LES DOSSIERS

SPACE SYSTEMS SUPPORTING SECURITY AND DEFENCE

A new European approach

AAE Dossier #43 2018

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FOREWORD

The Air and Space Academy has consistently voiced firm support for European cooperation in defence systems programmes, provided that an efficient organisational structure is set up to manage such programmes, by both the states involved and on the industrial side.

*In this respect, two AAE "Opinions" were published recently: Opinion no.6, "*Enabling the European Defence Agency to play its role to the fullest*", in 2015, and Opinion no.7, "*A Robust management system for joint European defence programmes*", in 2016, both of which formulate detailed recommendations to ensure that European defence systems programmes are managed under the right conditions, to the satisfaction of the government customer agency.*

The present AAE dossier tackles the question of space systems to meet defence and security needs. These are not weapons programmes in the traditional sense since they involve setting in orbit space systems that are shared between participants. Their development through European cooperation should thus be simpler, and yet the many failed attempts in the past thirty years prove the contrary. The present dossier endeavours to analyse this situation and puts forward an entirely different approach for the next generation of space systems, based on the now well-proven capability of European industry to deliver a range of telecommunication, observation, positioning/navigation and even electronic intelligence systems capable of meeting the defence and security needs of states. This new approach, which assumes that the statement of requirements is sufficiently mature, would help maximise efficiency gains resulting from the well-recognised duality of space systems and facilitate European cooperation, since it would take place at the industrial level.

I would like to express the hope that the recommendations in this report on European cooperation in the development of future space assets for defence and security will facilitate decisions and optimise synergies resulting from the European industrial mergers in the last few years.

Anne-Marie Mainguy

President of the Air and Space Academy (AAE)

EXECUTIVE SUMMARY

Space-based capabilities serving military requirements offer wide-ranging pooling and sharing possibilities and should therefore be a privileged area for European cooperation. However, with the notable exception of the EU Galileo positioning/navigation system, the many attempts to set up such services in European cooperation have proved unsuccessful. These initiatives were too focused on deployment of the space infrastructure – with a strong "national" connotation – when the real objective is to provide a service. An analysis of military requirements for space-based services shows that it is possible to meet needs for the most part with dual-use systems or, for those that are military specific, to consider a "service purchase" approach. Such an initiative has the advantage of facilitating a pooling and sharing of capabilities. This would help relaunch European cooperation in the area to plan for the post-2030 or 2035 generation of space-based services capable of meeting EU military needs in the mid-21st century.

These space-based services correspond to the following defence and security missions:

- *intelligence and military geography, with optical and radar observation satellites as well as electronic intelligence satellites;*
- *command and control of military operations with telecommunication satellites and navigation/positioning satellite constellations;*
- *freedom of use of outer space, ensuring the security of our space-based assets by means of space surveillance techniques;*
- *protection of our territory, improving our deterrence capability with early warning systems.*

An overview is given of present and planned capabilities of European states. Although significant, they are scattered and poorly coordinated. However, substantial progress towards European strategic autonomy has been achieved firstly in the

shape of independent access to outer space by the Ariane and Vega launchers, and more recently by means of the Galileo positioning and navigation system, with its PRS service restricted to government uses. Other EU initiatives, such as Govsatcom for secure satellite telecommunication services, show the way forward and, in the future, innovative approaches by industry to offer competitive services should facilitate the selection of the "service purchase" option, less costly and more flexible than traditional procurement of dedicated infrastructures.

The vulnerability of space systems does however call for specific protective measures. The security of outer space assets, operated by, or on behalf of, European States and the European Union, is threatened by the proliferation of space debris and, in the case of dual-use or military space systems, new risks related to the deployment of in-orbit inspection and intervention vehicles by other space powers. To mitigate these risks, Europe must improve the resilience of its space infrastructures and their associated ground segments and enhance its space situation awareness capability by pooling existing space surveillance systems operated by member states and developing additional EU capability.

1. INTRODUCTION

*In the recent past, and particularly since the Brexit referendum of 23 June 2016, many voices have been raised underlining the compelling need for a reinforced European approach to defence issues. The presentation at the end of June 2016 by Federica Mogherini, High representative of the European Union for Foreign Affairs and Security Policy, of the "*Global Strategy for the European Union's Foreign and Security Policy*", together with the implementation document in the areas of security and defence published in November 2016*[1]*, have given a new impulse to these reflections, based on the need to maintain Europe's autonomy in its strategy and decision process. This new dynamic once again appears very strongly in the European Commission's Communication to the European Parliament and the Council: "*A European Defence Action Plan*", published on 30 November 2016*[2]*, which proposes setting up a "European Defence Fund" aimed at funding defence-related research, on the one hand, and the joint development of new capabilities, on the other.*

The first concrete implementation step was the setting up in 2016 of a small budget for a pilot action on defence research, followed in 2017 by the Preparatory Action as a precursor to a future defence-oriented research programme (European Defence Research Programme, EDRP), at a level of €500 million per year for the 2021-2027 period, within the next EU Framework Research Programme beyond "Horizon 2020".

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1 "Implementation Plan on Security and Defence*", note from the High Representative of the Union for Foreign Affairs and Security Policy to the Council of the European Union, 14392/16, 14 November 2016.*

2 *Communication from the European Commission to the European Parliament and the Council: "*European Defence Action Plan*" (COM(2016) 950), 30 November 2016.*

*More recently, on 7 June 2017, the president of the European Commission, Jean-Claude Juncker, presented a contribution called "*Reflection paper on the future of European Defence*"*[3] *which considers three possible scenarios for the evolution of European defence:*

- ***Security and defence cooperation.*** *This scenario corresponds to a continuation of the present situation, with more active involvement of the European Union.*
- ***Shared security and defence.*** *In this scenario, the 27 EU Member States would move towards shared security and defence. They would show far greater financial and operational solidarity in the field of defence.*
- ***Common defence and security.*** *This scenario assumes that Member States would be ready to deepen cooperation and integration further towards common defence and security, leading to a genuine European Security and Defence Union.*

The European Council of June 2017 confirmed Member States' interest and agreement in principle with this initiative. The European Parliament also expressed its support.

The fact remains that more systematic development of defence systems in a European cooperative mode could prevent certain duplications and increase efficiency, provided that appropriate management rules are accepted and implemented.

Focusing on space systems supporting security and defence, these should be a key area for European cooperation because the services provided can easily be shared in principle. However, the numerous attempts – mostly on a bilateral basis – that have taken place over past decades have had limited, disappointing results. One possible explanation is that these initiatives were overly focused on space infrastructure, perceived as a national asset, while the purpose is essentially to provide services to the armed forces. It is therefore necessary to modify the approach taken for the last 30 years and adopt a new approach, based on a clear definition of services that need to be provided, with a view to relaunching a broad, ambitious proposal in this area. This cooperation could either go on within a European Union framework, or take the shape of multilateral cooperation programmes involving certain European nations, relying on the OCCAR organisation which was set up in the early 2000s for this purpose.

It is now time to launch a new plan for broad, ambitious European cooperation. The Defence commission of the Air and Space Academy is well positioned to promote

3 "Reflection paper on the future of European Defence*",* COM(2017) 315, *Federica Mogherini and Jyrki Katainen, European Commission, 7 June 2017*

such an initiative which should concern all sectors where space-based systems play an essential role in meeting security and defence requirements, i.e.:

- *intelligence and military geography, with optical and radar observation satellites as well as electronic intelligence satellites;*
- *command and control of military operations with telecommunication satellites and navigation/positioning satellite constellations;*
- *freedom of use of outer space, insuring the security of our space-based assets with space surveillance techniques;*
- *protection of our territory, improving our deterrence capability with early warning systems.*

Whenever a European programme is already implemented (Galileo), or at an early stage, as is the case of space surveillance (EUSST initiative) or at a discussion stage, e.g. governmental communication (the "Govsatcom" proposal from the European Commission and the European Defence Agency), reflections presented in this dossier incorporate aspects already agreed on.

2. CONTRIBUTION OF SPACE-BASED SYSTEMS TO SECURITY AND DEFENCE

2.1 The role of space systems to meet security and defence requirements

The security and defence missions that can be supported by space assets are in general well known and all concern data and information exchanges: telecommunications and data transmission, in particular to and from external theatres of operations, intelligence gathering and surveillance missions for strategic and sometimes tactical purposes, positioning and guidance systems, electromagnetic intelligence, early warning and space situation awareness. They should not be seen as limited to operational support missions as their contribution is often essential before the development of crises, hence their importance within the framework of the reinforcement of strategic autonomy underlined in the Global Strategy for the EU's Foreign and Security Policy. Consequently, a great deal of attention should be given to what is specific to space assets, and therefore irreplaceable: the capacity for observation on a global scale with the highest degree of discretion, the instantaneous nature of information gathering, and the capacity of satellites to relay information without delay.

The notions of crisis and operations are naturally understood in the military sense, but can also be applied to situations of crisis following natural, human (migration) or industrial disasters, or resulting from acts of terrorism.

The main contribution by far is that of telecommunication satellites. It is worth noting that requirements for military telecommunication capacity grow by a factor of 10 every ten years due to the modernisation of information and command systems, and the very large data bases that support them. This explains the priority given to them in most European states (Skynet satellites in the UK, Syracuse in France, Sicral in Italy, SatcomBW in Germany, Secomsat in Spain, etc.). One must note here that high speed telecommunication requirements are growing at a very high rate with the rapid deployment of military Unmanned Air Vehicles (UAVs), in particular for reconnaissance and weapon delivery.

The second largest contribution of space systems to security and defence is that of reconnaissance satellites, thanks to low Earth orbit observation satellites, optical initially (the Helios 1 and Helios 2 systems deployed from the mid-1990s, Pleiades, a dual system, and tomorrow, CSO), then complemented by radar imagery from the early 2000s (the German military system SarLupe and its follow-up SARah, the Italian dual system COSMO-SkyMed). One should also note the important contribution of civilian observation satellites to meet military mapping requirements (SPOT 1 to 5 satellites programme funded by France, Belgium and Sweden, 1986 to 2012, followed by SPOT 6 and 7 funded by Airbus Defence & Space). The Sentinel 1 and 2 satellites of the EU Copernicus programme now help to satisfy this type of requirement.

In this area, satellites are also used for electronic intelligence (ELINT) and early warning of missile launches but so far in Europe, only France has deployed demonstrator satellites for such services, with satisfactory results. An operational ELINT satellite system (CERES) will be deployed by France in 2020 within a strictly national framework.

The other major contributions of space systems to security and defence are in the field of positioning and navigation, thanks in large part to the American GPS system, whose military navigation signal (Code M) is accessible to some European states through specific bilateral agreements. The gradual introduction of the complementary European Galileo positioning services over the next few years, whose open service (OS) is interoperable with the GPS civilian open service, will reduce European dependence on the US system and increase the robustness of satellite-based positioning and time synchronisation services, thanks to a larger number of satellites and increased orbital diversity of the two constellations. In addition, the Galileo PRS service, restricted to government uses, will deliver to the armed forces of European states an autonomous positioning capability, independent of the US-controlled GPS.

To be comprehensive, one might note the important contribution of meteorological satellites to weather forecasting over operation theatres and of oceanographic satellites for modelling the propagation of acoustic waves within the oceans. Most of these satellites are deployed and operated by civilian entities, for example the

European organisation EUMETSAT. See section 2.2 for a discussion of dual use of certain satellite systems.

A specific requirement that needs to be described in more detail is that of space situation awareness. An analysis of new threats highlights the need to take account of orbital debris, ballistic missile proliferation and weapons of mass destruction (although strictly forbidden by the Outer Space Treaty), and even the possible appearance of space weaponry (which might entail "killer" satellites or "neutralising" satellites), and the potential threatening presence in orbit of nuclear or chemical devices. If such threats were to emerge, capabilities to oppose them should be developed. Space situation awareness also includes space weather monitoring. Like classic weather forecasting, space weather – and in particular monitoring of solar flares – has important military implications, not only on satellite operations, but also on terrestrial infrastructures.

It is no doubt premature for Europe to plan for neutralisation weapons to be placed in orbit, but it is now urgent to reinforce European capacity for monitoring space, which means possessing an autonomous capacity to detect and track space objects, including debris, and to be able to identify them. Europe is still very dependent on the United States for the provision of information by the Space Surveillance Network even though significant progress has been made thanks to the French GRAVES monitoring radar, in operation since 2005, and the TIRA experimental imaging radar in Germany. Space surveillance is clearly of dual civil and military interest because it helps to prevent the risk of collision and to predict fall-out zones for space objects, thus ensuring the safety of the population.

Concerning military threats, another form of surveillance involves space-based systems able to detect missile launches and provide early warning. The first of these missions consists of monitoring a given geographical zone, detecting ballistic missile launches by the signature of the plume and determining the location of launch sites as well as giving an early estimate of the missile trajectory. The second mission, early warning, can play a role in the context of deterrence thanks to its capacity to identify the aggressor and to support missile interception. It is thus an essential component of anti-ballistic missile defence.

Generally speaking, a prerequisite to European cooperation in the area of space infrastructure for security and defence is the notion that national sovereignty and the control of certain systems must evolve towards assumed mutual dependency, ensuring greater autonomy at the European level. In most cases, with the notable exception of specific systems for nuclear deterrent forces, it seems that national sovereignty is not placed in jeopardy by sharing space-based systems, provided that operational rules for the shared infrastructure are carefully negotiated beforehand. ***A new notion of European "sovereignty" should progressively take over from the more traditional one of national sovereignty. Only a strong political vision can promote the emergence of this notion, but is this not***

precisely what has happened with the implementation of the Galileo positioning/navigation programme? *On this topic, the notion of "structured cooperation", as provided in the Lisbon Treaty, is generating renewed interest today and could constitute the ideal framework for new military or dual-use space programmes.*

2.2 Duality of certain space assets

The space assets used to meet the needs of certain security and defence missions can be civil systems, whether commercial or not (e.g. mobile telecommunications via Inmarsat, European meteorological satellites Meteosat and MetOp, the series of French-American oceanographic satellites Jason and the Sentinel 1, 2 and 3 satellites within the Copernicus programme of the European Union), or dual purpose assets (e.g. the Galileo positioning/navigation system, the Pleiades and COSMO-SkyMed observation satellites). The advantage of using commercial or dual-purpose assets, besides avoiding the cost of a dedicated infrastructure, is that available capabilities can be mobilised rapidly in the event of a crisis, as long as the regulatory and contractual arrangements have been properly anticipated.

In the case of the European satellite navigation system Galileo, a specific service, the public regulated service (PRS), is dedicated to government applications with controlled access. Likewise, thanks to its stereoscopic instrument "HRS", the civil observation system SPOT 5 was a very efficient tool for generating digital terrain models useful for the guidance of certain weapon systems, anywhere on the globe. Today, the Pleiades optical satellites (France) and the COSMO-SkyMed radar satellites (Italy) are managed in dual-use mode, with specific arrangements in place to properly satisfy military requirements. It should also be noted that the United States is calling increasingly on commercial sources for high resolution satellite imagery to satisfy its geo-intelligence requirements.

Generally speaking, a well thought out approach to duality leads to carefully distinguishing between space systems which are dual in their objectives – for which specifications for military requirements are taken into account from the design stage – and space systems for dual usage, for which the initial design does not take account of specific military needs and military users are just ordinary customers. Clearly, systems in the former category should benefit from adequate financing from defence budgets.

3. EUROPEAN SPACE SYSTEMS CURRENTLY CONTRIBUTING TO SECURITY AND DEFENCE

With its operational systems – Syracuse for telecommunications, Helios 1 and Helios 2, and shortly CSO, for optical observation, GRAVES for space surveillance, and demonstrators like Essaim and ELISA for electro-magnetic intelligence, soon to be followed by the operational CERES system and Spirale for preparatory experiments in view of the definition of a future early warning system – France has made considerable investments since the 1980s but is held back more and more by economic and budgetary considerations. The same is true of the other European countries active in the space domain: the United Kingdom, Germany, Italy and Spain.

*The report published by the European Parliament in January 2014 entitled "*Space Sovereignty and European Security - Building European capabilities in an advanced institutional framework*"*[4] *comprehensively describes the efforts of the European states in the field of space infrastructure for security and defence. The report examines those space systems dedicated to access to space, observation satellite systems, telecommunication satellite systems, positioning/navigation systems, electronic intelligence systems and early warning systems. The table below, extracted from this report, summarises the capacities of the European states as they existed in 2013 and the additional capacities that were planned for the future.*

4 *Report EXPO/B/SEDE/2012/21, January 2014, ISBN: 978-92-823-5370-7*

	Launchers	Earth Observation	SATCOM	Navigation and Positioning	SSA Space Situational Awareness	ELINT Early warning
National Programmes		**Present:** SPOT Helios 2 Pleiades COSMO-SkyMed SAR Lupe TerraSAR-X TanDEM-X **2014-17** CSO CSG SARAH PAZ INGENIO	**Present**: Skynet 5 SatcomBw Secomsat Syracuse 3 Sicral **2015-19** Heinrich Hertz Comsat NG SigMa		GRAVES TAROT TIRA Starbrook Fylingdales Chimbolton	**Present:** ELISA **2020+** CERES Future Early Warning Space Based System
Cooperative Programmes	**Present:** Ariane 5 Soyuz Vega **Future:** Ariane 5 ME Ariane 6	**Present:** Helios 2- COSMO-SkyMed Helios 2- SAR Lupe ORFEO **2014-17(?)** MUSIS	Sicral 2 Athena-FIDUS ESCPC ETISC SECTELSAT NSP2K EDRS		ESA SSA programme	**2020+** CERES
EU Programmes		**Present:** GMES contributing missions **2014-17** GMES operational system		**Present**: EGNOS Galileo IOV **2014** Galileo pre-operational **2020** Galileo operational	EU support programme to SST segment of ESA SSA	

The structure of this table is however difficult to understand since the differentiation between national and cooperative programmes is not always obvious. Indeed, many of the systems listed in this table under "National Programmes" are in fact involved

in cross cooperation agreements. For example, France has signed classical cooperation agreements where the investment is shared (Helios 1 and 2 for reconnaissance satellites and Athena-Fidus, with Italy, for telecommunication satellites), as well as capacity exchange agreements between autonomous systems, for example with Germany's radar observation satellites SAR-Lupe and the Italian COSMO-SkyMed satellites, in exchange to access to the Helios 2 satellites. In such cases of capacity sharing, ground systems must be capable of receiving and processing various types of observation data. A new architectural concept of ground infrastructure is therefore needed, integrating the different characteristics of space-based observation systems, in this case optical and radar. Data exchange agreements have also been signed in the field of space surveillance between the French GRAVES system and the German radar TIRA.

For the new generation of optical reconnaissance satellites, known as "CSO" (Composante spatiale optique), which will take over from the Helios 2 satellites from 2018 onwards, three spacecraft have been ordered from industry, one of which has had about 70% funding from Germany, which will therefore benefit from a priority access to this new constellation. CSO should therefore be considered as a cooperative programme.

On the other hand, no cooperation is planned at this stage for the operational electronic intelligence system CERES and no early warning satellite system is planned by a European state.

An updated (as of August 2017) version of the table above is provided below (not including the launchers segment).

Telecommunications	Observation/ Reconnaissance	Positioning/ Navigation	ELINT	Space surveillance
Syracuse 3 (FR) Athena-Fidus (FR, IT) Syracuse 4 (FR)	Helios 2 (FR) Pleiades (FR) CSO (FR, DE, BE, SE)		ELISA (FR) CERES (FR)	GRAVES (FR)
SatcomBW (DE)	SAR Lupe (DE) SARAH (DE)			TIRA (DE)
SICRAL 1 & 2	COSMO-SkyMed (IT) COSMO-SkyMed Second Generation (IT) Optsat-3000 (IT)			
Secomsat (ES)	PAZ (ES) SEOSAT/Ingenio (ES)			
Govsatcom [5] (EU)		Galileo (UE)		Initiative EUSST
Skynet 5 (GB) Skynet 6 (GB)				Starbrook (GB)

5 *Govsatcom is a proposal by the European Commission to set up an EU-wide telecommunication satellite system dedicated to government communications (see Annex page 58).*

The table above includes only governmental systems, to which should be added the "VHR 2020" system initiated by Airbus Defence & Space Intelligence. VHR 2020, now renamed "Pleiades Neo", a constellation of four optical observation satellites collecting very high-resolution imagery (40 cm), is scheduled to be launched in 2020 and 2021. This programme, representing an investment of around €600 million, is entirely self-funded by Airbus Defence & Space. Of course, their business plan includes a significant level of usage by the governmental authorities of certain European states, among which France and Germany, but no purchase commitments have been made at this stage.

4. THE NEED TO MAINTAIN INDEPENDENT ACCESS TO SPACE

The very concept of space systems for security and defence requires control over launch operations, and therefore for European states to have an autonomous capacity to place their own satellites into orbit. The United States prohibits the launch of satellites exclusively funded by the Federal government by non-American launch vehicles or from a base not located on American soil.

Europe must continue to maintain independent, reliable access to space, access ensured so far thanks to the Ariane family and the French Guiana launch site, now complemented by the Vega light launcher. The decision taken in 2012 to develop the new generation Ariane 6 launcher to take over from Ariane 5 will restore the flexibility that largely contributed to the success of Ariane 4. The characteristics of these launch vehicles should be kept in mind when designing the spacecraft required by European states to meet their security and defence requirements.

The vital importance of independent access to space is now fully recognised by most European partners, but this autonomous access has its price, in terms of the cost of maintaining the launch base, the infrastructure, the industrial teams necessary for the launcher production and the cost of the development teams who prepare vehicle evolutions and guarantee performance. It is advisable to take this into account in any budgetary planning for space activities for security and defence in Europe, while not losing sight of the necessary benchmarking to avoid any unacceptable spiraling of costs.

Looking beyond the current generation of launchers, the means necessary to realise this ambition should be tailored to operational requirements, in accordance with the evolving satellite design, notably in terms of mass and missions (orbits, integration into wider systems, support to ground operations). In particular, regular and low-cost

access to orbit for very low mass micro- or nano-satellites is a real challenge, not necessarily met by smaller launchers! In this respect, a robust policy of support to technological research and openness to innovative solutions, remains indispensable. Reliable, cost-effective technical solutions should also be sought so that the cost of access to space weighs less heavily on the economy of new programmes.

5. RISKS AND THREATS, MITIGATION AND PROTECTION

The theme of the vulnerability of space systems is frequently mentioned nowadays because of the increasing dependence of the main space powers on these systems. This vulnerability comes firstly from the inherent risks of occupying the space environment which is, in itself, a hostile and demanding milieu that puts technologies to the test, multiplying risks of breakdowns or mission failures. Added to this are the fears of strategists regarding possible attacks on the systems, which are currently deemed to be "vital". The deliberate destruction by China in January 2007 of one of its own spacecraft nearing the end of its useful life, as well as creating over 3000 additional orbital debris in the vicinity of the Sun-synchronous orbit, also raised awareness world-wide that the risk of an aggression in outer space is not purely theoretical!

Space was used for military purposes from the outset, indeed most past expenditure in space has gone into military applications.

*The military use of space comprises all space assets that enable armed forces to improve their military efficiency. This means, for example, the use of satellites for intelligence gathering (observation or electronic intelligence), encrypted telecommunications, early warning, navigation and positioning. It is widely understood that this is covered by the Outer Space Treaty with its call for the use of space for peaceful purposes, and more precisely by the requirement that "*States Parties to the Treaty shall carry on activities … in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security *…"*[6]*. In this case, states that master access to space and the use of space for defence motives use space in a non-aggressive and pacific manner.*

6 *Extract of Article III of the "*Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*", RES 2222 (XXI), United Nations Office for Outer Space Affairs, 19 December 1966.*

The Outer Space Treaty prohibits placing in Earth orbit or stationing in space in any other manner objects carrying weapons of mass destruction, but it says nothing about "conventional" weapons. Up till now, no state has claimed to have placed weapons in outer space, and it is therefore assumed that this has not yet happened. However, several states like Russia, the US or China have demonstrated their capability to destroy orbiting satellites from the ground or from air-based platforms. The placing in space of weapon systems directed against other satellites would create a new operational option for a potential attacker and could have a destabilising effect on the international environment in crises.

In addition to weapon systems intended for kinetic interference with satellites, there are numerous other options to destroy targets in space or to disrupt their functions, including for example, the use of directed energy (such as lasers) and electronic interference like jamming or cyber-attacks. Such attacks may be directed against the space assets, their ground infrastructure or the communication links between the two.

In addition, technologies are emerging to approach and interact with space objects in orbit for entirely non-aggressive purposes, such as servicing and repairing of satellites or active removal of debris. These technologies could also be employed with hostile intent, however.

In Europe, the European Union and its Member States should thus take existing and potential future threats into account in their future plans for the use of space, whether the applications in question are essentially civil or directly concern security and defence.

Faced with such a threat, and within the framework of a space effort to enhance its security and defence component, it is important for Europe to strengthen the protection of its systems and develop autonomous means to monitor the space environment around the Earth, in order to gain a better understanding of this environment and identify possible hostile or illegitimate acts.

5.1 Protection

Systems protection notably entails hardening the electronic components that equip satellite platforms. Such adjustments naturally increase costs. While these measures can be taken for constructing dedicated military assets, they are a handicap in civil applications for commercial systems. At a time of increased duality in space technology, thought should be given to balancing out the viability of such measures, notably in association with industrial partners and operators. At the same time, the security of ground segments is part of the protection of a space system and should be considered with attention. Today, the vulnerability of our space systems is rather due to their ground segments. An antenna for command and control or for reception of telemetry is, in fact, highly vulnerable to a

commando-type attack, and we should ask ourselves how best to limit this risk. Ground segments, which rely on IT systems and digital communication, are also vulnerable to cyber-attacks.

5.2 Monitoring and surveillance

Space surveillance systems should be developed to enable Europe to monitor and to characterise any abnormal event that takes place in orbit. Some actions have been taken on an experimental level: in France, the bi-static radar Graves, in Germany, the FGAN-TIRA radar, and in the United Kingdom the PIMS optical instruments, which provide a capacity for detection, orbitography, catalogue management and identification of objects in orbit. It is important to maintain this effort and increase these capabilities on a European level, as planned in the EU "Space Surveillance and Tracking" (SST) programme initiated in 2014, although its current level of funding seems to be far too low. Europe needs a sensor configuration which provides a situational picture sufficient for its own security requirements. For this, additional sensors are required. The current systems in Europe were not designed to operate in complementarity with each other nor to guarantee the necessary operational readiness.

Furthermore, the European SSA/SST capability must ensure that Europe will be a credible and relevant partner for cooperation with the United States who are now providing the bulk of space surveillance data.

Beyond space situation awareness, it might be necessary to plan for future European space systems to carry on-board equipment for self-protection, designed to ensure their security in case of attack.

5.3 Toward space deterrence?

Hostile actions in space cannot be separated from the overall political and military situation. Deterrence against acts of aggression targeting space assets does not necessarily require a capability to respond in kind by anti-satellite systems. While the definition of proportionality might raise questions, retaliation could also take place in the land, sea, air or cyber domains or simply through economic sanctions. What is essential is to be able to detect, characterise and identify the threats and to attribute responsibility with some certainty in order to produce indisputable proof. Another important element of deterrence is the deployment of redundant systems to increase resilience, so that to knock out an entire capability (such as satellite navigation or telecommunications) would require the destruction of so many spacecraft that it would be unfeasible in practice or constitute an act of war that

would invoke a major military response in other domains. This resilience may also be obtained by multinational agreements: allied nations (European and non-European) could negotiate mutual support agreements in order to minimise the loss of an operational space system, whether accidental or due to hostile actions. For example, if the loss of an observation satellite were to reduce France's capacity to collect images on a specific external theatre, its partners would use their own satellite observation assets to collect imagery over the area of interest and allow the operations to continue in the area. This type of mutual support agreement would apply equally to telecommunication and electronic surveillance and possibly to early warning. For global navigation/positioning functions, allies will benefit from the redundancy between GPS and Galileo.

This type of redundancy (often called "resilience" in specialised literature), is not accessible to a single country and not easy either to organise at the European level, although it would clearly be within the remit of the European Defence Agency to conduct studies on this issue. This explains why a broader framework has been sought to maximise the resilience of our space systems, the main factor in deterring an attack on our space systems in the next ten to fifteen years. The allied countries have been working on this topic for a few years already.

6. HOW TO PREPARE FOR THE NEXT GENERATION OF EUROPEAN MILITARY SPACE SYSTEMS BEYOND 2030?

6.1 Defining mission requirements

It is clear that enhanced synergy between European states for the utilisation of space systems supporting security and defence missions first requires a convergence of the analysis and definition of mission requirements. Space systems are not weapons, they essentially provide services, so what is needed is not only a very precise definition of the required services but also for this definition to be commonly accepted by all partners, including specific military aspects such as the protection of information and ensuring secure communication. This convergence in the definition of services has so far been difficult to achieve, in part due to the significant differences of appreciation between states as to the role of space systems in satisfying the requirements of the armed forces, whether in telecommunications, intelligence gathering or positioning/navigation. As for early warning, this function is often considered as falling under NATO responsibility. The necessary convergence of understanding as to how certain requirements can best be satisfied by space systems could be a task devoted to the European Defence Agency (EDA), in line with its terms of reference, but subject to the explicit agreement of EDA's Member States. This is essential, in particular for requirements associated with intelligence where the traditional way of operating is to proceed by exchange of information rather than by sharing of information.

6.2 Choice between purchasing services and owning and operating dedicated systems

Another issue to be considered by European states before initiating new satellite programmes is whether to buy services, as the United Kingdom did for example with the Paradigm mechanism for its Skynet 5 – and more recently Skynet 6 – telecommunication satellites, or to possess their own space infrastructure dedicated to satisfying their military requirements. Intermediary solutions are also possible, as in the case of Germany's Bundeswehr for its SatcomBW telecommunication satellite, in which Germany retains ownership while its operation is contracted out to a commercial company. Besides the economic dimension of this choice, which remains a major parameter, an important consideration is that of control of the space infrastructure and its operation. This issue comprises questions as to the physical protection of the infrastructure in case of conflict, the risk of a take-over by enemy entities and the protection of confidential information concerning the infrastructure or relayed by it. Nonetheless, since the objective of a space system is to provide a service to the armed forces, the option of purchasing the service rather than the whole system should be considered very seriously, even though this option is sometimes seen as going against the traditional approach within the military community. The one exception to this is the early warning mission, which is inherently linked to anti-missile defence and deterrence. The fact of purchasing services also offers the additional advantage of being able to call on dual-use systems which, since they also serve the commercial markets, can benefit from lower prices.

6.3 Managing procurement programmes

*Principles for the efficient management of joint defence-related development programmes were established following in-depth discussions within the Defence commission of the Air and Space Academy and were published in a formal "Opinion" of the Academy in 2016: "*A robust management system for joint European defence programmes*"*[7]*. The main principles contained in this opinion paper, summarised below, are directly applicable to the management of space systems development programmes. However, they will need to be adapted if the option of purchasing services is selected instead of the procurement of a dedicated infrastructure.*

- *Responsibility for overall programme management should lie with the EDA, assisted by a programme committee comprising representatives of the participating member states. The European Defence Agency could delegate some programme management tasks of certain programmes to the European*

7 *A robust management system for joint European defence programmes, Air and Space Academy, Opinion no 7, 2016, ISBN 978-2-913331-67-9, ISSN 2426 3931.*

Space Agency (as is the case already for the demonstration phase of Govsatcom), or to a Member State. In particular, this would be appropriate when the programme was initially proposed by a Member State ready to bear a large share of its funding. In both cases, the supervisory role of the EDA should remain unchanged.

- *Programme management from the initial design studies should be the responsibility of a prime contractor with recognised competencies and with all necessary decision powers.*

6.4 Organising the exploitation phase

When a space system is used by several partners, it means that once deployed and tested in orbit, the infrastructure is shared between them. This situation requires agreement on a set of clear, precise exploitation rules from the system's initial definition phase. These rules have a strong impact on the architecture of the ground segment and determine operational procedures, capacity sharing and rules for information protection, etc. As an example, the experience gained through the exploitation of reconnaissance satellites, both optical (Helios 2 and Pleiades by France and its partners) and radar (SAR Lupe by Germany and COSMO-SkyMed by Italy), has shown that sharing of capacity on a daily basis is a challenging job and requires efficient, rapid interaction between the authorities responsible within each partner country. To be effective, this interaction must be based on mutual trust and a good understanding of the technical constraints affecting the system. Specific attention must therefore be given to organisation of the exploitation phase from the outset of discussions on any new cooperative space system. If not adequately prepared, the early phase of exploitation will face considerable difficulties which could negatively affect partners' confidence in each other.

7. CONCLUSIONS AND RECOMMENDATIONS

Contrary to the situation in the United States and Russia, the contribution of space systems to meeting security and defence requirements has long been underestimated by the armed forces of European states. However, this contribution is better recognised today. In addition, the cost of deployment of space systems has significantly decreased, thanks to the availability of new technologies, e.g. mini- and microsatellites, and also because sharing space-based capabilities between civilian and military needs has proved to be feasible.

One must regrettably observe that European cooperation in the development and deployment of space systems serving security and defence has been very limited since the years 1980-1990. An analysis of the many failed attempts to set up European cooperation programmes for the development of military space systems points to two main obstacles which have proved difficult to overcome:

- *major differences between states in their degree of understanding as to how space-based services should be integrated within their military operation plans because of lack of experience in using such services, particularly to support military operations on foreign theatres;*
- *priority given to building up dedicated space infrastructures with a strong national character, with a clear objective of supporting national industry.*

This situation has led to a proliferation of uncoordinated space systems, all funded by national defence budgets at a time when these same defence budgets are under extreme stress. In addition, some areas of space systems serving security and defence requirements are poorly covered, such as space situation awareness and electronic intelligence, or not covered at all in the case of early warning.

The new approach suggested in this dossier, for the next generation of space systems serving security and defence, is to go back to basics, i.e. to start from a better definition of the expected services without any blanket assumption on the technical architecture of the space infrastructure, nor of its ground based component. This approach should facilitate the sharing of capacities between partners and encourage, whenever possible, the purchase of services from industry operators, as is often the case today for satellite telecommunications.

Finally, one specific recommendation needs to be highlighted: the setting up of an EU-owned space surveillance capability that goes much further than merely improving on the radar systems already available in France and Germany. The security of both civilian and military activities in outer space of the European states and of the European Union is threatened by the deployment by the other major space powers of new inspection and potentially aggressive orbital systems. Europe must be better equipped to face these threats.

ANNEX:
Govsatcom: A European initiative for secure satellite communication services

Today, numerous missions dedicated to monitoring unstable regions, managing crises (often humanitarian) and operating critical European infrastructures are conducted by European Union agencies and Member States. These missions, especially those with a security dimension, make ever greater use of satellite communication. However, no communication service can satisfy the European secure communication requirements to date. In order to fill this gap, the European Union has launched the Govsatcom initiative.

This initiative concerns three different EU policies: Space, Defence and Security. It aims to support the defence activities of its Members States, most of which do not have their own secure satellite communication system.

Several studies have been carried out on this topic. Notably the study performed in 2015 by PwC, under contract from DG GROW, to better define and quantify requirements in terms of the civilian secure satellite communications generated by EU and Member States services. In 2016, at the request of the European Defence Agency (EDA), Euroconsult completed a study of the military requirements of the Member States. Lastly, in 2017, PwC carried out an impact study, based on the civilian and military requirements identified in the two earlier studies.

Several scenarios were considered and compared:

- *Option 0: no EU action;*
- *Option 1: minimal intervention by the EU: European certification of service providers, at their own request;*
- *Option 2: more active EU intervention: framework contract with some certified service providers;*
- *Option 3: Public-Private partnership between the EU and certified service providers;*
- *Option 4: procurement and deployment by the EU of a complementary dedicated space infrastructure.*

It is envisaged that the four identified options be implemented in sequence, with each option building on the former option.

The Council of the European Defence Agency has authorised a demonstration phase for Govsatcom and a contact was signed with Airbus Defence & Space during the summer of 2017.

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The Air and Space Academy has consistently voiced firm support for European cooperation in defence systems programmes, provided that an efficient organisational structure is set up to manage such programmes. Space systems to meet defence and security requirements are not weapons programmes in the traditional sense since they involve setting in orbit space systems that are shared between participants. Their development through European cooperation should thus be simpler, and yet the many failed attempts in the past thirty years prove the contrary.

The present dossier endeavours to analyse this situation and puts forward recommendations for an entirely different approach to future space assets for defence and security aimed at facilitating decisions and optimising synergies resulting from the European industrial mergers in the last few years.

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