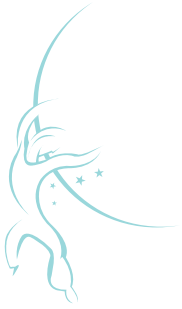


"Space for Earth" Collection

Space, Defence and Security

Contents

Preface

“Space now bears a genuine responsibility in terms of Defence and Security”

Even before the first aircraft had been developed, Clément Ader, the French engineer, had foreseen it: *“Whoever controls the skies will control the world.”* While he was trying to sell his project for heavier-than-air machines to the French military authorities, the inventor had understood the advantage to be secured not only from gaining height (which balloons already offered) but also from being able to move at altitude. Aviation history has proved him right. The first rockets, whether used to bombard enemy cities or to take measurements in the upper atmosphere, exemplify this: although they were not all developed for defence purposes, the military quickly took an interest and hence, with the scientists, became the pioneers of space exploration.

So now, we should commend the caution and the wisdom of the lawyers and politicians of the 1960s who strived to prevent nuclear arms and other weapons of mass destruction from being sent into space, and to preserve it for activities of a peaceful nature. Although it has not remained totally ‘innocent’, space was bestowed with and now bears a genuine responsibility in terms of Defence and Security. Its inherent complexity makes it difficult to know where the boundaries of security fall: the aim of monitoring and gathering information is to care for, watch over or dominate the ‘other party’, whether this be compatriot, ally or enemy. Creating a set of shifting alliances according to which national borders are sometimes defended and sometimes ignored, this responsibility encourages the emergence of a community- or even international-level capability and *savoir vivre*.

With a commitment to both camps, Defence and Security, space modifies the ancient proverb *“si vis pacem, para bellum”* (*“if you want peace, prepare for war”*) which becomes *“si vis pacem, para ... pacem”* (*“if you want peace, prepare... for peace”*)!

Jacques Arnould, *Ethics specialist at CNES*

Introduction

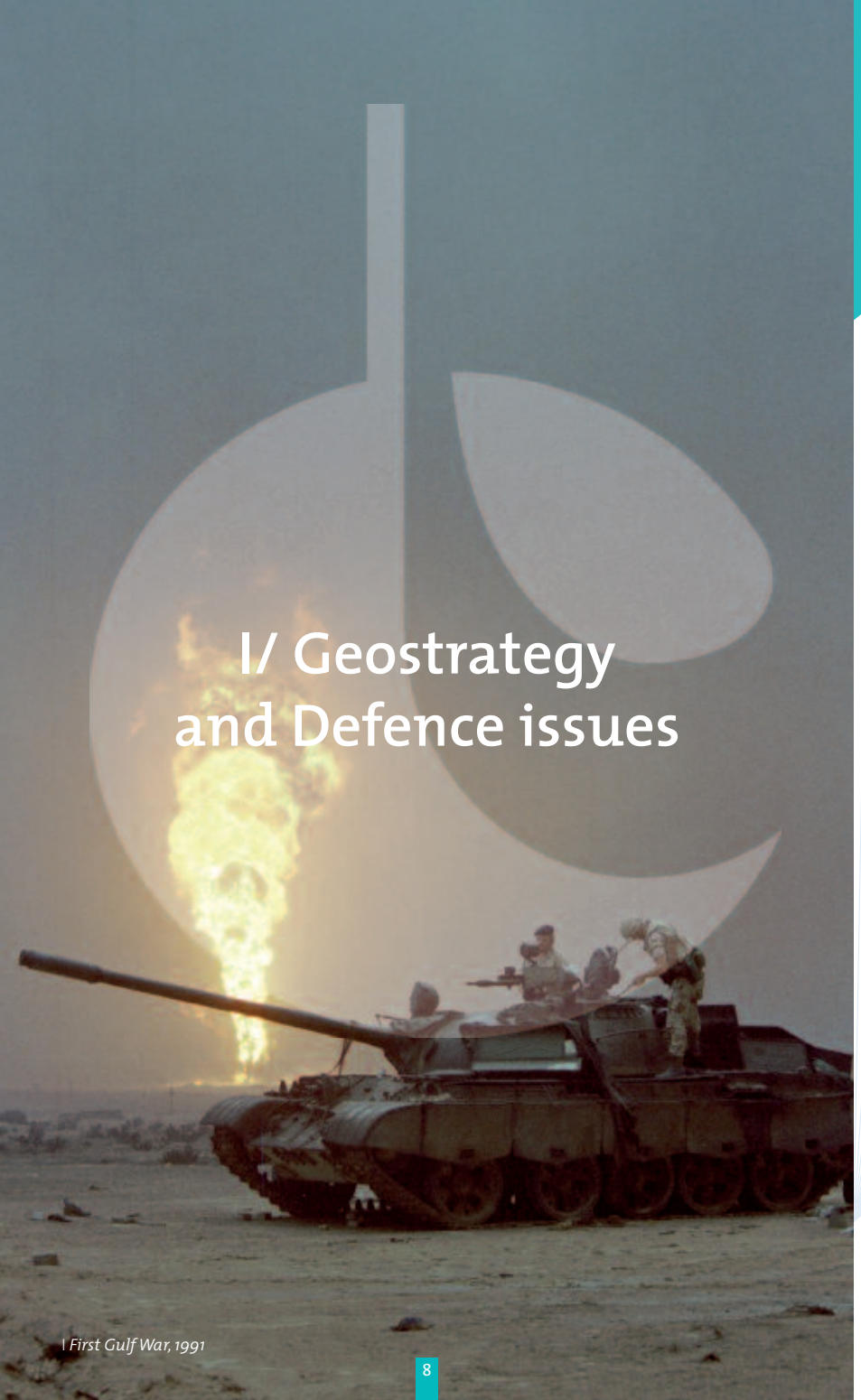
Space for Earth, and for its Security and Defence

Since it was first established, CNES has been driving and implementing France's space strategy for defence, through the provision of increasingly advanced technologies and satellites. Today it also provides this service for Europe.

As critical tools for collecting and analysing vast quantities of hitherto inaccessible data, satellites help us gain a better understanding of our environment. In an ever-more complex world, where interdependence and the scarcity of certain resources may lead to tensions, satellites meet the needs of both civil and military policymakers and enable the latter to take effective, informed decisions. Providing for intelligence gathering, telecommunications, surveillance at a global level and in all weather conditions, not to mention independent access to space; these are the main security and defence challenges.

What is the world's current status from a geostrategic point of view? Which satellites participate in national and European defence and security policy, and what role do they play? How is mastery of space crucial to a sovereign Europe? You can find the answers to these questions in the pages of this booklet.

I/ Geostrategy and Defence issues



| First Gulf War, 1991

I-1-a A rapidly-changing multipolar world

"The post Cold-war world is rapidly giving way to a more shifting, more uncertain, less predictable world, exposed to new forms of vulnerability. In tomorrow's world, France's national security will be assured, and France will play its role to the full in the defence of peace and its values."

Nicolas Sarkozy, *President of the Republic and Head of the Armed Forces, foreword to the White Paper on Defence and National Security*

After the fall of the Berlin Wall in 1989, the change in international relations resulted twenty years later in what we now call globalisation: the unprecedented development of international trade and a constantly growing economic interdependence between states.

| Berlin Wall

This new global situation has seen the emergence of new risks, with the end of the Cold War giving rise to tensions that were previously suppressed by East-West hostility.

Apart from the economic and demographic aspects, many countries have been seeking to protect their territory by developing nuclear weapons or increasing the share of their national budget devoted to defence spending.

Burning oil well

This new global situation has seen the emergence of new risks

Kabul

Darfur

I-1-b The current geopolitical situation in Europe

Since the mid-1990s, Europe has managed to calm any lingering tensions resulting from the collapse of the Iron Curtain. Opening the European Union to former Eastern bloc countries has brought about numerous mutual benefits: unprecedented economic growth on one side, access for the EU to the rank of leading economic and commercial power on the other. One of the most remarkable signs of the radical strategic turnaround that has occurred since the mid-1990s is the number of former Warsaw Pact countries to have joined the North Atlantic Treaty Organization, whose principle of solidarity between members guarantees the security of all.

In France, this upheaval has made sweeping strategic reform necessary, which has led to the reinforcing of its external projection capability and the professionalisation of the armed forces.

As major elements of European construction in a rapidly changing world, France's security and defence are no longer confined to the country's borders, but now have a global reach. In this context, satellite applications, major instruments of international cooperation which alone are capable of providing planetary coverage, are clearly going to play an increasingly important role in the future.

Medical evacuation exercise in Kosovo

I-1 The major geostrategic balancing acts

References: the three main institutional players for space activities in defence

Chief of the Defence Staff (EMA)

Working under the authority of the President of the Republic and the Government, the Chief of the Defence Staff decides how forces are used and commands military operations. He is the government's military adviser and is primarily responsible for the armed forces' expression of needs in terms of personnel, equipment and services, as well as for military intelligence.

Defence Procurement Agency (DGA)

The DGA reports to the Ministry of Defence and is responsible for specifying and evaluating weapons systems likely to be used by the forces, based on needs expressed by the EMA. It guarantees availability of technologies and expertise.

French Space Agency (CNES)

CNES's mission is to implement France's space policy. It intervenes in defence space programmes on behalf of the DGA and capitalises on its expertise in the field for satellite applications for defence.

Oil drilling platform in the North Sea

Drawing water from a well in a Darfur refugee camp

I-2-a Tensions over supplies

The steady economic growth in large parts of Asia has been driving a strong demand for fossil fuels, primarily oil. Europe itself depends on fossil fuels for 75% of its energy needs, with production coming from the Middle East, Africa or Russia. Even the most optimistic specialists predict an inevitable decline in worldwide oil production after 2020, due to the depletion of easily exploitable reserves. The most pessimistic assert that this pivotal moment, which would lead to an uncontrollable rise in the price of oil, could be reached as early as 2010. Demand from rapidly developing countries is also being felt on the market for raw materials, some of which are strategic. In this context, food and water are also becoming key issues

Demand from rapidly developing countries is also being felt on the market for raw materials

I-2-b The consequences of climate change

Certain regional-scale conflicts with the potential to destabilise an entire continent, such as the one in Darfur in Africa, have their roots in climate factors. Agriculture in South East Asia has also shown itself to be highly sensitive to climate change, with a potential fall in rice production of 50% by 2100, while its predominantly young population continues to grow. The predicted rise in sea level in highly-populated regions such as the coasts of India will lead to massive population movements, an obvious source of tensions.

I-2-c Nuclear and ballistic proliferation

One undesirable effect of globalisation is the broad dissemination of technologies enabling the manufacture of ballistic or cruise missiles. Since 1994, several countries have achieved a range of over 1000 km (Pakistan), 2000 km (Iran) or far greater (India, North Korea). Combined with a nuclear capability, this new ballistic power widens the array of threats and potentially places European Union member states within striking range of nuclear-armed enemies.

Terrorism in Algeria

I-2-d New vulnerabilities

Terrorism

While Europe had been faced with political terrorism since the 1960s, the 1990s saw the rise of Islamist terrorism. This culminated in deadly intensity with the attacks in the United States (2001), Madrid (2004) and London (2005). In this context, the main terrorist threat is the use of non-conventional offensive weapons, i.e. radioactive, biological or chemical.

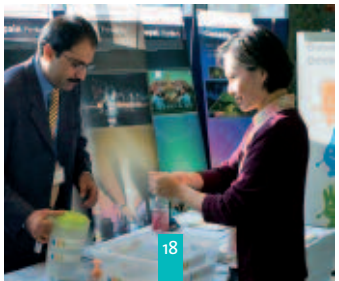
Criminal trafficking

Human and drug trafficking are among the greatest challenges facing European societies in the future. Criminal organisations currently have considerable financial and logistical resources, in many cases comparable to those of actual governments.

Health and technological risks

The opening of national borders and the speed of international transport has also facilitated the transmission of new viral or bacterial strains. The potential resulting epidemics could seriously disrupt economies, hence the efforts being made to prevent and monitor the spread of epidemics.

Faced with the proliferation and geographical dispersion of these risks, the solutions offered by space technologies will play an increasingly central role in peacekeeping.



Prevention of disease propagation

"The international context makes it essential to incorporate strategic uncertainty as one of the fundamentals of French defence and security thinking and policy.

This emphasis on uncertainty signals neither a lack of information nor an intellectual shortcoming. Precisely the opposite: it posits the ability to anticipate and protect the nation as the fundamental criterion of a new strategy founded on an autonomous decision-making capacity."

(White Paper on Defence and National Security)

II/ Space technologies serving Defence and Security

Illustration of the operating principle of the HRS instrument on Spot5

II-1 Technologies used in both civil and military applications

Telecommunications, Earth observation and a wide range of other space applications respond equally well to defence or civil needs. There are thus numerous advantages, primarily financial, to pooling space technologies and tools. For example, civil observation satellites are used by the military, while soldiers in the field are able to communicate with their families via civil telecommunications satellites. But the main advantage of this duality of civil and military applications comes from the pooling of space technologies.

The design of a satellite such as Helios 2A is very similar to that of a civil observation satellite. It therefore makes sense to exploit civil expertise for military use. In this respect, CNES acts as a gateway between the military and civil domains. Its defence team, made up of staff from the DGA, the EMA and CNES, is a forum that strives to match the resources and needs of each party. Aside from telecommunications and Earth observation, a wealth of other application areas demonstrate the dual nature of space applications.

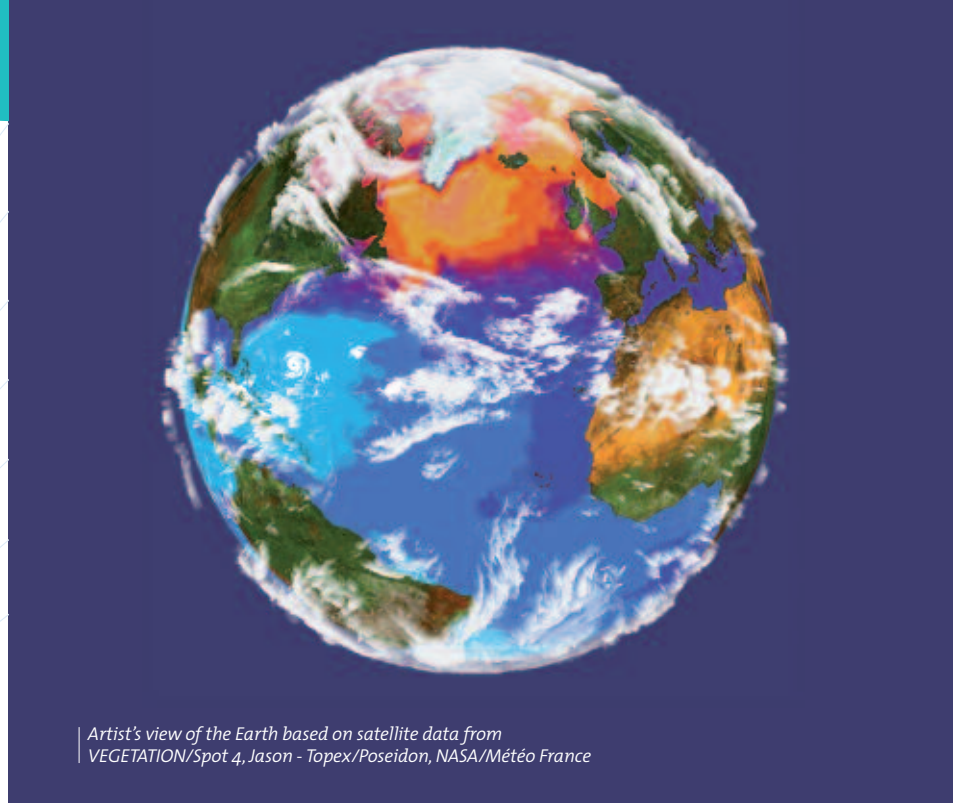
Detection and control centre in Cinq-Mars-la-Pile (Tours)

Access to space

Free access to space is vital; not depending on an external power to launch its own military satellites is a major advantage for any country. The Ariane 5 launcher is thus a key player in our national defence.

Oceanography

Although the main purpose of satellite oceanography is to observe major trends in changes to the ocean-atmosphere system, some of the data collected by radar altimeters is also of interest to the French Navy, either for its surface vessels or submarines. For instance, French Navy ships use radar altimetry data from the Jason family of satellites on a daily basis to plot optimal courses.



Artist's view of the Earth based on satellite data from VEGETATION/Spot 4, Jason - Topex/Poseidon, NASA/Météo France

Meteorology

From the resounding defeat of the Spanish Armada to the success of the Normandy Landings in June 1944, the weather has always been a crucial parameter in the timing, and often the outcome, of military operations. Data from geostationary meteorological satellites are today integrated with highly sophisticated forecasting models. These, together with complementary data from non-geostationary weather satellites such as MetOp and its IASI instrument, enable us to manage the risk ensuing from violent, localised weather phenomena (storms, sandstorms) which might otherwise compromise the successful execution of operations.

Not depending on an external power to launch its own military satellites is a major advantage for any country

Submarine

Artist's impression of the MetOp satellite

Giove-B satellite, part of the Galileo constellation

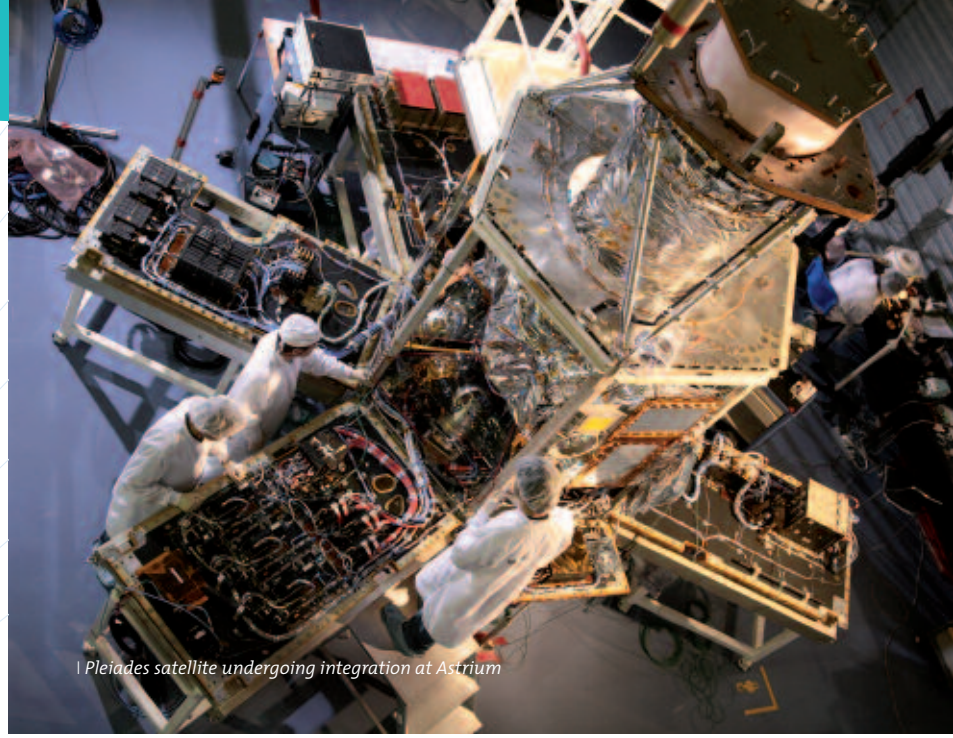
Observation

At the outbreak of the first Gulf War in 1990, the principal customers of France's Spot observation system were the American armed forces. In theory they could have acquired higher resolution images from American spy satellites, but the procedure for obtaining them was so complex that the authorities preferred to use a foreign, civil system to help evaluate the accuracy of their air strikes. This anecdote highlights two of the issues that arise when space applications are used for defence: the length of the processing chain and the level of confidentiality, and the choice of the best resolution depending on whether you seek an overall view or, on the contrary, a close-up on details.

The Spot satellites are soon to be replaced by the Pleiades family. These satellites retain the advances made by the Spot family but their added manoeuvrability will enable them to acquire cross-track images, on either side of the satellite vertical.

Pleiades is a typical dual-use satellite system: the images it provides will be dealt with by different processing systems depending on the resolution, the highest resolutions being reserved for military users.

A simulated Pleiades image of Port-de-Bouc



Pleiades satellite undergoing integration at Astrium

Satellite positioning

The GPS "Global Positioning System" is now in everyday use around the world. Originally, however, the system was developed entirely for the American armed forces. Not only does it give troops in the field their position to within a few metres, it can also be used to locate and identify targets. In view of the crucial nature of this information, the American military retains overall control of the system and could degrade the signal if it suited its operational needs. This is why the European Union has launched Galileo, a positioning system that will provide a whole range of applications and above all guaranteed service, which the American system does not. In particular it will offer Public Regulated Services (PRS).

The Principal Helios Centre, France (CPHF)

Satellite transmission

Operations control room of the Temporary Medium-Altitude Long-Endurance drone system (MALE)

A Rafale in flight

Syracuse III

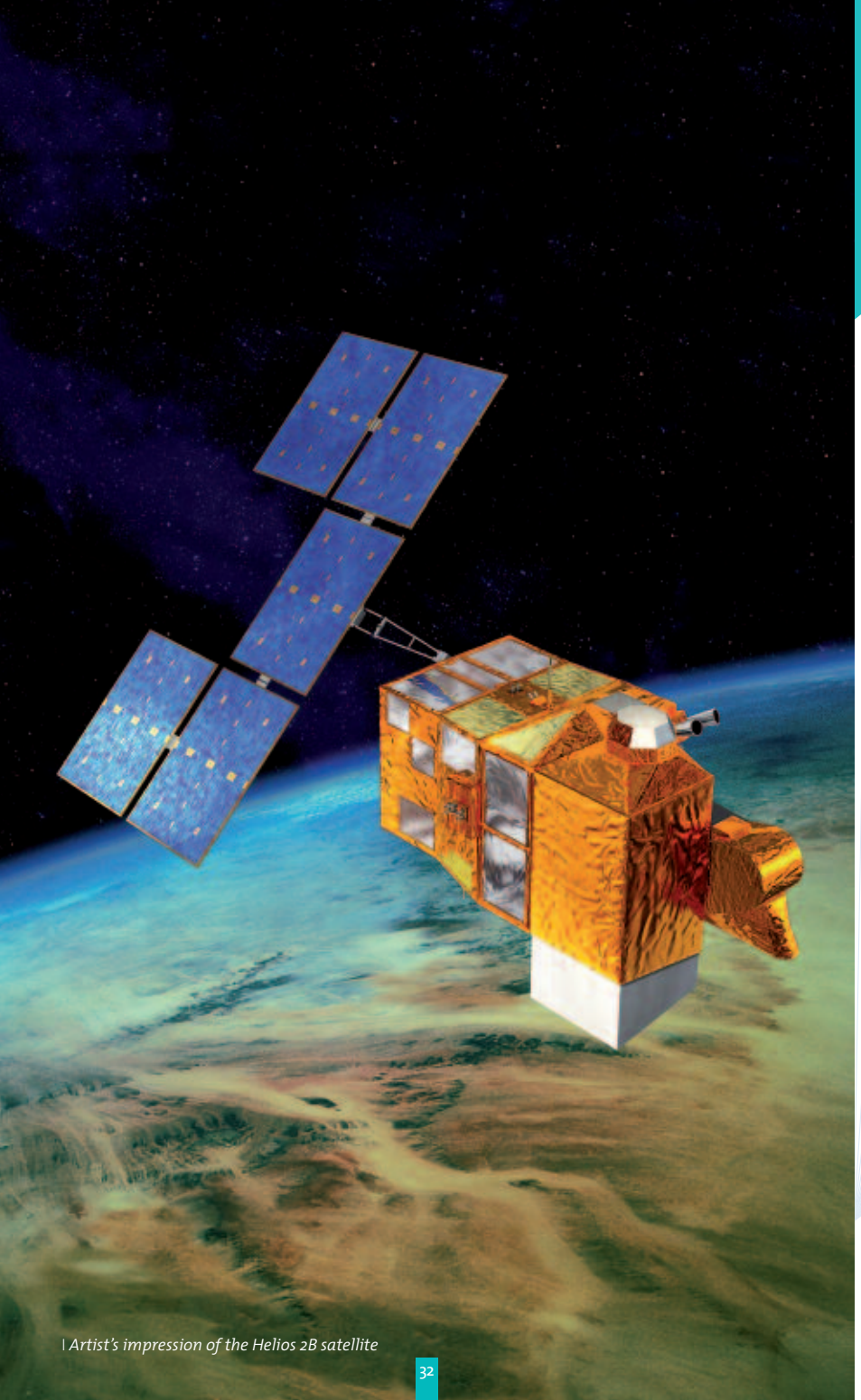
Syracuse III (which stands for "SYstem for RAdio Communication Using a SatellitE") is a programme of telecommunications satellites in geostationary orbit developed exclusively for defence purposes. The system is secure, resistant to jamming and robust against the electromagnetic pulses that would follow extra-atmospheric nuclear explosions. Syracuse satellites allow central commands and forces deployed anywhere in the world to exchange strategic information in complete confidentiality.

Athena-Fidus*

Not all military communications need as high a level of security as that offered by Syracuse. At the same time, more and more new applications require bandwidths allowing very high data transmission rates. These are the needs CNES has sought to satisfy by proposing the Athena-Fidus programme to the military authorities, a project initially developed for civil applications in the fight to close the digital divide. Athena-Fidus should be launched in 2013.

Portable Syracuse dish aerial

Syracuse 3B



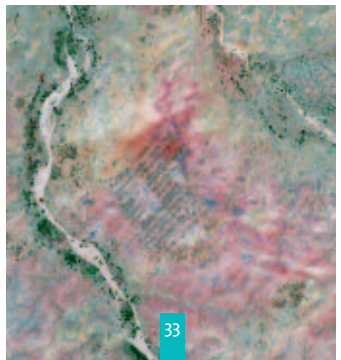
Artist's impression of the Helios 2B satellite

II-3-a Optical intelligence

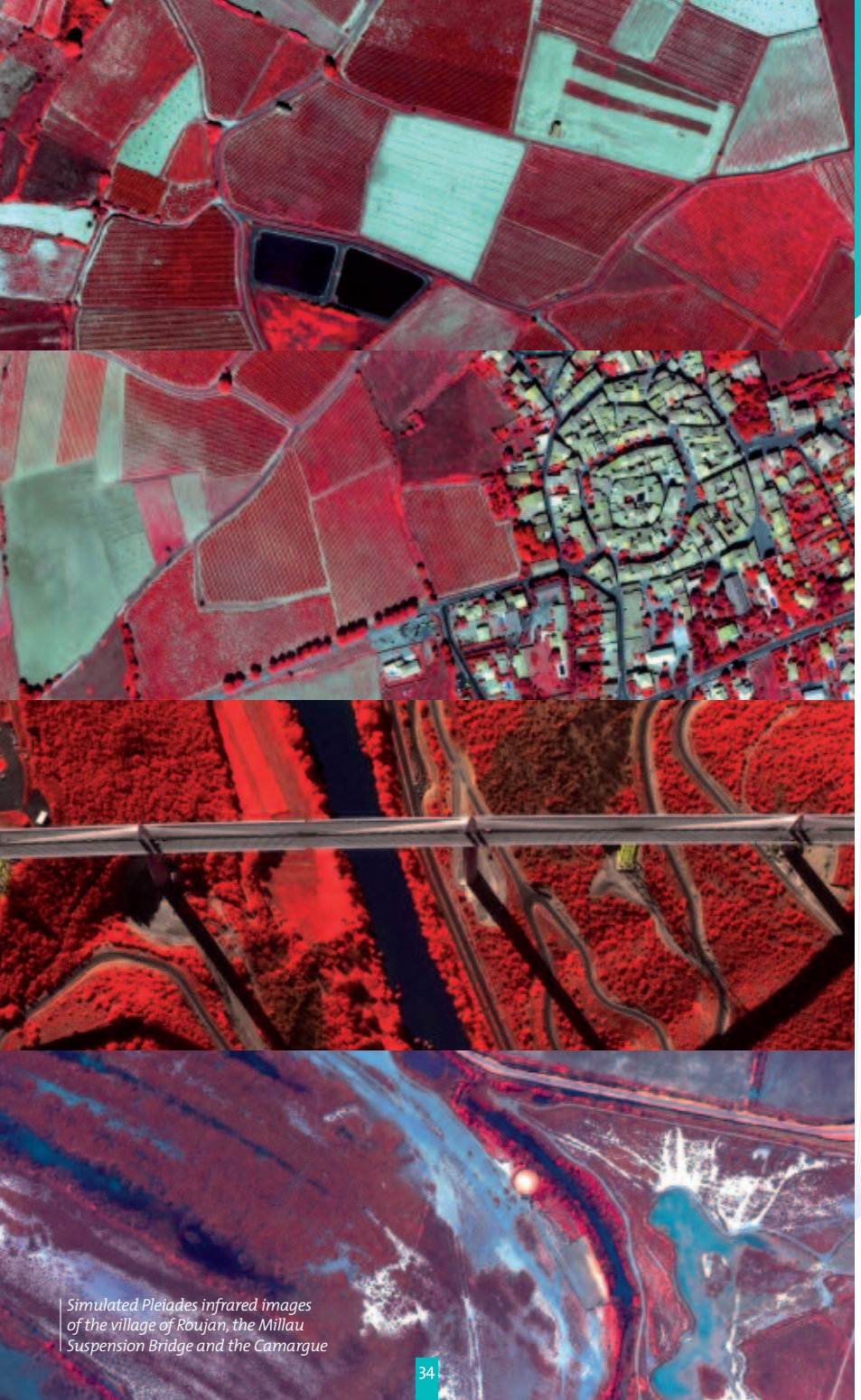
Space-based optical intelligence has many goals. It is not just for identifying targets but can also be used to develop digital terrain models to satisfy the geographical needs of new weapons systems.

Exchanging radar and optical images: a model of European cooperation

Space-borne optical imagery, even when it has an infrared capability, is at the mercy of the weather. A different technique, radar imagery, is the only one that remains operational in all weather conditions, but the resulting images are of much lower quality. These two techniques are therefore complementary. France has formed a partnership with Germany and Italy, which each have radar imaging satellites. This agreement allows all three countries to cover their space observation needs.



Darfur refugee camp, seen by the Spot5 satellite



Simulated Pleiades infrared images of the village of Roujan, the Millau Suspension Bridge and the Camargue

Helios

Helios is a family of Earth observation satellites for gathering optical intelligence. The current mission of Helios 1A and 2A is to provide high-definition images of any point on the globe in the space of a few hours, with a high revisit and therefore updating capacity. Thanks to its infrared capability, Helios 2A can acquire images by both day and night. When Helios 2B comes online in the near future, this will double the system's image acquisition capacity.
The Helios 2 system is financed principally by France but also by Greece, Belgium, Spain and Italy.

Spirale*

Spirale (which stands for "Système Préparatoire Infrarouge pour l'ALErte") was launched by Ariane 5 in February 2009. It consists of two satellites based on the Myriade micro-satellite platform developed by CNES. The purpose of these satellites is to acquire infrared signatures in different contexts, so as to evaluate the feasibility of a reliable operational system for detecting the launch of ballistic missiles. In the long term, such a capability could provide the basis for a future anti-ballistic missile defence system.

Musis*

Musis (which stands for “MUltinational Space-based Imaging System”) is a satellite programme for surveillance, reconnaissance and observation. It consists of several satellites operating in the visible, infrared and radar domains, giving it an all-weather and 24-hour observation capability. It is run as an international project involving France, Germany, Belgium, Spain, Italy and Greece. From 2015, Musis is destined to take over the roles of the French Helios satellites (visible and near-infrared), the German SAR-Lupe system (radar) and the Italian Cosmo-Skymed system (radar).

CSO*

CSO (an acronym for “Composante Spatiale Optique”) is France’s contribution to the Musis system. CSO will consist of three satellites on two different orbits: two in high Earth orbit for a monitoring and reconnaissance mission, and one in low Earth orbit for identification missions. The system will benefit from agility techniques developed for the Pleiades system and, with a minimum life span of 10 years, will last twice as long.

Artist’s impression of the CSO-Musis satellite constellation

II-3-b Electronic Intelligence (ELINT)

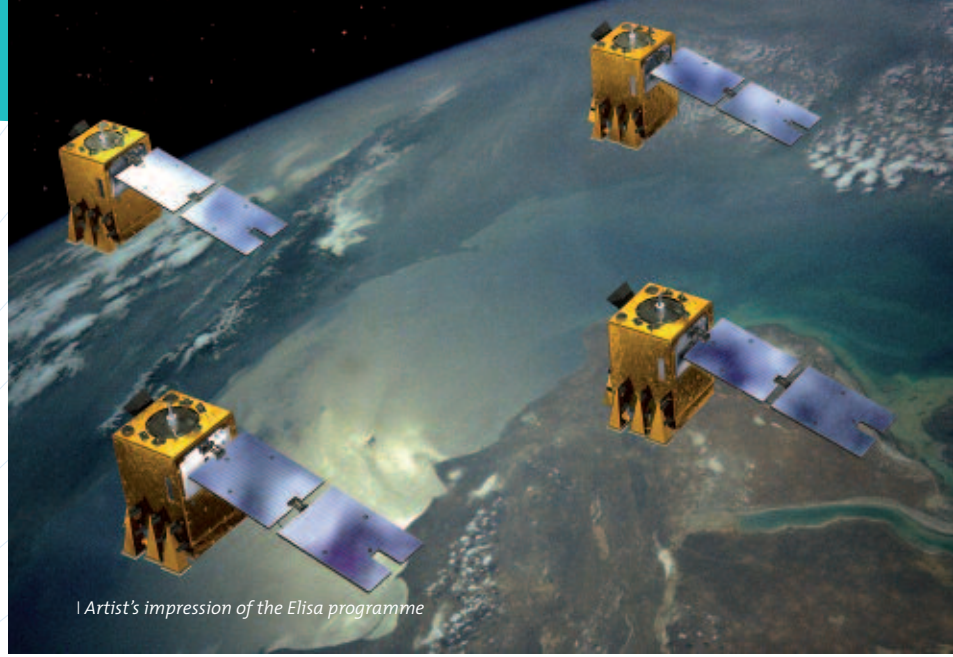
If Earth observation satellites are the eyes of our defence system, the satellites that analyse the electromagnetic field are its ears. Their role is to analyse the electromagnetic spectrum and so measure and map the intensity of communications detected.

Essaim (Swarm)

Essaim is a demonstrator project designed to explore a new concept for information-gathering, outside the visible and infrared domains. Besides telecommunications networks, a number of weapons systems emit electromagnetic waves whose characteristics provide information about their exact nature, capabilities or even whether or not they really exist (detecting decoys). This surveillance can give advance warning by detecting signs that offensive action is being prepared. Essaim consists of a constellation of four Myriade micro-satellites (a family developed by CNES).

Elisa

Elisa plays a similar role to Essaim, being designed to map and provide technical descriptions of radar systems and communications transmitters around the world. It is to be launched in the second half of 2010.



Artist's impression of the Elisa programme

Ceres*

Ceres will be the operational version of the worldwide system for the eavesdropping and characterisation of electromagnetic transmissions. It is currently in its design phase and is unlikely to be launched before the end of 2015. Greece and Sweden are participating with France in the study phase of the Ceres project.

> This surveillance can give advance warning by detecting signs that offensive action is being prepared

** Athena-Fidus, Musis, Spirale and Ceres are programmes currently in the project phase.*

III/ Space: challenges for Defence

A Pleiades simulation of the Toulouse Space Centre

III-1 Independent access to space, one pillar of an autonomous European Defence policy

CNES was founded in 1961 by Air Force General Robert Aubinière on the instructions of General de Gaulle. Its mission was to ensure national independence in the control of launch techniques and satellite design. Although CNES is increasingly open to civil space applications, it has never abandoned its defence mission. The changing geopolitical order and its new dangers mean that space is a key element in national defence and the future European defence system.

Whether civil, dual-use or purely military, satellite applications today play a strategic role in numerous domains. Satellites, and space itself, can be considered as resources, just like oil or uranium. It is therefore important to guarantee independent access to space.

Ariane 5 ECA

Thanks to Europe's spaceport at Kourou in French Guiana and the Ariane family of launchers, Europe has had independent access to space since 1979. Europe's capability owes a great deal to France which, through CNES, has long been the largest contributor to the research and development necessary to produce this family of tried and tested launch vehicles. Defining a strong and consistent space policy, including defence and security applications, is sure to be one of the crucial challenges for European construction in the coming years.

One of the crucial challenges for European construction in the coming years

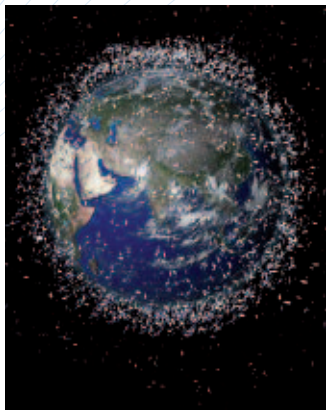
View of Europe by the VEGETATION instrument carried by the Spot4 satellite

III-2 Space situational awareness, a strategic challenge for Europe

SSA (Space Situational Awareness) is a European space monitoring programme. Its primary objective is to compile an independent catalogue of the population of space debris in orbit. This debris, which includes over 11,000 pieces measuring more than 10 cm, represents a threat to the integrity of operating satellites.

Precise mapping of the objects or debris in space is therefore indispensable for protecting civil and military satellites from accidental collisions, or even malicious acts.

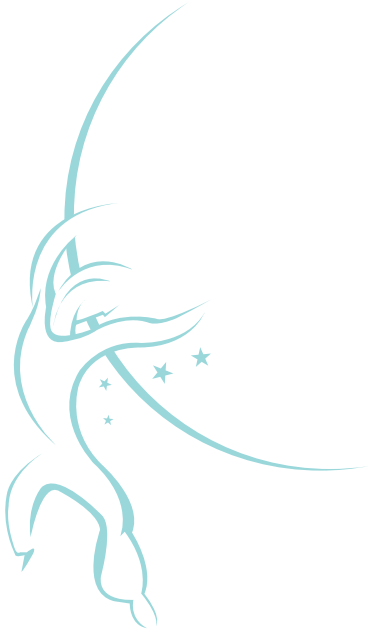
For these reasons, France has set up the GRAVES radar facility, which also supplies data used to calculate launch windows for Ariane 5.



Representation of orbiting space debris

GRAVES radar facility

The 'Patrouille de France' (French Acrobatic Squadron) flying over the Guiana Space Centre



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