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# European Satellite Imagery Continuity

## The Fusion of Political, Industrial, and Commercial Interests

## March 1990 to March 2010…and Beyond

*"Today, space programs are an important collective endeavor helping Europe to develop its expertise and industrial base. But, as programs that originated under clear civilian and European control and then evolved to include security and even defense aspects, they are also perfect symbols of Europe's new security policy."*

*A European Approach to Space Security, Dr. Xavier Pasco, 2009*

*"The head of the U.S. Department of Defense agency that manages and provides imagery and geospatial information for diverse military, civil, and international needs said that many levels of collaboration – interagency, commercial / government, and international – have improved his agency's ability to support operational needs. He credited much of the advancement to arrangements with both commercial and international space providers that increase capacity and improve flexibility and adaptability."*

*Press release, Strategic Space Symposium, 4 Nov 2009*

The International Commercial Remote Sensing Symposium (ICRSS) in Washington takes place 20 years after the Western European Union (WEU) held detailed discussions on the need for observation satellites. Dr. Pasco's point about the transformation of space-related activity in Europe is salient because it indicates that the effort has a sense of purpose and direction. The March 2010 Symposium in Washington is an opportunity for delegates to discuss the way ahead for commercial satellite imagery programs, and prospects for international partnerships that appear to be gaining importance for the U.S. Department of Defense, mindful that Atlantic relations can be fractious when business advantage is at stake.

1990 was a defining year for Europe in this field because arms control monitoring concern caused decision makers to chart a course they believed could be supported by advances in satellite technology. In 1990, the SPOT-1 satellite was only European imaging satellite in space, and the first European Earth Resources Satellite (ERS-1) with a radar imagery sensor was poised for launch within one year. Nonetheless, the WEU set forth a vision that gave rise to what has become a broad, multi-national, politically-supported European effort with diverse space-based capabilities.

This paper examines events in Europe that led to deploying a range of valuable earth observation data sources, and the judgment that autonomous capabilities are necessary to help balance the Atlantic relationship. The collapse of the Pact did not dash European momentum toward a future in space independent of the United States, even though partnering projects were established in the civil space area, and were considered for national security purposes. The need for an indigenous European means of treaty verification was driven by the sheer land area of the Warsaw Pact, and a political view that Europe had the technical ability to field satellites that support various users.

**Pre-1990 Impact of the SPOT Satellite**

For decades, France has had a leading role developing Europe's presence in space. Steps were taken in internal French channels, and internationally as part of a major contribution to the European Space Agency (ESA) formed in 1975. Dr. Pasco wrote in 2000 that "Commercialization of capabilities appeared very early in the planning process as the most convenient way to achieve a French or European space observation capability." The 1970s U.S. experience with Landsat civil program was positive, but what to do about the future of the program was uncertain. Expected competition from the future French SPOT system was a factor. On 14 October 1980, the Acting Director of Central Intelligence wrote to the Secretary of Commerce with views on what to do about a Landsat follow-on system.

- "…the French SPOT program is comprehensive and aggressive…the pointing aspect will afford a stereoscopic capability that will be especially useful…"

- "This SPOT program has been under development for a number of years and was approved in late 1977 by the French government…various parts of the French government's scientific and technical organizations are apparently being geared up to provide additional specialized imagery interpretation and analytical services."

- "…an inadequate or poorly implemented system of capital investments poses the risk of developing and inefficient or unreliable remote sensing system…this will only serve to further stimulate foreign competition in the international market…"

In September 1983, ***The Wall Street Journal*** called SPOT Image Corp. an "invader". With aggressive marketing tactics, "SPOT is encroaching on the very homeland of a global monopoly enjoyed by the U.S. Government's pace-setting Landsat satellites." SPOT Image Corp., however, was not affected by the criticism, and used an ad with a simulated SPOT picture of Washington, D.C., noting that "…we're launching a better way to look at your business."

Even before SPOT was launched, ***Aviation Week & Space Technology*** reported in 1985 that SPOT 3 and 4 would be built. Agreements with distributors in 32 countries had already been struck, and a preliminary data evaluation program was organized to evaluate the data. 315 responses from 48 countries were received in response to a data call for participants. Meanwhile, the SPOT Image Corp. workforce in the United States was eight, with an increase to 15 expected by the end of the year. According to pre-launch price list information, the list price for a color print from SPOT at 1:100,000 scale was $515.00. Computer compatible tapes were priced at about three times more than prints. In 1986, no fee was charged for programming the satellite. Prices were listed as "subject to change".

SPOT had luck on its side when launched in February 1986. The Ariane rocket was not yet reliable and failed four times in 18 tries since its first launch in 1979, including the launch prior to SPOT's. The Chernobyl reactor in the USSR exploded two months after SPOT's launch, giving news organizations worldwide their best overhead view of the scene. According to ***The Washington Post***, CIA Director William Casey commented on SPOT at a meeting of newspaper executives: "Oh, I don't think there's anything we can do about it. Anybody can go out and get whatever information they can get, the press and anybody else in any other country…".

In June 1986, the ***Washington Journalism Review*** used a SPOT photo of Chernobyl to discuss the possible public impact of high-quality imaging from space. The ***USA Today*** newspaper called it "the ultimate skycam". In August, in a front page ***Washington Times*** story, titled "Photo satellites for media worry intelligence brass", a former CIA official reportedly said he was "…not used to seeing pictures like that outside the agency."

The SPOT project had ongoing publicity well after launch. Pictures taken by SPOT of the Soviet space shuttle facility were published in ***The New York Times*** and ***Aviation Week***. SPOT marketing literature was graphic, including the SPOT Image Corp. quarterly letter called SPOTLIGHT, and other handouts such as "A New Era in Remote Sensing". French satellite builder MATRA ran an ad describing the satellite as "an image harvester…a new tool as yet unequalled in the world." SPOT received positive press in a full-page article in ***The Washington Post*** in December 1987 called "The New Spy-in-the-Sky Race".

- "In releasing these new, more precise views of the Earth, France whetted the news media's appetite for imagery of this kind and also poached on the surveillance turf of the great powers."

- "The photos from SPOT are sharp…At times they reveal new strategic information…"

- "SPOT photos have sex appeal because they disclose things that interest the casual observer: factories, houses, boats, sometimes even planes and trucks."

The ability to see planes and trucks was important because in November 1988 the WEU debated whether to have an arms verification agency. This made sense because the Intermediate Range Nuclear Forces (INF) Treaty was realized in 1987. The WEU Assembly considered a roadmap that by 1990 would include "A modest SPOT buying center in the region of [$15 million US dollars], but in terms of political investment would prove invaluable as a demonstration of European will."

The WEU paper used as a basis for considering a verification agency noted that imagery of different resolutions could be used for different verification tasks. The paper included an "Example of imagery possible with SPOT-type satellites", and an "Example of imagery from reconnaissance satellites." The comparative imagery was of Nikolayev, USSR. The "reconnaissance image" was derived from ***Jane's Defence Weekly***, dated 11 August 1984, page 172. In that issue, ***Jane's*** claimed that it had "three exclusive pictures, taken by a satellite only last month." The source of the imagery was not stated. Almost as a prelude to the 1988 WEU paper, another image of the aircraft carrier was used as an insert on a SPOT image of a Soviet nuclear test site was published in ***Discover*** magazine in April 1987. The author was a Massachusetts Institute of Technology physicist who argued that arms control agreements can be verified.

The WEU debate championed the prospect of a joint European satellite verification system, noting that it "…could have great political significance." By setting up a European satellite monitoring agency, the WEU "…would be offering all its partners a coherent system of monitoring from space." Moreover, ties with the United States would not be weakened, but strengthened: "Independent European analysis could well help, rather than hinder, transatlantic cooperation."

While Europe charted its own path on earth observation, a new U.S. National Space Policy was also released in 1988, near the end of President Reagan's administration. The fundamental objective was space leadership, but the policy stated that "Leadership in an increasingly competitive international environment does not require United States

preeminence in all areas and disciplines of space enterprise." This may have signaled that the United States was open-minded regarding space-related advances in Europe and elsewhere.

**March to May 1990 in Europe**

In the United States, the term "continuity" became a major focus in the earth observation lexicon due to debate on preserving Landsat after the 1980s failed attempt to privatize operation of the system. Continuity was a tenet in Europe because earth observation could contribute to global transparency, and SPOT-2 had just been launched in January 1990. WEU officials gathered in Rome in March to discuss the use of satellites for monitoring disarmament associated with an evolving NATO-Warsaw Pact agreement on Conventional Forces in Europe (CFE; November 1990). They set an enduring course on need for satellites. Having indigenous European assets was a central theme.

- **WEU Assembly President Mr. Charles Goerens**: "If Europe wishes to retain control of its own security, it must certainly not move away from the Atlantic Alliance, but, as the United States Secretary of State called on it to do, it must be able to behave as a true partner. It must have its own means of monitoring the deployment of armaments and forces in Europe and throughout the world".

- **Netherlands Minister of Defence A.L. ter Beek:** "At present the United States shares information obtained by its satellites in a number of cases. For the last few years, however, it has become clear that the US intends to make greater use of its satellite surveillance capability for its own purposes. Pleas in the US Congress to increase the number of satellites, each costing more than two billion dollars, are not welcomed with enthusiasm, given the budgetary problems in the US."

- **Dr. Hans Eschelbacher, German Chancellory Office:** "The countries of Western Europe – and in particular the Federal Republic of Germany as an important member state of NATO, the EC, and the WEU – will be more dependent than ever in the future on having a secure and up-to-date information base of their own if they are to safeguard their politico-strategic, security, and economic interests as partners. Space-based observation may be a decisive prerequisite for this."

- **P. Goldsmith, Director of Earth Observation at ESA:** "ESA, as the sole agency responsible for space activities at the European level, could be the natural framework to provide assistance and support to a European verification satellite program, should such a program be decided."

The WEU's May 1990 publication of guidelines based on the symposium (Document 1230) were a clear statement that European observation satellites would be central to European security.

- "It should not be forgotten that the antagonism of the East and West during the cold war…nevertheless had relative advantage of bipolar stability. With this no longer being the case, the world will be a less orderly and sometimes even less secure place."

- "…Islamic fundamentalism, a declared enemy of the western industrialized and secularized world, is gaining importance among all nations along Europe's southern border. This fundamentalism, combined with ethnic and nationalistic ambitions and a still increasing arsenal of armaments, is beginning to constitute a serious threat."

- "While maintaining the alliance with the United States, Europe will have to pull together and respond to the new challenges. Only then will it be able to play its part and guarantee its security in a changing world."

- "With an apparently growing need for monitoring by satellite, for a number of reasons, Europe, notwithstanding the existing capability in the United States, should have its own observation satellite system."

- "Observation by satellite on a world-wide scale will be one of the key elements in future security measures because it allows the development of threats to be followed autonomously. Europe cannot rely only on the means of verification written into arms control treaties."

- "Opponents of an autonomous European observation satellite capability always refer to the existing American means which, it is said, will always provide the European allies with the information they require. Without blaming the Americans, it should be observed here that they only provide their satellite data up to a certain point."

- "The United States is understandably reluctant to share with its allies extensive information obtained from its satellites so as to not compromise its capabilities in this field. This has been demonstrated time and again. Whenever the United States has wished to denounce important events or developments in unfriendly territory

which no doubt had been observed in detail by their own satellites, it has always made use of SPOT images…"

- "The complete European dependency on United States satellite data was quite embarrassing for some European governments during the INF crisis. The fact that information obtained from satellite data was provided by the United States, considered to be a biased party in the debate, did not help to calm down heated emotions. There can be no doubt that in this case an autonomous European observation satellite would have facilitated a rational debate."

- "For Europe, equal partnership with its American allies requires an autonomous observation satellite capability in order to enable it to co-operate on equal terms with the United States."

The technical capabilities needed to address the WEU aspirations were described as a full-scale system with day-night, all-weather capability, including optical, multispectral, and radar sensors. Fielding an optical system was not deemed a barrier because the forthcoming French Helios satellite had an "alleged" resolution of about one meter. Fielding a radar system suitable for verification purposes would be more difficult, but UK official noted that studies in ESA pointed to using a steerable phased array antenna to provide "spotlight" mode imagery with much higher quality than expected from ERS.

**1990: Possible Partnership with U.S. Companies**

The National Security Strategy of the United States in March 1990 called for greater sharing of global leadership and responsibilities, and support for economic, political, and defense integration in Western Europe. Against this backdrop, U.S. companies eyed possible partnerships in Europe.

- A U.S. company gave a briefing to WEU officials including comments on the WEU's May 1990 guidelines based on the Rome symposium. The U.S. firm estimated that the cost for a complete earth observation system with one-meter optical, and five-meter SAR satellites would roughly cost about $1 billion US dollars per year over 15 years. One of the company's main points was that "An all European system will be significantly more expensive than a joint European-U.S. program". Whether this assertion was correct is a moot point because a joint program was not realized.

- Another U.S. company was approached by a German company about a possible joint effort to build an optical satellite imaging system. The idea could have led to joint work to field a 1-2 meter resolution system. The cooperation was not realized.

- Meanwhile, German industry continued to work on optical satellite technology. According to ***SpaceNews*** in October 2009, German technology has now advanced to the point where a system called Hi-ROS is now possible, with a resolution of 0.5 meters. The German government would decide whether to go ahead with the project.

**1991: The Persian Gulf War**

The 1991 Persian Gulf War gave SPOT imagery a chance to be relevant in planning for, and execution of military conflict. According to ***Aviation Week & Space Technology***, Lt. General Charles A. Horner said that "the accuracy of the SPOT satellite imagery was an invaluable asset to the offensive air campaign". According to a 2000 book on ***Commercial Observation Satellites, At the Leading Edge of Transparency***, between 1986 and 1991 SPOT reported average annual revenue growth of 42 percent. An article in the journal ***Orbis*** in October 1991 noted that "new sources of imagery will emerge over the next twenty years. The European Space Agency's earth resources satellites will be able to produce high resolution imagery, and will be able to image at night and through cloud cover, a capability not possessed by most current satellites." ***Aviation Week*** noted in July 1992 that a U.S. Air Force urged greater use of SPOT based on Gulf War experience.

The Gulf War also gave impetus to France's national reconnaissance efforts. According to ***The New York Times*** in May 1991, Defense Minister Pierre Joxe bemoaned the reliance on American intelligence during the war: "What is the point of carrying a big stick if you are blind?" One year later on French television, Joxe said that France would not have capabilities comparable to America for a long time, but "we must not forget that during the Gulf war the Americans and allies used SPOT pictures." In fact, according to ***Aviation Week***, the Gulf war rekindled European interest in developing military satellites because modifications to SPOT would not suffice. France was not alone in thinking about indigenous satellites; in 1991, a satellite system called COSMO (Constellation of Small satellites for Mediterranean Observation) was conceived by Italian industry.

The Gulf War and Warsaw Pact collapse also altered the American intelligence enterprise. According to a 1 April 1992 statement by Director of Central Intelligence Robert M. Gates, "…the world has turned upside down." He noted that "One of the most difficult areas for us to address was that of imagery…It is a critical capability but one that has been identified repeatedly in post-mortems of Operation Desert Storm…I appointed a task force [which] concluded that we needed a National Imagery Agency". This led to the 1996 creation of what is now the National Geospatial-Intelligence Agency.

**1991-1993: The European Union Satellite Centre**

European aspiration for a space-based monitoring capability led to the July 1991 creation of the European Union Satellite Centre near Madrid, Spain. The WEU Council Joint Action statement termed the EUSC "…essential for strengthening early warning and crisis monitoring functions", according to the ***Official Journal of the European Communities***. The Centre's mission was to provide "material resulting from the analysis of satellite imagery and collateral data". Article 21 made provision for non-EU European NATO members to submit requests for imagery analysis, but there was no provision for cooperation with the United States. When inaugurated in April 1993, however, WEU Secretary General Willem van Eekelen left room for cooperation because European autonomy would increase the odds for a balanced partnership.

- "The activities of this new body must be seen as the first stages of a much bolder project to be carried out in the next century. Indeed, the planned establishment of an independent European space-based observation system is consistent with the strengthening of the European pillar of the Atlantic Alliance, as foreseen in the WEU Maastricht Declaration. It is intended to develop a new autonomous system for the benefit of all concerned. The possibilities for future cooperation between the Centre and other corresponding bodies, particularly in Europe and in the US, on the basis of a balanced partnership, will remain high on our agenda."

Part of the cooperation was established in a 27 April 1993 Memorandum of Understanding between the Helios partner countries and the WEU that enabled the Centre to gain access to Helios imagery on 3 May 1996, according to WEU summary on the Centre's history.

**1994: Possible Partnership with the United States…and a Russian Overture**

The U.S. military did not forget SPOT's value. In June 1994, according to ***SpaceNews***, just weeks after the U.S. Government released a new policy on commercial remote sensing, the first transportable SPOT ground station was delivered to the U.S. Air Force. Within a month, the Deputy Secretary of Defense wrote to the chairman of the President's Foreign Intelligence Advisory Board recommending cooperation with allies in space-based reconnaissance, noting the possible advantage of cost sharing.

- "…the Intelligence Community has been much too cautious in giving our NATO allies, Japan, and others access to and a role in space based surveillance, reconnaissance, and SIGINT. Initiatives in these areas will strengthen the alliance, spread the cost of these expensive systems, and most importantly, avoid the risk that other countries,

notably France and Germany will develop their own satellite technology and systems."

The general idea for collaboration had merit because at the time neither France nor Germany had a reconnaissance satellite. SPOT had proven its utility, but by the end of 1994 it was still a separate program from the classified French Helios satellite project. French Defense Minister Leotard announced that Helios 2 was in the definition phase with a projected launch for 2001, even though ***Jane's Defence Weekly*** reported in mid-1993 that it could be "doomed" for budget reasons, especially since space promoter Pierre Joxe was no longer leading French defense. Leotard kept Helios alive, and projected that a new Franco-German agency would one day manage a joint satellite program; "…what is Franco-German today will be European in the future." France's Prime Minister Balladur stressed on 30 November 1994 to the WEU Assembly the importance of such cooperation.

- "This is an operational, technological, and industrial project which will emancipate Europe in some measure in the matter of space reconnaissance. I say emancipate deliberately. I discussed this subject yesterday evening and as late as this morning with Chancellor Kohl at the Franco-German summit just held in Bonn. I have every hope that the determination of our two countries will enable Europe towards equipping itself with the operational resources that it lacks."

Prospects for cooperation with the United States were unclear, and Helios was well along in development. Moreover, according to ***Hamburg Die Welt***, Germany needed an independent capability to provide unfiltered information. The newspaper claimed that this was the intent of a 1994 White Book on defense in Germany.

- "For the early recognition of regional crises…and to defend its interests in developing joint action plans within alliances and the United Nations, the federal government requires an accurate, up-to-date view of the situation."

Russia also seemed interested in an imagery partnership with Europe. According to ***Reuters*** on 1 December 1994 during an address to the WEU parliamentary assembly, Russian Foreign Minister Kozyrev offered to provide satellite intelligence to the WEU. His proposal was to "provide on a commercial basis the WEU Satellite Centre with photo information from our satellites." The landscape for a European future in space reconnaissance was complicated, but momentum for an autonomous capability was clearly established.

**<u>European Aerospace Merger; U.S. Cooperation Attempt Fails</u>**

1995 was a pivotal year for French earth observation projects, and transition to Franco-German cooperation in this field in lieu of cooperation with the United States. In May, a U.S.

official conveyed to the WEU Assembly the "…readiness and eagerness to increase the level of cooperation between the United States, WEU, and all of our Atlantic partners with regard to space systems." Nonetheless, there were many subsequent press articles on prospects for Franco-German satellite cooperation. The French press claimed that Aerospatiale wanted an alliance with Germany's Deutsche Aerospace (DASA) to win back some ground lost to the United States. Helios 1A launched successfully in July. Technology Minister Francois Fillon said "…we are putting in place the machinery that will enable Europe one day to have a true European security policy, so it is a considerable development."

In July, French press indicated that an Aerospatiale-DASA merger was subject to a pledge by Germany to join the Helios 2 project. But, it was a complicated political decision.

- According to ***Reuters***, "Diplomats said Bonn is more interested in an advanced 24-hour, all-weather radar satellite, tentatively dubbed Osiris or Horus, which would be launched around 2005." Moreover, "Paris has been pressing the Germans to choose the European project over an offer from the U.S. firm Lockheed Martin to buy its own spy satellite for $500 million, less than half the cost of Helios."

- According to ***LeMonde***, "When it comes to observation from space, Germany is the standard partner with a view to European defense, and area in which it could play a more active role. However, this partnership is no easy matter. First, because the United States is inviting Bonn to join forces with it by offering it a rival system that is up and ready to run."

- According to ***Berlin Die Tageszeitung***, "…There will be money for Helios only if French participation in Horus is assured." Moreover, "The alleged commercial success of the French SPOT program is probably also based on a bookkeeping trick. Neither the acquisition cost nor the high expenditures for development are taken into account. The revenues for SPOT pictures just about cover current costs. The development expenditures for the civilian SPOT satellites can hardly be separated from those for the military Helios series."

- According to ***Hamburg Der Spiegel***, "If the Paris government has its way, Bonn will soon have to participate in the French photographic satellite Helios 2."

- According to ***Defense News***, "Germany is considering buying a Lockheed Martin optical spy satellite, then later joining France in a future radar-equipped spy satellite, German officials said. The Lockheed Martin proposal is less expensive for us, but we want to establish long-term relations with France in a radar satellite."

- According to ***The Sunday Times*** in London, there was little chance the United Kingdom would work with France on Helios 2 because "…the British government feels that Helios is very expensive and not particularly advanced. In addition, intelligence officials believe that the relationship with America and its vast spy network is much more important than forging new links with Europe."

Discussions continued for months about possible Franco-German aerospace cooperation. According to ***Jane's Defence Weekly***, expectations were that Germany would join the Helios 2 project, with German leadership retained on the Horus project as a quid pro quo. On 7 December, after a summit with President Chirac of France, Chancellor Kohl of Germany told the press that "There has hardly been any other summit at which we have reached as many decisions as we have here in Baden-Baden." Claimed achievements included a deal on the Helios satellite project, and a satellite industry merger.

- Aerospatiale stated that "This joint decision of France and Germany is very important for the structure of the European defense industry."

- Germany's ***Soldat and Technik*** magazine said that pooling was necessary to be competitive in the marketplace. The DASA chairman said the decision provided "…the conditions for progressive integration of the aeronautical, space, and defense industries in Europe."

- ***Aviation Week*** said that the "Franco-German deal heralds an autonomous security structure for Europe and bolstering of the continent's crisis-ridden aerospace industry."

1995 was also pivotal for SPOT in the United States because it began to lose momentum. Sales to the Department of Defense generally declined and flattened after the 1994 U.S. Government decision to encourage the growth of a commercial imaging industry. In November, ***The Wall Street Journal*** stated that "The new technology will make for publicly accessible pictures at least 10 times clearer than those from today's best-resolution private system, the French SPOT satellites." The positive 1980s press reporting on SPOT as new technology was gone due to prospects for new U.S. commercial satellite systems.

The Franco-German aerospace merger had bumps along the way. In 1997, Germany did not have funds for Helios 2, so France went ahead with the system alone, according to ***Jane's Defence Weekly***. Similarly, due to budget concerns, France abandoned plans to help Germany to build the Horus radar satellite, according to ***SpaceNews***. France and Germany eventually agreed to a division of labor on satellites whereby France would build Helios 2 and Germany

would build a radar imaging system called SAR Lupe, according to ***Frankfurter Allgemeine***. A spokesman for DASA in Friederichshafen, Germany, noted that "…everyone agrees the future commercial competition in satellites is not between the Europeans, but between Europeans and the Americans", according to ***Defense News***.

The imagery competition entered a new phase with the successful 1999 launch of the commercial Ikonos satellite by the U.S. firm Space Imaging. The competition, however, was limited to optical sensing, not radar imaging systems. Canada's first radar satellite was launched in 1995 on a U.S. rocket, in a partnership that provided data to the U.S. at no cost. A copy of the first Radarsat-1 image was published in ***Aviation Week*** on 1 January 1996. U.S. firms wanted to operate SAR systems for commercial purposes at least as capable as a future Canadian satellite called Radarsat-2, but were barred by DoD from doing so because DoD recommended a 5 meter best-resolution limit, according to ***SpaceNews***. There was little apparent reason for concern by U.S. companies, however, because the Government of Canada issued a press release in June 1999, stating that the foreign and defense ministries agreed legislation was needed to control imaging satellites.

- "As modern remote sensing satellites can produce imagery whose quality approaches that obtained from specialized intelligence satellites, we must ensure that the data produced by Canadian satellites cannot be used to the detriment of our national security and that of our allies."

Canadian sentiment soured within weeks, however, because it seemed that American rules would determine the capabilities of Radarsat-2, and how it could be launched, resulting in increased cost and reduced performance. Industry Minister John Manley ordered the makers of Radarsat-2 to take their business for satellite parts to Europe, according to reporting in ***The Globe and Mail***. He accused the U.S. Government of illegally applying U.S. rules to Canada -- "We're going to work on a European solution." Meanwhile, according to ***The Ottawa Citizen***, the Canadian military was investing in a way to receive "vital" information from secret U.S. satellites. This showed that cooperation and competition in earth observation takes place at the same time.

The dispute between the United States and Canada had no apparent impact on plans in Italy to field the Cosmo-Skymed system, comprised of four radar and three optical satellites. According to a 1997 brochure by Alenia Aerospazio, the future Cosmo radar satellites would have a 3 meter resolution, similar to Radarsat-2, and better than DoD's preferred 5 meter limit.

**2000 – 2004: Franco-German Imagery Advances, and EU Security Strategy**

Against a backdrop of emerging U.S.-European commercial imagery competition, the successful February 2000 Shuttle Radar Topography Mission (SRTM), flown jointly by NASA and the National Imagery and Mapping Agency (NIMA), was a good example of U.S. teamwork with German aerospace. But, another attempt at Franco-German cooperation emerged from a June 2000 summit in Mainz, Germany. According to ***Reuters***, the countries "…agreed to cooperate on a spy satellite system that would cut Europe's reliance on U.S. military intelligence and revives an idea previously shelved as being too expensive…This bilateral initiative creates the basis for a European reconnaissance system that is open to other European partners."

The SRTM mission used a technique called Interferometric SAR to take images simultaneously from two antennas, thereby creating an elevation map of the world. The technique was based on two Shuttle Imaging Radar (SIR-C) missions flown in 1994, also known as X-SAR, because the missions involved both C-Band and X-Band collection. German aerospace was involved in the X-SAR portion. According to ***SpaceNews***, German officials planned to use the X-Band success as a "springboard toward a commercial imaging system called TerraSAR".

The SRTM mission cost $142 million, according to NASA. The X-SAR portion cost $40 million. A post-mission paper co-authored by NASA, the German Space Agency (DLR), and university experts called the dataset "revolutionary". They stated that "SRTM was an example of engineering at its best; it marked a milestone in the field of remote sensing." What the paper did not say is that it gave German engineers more confidence that the future TerraSAR-X commercial satellite system would be viable.

- In 1997, well before the SRTM mission, an article in ***Bonn Luft und Raumfahrt*** magazine claimed that a third flight of X-SAR was a priority because Germany holds a leading position in the field of radar technology that entails exceptional civil and commercial prospects.

- According to DLR, TerraSAR-X was begun in September 2001, about 18 months after the SRTM mission, which was also roughly the end of the data processing period, according to NASA.

- TerraSAR-X was described by DLR as "A national, operational science satellite with commercial potential." And as "…the scientific / technological continuation of the highly successful national missions X-SAR (1994) and SRTM (2000)." A ***SpaceNews*** headline in 2002 termed the system a test of public-private satellite partnerships. Radar imaging was a high priority in Germany, according to ***Air & Cosmos***.

On 10 April 2001, according to the ***International Herald Tribune***, the United States was on a path to spend $25 billion on a new generation of spy satellites called the future imagery architecture. ***The Daily Telegraph*** in London reported that the United Kingdom wanted to be part of the project, noting that participation would ensure that some "jobs come to Britain". With regard to commercial imagery, ***The Economist*** reported that "High launch costs, and the fact that the biggest customers for high-resolution imagery are governments, are likely to sustain the cozy relationship between commercial satellite operators and the military." Nonetheless, according to French defense analyst Francois Heisbourg, the pooling of information from Helios 2 and SAR Lupe would be "enough to keep the Americans honest" in telling other governments what satellites see in a crisis. According to ***SpaceNews***, France also considered lowering security restrictions on Helios 1 imagery, and adjusting the price to reflect the availability of high-resolution data from the commercial Ikonos satellite.

Franco-German national earth observation programs moved ahead against a backdrop of rising EU interest in a more coherent approach. A December 2001 report from the European Commission to the Council and European Parliament concluded that due to "…competitive pressure coming from other regions of the world, the European space actors cannot afford to address issues in a dispersed and fragmented way." The report stated that "a major challenge lies in the coordination of the various emerging national, intergovernmental or international initiatives and their resulting capabilities." One such initiative is the EU's Global Monitoring for Environment and Security (GMES) project. According to the 2001-2003 EC Action Plan for GMES, "by mobilizing scientists, industrialists, and politicians and the full range of satellite and terrestrial observation technologies…Europe will have its own genuinely autonomous surveillance capability." The future satellites in this project are named Sentinel. According to ESA summary information on the Sentinels, they will complement, not replace or duplicate national satellite initiatives. The first two satellites will have imaging payloads.

The SPOT 5 commercial satellite was launched on 2 May 2002, just two months after ESA launched ENVISAT as the successor to ERS-type satellites. ***SPOT Magazine*** published a pre-launch special issue on the system. SPOT Chairman and CEO Jean-Marc Nasr that SPOT would by mid-2003 be able to produce geo-referenced ortho-images "automatically, quickly, and cheaply". He also stated that "we are working with InfoTerra…to leverage our respective offerings and create commercial synergies." This was an indication that combinations of optical and radar imagery can service an array of applications.

SPOT 5 was not designed as a direct competitor for American one-meter resolution commercial satellites, but it provided a 2.5 meter resolution capability, with a 60km wide swath, and stereoscopy. The French Institut Geographique National called SPOT 5 "a perfect tool for mapping". According to ***SpaceNews***, before SPOT 5 was launched, the U.S. company

DigitalGlobe agreed to pay SPOT Image Corp. $50 million over six and one-half years for exclusive rights to distribute SPOT products and services to the U.S. agriculture and defense markets.

- According to a DigitalGlobe press release dated 25 January 2002, the company CEO said "…we must be able to partner with market leaders to provide product options for our customers." Within one year after launch, according to ***SpaceNews***, SPOT 5 caused a 48 percent increase in revenue for the SPOT company, up to $58 million for calendar year 2003.

Within weeks after the SPOT 5 launch, France and Germany agreed at a summit in Schwerin on a common military satellite-supported optical and radar reconnaissance system, according to ***Frankfurter Allgemeine***; "The combination of the two systems should contribute to the creation of a satellite reconnaissance system for the EU, independent of the United States." The Franco-German bilateral deal did not, however, foreclose the possibility of including NATO states in light of a Spring 2002 idea to explore multinational satellite cooperation that could be considered at a November 2002 NATO Summit in Prague. This fleeting opportunity came about because European satellite monitoring of CFE treaty limited equipment east of the Urals would be possible with Helios 2 and SAR Lupe. According to the ***New Statesman*** in London, France was in the vanguard of European observation satellite efforts, Germany needed a radar satellite due to lack of U.S. support during the Kosovo conflict, but "privileged" UK access to imagery from U.S. spy satellites made the British reluctant to develop national or European observation satellites.

Although Helios 2 and SAR Lupe were not factors in NATO's Capabilities Commitment discussed in Prague, the line of the EU toward the United States was clearly stated in the European Security Strategy published in December 2003. The key premise is that U.S.-European ties benefit from a capable Europe.

- "The transatlantic relationship is irreplaceable. Acting together, the European Union and the United States can be a formidable force for good in the world. Our aim should be an effective and balanced partnership with the USA. This is a reason for the EU to build up further its capabilities and increase its coherence."

By the end of 2004, the SPOT CEO said that "…we will continue to increase resolution while maintaining the largest possible scene size, and we will still give the fastest response for users. The high resolution Pleiades constellation will gather top quality images at 0.5m resolution, comparable to any on the market today or in this decade, and we will provide unrivaled access to imagery and the information contained within." This projection was only months after ***SPOT Magazine*** reported the beginning of the integration phase for TerraSAR-X at

Friederichshafen, Germany. According to the magazine, in early 2004 InfoTerra chose SPOT "…as the sole agent for the sale of all products and services derived from TerraSAR, particularly in countries where SPOT Image has channel partnership agreements."

- Satellite experts at the German Space Agency (DLR), in a 2004 perspective on earth observation satellites and services for the next decade, wrote that InfoTerra GmbH was "…in negotiation with several international customers for direct data reception in their respective countries. Experiences with marketing partners such as SPOT Image contribute to the globalization of such national missions."

DLR was correct that globalization in earth observation was well under way. An easy way for the public to use satellite imagery was near at hand. In October 2004, as consolidation of the SPOT InfoTerra product line took shape, the company Google in the United States acquired a company called Keyhole. According to ***IntelligenceOnline.com***, Keyhole owned a huge library of satellite imagery and developed 3D imagery display services. By Spring 2005, Google offered a new service called Google Maps. Using Google, users can view either images or maps. Google's products became part of the geospatial technologies market, estimated in 2005 by the United States Department of Labor to have annual revenues of $30 billion.

Germany's TerraSAR-X and Italy's Cosmo-Skymed radar satellite projects were well underway when the first European Space Council meeting took place on 25 November 2004. According to ESA's website, the then chairman of the EU Competitiveness Council stated that "Space technologies and applications will help Europe to reach its common goals in the field, i.e., competitiveness, environment, and security." The EU Commissioner for Enterprise and Industry noted that "The industrial dimension of space is key to increasing the competitiveness of European industry." According to an article by DLR with a ten-year perspective on earth observation, resources for preparatory studies for GMES were released in September 2004, and future hyper-spectral imaging satellite called EnMAP would be studied. Such studies took place against the reality that satellites called Pleaides, RapidEye, TerraSAR-X, and Cosmo-Skymed would be launched. The authors noted that the political focus of GMES, and the European Defense and Security Policy, would "drive and amplify" demand for earth observation data of various types. With the political framework in place, the authors argued that "…the European [earth observation] market becomes very attractive for both service suppliers and customers."

## 2005 - 2009: The Rate of Change Accelerates

European earth observation satellite efforts gained quick success when Helios-2A became operational in April 2005. According to ***Air & Cosmos***, images from flight acceptance testing had "stunning clarity", including images of Las Vegas, Nevada. The magazine claimed to have access to the images, but could not show them to readers because they were classified.

Some weeks later, ***intelligenceonline.com*** reported that the high resolution thermal infrared sensor had provided operational images.

According to ***SpaceNews***, the Helios-2A satellite produced optical images claimed by the French Defense Ministry to be several tens of centimeters in resolution. The French Joint Defense Staff later confirmed in 2007 that the satellite was also producing better-than-expected infrared imagery. According to Colonel Christophe Morand in an interview with ***SpaceNews***, "The infrared feature has been a real success…we have been able to evaluate many industries that make extensive use of cooling systems." The news about Helios 2 was good news for SPOT because the post-Helios 2 satellite system to be deployed by 2015 "…will bear strong resemblance to the civil-military Pleiades satellites to be launched in 2010 and 2011, but will have a sharper ground resolution", according to ***SpaceNews***.

As the new Helios-2A settled into service, the SPOT company gained the rights to market South Korea's Kompsat-2 data outside of Korea, the Middle East, and the United States. SPOT Chairman and CEO Herve Buchwalter projected that gaining a foothold in the very high resolution market would be a major challenge, but that there is "…huge potential for combining optical and radar data in many application areas. The TerraSAR-X satellite will give us the chance to offer customers a really comprehensive range of products and services. This unique capability will further consolidate our market position."

- InfoTerra Germany projected in March 2005 that the SAR earth observation market was about $60 million, roughly about 15 percent of the overall spaceborne earth observation market.

- Combining datasets seemed to be the wave of the future. According to the ***London Daily Telegraph*** in November 2005, the EU Commission's spokesman for industrial policy, in announcing the pilot state for GMES, stated that the project is intended to exploit assets belonging to individual nations. Nations would retain control of their satellites, but collected data would be shared.

SPOT's corporate mission as of 2006 was "To deliver satellite imagery and geographic information solutions to private and public sector worldwide." The transition would take the company from providing products to the scientific community in the 1980s, to providing imagery to governments and the commercial market over 20 years later. Whereas 19 percent of the company's 2005 revenue was gained in North America (70 percent of this from defense and intelligence), 39 percent was gained in the Asia-Pacific region. This strategy was presented just before the May 2006 announcement that DLR and Astrium would cooperate on the TanDEM-X satellite, according to German press reporting. The mission would be to generate a "…worldwide, consistent and homogeneous terrain model with no discontinuity at regional or

national borders, and no inconsistencies resulting from different measurement protocols or measurement efforts staggered in time." The satellite would cost $110 million, only three times more than X-SAR flown on the Space Shuttle in 2000.

- TerraSAR-X was launched into space in June 2007, and the TanDEM-X project was well underway. The first of five successful SAR Lupe German military radar imaging satellites was launched in December 2006 (the final satellite was orbited in July 2008). Moreover, the first Cosmo-Skymed satellite was also in space. According to German media reporting, Colonel Reinhard Pfaff said SAR Lupe was a "quantum leap in the acquisition of information."

The variety and number of satellites launched by French, German, and Italian industry went from virtually none between 2000 and 2005, to several in the last five years. This rapid expansion was one of the reasons that six European nations began work in mid-2007 on ways to coordinate future space-based reconnaissance systems, such as sharing imagery from multiple satellites, in a project called Multi-national Satellite Imaging System (MUSIS). This meant that data sharing paradigms were being examined within both the GMES and MUSIS projects. According to ***SIGNAL Magazine*** in October 2007, the capability to process and share imagery among several nations would be core to MUSIS.

2008 was a significant year regarding earth observation programs in Europe as a whole. The Germany firm RapidEye AG launched a fleet of five, innovative small commercial satellites designed to quickly monitor change to vegetation, especially crops. Dr. Ray Williamson wrote in ***Imaging Notes*** magazine that the approach "…could well revolutionize the business of remote sensing." ESA signed contracts for two Sentinel observation satellites for GMES, according to ***SpaceNews***. ***Aviation Week*** reported that Astrium Services decided to take over the 41 percent share of SPOT held by CNES. This would give Astrium Services an ability "…to develop an integrated strategy for the full range of earth observation services and applications, along the entire geo-information value chain, according to Astrium CEO Eric Beranger. This move aligned with a White Paper on defense produced in June 2007 that recommended giving "great prominence" to space intelligence, according to ***www.francesoir.fr***, and ***Reuters***. Prime Minister Francois Fillon said that the White Paper "…gives a central role to capacities of reconnaissance and anticipation." This would result in a budget for space of about $500 million in 2008, increasing to $1 billion in 2020.

The EUSC reported in 2008 that acquisition of satellite imagery is a prerequisite of the Centre's work. The Centre claimed that it "greatly improved" its access to imagery from commercial and governmental sources. Although commercial sources comprised the largest share of imagery used by the Centre, "…governmental imagery is very important to EUSC…and guarantees European autonomy."

The importance of coordination across civil and defense earth observation programs and ground-processing gained increasing prominence in 2008. According to a vision statement on European Space Policy by the EU Council's Competitiveness Council on 26 September, the vision called for improving synergy between civil and defense space programs.

- Consolidation requires much attention to processing data from multiple sensors in an efficient, timely manner. According to ***SpaceNews*** in November 2008, a product called Pixel Factory by InfoTerra France is a solution for the problem of too much imagery. The Pixel Factory is a product to process data from many sensors. This digital geo-production processing capability is described in marketing literature as "The Next Generation Solution for Industrial Geo-Production".

- Recommendation 830, adopted by the EU Assembly on 3 December 2008, stated that 40 percent of the MUSIS budget is devoted to the ground segment because "…even the best-performing satellite architecture is useless without an equally efficient ground segment to receive the images."

- According to ***Defensenews.com***, the MUSIS plan was ratified on 5 March 2009, and would involve the European systems to succeed Helios 2, SAR Lupe, Italy's Cosmo-Skymed, and Pleiades in about the 2015-2017 timeframe. MUSIS is consistent with the EU's December 2008 report on implementation of the 2003 European Security Strategy, i.e., "…to be still *more capable, more coherent, and more active*."

- Strengthening space capabilities for military missions was mentioned in the December 2008 report on Strategy implementation. This task is assigned to the European Defense Agency. According to a 5 March EDA press release, one of the tasks in MUSIS is to seek synergies with civilian earth observation programs, in particular with GMES.

In the past year, the rate of change continued to accelerate. According to ***Aviation Week*** in June 2009, the future SPOT 6 and 7 satellites, along with Pleiades, and TanDEM-X "…will give Astrium a fleet of imagers and a portfolio of geo-information services unparalleled in the industry". The challenge for the future is to align a major increase in collection capacity with processing output to service high, medium, and low-resolution needs. In 2008, revenue at SPOT was about $150 million, an increase of almost $100 million since 2002. The upside potential is significant because sensor diversity provides alternative data sources and solutions.

- Increased product accuracy and timely delivery of solutions will be expected by commercial and military users. Because a Pleiades replacement will be needed by

about 2015 or soon thereafter, commonality between the replacement system and Helios 3 seems likely. According to ***SpaceNews***, Helios 3 may be comprised of three satellites, including one in a lower orbit to maximize resolution.

- In June 2009, TerraSAR-X marked two successful years in orbit. According to an Astrium press release. "What has been particularly impressive is the outstanding geo-location accuracy of better than 0.5 meters. This allows fully automatic, pixel-accurate superposition of two images of a scene acquired at different times."

- According to ***SpaceNews***, French military space spending is on path to increase about 8 percent per year, and ESA signed more contracts for GMES-related earth observation satellites.

- In November, ESA member states approved the Sentinel Data Policy that ensures free-of-charge access to all Sentinel data.

**2010 and Beyond**

European nations individually and collectively have a bold range of commercial, civil, and military earth observation satellite projects. European political, industrial, and commercial interests all know the importance of success. The satellites already in space and in development have spatial and spectral features that can service a wide variety of users, but the earth observation community is in a decade of data overload. Customers will want to spend their money on solutions that are not skewed to collecting more information they are unable to use. For this reason, paying close attention to ground-based European solutions is important. Kongsberg Satellite Services AS (KSAT) in Norway, for example, provides speedy service due to its optimum location for data links to satellites in polar, low-earth orbits. KSAT's 2008 Annual Report stated that "Image Anywhere is one of KSATs contributions to the information society" which craves on-demand service. According to a recent article in ***Imaging Notes*** magazine, speed and time are important because the "…the entire premise of the geospatial industry is to track the changes on the planet…".

Assuming that the TanDEM-X, Pleaides, Cosmo-Skymed satellite number four, the Sentinel series, EnMAP, and MUSIS satellites all launch successfully over the next five years, Europe will build on a leading role in commercial, civil, and military earth observation through 2020. The result could be assets with unmatched spatial and spectral diversity. The three sectors could become almost indistinguishable for certain users. Data costs in this "source agnostic" future will range from expensive to free, giving users more power to leverage suppliers.

Delegates to the March symposium Washington may wish to pause for a moment and think about the fact that the first space reconnaissance success for the United States occurred 50 years ago, in August 1960. The ability to monitor the growing USSR and Warsaw Pact threat was a strategic imperative. Conversely, the 1990 European incentive for an independent space-based earth observation capability was rooted in the Pact's demise. There is ample room for U.S.-European partnership in this sector, and ample room for competition in a market-driven industry where use of innovative technology in the space and ground segments is the key to success.

Although a review of non-European earth observation programs is beyond the scope of this paper, delegates should also pay close attention to the status of earth observation programs in other nations. Such programs advance as a function of national will and self-determination, and the number and type of satellites is expanding rapidly. According to Japan's ***ASAHI*** press in September 2006, it is acceptable to have satellites with greatly different capabilities than U.S. systems because "It is more effective to see with our own eyes even if the performance is inferior." Regarding India, ***The Washington Post*** reported in November 2009 that "India now has among the world's largest constellations of remote-sensing satellites." South Korea's National Space Program published in December 2000 stated that "Space is the new realm to challenge". Advances in this area will "drive other high-tech industries in the 21st century"; "expand commercialized uses of space technology"; and be a "core for technological independence". The incentive to develop indigenous sources of satellite-based information is unmistakable.

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