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MILITARY USES OF SPACE

Space plays an increasing role in military activities. Over 800 satellites orbit the earth, many of which have military uses, from reconnaissance to guiding weapons systems. This POSTnote outlines national, EU level and wider military space activities. It discusses small satellite development in the UK and the growing debate over the role of space in European Security and Defence Policy. It highlights concerns over the vulnerability of satellites to accidental damage or hostile acts.

Current military uses of space (Box 1)

Satellites are the main focus of military space activities. They are widely used to provide support for military or security related activities such as verifying compliance with arms control treaties. They are also increasingly used to provide direct support for military operations. During the 2004 Iraq war, 68% of munitions were satellite guided (up from 10% in the 1991 Iraq War).

International activities

The US and Russia lead on military space activities, but more countries are now getting involved (Box 2). Reasons include:

- the growing availability of commercial satellite data of a standard suitable for military use;
- launch facilities: as well as the US and Russia, China, India, Israel, Japan and the European Space Agency ESA (for civilian purposes) now have launch facilities, which other countries can pay to use;
- a move towards small satellites (Box 4).

Military space activities in the UK

The UK's main strength is in telecoms: the *Skynet* network supports the UK Armed Forces. Skynet services have been provided since 2005 via Paradigm, a private contractor. The UK has no exclusively military satellites of its own. The existing network, Skynet 4, is being replaced at a cost of £2.5 billion. The first of three Skynet 5 satellites will be launched in 2007. The UK is described as being '*reliant on the United States for [space based] security and defence technology*' in an ESA-funded paper.[1] However, UK industry is developing expertise in small satellites (Box 4).

Box 1 Military uses of satellites

There are over 270 military satellites as well as ~600 civil, commercial and multi-purpose satellites. Satellites are increasingly 'dual-use' (can be used for both military and non-military purposes). Military uses include:

- **imagery**: from identifying targets to detecting the effects of underground nuclear detonations. Some US satellites can spot objects a few tens of centimetres across.
- **navigation**: from target location to guiding weapons systems. There are two main systems: the US military's global positioning system or GPS (used by the UK armed forces) and the Russian GLONASS system. GPS is usually accurate to within a few metres.
- **signals intelligence** (SIGINT): detecting communications, including broadcasting signals. US SIGINT gave early warning of Iraq's invasion of Kuwait in July 1990, when an out-of-use radar in southern Iraq resumed operation;
- **telecommunications** (telecoms): in military operations this enables exchange of information, for example between the 'front-line' and strategic commanders, so decisions can be based on up-to-date intelligence;
- **early warning**: infrared satellite sensors can *spot* missile launches by detecting their hot plumes. However the technology to *track* missiles along their trajectory, from space, is in its early stages;
- **meteorology**: to provide weather data for the military. The UK gains access to such data via EUMETSAT, which maintains Europe's meteorological satellites.

Satellites relay data to ground stations where it is processed. Most satellites communicate at radio frequencies.

UK military space policy[2]

There is no agency within the Ministry of Defence (MoD), and no specific budget, dedicated to military space. The Assistant Chief of the Air Staff within the Royal Air Force (RAF) co-ordinates space activities across the MoD. Activities are funded if they are a cost-effective way of achieving a specific objective. While the MoD's military

Box 2 US, Russia & wider international activities

The US operates around half of all military satellites and spends $~20 billion per year on military space activities. It has satellites to perform all the functions outlined in Box 1. Space plays a role in the planned US Ballistic Missile Defence System (BMDS) which follows on from National Missile Defence, discussed in POSTnote 148 (see page 4).

Russia owns around 85 military satellites and next to the US has the biggest military presence in space, although investment has dropped since the end of the Cold War. As of 2004, the military space budget was $~170 million.[3] Some reports claim that over 80% of Russia's satellites have exceeded their planned service life. Russia maintains early warning and communications systems. It is also building up its navigation system, GLONASS, which will have both civil and military applications.

Wider international activities

As of 2005, 45 countries had launched a satellite, with Iran being the 45th. India and China's programmes are developing fast. India's first dedicated military satellite system for surveillance and reconnaissance is planned for 2007. China has an extensive space-based science programme and also has its own navigation, telecoms and imagery satellites. As with many countries, the 'dual-use' nature of satellites means it can be hard to distinguish between military and civilian activities.

Box 3 EU activities

Activities of individual member states

Of the applications outlined in Box 1, only imagery and telecoms are well developed. France, Germany, Italy and the UK have the most advanced national programmes. All four have telecoms satellites for military use. France leads in imagery. It has a budget of € 250 million per year for military space activities and is developing its own intelligence, space surveillance and early warning systems.

Multilateral activities

- *Besoins Operational Commun* is an agreement between France, Belgium, Germany, Italy, Spain and Greece to integrate data from existing national military imagery systems, and to share these with the EU.
- *SATCOM*: The UK's Skynet, France's Syracuse, and Italy's Spiral telecoms satellites are being integrated to provide a satellite communications service for NATO.

EU wide civilian plans (POSTnote 262) include the **Galileo** satellite navigation system (POSTnote 150) and **Global Monitoring for Environment and Security (GMES)** aimed at improving provision of environmental data to policymakers from 2008. Both are EU/ESA projects. In addition the **EU Satellite Centre** provides imagery and analysis to support EU decision-making on security and defence. It relies largely on commercial data but has some agreements with individual member states to use data from their military satellites. Within Framework 7 (2007-13), space has a budget of €1.43 billion (85% of which will be allocated to GMES), while security has a budget of €1.35 billion.

space policy is classified, the RAF's *Future Air and Space Operational Concept* (FASOC) document indicates priorities over the next 20 years. FASOC highlights the role of small satellites and also the need for space surveillance (detecting and tracking objects in space).[4]

Technological development in the UK

The MoD's space research priorities are small, low-cost satellites, surveillance of space systems, and space weather effects (page 3). It collaborates with other UK government departments on technological development activities such as TopSat. Preliminary talks are underway on a follow-on to TopSat (Box 4), which may employ advanced synthetic aperture radar (SAR) technology. SAR is less dependent on weather conditions than optical imagery. Initial estimates for a small low-cost SAR satellite are £~50 million but no decisions have been made on how to finance it.

The MoD spends £~1 million per year on space research. The British National Space Centre (BNSC) say there is a need for greater investment across government in developing space technologies. Various commentators say that, in addition to small satellite development, the UK should consider whether to develop its own launch facilities (there are currently no plans for this). This could reduce reliance on other countries' facilities, and bring benefits for UK industry.

European Security and Defence Policy (ESDP)

There is increasing debate within the EU about the role of space in ESDP. There are no existing or planned EU wide military satellite networks. They would cost billions to develop, so there is more emphasis on linking national systems together. However, projects in this area, such as BOC (Box 3) have faced problems agreeing on common data formats, and working out how to share sensitive data between countries. There are calls for problems of interoperability to be addressed now, while many systems are being upgraded. A follow-on project to BOC (Box 3), which would look at options to make future space assets interoperable, is under consideration.

Progress towards a European Space Policy and a common programme of activities is slow, partly because member states differ on issues such as:

- the importance of space relative to other priorities;
- whether Europe needs space assets independent of the US, and how the North Atlantic Treaty Organisation would fit into any future EU programme;
- whether civilian systems may be used for other purposes. The UK is opposed to military use of these systems; others including France, are not.

There is also confusion over the roles of organisations involved in space activities. ESA is increasingly involved in security-related activities. Some favour this, while others say this conflicts with ESA's remit to promote peaceful uses of space, and point out that it has members who are not part of the EU. The European Space Policy is expected to be put forward for endorsement by Ministers at the EU/ESA Space Council in May 2007. While it is not expected to contain a high level of detail, follow on discussions are expected, aimed at clarifying how ESA and the EU will work together on space activities. Some say clarification is also needed at EU level on the future uses of GMES and Galileo.[5]

Balancing the US and Europe

The UK is described as having '*a hesitation to develop European military space systems*' although there is strong UK involvement in civil EU/ESA programmes.[1]

Box 4 Small satellites

This image of the Queen Elizabeth II bridge at Dartford was taken by the UK's TopSat demonstration optical imaging satellite. Launched in 2005, Topsat (Tactical Optical Satellite) is as big as a washing machine with a resolution of up to ~2.8 metres. It was funded by the BNSC and MoD. Proponents of small satellites argue that although they do not yet provide the same data quality as conventional satellites, more can be deployed for the same cost, reducing reliance on a single satellite, allowing more timely data delivery and covering a wider area. *Source:BNSC*

Box 5 Orbital 'slots' and frequency allocation

Satellites orbit the earth at anything from a few hundreds of kilometres (km) to tens of thousands. For a given orbit, a satellite must travel at a specific orbital velocity to maintain its altitude. At ~36000 km **(geo-synchronous orbit or GEO)** this velocity is such that satellites orbit the earth once in 24 hours. The equatorial GEO orbit (geostationary orbit) is popular, particularly for telecoms and weather, as satellites remain stationary over the same point on the Earth's surface. Because of possible signal interference, there is room in GEO for only ~180 active satellites, so demand for orbital 'slots' is high as well as for the frequencies at which they may communicate. The United Nations International Telecommunications Union allocates orbital slots and frequencies in GEO. These are valid for a limited time only, once awarded. Allocation is on a 'first come, first served' basis, although there have been calls for more equal distribution between countries. The Met Office stresses the need to protect specific radio frequencies, the loss of which would affect weather forecasting accuracy.

Medium Earth Orbit or MEO (5000 - 10000 km) is generally used for navigation satellites. **Low Earth Orbit or LEO** (500-1500 km) is used for remote sensing. Because of the range of altitudes in MEO and LEO, there is less competition for orbital slots than in GEO.

This is partly because such systems might duplicate those to which the UK already has access through the US, and so would not be cost effective for the UK. The MoD and Foreign and Commonwealth Office state that '*defence is a member state rather than community competence and as such military equipment should be funded nationally or by a group of nations working together, rather than funded from the community budget*'. Developing a niche small satellite capability is seen as a way of allowing the UK contribute to both the US and Europe in a way which benefits UK industry.

Accidental damage to space systems

Space debris

Collisions with space debris (ranging in size from flecks of paint to entire defunct satellites) can damage working satellites. Measures taken in recent years to mitigate debris production have had some success. In 2005, the amount of debris rose by 2.1% compared with 5% in earlier years. One example of a measure is to ensure engines run until all fuel is used up, thereby preventing explosions that can generate more debris. However many measures are costly and so are not widespread. There are no binding international standards on debris mitigation, although guidelines exist. The 'launch authority' in the country where a satellite is launched, is responsible for enforcing that country's standards.

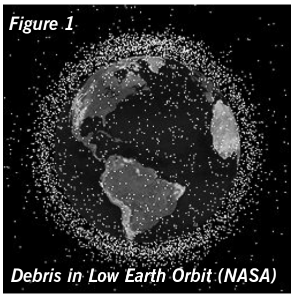

Figure 1

Debris in Low Earth Orbit (NASA)

Studies estimate that overall, one serious collision is likely to occur every decade. NASA studies show the risk of collision will rise unless mitigation measures become more widespread. Debris over ~10cm in Low Earth Orbit (Figure 1) and ~1m in GEO (Box 5) can be tracked. There are ~10,000 such objects (and possibly millions more too small to track). To avoid collisions, many countries rely on data from the US Space Surveillance Network (SSN) of which data from RAF Fylingdales forms part. SSN does not provide comprehensive global coverage and access to its data has recently been restricted. Canada, China, France and Japan are developing their own systems. The BNSC is funding a trial project (the *Starbrook* trial by UK-based company Space Insight) and ESA has conducted feasibility studies. Russia has had its own network for years but data are not public.

Space weather

Conditions in space, such as solar storms, can give rise to rapidly changing magnetic fields or streams of high energy particles harmful to satellites, particularly in MEO (used for navigation – see Box 5). The 2003 'Halloween' magnetic storm damaged 30 satellites, one of which ceased operating. The US Space Environment Centre provides free access to space weather data so operators can take advance measures, such as temporarily scaling down operations. There is no such facility in the UK or EU. However, the Met Office is investigating some space weather related topics and would like to become involved in this area. ESA has also conducted pilot studies.

Human threats to space systems

National space policies, while giving importance to international co-operation, increasingly stress the need to protect satellites from hostile acts. The US is considered to be the most dependent on space. Concerns arising from this dependency are reflected in the recently published US national space policy, which says the US will develop capabilities for space control and to deny its adversaries access to space if necessary. Some say that concerns over hostile acts are inflated and statements such as those made in the 2001 Rumsfeld Commission report, about a future '*space Pearl Harbor*', [6] create tension which can hinder the smooth resolution of disputes, for example over orbital slot allocations (Box 5).

Current threats

There are various ways of disrupting satellite operations. They are mainly ground-based and include:

- jamming: interrupting communication between satellites and ground stations, by 'drowning out' the signal with a more powerful 'fake' signal.
- targeting ground stations: for example via physical attacks or computer hacking. Ground stations are considered more vulnerable than satellites themselves.

Several other techniques are possible although there is no evidence they have ever been used (except in tests):
- Low power lasers can disrupt satellite sensors and according to some reports over 30 countries may have this capability, although this figure is hard to verify.
- Nuclear weapons explosions in space: in 1962, the US High Altitude Nuclear Detonation resulted in high radiation levels, destroying 7 satellites within months. Placing weapons of mass destruction in space has since been banned by the 1967 Outer Space Treaty.
- Use of ground or air-launched missiles: during the Cold War, both the US and Russia were developing air-launched missiles for this purpose, but this has been discontinued. Tests by both sides created debris which took years to fall out of orbit.

Taking protective measures adds to cost. Many commercial satellites have only one ground station, leaving them particularly vulnerable. Military systems are usually better protected than commercial satellites, but the latter are increasingly used for military purposes. In operation 'Iraqi Freedom', commercial satellites provided 80% of US data, compared with only 45% in 'Desert Storm' in the early 1990s. There are concerns about military dependence on commercial satellites, particularly for communications.

Future threats - space-based weapons

Proponents say that future space-based weapons would allow countries to protect space assets, and potentially enable them to strike earth-based targets rapidly over a wide geographical range. However, there is widespread opposition on the grounds, for example, that:
- if one country takes a step towards developing space-based weapons, others may follow in an 'arms-race' to weaponise space. This could create international tension and consume resources, even if the systems were many years from being realised.
- any destruction of objects in space, even for tests, could give rise to space debris which could threaten the use of space for peaceful purposes.

There are no weapons in space and no countries have overt plans to deploy them. However many technologies either in use, or being developed, for peaceful purposes or for defensive purposes, could also have offensive uses. For example, small manoeuvrable satellites used to inspect and repair spacecraft, could themselves be used as space-based weapons. There are also concerns that any future space-based interceptors could be used as weapons (Box 6). The Centre for Defence Information has speculated that the US may be funding basic research which could be relevant to space-based weapons.[7] Since the demise of the US-Russian Anti Ballistic Missile Treaty in 2002, there have been no restrictions on placing conventional weapons in space. There is little progress towards treaties in this area. One obstacle is lack of US support. The new US space policy says the US will '*oppose the development of new legal regimes ... that seek to prohibit or limit US access to or use of space*'. There is also uncertainty over what such a treaty should cover: for example whether it should prohibit space-based weapons, or *any* use of force against space-based objects (even from the ground). How to verify compliance with such a treaty is also unclear.

Box 6 Space based missile defence in the US

Space based *interceptors* (SBI) to destroy incoming missiles from space, are a controversial concept. Proponents say SBI could enable significant protection for America and its allies. Opponents say SBI might hasten a move towards space weapons. There are concerns that SBI may form part of US Missile Defence Agency (MDA) plans for Ballistic Missile Defence. The MDA says it is *not developing space based interceptors* although it is *exploring the viability of the technology that would be required for such an initiative.*[8] MDA budget documents indicate plans to request funding for a space based 'test bed' from 2008, one use of which would be to conduct experiments demonstrating the viability of space based interceptors. However a US Congressional Committee has ruled that funding will not be granted for the test bed or for SBI until a report on their purpose, cost and international implications has been submitted.

Overview

- UK industry is developing expertise in small satellite technologies that could provide an affordable means of gaining access to military space capabilities.
- Debate in the EU over the role of space in European security and defence policy is increasing. Some say the UK faces a challenge in striking a balance between collaboration with the US and EU.
- Satellite operations are vulnerable to disruption due to space weather and space debris; this could be further complicated by any future space-based weapons.
- No countries have overt plans for space weapons but there are concerns that technologies for peaceful purposes or for defensive purposes could be adapted for offensive uses.

Endnotes

1 *Space and Security Policy in Europe*, Instituto Affari Internazionali, 2003.

2 Note that the House of Commons Science and Technology Committee is currently conducting an inquiry into aspects of UK space policy.

3 Data reproduced by kind permission of Euroconsult.

4 **'Space system'** means both a satellite and its ground station(s).

5 *Europe's Space Policies and their Relevance to ESDP,* Dr R. Johnson, European Parliament, 2006.

6 *Report of the Commission to Assess US National Security Space Management and Organisation*, 2001.

7 *Space Weapons Funding in the FY 2007 Defense Budget*, T. Hitchens, M. Katz-Hyman, V. Samson, 2006.

8 Personal communication from the US Missile Defence Agency.

POST is an office of both Houses of Parliament, charged with providing independent and balanced analysis of public policy issues that have a basis in science and technology. POST is grateful to all contributors and reviewers. For further information on this subject, please contact Dr Chandrika Nath, at POST.

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