

The Importance of Space from a Security and Defence Perspective, Military Applications of Space Technologies and Expected Technological Developments

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Excellencies,

Generals, Admirals,

Ladies and Gentlemen,

I am pleased to appear before you today to discuss the importance of space regarding its security and defence applications. In order to introduce my address, I do not resist to the temptation to paraphrase a US Official commenting the role of UAV systems in modern warfare. His words could certainly well fit with our current issue: “*Everyone knows that space is the answer... but what is the question?*” I hope that my paper will help to clarify the importance of space in a security and defence perspective.

Since the end of the Cold War and the occurrence of the wide transformation process most western military organizations have engaged, space has acquired different doctrinal meanings over time. First considered as a strategic asset in order to gather intelligence about the conventional and nuclear arsenals of the Soviet Union, space did then accede to the status of a “multiplier of effects”. In this regard, the first Gulf War (that is, the coalition led intervention against Iraq during operation *Desert Storm*) is often hailed by analysts as the first space war. During this campaign, coalition forces gained an edge with superior intelligence, surveillance and reconnaissance assets. While the United States deployed, during this campaign, a vast array of existing satellites, the operations in Iraq also demonstrated the absolute necessity of adapting military space to the new strategic environment. This was especially the case of early warning, telecommunications and observation. These considerations led the military community, especially in the US, to adopt the concept of what Xavier Pasco describes as “*transverse convergence architecture*”. According to this concept, space systems were designed to better serve existing – that is, legacy – military systems in order to elevate the tempo of operations and to engage more precise – and thus, more discriminate – firepower. All these reflections were fueled by the “epochal change” discourse of the *Revolution in Military Affairs* (see below).

As advanced military technologies evolved, the necessity to closely integrate space assets to the new information-based armaments became critical. Indeed, in terms of military procurement strategies, one has assisted to a very clear shift away from the procurement of large platforms towards network-enabled capabilities. The wars of Afghanistan and Iraq also confirmed the advent of a new doctrinal view about the use of space for security and defence uses. Formerly deemed as a “multiplier of effects”, space assets progressively formed an integral part of the weapons system they supported. Today, one might say that “*every weapons system constitutes a space system*”.

Current Capabilities

First of all, I would like to briefly describe the main capabilities the military rely on. The aim of this chapter is not to present an exhaustive listing of existing technologies but rather to introduce this issue through an

illustrative approach. Capabilities provided by current space assets can be labeled according to their operational uses. These form four main clusters.

Observation

Space-based assets (and their ground segments) provide political decision-maker and the military with *intelligence gathering and dissemination technologies*. These are mandatory for any crisis prevention and management activity. Space is ideal for observation and surveillance tasks. From their orbits, satellites can cover a far bigger area of the earth surface than can be covered by any aircraft (manned or unmanned) or by facilities on the ground. Intelligence gathered by satellites provides risk free access to information in denied or adverse areas. It grants political and military leaders with a near-permanent assessment tool for tracking the movement of refugees, damage assessment, search and rescue operations, planning of operations, etc. Yet, satellites do not always offer a real-time picture of the situation and must be combined with traditional ISR sensors or unmanned aerial vehicles (UAV). While there is a certain degree of competition between airborne and space-borne sensors, one might however admit that each type of systems has its own advantages. Space assets escapes the legal constraints regarding the sovereignty of states (satellites never violate air spaces). Airborne sensors are more responsive. In conclusion, it can be said that the two clusters of systems complement each other.

Satellites capabilities also offer critical tools for arms control and non-proliferation policy. As it was underlined by the European Security Strategy, “*the proliferation of weapons of mass destruction is potentially the greatest threat to our security*”. To this end, ISR satellites are of great interest in order to ensure compliance with treaties.

Communications

In today's strategic environment, forces must be rapidly deployable and characterized by a high level of flexibility and interconnection, especially in the case of multinational operations. When arriving on the theatre, troops have to operate in terrain with poor or limited infrastructures and a lack of local support. Networking of the forces, if supported by the right training and the tailored doctrines, can reveal itself as a technological advantage in order to restore stability. To this end, network-enabled capabilities require interoperable C2 systems that are able to transfer and to share a large amount of information. These capabilities must rely, moreover, on robust infrastructures. These aspects will be discussed later.

Navigation

Navigation systems enable the military to have a precise idea of the position of its troops and equipments on a theatre of crisis. It must be added that most modern weapons systems rely on accurate and reliable positioning space capabilities in order to deliver their focused and effect-oriented power with minimum collateral damages. Concepts as such as *Effect-Based Operations* or *Swarming* could not be performed without positioning satellites. Positioning satellites are of particular interest regarding cruise missiles. These systems are optimized for use in pre-planned attacks against heavily defended, hardened and high-value targets whose positions are accurately known before the mission. Cruise missiles provides political leaders with a cutting-edge technology either in order to dissuade an adversary before the occurrence of a crisis or to send a clear signal to decision-making bodies by making them realize that any point of its social-economic infrastructure can be attacked. The independence of action conferred by these systems could not be ensured without space capabilities that remain under the control of the state.

Early Warning Systems

The proliferation of aerial and ballistic missiles capable of delivering weapons of mass destruction represents, today, a serious threat not only for the entire territory of NATO and the EU but moreover for troops deployed on external and distant theatres of operation. Observation satellites play a critical role in order to monitor proliferating networks or violations of non-proliferation treaties. However, in the case of a direct ballistic aggression, early warning satellites – relying on infrared sensors – are critical tools in order to (1) identify the aggressor, (2) determine the ballistic trajectory and the targeted objectives, (3) optimize intercept opportunities and (4) evaluate or minimize the risks of debris.

Early warning remains the unrivalled domain of the US and Russia. However, France is preparing a SPIRALE demonstrator which will comprise two 130kg micro satellites, which are due to be launched in 2008. SPIRALE is solely a demonstrator system which will also be able to generate an amount of experience that will be useful to develop operational systems.

Hyper-spectral Technology

Depending on their composition, objects emit, absorb or reflect electromagnetic radiations. Hyper-spectral technologies have the

possibility to capture a radiation and thereby the hyper-spectral signature of an object. For the moment, hyper-spectral satellites are being used for civilian purposes. However, this type of sensor could offer a multitude of military applications regarding environmental information about theatres of crisis. Hyper-spectral sensors can provide the defence staffs with precious information regarding the nature of the soil, as well as its humidity, density, etc. Moreover, as far as arms control is concerned, hyper-spectral technology could detect signs of proliferation by observing the gaseous and/or liquid emissions of suspect installations.

Interferometry

Interferometry involves superposing two radar images in order to observe differences of elevation on a given large surface area. This technology is particularly helpful for detecting underground nuclear tests. However, in order to identify the change of elevation resulting from such a test, archives must contain an image of the suspect terrain prior to the explosion. The main challenge is to compile a database of images for comparison purposes.

Space in a Network-Centric Doctrine

Technologies are always socially constructed³⁹⁰. Technology development is a process in which a relevant social group embodying a specific interpretation of an artifact will try to influence the concepts of employment regarding that artifact. Since the end of the Gulf War, network-centric approaches are the main concepts of employment of space technologies. What does NCW mean? How do space technologies contribute to network-centric concepts and doctrines?

Reducing the Sensor-to-Shooter Loop

In the aftermath of the Gulf War, western military organizations did realize the potential of space assets for operational military use. However, and in order to better fit space technologies with the realities of operations, it rapidly appeared that space would require innovative doctrines that take into account its unique physical characteristics. Proposals aimed at interconnecting information flows stemming from satellites with other ISR

³⁹⁰ Hans K. Klein & Daniel Lee Kleinman, "The Social Construction of Technology: Structural Considerations", *Science, Technology and Human Values*, Vol. 27, No. 1, Winter 2002, pp. 28 - 52.

platforms and sensors (manned or unmanned) rapidly emerged among the Alliance and EU member states. The main objective was to reach a high level of responsiveness during crisis operations. This is the reason why recent years have seen an increasing migration of military capabilities to space through the development of weapons systems that are directly enabled by space support.

In this context, “Networked-Centric” doctrines gave a new intellectual impulse to the use of space for military and crisis response operations. Since then, space technologies have played an essential role in the fielding concept of NCW as they appeared to be the most secure and far-reaching means of communication available.

Network-centric concepts are intended to confer the military with a highly agile and more precise force. This force should be clever enough to shift from one kind of mission to another in order to, first, maximise the pressure against the enemy and, second, disrupt the cognitive process permitting the enemy to draw its own mental picture of the battlefield. In other terms, NCW is just about the impact of kinetics on cognition. NCW paradigm proceeds, in fact, from a threefold revolution³⁹¹:

- A first revolution occurred in sensor technology, allowing the military to engage near-real time surveillance and observation. It is in this category that one can situate space-based assets (and, also manned and unmanned sensor aircraft, unmanned ground reconnaissance vehicles, etc.);
- A second revolution concerns information technology. Computerised systems permit to the command and control (C²) centres to deal with a great amount of data coming from the “integrated” battlefield. Growing performances of information systems could lead, in a middle term, to a complete evacuation of man from the tactical decision cycle, leading the military to rely on machines-to-machines or merely on “sensor-to-shooter” interfaces, much less time-consuming.
- A third revolution induced by the network-centric paradigm lies in recent improvements in precision guided munitions.

³⁹¹ Edward A. Smith, “Network-Centric Warfare. What’s the Point?”, *Naval War College Review*, Vol. LIV, No. 1, Winter 2001, pp. 59 – 60.

In all of these three aspects (sensor technology, information technology and precision guided munitions), space assets play a critical role and will constitute a force multiplier in future combat operations.

Space assets are intended to guarantee a greater interconnectivity between platforms, troops and C² centres. Future military operations will be designed to be more responsive and more resilient in order to achieve information superiority. In this context, the main advantage of space systems is just about providing the warrior with the “*right information in the right place and in the right time*”³⁹². In this sense, interconnectivity is deemed as a critical tool in order to dominate the entire battlefield thanks to a better situational awareness.

Stand-Off Operations

Space assets are also helpful in order to go across crisis theatres without sending any troops of logistics in the first phase of a conflict. They will permit to work in several theatres simultaneously in the full spectrum of violence. Added to the extraordinary performances of smart bombs and stand-off munitions (as cruise missiles), a nation dominating critical space technologies, is able to reach (and strike) any point on the surface of the planet where its interests are at stake. It is very interesting to note that during OIF, the vast majority of operations including space-based assets were conducted from the Continental United States, thus reducing, one again, the exposure of combatants and operators. For instance, UAV either employed for reconnaissance or time-critical targeting missions were piloted from afar via sophisticated communication satellites.

Expected Technological and Doctrinal Challenges

Yet, space systems provide the military with powerful and flexible tools in the conduct of modern warfare. Satellites and, more generally, space technologies give the western defence organizations critical advantages in the accomplishment of their crisis response missions. However, space technology, like any military-oriented technology, does not only represent a “cutting-edge technology”. It also constitutes a “double-edge sword”. Each

³⁹² Edward T. Blair, “Actionable Intelligence”, *Intelligence, Surveillance and Reconnaissance Journal*, Vol. 3, No. 7, August 2003, p. 46.

technological breakthrough generates new needs and challenges. Some of them have not been correctly anticipated.

Interoperability

“Interoperability – it is said – is not a buzz word, it is the word”. Today, space programs are moving away from systems aimed at support for a single service and more towards systems which cut across the traditional boundaries existing not only between the army, the navy and the air force but also between agencies involved in time of crisis. Interoperability is not only a technical issue. It also is a doctrinal and organizational matter. An overriding need is the easy integration of satellites services in the existing activities without the need to re-design the interfaces for each particular system. There is an urgent need to take stock of the security related projects which will be undertaken in the coming years and ensure that an appropriate set of standards, procedures and concepts are built into the program development stages at the outset. This is especially true regarding European communications satellites.

Bandwidth

Another concerning issue is related to bandwidth. Since the Gulf War, in 1991, capacity demands have noticeably increased. For instance, the increase in capacity between Desert Storm and Iraqi Freedom (2003) has been multiplied by a factor 30. It appears today that the demand for capacities has been largely underestimated. Today’s war fighter depends on space. Issues such as communication, intelligence, missile warning, weather, space control... all have contributed to an increase of bandwidth needs. It must also be underlined that the current fight against terrorism has created more demanding forms of requirements: there is now a daily requirement for space support.

Moreover, the growing use of networked platforms as such as UAVs strains bandwidth. The adding of advanced sensors, weapons capabilities and the ability to transfer high-speed, full-motion video have dramatically increased the amount of bandwidth needed. This is one of the most critical challenges for the military. Yet, it could be said that this problem finds its roots in the “point-to-point systems” approach while a more networked-approach is more and more mandatory.

Making Space Tactically Responsive: Toward A New Management Model?

As it has previously been said, there is currently a daily need for space support. This conclusion has drawn many observers to call the political-military for a new kind of doctrinal approach regarding the use of space assets. By developing their networked-enabled organizations, western militaries have gone from the strategic to the tactical arena. Commanders and soldiers are now interested in having “on-the-move” applications exploiting space assets. More precisely, some initiatives, as those engaged in the US, aim at making the space community more responsive to military needs. Among the ideas developed by officials figures the building of a stockpile of small, low-cost, ready-to-go satellites. Such a project would enable the military to rely on critical capacities on short-notice in case of grave crisis. This project would also increase the operational responsiveness of space programs in order to adapt them to sudden changes in the strategic environment. Who could have thought, 10 years ago, that our forces would be today in Afghanistan?

Some observers argue that small satellites could be the answer to prayers of Ministries of Defence worldwide. Moreover, it is said, small satellites could be an interesting answer to security and independence issues. Today, 80% of the capacity being used for military operations is commercial, rather than from dedicated military systems. This poses grave risks regarding security and robustness. The more satellites are used for military communications, the more they become targets. Maybe, a cluster of smaller satellites could be potentially a lot more robust.

Making space tactically – or operationally – responsive requires a new management model for technological developments. Rather than trying to operationalize space assets, advocates of the new management model suggest to design military capabilities directly for the operational commanders. The overall objective is to closely meet the specific war fighter’s needs. The proposed model is not meant to replace the existing legacy space systems. New technologies that would be developed in accordance with this model would be complementary.

Preventing Space-Based Weapons and Managing Inherent Vulnerabilities of Space Assets

Finally, I would like to make a special emphasis on security challenges regarding recent movements toward space-based weapons. I will also evoke

the vulnerabilities resulting from the dependence of most western militaries to space.

Space-Based Weapons

There is no question that outer space is already militarized. It must be however underlined that this phenomenon has become more profound and embedded. What remains unclear is if increased militarization of space will inevitably lead toward the actual “weaponization of space”. The answer, however, lies less in the progress of technology and more in the realm of geopolitical calculations and of political and/or financial costs assessments. In strategic terms, one must discuss whether a decision to base weapons in space would produce an increase in military capability or serve to reduce military security. To this end, a first step is to define a “space-based weapon”. I will define SBW as *a system placed in orbit or deep space that is designed for destroying, damaging, rendering inoperable, or changing the flight trajectory of space objects, or for damaging objects in the atmosphere or on the ground.*

Space-based weapons can also recover many forms:

1. laser-generating satellites, orbiting mirrors reflecting lasers for missile defence purposes;
2. space-based radio-frequency energy weapons to disrupt, disable or destroy a wide variety of electronics and command and control systems;
3. directional fragmentation warheads;
4. or hypervelocity rod bundles.

Arguments for SBW are many and diverse. The most commonly heard argument is that space is a “center of gravity” that Western nations – and first of all, the US – must weaponize in order to protect. Another argument – an American one – is that moving first to weaponize space would achieve a complete dominance of space. This position is congruent with the US National Space Policy re-edited in 2006. A third argument is that weaponization of space is just inevitable.

According to some analysts, if technical and fiscal challenges are overcome, there is little doubt that a combination of airborne, terrestrial and space-based weapons will actually form a concrete constellation. One must however question the expected “pay-off” of such a solution. There is no doubt that placing weapons in outer space will dramatically threaten

international security. Effectiveness of SBW has to be gauged in terms of the probable reaction of potential opponents. These have many countermeasures options that could take advantage of Western – and especially US – dependence on space.

Achilles' Heels

The successful Chinese ASAT test in January 2007 has created a mass of speculations on the future military and civil uses of space. This essay has clearly proved that a conventional ballistic device³⁹³ has the potential to inflict severe damages to space systems deployed by the most technologically advanced powers, including the US. There is no doubt that SBW will not be an exception. This capacity of nuisance is reinforced by the ease of access to critical information about the orbital trajectories used by satellites. These are on predictable orbits. Such information can be sometimes downloaded from specialized Internet websites. Whether future ASAT attacks (from wherever they will come from) will use similar technologies (that is, modified IRBMs or SLVs) is unclear. Other strategies of aggressions that rely either upon satellite technologies that are well understood and available or more elementary techniques represent serious sources of trouble:

1. It can be possible, for instance, to place a satellite on orbit disguised by another role or as debris and activate it later as an ASAT device;
2. It is also possible for potential dissymmetrical adversaries to destroy their own space-based assets in order to generate pieces of debris in order to deteriorate other satellite systems;
3. An adversary lacking advanced space technologies could also fire high-power laser in order to try to blind satellites. In 2006, China was suspected to make such an attempt. Blinding a satellite, according to observers, is easier than launching an ASAT attack. Current satellites are large, on predictable orbits that are easy to track and have scant defences against lasers.
4. Another technique of aggression – more defensive – could rely on satellites jamming capabilities. It is useful to note that such jamming

³⁹³ It is however unclear if the Chinese ASAT test used an adapted satellite launch vehicle of a modified IRBM

capabilities were deployed in Iraq to keep American GPS guided bombs from finding their targets;

5. A more conventional and less costly strategy could consist for an opponent in attacking ground stations by using missiles, Special Forces or terrorist organizations.

Concluding Remarks

To conclude, I would like to make some remarks regarding the use of space systems for security and defence purposes:

1. Space systems are “structural parts” of our current concepts of military interventions. In strategic terms, space belongs to the list of the Great Commons that must be exploited in order to guarantee the security and the success of military operations ;
2. No longer is space reserved for great powers alone. Today, a nation does not need to be a space player to employ space power.