HCSS Security Snapshot

Military Space Developments: Challenges and Opportunities for Defense and Industry

Patrick Bolder & Esther Chavannes

In December 2019, NATO, during a session of the Defense ministers, decided that space is a military domain, and therefore falls within the regime of the renowned 'Article 5' for mutual assistance and defense. This will drive developments in military space capabilities from which industry can profit.

In May 2020, HCSS and Clingendael published their Space Alert, which highlighted the world's – and especially the Netherlands' – dependency on the space domain.[1] In addition, the Alert concluded that these dependencies will grow rather than shrink. Geopolitical tensions are on the rise, and while space is being militarized, it is also operationally indispensable.

This snapshot addresses how the developments in and towards space will drive military needs.

Military use of space

Space already is, and will only become more, crucial for military use. Position, navigation, and timing (PNT) remain core functions for weapon delivery. The on-going need for improved high-precision kinetic attacks, where any collateral damage should be prevented and civilian casualties are a no-go, furthers the need for constant improvement of PNT services.[2] The classical functions of space to support the warfighting community will thus remain in demand, and their importance is set to increase.[3]

"Space already is, and will only become more, crucial for military use"

Observation capabilities will also increase in importance, as a number of weapon control regimes are under pressure now that certain treaties have been nullified and their verification mechanisms reduced.[4] Observation can be improved through the use of space assets.[5] New types of weapons, which stay below the (radar) horizon and can reach tremendous speeds, require warning times that can only be delivered via space.

Furthermore, targeting further enhances the need for continuous observation of earth from space.

Present communication applications delivered by space assets will be overtasked when airplanes (manned and unmanned) gather ever more detailed information with their continuously improving sensor suites and over long distances. Such information has to be processed by intelligence services in near-real time. As the use of unmanned systems will likely increase,[6] potentially with extended options for autonomy, the need for long-distance communication will increase. In particular with regard to the direction of signals to and from these unmanned systems, commands to deploy weapons, and the relay of their accumulated information.

Furthermore, several other certainties for the (military) space domain can be distinguished:

a) Space will become indispensable to military operations;
b) Micro-satellites will become the logical response in terms of space assets in the near future;[7]
c) Launch costs per kilogram are decreasing rapidly;[8]
d) Operational circumstances, and thus military requirements, can and will change quickly over time;
e) Commercial uses of space and our increasing dependencies thereon have led to companies such as SpaceX, OneWeb, and Blue Origin receiving permission to place thousands of satellites into Low Earth Orbits (LEO), making especially these orbits closer to Earth (400-1000km above Earth's surface) very crowded in the near future;
f) As a consequence of the previous point, Space Situational Awareness and Space Traffic Management will become of increasing importance for safely operating assets in LEO;
g) Commercial companies will provide increasing numbers of space assets for defense applications, making 'military space' more depending on the 'civil' space industry.
h) Mining of rare earth materials on extra-terrestrial bodies is becoming more and more of interest for both states and commercial companies;[9]
i) The character of conflict is changing, the signs of the direction of change are clear and assist in identifying future operational needs for space-intended applications and products.

Strategic implications

Space – especially the Low Earth Orbits at 400 to 1000 km above Earth's surface – is becoming more accessible, even to countries with no previous aspirations in space and relatively small budgets. As such, space will also be used more for military applications. Through this dynamic, the dependencies on the space domain will increase. And as space is becoming more congested, the risk of collisions rises. Furthermore, the more countries rely on space for their domestic security, the more their space assets become attractive targets in and of themselves.

Advanced Developments in the Militarization of Space

Russia
Russian Cosmos 2542 satellite, launched on September 29, 2019 has been seen releasing a sub-satellite Cosmos 2543 as an inspector satellite, which in turn fired a missile, likely in a trial as an anti-satellite weapon. Sub-satellite Cosmos 2543 made proximity maneuvers towards the US KH-11 spy satellite and was also observed near French and Italian observation satellites.[10]

United States
The US X-37B Orbital Test Vehicle reusable space craft (the unmanned mini-space shuttle) has been accredited by the Chinese as an offensive space weapon.[11]

China
China has demonstrated its capabilities for space warfare as well.[12] Recently, Beijing launched an unmanned, reusable spacecraft, which some speculate is China's own version of the X-37B.[13]

These developments demonstrate how the space domain is both becoming indispensable in supporting military operations and how space itself is developing into a theatre for military operations.

Additionally, our day to day life on Earth already is highly dependent on space assets, as is our security. One outstanding example of this, is how climate change affects weather and causes extreme weather phenomena. Weather satellites help in forecasting where and how much certain areas are influenced by such occurrences. Thanks to these satellites, improved consequence management, aiming to minimize human inconveniences, suffering and economic fall-out, can be applied.[14]

These types of dependencies on the space domain raise additional questions and concerns, which require answers. The example discussed above, on weather information and forecasting, is also of importance for planning and executing military operations. Because of such converging interests in the uses of space, solutions and implications within both the military and civil domains will reinforce and supplement each other.

"These dependencies on space raise questions, which require answers"

Design and development implications

As the use of and access to space cannot be 'uninvented' it is imperative to define how the military can use space assets, protect them, and devise new ways of handling this unique environment. At the same time, protection of our daily life on Earth – already highly dependent on accurate and unincumbered functioning of many space assets – requires consideration as well. This will result in a need for rapid development in different areas of application. The certainties as given above and their strategic implications will guide where (military) developments and requirements are headed. An overview of interesting and worthwhile developments – either already in the works or still abstract – can be found below:

- **Reprogrammable satellites, sensors, and communications.** In the need for rapidly adaptable applications for satellites, this demand could be answered with satellites which can easily be rerouted (in terms of functionalities) from a distance. Further

miniaturization and new chip techniques will play an important role in supporting this development.

- **Advanced optical communications.** The rise of communication satellites with a requirement for safe, high-throughput, low-latency communication requires laser communication between satellites; between satellites and aircraft (vice versa); and between satellites, aircraft, and ground stations. Further development in optronics technologies will be required.

- **Space Security Awareness (SSA) products to improve safety of assets.** Operating with assets in space means that they have to be safeguarded against interference and collisions, accidental or on purpose.

- **Closer-proximity operations.** By improving SSA and precision guidance of satellites, satellites can operate in closer proximity, answering to the increasing congestion of the space domain. Highly capable radar systems, placed at strategic positions and connected through reliable, safe, and high-bandwidth communication systems will be essential.

- **Improved hardening of hardware.** Debris and Anti Satellite (ASAT) weapons are increasingly a threat to satellite operations. Hardening of satellites against such threats can improve their lifetime. The same is valid for Earth-bound space infrastructure which could be targets as well for other kind of attacks, physically or in the cyber domain.

- **Improved hardening of on-board equipment.** Close-proximity operations by opponents will target on-board sensors, making satellites blind, deaf, and mute. Better protection against harmful lasers and electro-magnetic radiation improves survivability and lifetime.

- **Built-in self-protection.** Automatic or autonomous self-protection applications safeguard satellites, by preventing external tampering or by disabling attacking satellites as a means of self-defense.

Photo by: United States Air Force

- **Built-in agility in movement, e.g., electric propulsion.** Satellites which can outmaneuver other satellites have a greater chance of survivability. An example of a way to provide endless power is by electric propulsion where energy is gained through solar cells.

- **Responsive design, development, construction, and launch.** Although reprogrammable satellites can alleviate the pressure of constructing and launching new satellites, not all requirements can be covered. A method of responsive production and launch of satellites with advanced capabilities will support rapid (re)placement of space assets and become much needed.

- **Agreements, rules, laws.** As space is now a fast-changing environment, the laws, rules, and regulations concerning use of space, weaponization of space, mining of extra-terrestrial bodies, ownership of mined materials, and responsibilities in the use of space are lagging behind. A new and improved internationally accepted framework of space laws should create clarity concerning space use and operations.

The way forward

This snapshot presents a wide array of future needs and possibilities concerning safety and security within, towards, and from the space domain. Space-related firms, or those who are to venture their businesses in this domain, are provided with some leads for development which can be worthwhile. Military operators, meanwhile, may find some interesting avenues of approach for future capabilities. As the unattributed saying goes, “it is difficult to make predictions, especially about the future.” But one thing in future warfare is for sure: (military) space is here to stay and will become increasingly important.

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