducing the threats while offering solutions to crisis situations. To that end GMOSS will use generic methods, algorithms and software enabling the automatic display and interpretation of images as well as specific scientific and technical methods to provide effective monitoring of international treaties for the fight against the proliferation of WDM and develop early warning tools[62]. It will enable observation of the population on a global scale, monitoring of infrastructure and borders and rapid damage assessments. Research on current and future threats is to continue in parallel.

70. For treaty-monitoring purposes the tasks of one of the GMOSS working groups[63] are to (1) develop a common understanding of characteristic features of treaty-relevant facilities that can be identified in satellite images, (2) develop and exchange software tools for verification of declared with actual information on relevant sites, (3) develop methodologies, algorithms and software for identification of security-relevant changes at both sites declared under the international treaties and clandestine sites, and (4) identify seismically detected explosions relevant to the nuclear testing and dubious events"[64]. Hence, under that definition, a number of treaties such as the NPT, CTBT, CFE treaty and CWC could qualify for satellite-based verification. For the moment, verification is only possible for the NPT and, to a lesser extent the CTBT[65]. Given the international situation both civilian and military analysts in the EU or from national institutions are inclined these days to focus on nuclear proliferation, rather than on, for example, the CFE Treaty, although it continues to be one of the foundations for Europe's security. Furthermore, although Europe's satellite capabilities are enough to monitor nuclear facilities, there are certain types of proliferation that they cannot so easily detect. Chemical weapons installations are difficult to identify, for example, and biological weapons facilities even more so.

IV. An EU role in arms control and non-proliferation? Technical and institutional prospects

71. The GMES initiative, based to begin with on existing capacities in Europe, will, as a second step, need to provide a catalyst for efforts at European level in the field of space policy. For Europe's strategic independence in the field of space to become a reality, it is essential that the Commission should continue its financial effort as regards this project[66], just as the government of the United States supports its space industry. Today's R&D effort, which will determine tomorrow's capabilities, is closely linked with the perception companies have of their markets. There can be no doubt that the EU needs to step up its involvement in the space sector if it wishes to avoid being dependent on non-European companies in such a sensitive area as that of satellite observation. If the EU is to acquire a space-observation capability for the long term, it must meet two major challenges: one technological, relating to future capabilities, and the other institutional, involving a definition of the EU's role in this area.

1. Future technological progress

72. Although the EU does not yet have its own satellites and does not offer outlets for companies in the short term, the new technologies developed by European companies will soon increase Europe's arms control and non-proliferation monitoring capabilities. Some of those are real innovations (hyperspectral technology), while others (early warning, interferometry, for example) are simply technologies that Europe did not master up until now.

---

[60] Including the EUSC but also other European national space agencies like CNES.
[61] Global Monitoring for Stability and Security.
[62] http://intelligence.jrc.cec.eu.int/gmoss/gmoss.html
[63] *Work Package 20400.*
[64] http://intelligence.jrc.cec.eu.int/gmoss/gmoss.html
[65] The CTBT has not yet entered into force as it has still not been ratified by certain nuclear states such as the United States and China.
[66] The EU allocated 100 million euros to the project for the period 2004-2006, but has not yet announced what funding will be available from 2007 onwards.

(a) Hyperspectral[67] technology

73. Depending on their composition, objects reflect, absorb or emit electromagnetic radiation. The satellite can capture that radiation and thereby the spectral signature of the object, making it possible to identify the object or measure the quantities of materials of which it is composed. The optical satellites that are currently in orbit are carrying panchromatic[68] or multispectral sensors. The latter, however, operate in only a few spectral bands and offer limited spectral resolution[69]. NASA's Landsat 7 satellite, for example, is the commercial satellite that offers the best spectral resolution although with only eight spectral bands it cannot cover the whole spectrum. Hence, a detailed spectral analysis can only be obtained by sensors working in several dozen spectral bands. This is the purpose of several demonstrators that were recently launched, the first being the American satellite EO-1. The Europeans have two hyperspectral sensors, CHRIS and MERIS. The former, developed by the British firm SIRA, is being flown on ESA's PROBA satellite and functions in 61 spectral bands, 18 of which can be used simultaneously. The latter, developed by Alcatel Space, is considered to be one of the highest-performance sensors. Indeed it offers ocean monitoring of unprecedented quality thanks to 15 spectral bands enabling it to observe different shades of blue. That detailed analysis of water colour provides information about the presence of sediments and various liquids.

74. Although for the moment hyperspectral sensors are being used for purely civilian purposes, they offer a multitude of military applications. Defence staffs are interested in environmental information[70] for the purpose of preparing a military operation, for example. The detailed analyses made possible by hyperspectral sensors enable the feasibility of an operation to be assessed according to the mineralogical nature of the soil, as well as its humidity, inclination, density etc. Such sensors can be used in the area of arms control and non-proliferation to detect indirect signs of proliferation by observing the gaseous and liquid emissions of suspect installations. Since every gas and liquid has its own spectral signature, a chemical substance can be detected by satellite, provided that its spectral signature already figures in the relevant database[71]. Hence, nuclear proliferation can be detected by identifying a chemical agent necessary for the production of the relevant materials.

75. Although ESA has abandoned plans to develop SPECTRA, a hyperspectral satellite that was to be incorporated in the GMES system[72], there are plans for integrating a superspectral sensor[73] in the system. The main market for hyperspectral technology remains the defence ministries. Alcatel Space, the recognised European leader in this field, is cooperating with the French procurement agency, DGA, on a study of this instrument's operational advantages. However, the real problem of hyperspectral technology is its utilisation, in that photo-interpreters need special training to be able to glean maximum information from the hyperspectral images.

(b) Early warning

76. The United States and Russia for a long time had the monopoly of the system for identifying a ballistic missile during the propulsion phase by measuring the thermal radiation produced by the engine's combustion. The technology is now being mastered in Europe, mainly by France, which is developing an early-warning demonstrator called Spirale[74].

77. Such a system is very difficult to put into practice since it involves striking a delicate balance between the resolution and sensitivity of the infrared sensor. Indeed, "resolution is necessary to measure the deviation of the missile during the propulsion phase and make an initial estimate of its ballistic trajectory. Sensitivity on the other hand results from a trade-off between the need for reliable

[67] From an interview on 8 March 2005 with Serge Taride of Alcatel Space.
[68] Panchromatic sensors offer better spatial resolution, but their spectral resolution is very low, since the images they obtain are only in black and white.
[69] Canadian Space Agency, http://www.space.gc.ca/asc/fr/satellites/hyper_foresterie.asp
[70] Known in the UK as soil intelligence.
[71] A database of spectral signatures needs to be set up before hyperspectral sensors are placed in orbit.
[72] It was to be part of the no 2 sentinel family.
[73] A superspectral sensor works in some twelve or fifteen, as opposed to several tens of spectral bands for a hyperspectral sensor.
[74] The French acronym for preparatory infrared system for early warning.

detection of the shortest-range (less powerful) missiles and the desire not to trigger a false alert"[75]. Advanced early warning satellites must be placed in geostationary orbit in order to be able to continuously monitor crisis zones.

78. Ballistic proliferation is a key concern addressed by the European Security Strategy. A space-based early warning system, however, can only detect missile tests or hostile missile launches, it is not a means of combating the proliferation of ballistic delivery vehicles as such. The United States is developing, more or less successfully, a missile shield with advanced early warning satellites at the heart of the system. Europe must decide whether early warning is to remain simply a tool for identifying proliferation or whether it should form the basis for a much more comprehensive system incorporating not only early-warning satellites but also interceptor missiles. This question is not on the table yet, since France for the moment is only at the stage of developing an early-warning demonstrator, but there will have to be discussion at a later stage of Europeanising early-warning systems, given that a missile attack could take place anywhere in Europe.

(c) Interferometry

79. Radar interferometry, which involves superposing two radar images (known as a master and a slave image[76]), is used to observe large surface areas, essentially for earthquakes and subsidence phenomena. It enables differences of elevation to be calculated by comparison with previous images and to detect tectonic shifts[77].

80. This technology, for many years inaccessible to the European states, is now within their reach. With the forthcoming launches of the TerraSAR, SARLupe and CosmoSkyMed satellites, Europe will at last have access to radar satellites offering metric resolution[78]. With the aid of interferometry, photo-interpreters will be able to detect slight changes of elevation or movements of the terrain which are not visible on optical images. Thus with the military quality of the future radar satellites, changes of even a few centimetres will become detectable.

81. This technology is relevant for detecting underground nuclear tests. The explosion zone can be detected using triangulation techniques authorised by the international network of seismographers, then located precisely by radar satellite. Indeed, a nuclear explosion initially causes a slight swelling of the ground followed by subsidence. However, in order to identify that change, the archives must contain an image of the terrain prior to the explosion. Hence, the essential first step is to compile a database of images for comparison purposes. Although satellite observation is not part of the official CTBT verification system, satellites are recognised as useful for the implementation the Treaty.

2. Towards a European space policy?

82. Arms control and non-proliferation appear to be areas which encourage action at European level. Although space-based capabilities are not the only monitoring tools, their role will increase, as will the EU's involvement in this area. Indeed, by pursuing the space effort the EU will be able to take its place among the powers possessing an observation capability that can be used at any time and anywhere, in all legality.

83. As the process of European integration forges ahead, European space activities can no longer be confined to purely scientific missions. This need for change is reflected in the policy of the European Commission, which has made space the responsibility of the Commissioner in charge of enterprises. The EU will soon have to take another major step: that of engaging in the construction of observation satellites. There have already been a number of initiatives that are promising for the EU's future commitment to space, such as the cooperation that is currently being organised between the EU and

[75] Jean Dupont, 2004, "*La France défriche l'alerte spatiale*" in *Air & Cosmos*, No. 1930, Paris, pp.22-23.
[76] The master image being the oldest one.
[77] For the measurement to be valid, the images must have identical spatial resolution and be taken from an almost identical angle. Moreover, the shorter the time lapse between the moments at which each image was taken, the greater the precision.
[78] The main radar satellites available to the European states are ERS-1 and 2 (ESA/Canadian Space Agency), with spatial resolution of about 20 metres.

ESA. The Common Operational Requirements, known by their French acronym BOC, are the forerunners for a new European space cooperation architecture, possibly with a variable geometry.

(a) ESA and the EU

84. Although ESA remains a separate entity from the EU with its own structures, the two have been drawing closer since 1998. That year the two organisations adopted a resolution aimed at strengthening the synergy between them. A second step was taken in 2000 with the adoption of a joint communication on Europe and space[79] by the Council of EU Research Ministers and the ESA Council of Ministers.

85. With ESA-EU cooperation covering a number of points the first step was to define an overall European space policy, including the security aspects[80]. A White Paper on space sets out the main points, such as guaranteeing independent and profitable access to space and gathering know-how with a view to increasing the coherence and hence synergy of space policies. Space policy must also support other EU policies such as the CFSP.

86. However, to achieve that Europe needs space-based tools providing independent access to global strategic and tactical information in order to speed up the decision-making process. Since no member state on its own has the means to develop the full range of observation instruments, the only way to gain access to the widest possible range of tools is to pool observation capabilities. The EU has set itself objectives which go beyond the current capabilities of all EU member states together, which means using satellites not only for telecommunications and observation in the area of security, but also surveillance, positioning and navigation, as well as synchronisation, communications, intelligence, transmissions, early warning and the surveillance of space, in order to be able to achieve the EU's security objectives.

87. For that purpose "the European Union should have the lead for federating society's needs for space-based services relevant to EU policies and for co-ordinating their delivery, while the European Space Agency should take the lead in elaborating, proposing and developing the required solutions"[81]. Although for the moment there are no plans for incorporating ESA within the EU, there is strong interaction between the two institutions. If the Commission wishes to launch a space programme, for example, it has to turn to ESA for its implementation.

88. Under the EU Constitutional Treaty space policy is a prerogative that is shared between the EU and its member states[82], which will be conducive to a further strengthening of the partnership between the ESA and the EU in the years to come. Nevertheless, at the present time the EU is not in a position to engage extensively in the construction of space-based capabilities, for although the Commission is endeavouring to make space policy (both civil and military) one of its prerogatives, the allocated budget is not enough to implement that policy of independent access to space.

89. Furthermore, for the EU to engage in military space policy it needs to overcome a number of obstacles, both within and outside the Union. For example, differences of opinion among the EU member states on space questions make it difficult to reach compromises on such sensitive subjects as satellite observation, while every decision on CFSP matters requires unanimity. External factors also come into play, such as the fact that many European states depend on American military intelligence and many would lose out, in the present situation, if a European agency for the development of a European military space-based capability were to be created.

---

[79] Commission of the European Communities, 2000: "Europe and space: turning to a new chapter", COM(2000) 597 final, Brussels, 26 pages

[80] Commission of the European Communities, 2003, White Paper on Space: "Towards a European Space Policy" COM (2003) final, Brussels, p. 41

[81] Commission of the European Communities, 2003, White Paper on *Space: a new European frontier for an expanding Union. An Action Plan for implementing the European Space policy*, COM (2003) 673 Final, Brussels, pp.36-37.

[82] Article I-14§3 states that: "In the areas of research, technological development and space, the Union shall have competence to carry out activities, in particular to define and implement programmes; however, the exercise of that competence shall not result in Member States being prevented from exercising theirs".

90. Another point is that ESA's statutes need to be clarified. The membership of the two organisations is not identical. Moreover, Article 2 of the ESA Convention states that: "The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems". That being the case, if the Convention is applied to the letter, ESA cannot conduct European projects that have military purposes. However, the current interpretation of the term "peaceful" only rules out the construction of space-based capabilities with an offensive purpose. Thus ESA's embryonic security bureau, which used to look totally improbable, could constitute a link between the two organisations for the realisation of military space programmes.

91. The system of cooperation that has evolved within ESA is the model that should be followed in order to avoid blocking the decision-making process. In the Agency, as the States are not obliged to participate in all programmes, a genuine *à la carte* system has developed. Such a system is beginning to be envisaged by the EU member states, in the form of the Common Operational Requirements.

(b) The Common Operational Requirements (BOC): the first step towards space cooperation?[83]

92. The Common Operational Requirements for a European Global Satellite Observation System was co-signed by the Chiefs of Defence Staffs of the French, German, Italian, Spanish, Belgian and Greek armed forces following a process of reflection launched in 1999. The document, which is open to signature by other European Chiefs of Defence Staffs, aims to specify the performance levels and architectures that are needed in the short and medium term for a future global European satellite system for security and defence purposes operating in the visible, infrared and radar spectrums[84]. In the longer term the aim of the process, above and beyond the joint use of satellite observation capabilities, is to set up a co-funding agreement for programmes.

93. Given its global nature the future satellite observation system will acquire and exploit imaging data on a continual basis. Indeed, the Defence Staffs have agreed on the different areas where permanent monitoring is called for, which include the identification and assessment of proliferation activities and the monitoring and verification of arms control and disarmament treaties. The BOC make provision for three types of mechanism for that purpose. The first entails an exchange of programming rights (exchange of capabilities) among the states in possession of a space observation system (this includes the Franco-German Helios 2−SAR-Lupe Agreement and the Franco-Italian Helios 2−Pleiades−Cosmo-SkyMed Agreement). The second involves the acquisition of programming rights by means of bilateral agreements (examples are the cooperation among France, Belgium and Spain and soon Greece on Helios 2). The third possibility is to submit a request for images to one of the nations in possession of an observation system (an example being the agreement on Helios 1 in the process of being concluded between the EU and France, Italy and Spain).

94. Nevertheless, implementation of the BOC shows the limits of such cooperation, particularly that involving an exchange of capabilities. Indeed, the different components of this European observation system are not interoperable, with each satellite having its own ground segment. From that standpoint the BOC somewhat resemble a conjuring act in which national capabilities are turned into European capabilities.

95. Although the BOC have paved the way for cooperation among countries with common interests in space observation, the time has now come to take things further by defining new requirements based on past experience. Thus the BOC, initially a technical document, must become a political document, given that any developments in the area of military space activities depend on political decisions being taken. The civilian space sector, which initially developed outside the European Community institutions, should provide a model on which to develop a common military space policy. One of the next steps should be for a European standard for the construction of the user ground segments of space observation systems to be drawn up within the BOC. Interoperability, which

[83] From an interview on 25 January 2005 with Colonel Yves Blin, Head of the Space Office of the French Defence Staff's Joint Forces Programmes Division.
[84] Senate 2004, report No. 77, Paris, page 42.

currently is cruelly lacking, will be an absolute prerequisite for a global European space observation system.

96. Europe is still not a military space power due to the fact that its capabilities in that area are dispersed. Nevertheless, European integration is a long process that must be achieved by a series of small steps. The signature by a number of European countries of the BOC is the first step towards that common European undertaking. Although for the moment it is unthinkable that the EU should be involved in building the next generation of observation satellites, the European nations must work together towards creating a European standard that can be used by the EU when the time comes, once it is ready to take the step of becoming a military space power, in harmony with its foreign policy and its objectives in the area of arms control and non-proliferation.

Acknowledgments

We would like to thank the following people for the interviews they granted us and their valuable assistance for drafting the present report:

David BERTOLOTTI: Minister of Foreign Affairs, Sub-Directorate on nuclear disarmament and non-proliferation, France;

Colonel Yves BLIN: Head of the Space Office of the Joint Forces Programmes of the French Defence Staff;

Gerhard BRAUER: European Space Agency, Head of Security Office;

Alain CLAVERIE: EADS Astrium;

Colonel Maurice DUNAND: French Defence Staff, Arms Control Office;

Louis LEVEQUE: EADS Space Transportation;

General Pierre LORENZI: CNES, Military Adviser;

Bernard MOLARD: EADS Astrium;

Philippe MUNIER: Spot Image, Deputy Director General;

Laurence NARDON: Research Fellow at IFRI (*Institut français des relations internationales*);

Colonel Saster KOCHANOWSKI: Commander of the Verification Unit, French Ministry of Defence;

Serge TARIDE: Alcatel Space.