Can the UK remain a First Division player in military operations without significant additional investment in space-based capability?

By Maj Stephen Jones

The UK will not remain a 'First Division' player in military operations if it does not retain access to military space-based capability. The maritime, land, and air-based components of the UK military are heavily reliant on space-based assets, and this dependence is only expected to increase in the future. The benefits of space are not just limited to the military; they have grown to involve nearly every aspect of the nation's society and are assessed to be a crucial, irreversible component of national security. Due to the prohibitively high costs associated with military space-based capabilities - combined with the fact that the UK enjoys unique access to the products of US space assets, the UK has been reluctant to get significantly involved in space and lags behind spacefaring nations of similar size. By continuing to rely on the US to provide for the vast majority of its military space-based capability, however, the UK may be making long-term sacrifices that could ultimately undermine the country's ability to act as a force for good in strengthening international peace and security - let alone provide for its own security needs.
Alternatives to continued US dependency must be considered if the UK is to remain resilient to future threats and an ally of choice of the US.

Introduction

Who controls low-Earth orbit controls near-earth space. Who controls near-Earth space dominates Terra. Who dominates Terra dominates the destiny of humankind.

Everett C. Dolman, *Astropolitik*[1]

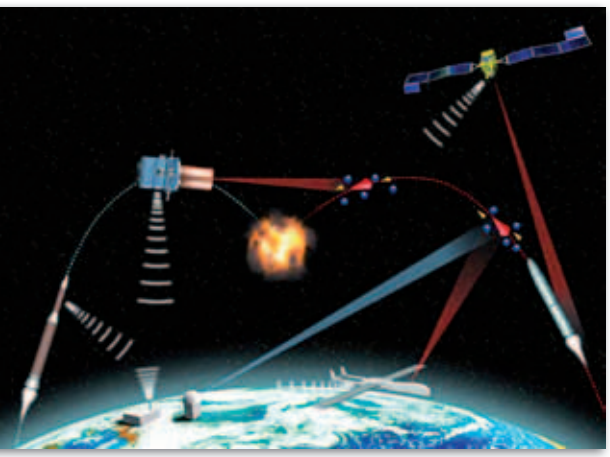
Astronaut Buzz Aldrin saluting the United States flag during an Apollo 11 Extravehicular Activity (EVA) on the lunar surface.

Everett C. Dolman writes of the contemporary importance of so-called 'space control' to a nation's overall security and prosperity in his book *Astropolitik*, echoing the language of a bygone era when Sir Walter Raleigh proclaimed that 'he that commands the sea, commands the trade, and he that is Lord of the trade of the world is Lord of the wealth of the world'.[2] It was British control of the sea during Raleigh's lifetime that afforded the country considerable power and wealth in the world and protected it from foreign invasion. Yet centuries have passed and technology has significantly evolved since Raleigh uttered his immortal words, and many space theorists such as Dolman now contend that the key to the world's wealth and power has shifted to the heavens, as only those countries possessing both the capability and the drive to access space are truly in control of their country's destiny. The importance of space to *terrestrial*-based military capability is undeniable. Due to the prohibitively high costs associated with military space-based capabilities - combined with the fact that the UK enjoys unique access to US space assets, the UK has been reluctant to get significantly involved in space. Yet as space-based capability is assessed to become even more critical to a nation's overall security in the future, the UK presently finds itself at a crossroads where it must decide what future price it is willing to pay for continued access, and whether the time has come for the nation to get more involved. Can the UK remain a 'First Division' player in military operations without significant additional investment in space-based capability?

Sir Walter Raleigh (1552-1618). An adventurer, courtier to Elizabeth 1, navigator, author and poet.

In answering this question, this article will first review why space is so important to the security of the nation - both in terms of its military specifically and society generally. It will examine where the country stands with respect to its space-based capability, focusing primarily on the

military uses of space, although an acknowledgement is made to the growing tendency of space-based assets to be dual-use in nature.[3] The article will then address the potential long-term consequences of failing to get more involved in space to the country's national security, economic prosperity, and diplomatic power. The second half of the article will recommend three steps for the UK to reposition itself in terms of its space-based capability that will not involve significant increases in spending, including 1) the creation of a permanent cadre of space experts, 2) recommitting itself to local industry, and 3) becoming an integral part of US Operationally Responsive Space.



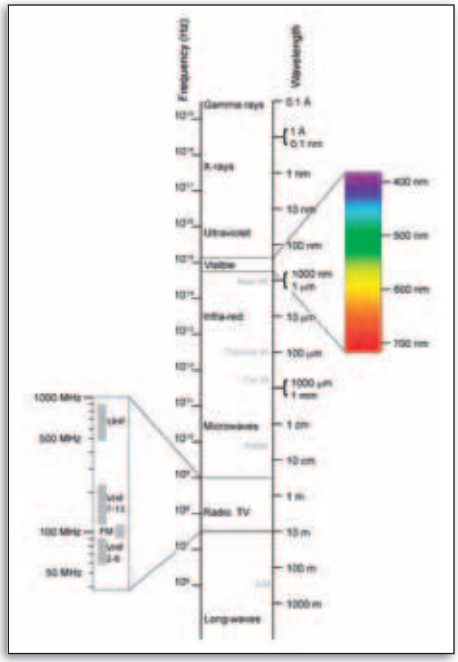
Missile defence scenario.

In his book *Space Warfare*, John Klein develops a compelling argument that space power can best be understood by putting it in context with the land and naval strategies of the past. Klein uses Sir Julian Corbett's writings on maritime strategy to suggest new and innovative ways of thinking of the future strategic value of space to national security. According to Klein, 'space operations and activities have national power implications during peace and war. Not being an absolute, national power only has meaning relative to others and is directly related to one's national security'.[4] A chapter is included on 'actions by lesser powers', in which Klein analyzes the choices available to countries such as the UK who are not as involved as other nations of comparable size that have both the capacity and drive to make space a priority.[5] Such space powers are faced with three simple choices regarding their future use of space - the choice to get more involved, maintain the status quo, or get weaker. Klein's chapter will be used as a framework to argue that despite the UK's involvement in space and the rhetoric published in its official documents, continuing to defer the decision to get more involved is placing the country on a path that will weaken it as a space as well as a national power. The potential long-term consequences of this choice could have significant unintended impacts to the overall security of the country. The choice not to get more involved may also detract from the force's ability to remain a 'partner of choice'[6] to the US.

Space: Limitations and Inevitabilities

One approach for the UK to address its reluctance to get further involved in military space-based capability is to attempt to reverse - or at least halt - the growing dependency its military has developed on such capability. Space-based capabilities have proven to be extremely vulnerable to hazards such as space weather and debris, and are assessed to be growing increasingly susceptible to attacks of both the kinetic and non-kinetic variety.[7] The long lead times

combined with the high costs of replacing such systems, should they be targeted, impose a potentially high burden to any country that has grown dependent on space to provide for its security. This is especially applicable to the UK, as its military activities in space are limited and provide for no redundancy. Moreover, as there are no near-term plans underway to replace or update its dedicated military satellites, the country would have limited recourse to replace such systems in a timely manner if they fall victim to denial activities.



Electromagnetic spectrum.

Space-based capabilities are vulnerable to attack in four ways: by targeting the ground-based launch and communication facilities, the communication links between the satellite and the ground facilities, the electromagnetic spectrum (EMS), and the satellites platforms themselves.[8] Space assets provide clear military advantages to countries that possess them, and it is only logical to assume that these assets will be targeted in future wars. British MoD satellites have been suspected of falling victim to computer hackers in the past, and despite updated security measures there is no guarantee that their systems will not be targeted in the future.[9] Ground based jamming has also taken place on a limited scale, as evidenced in the Iraqi military's use of Russian procured GPS jammers in an attempt to thwart coalition efforts in 2003.[10] Although satellites themselves have yet to be kinetically targeted in any attacks of a hostile nature, both the Chinese and the US have recently demonstrated their ability to shoot down satellites in orbit.[11] 'Future warfare will include war in space. That is a claim one can make with complete confidence' explains Colin Gray in *Another Bloody Century*, echoing the predictions of many other contemporary experts on future warfare.[12] Although provisions of the 1967 Outer Space Treaty (OST) specifically forbid the weaponization of space, hope may be running out that spaced-based systems will remain free from attack in future conflicts.

Despite these apparent vulnerabilities, however, the line has already been crossed where the military can no longer reverse the trend of its space dependence. The *Future Air and Space Operational Concept (FASOC)* reasons that 'much of the operational advantage enjoyed by the US and her allies and partners relies on unfettered access to and exploitation of space-based technologies'.[13] In addition to the tremendous Intelligence, Surveillance, Target Acquisition and Recognisance (ISTAR) benefits of

space, many military systems have grown dependent on the accurate timing signals provided by GPS (encrypted communication and Network Enabled Capability (NEC) being prime examples). A 2008 draft edition of the FASOC from MoD's Development, Concepts and Doctrine Centre (DCDC) explains that 'present and future military operations would be impossible without the time element of PNT (Position, Navigation and Timing)'.[14] *Royal Air Force Strategy* reiterates the assessment of space's indispensable value to the military, and stresses the importance of the RAF 'nurtur[ing] a powerful and decisive capability to establish and maintain control of the air against threats from the surface, the air and potentially from, or through, space'. Given predictions that future warfare in space is inevitable, it is an area the military simply cannot afford to ignore.

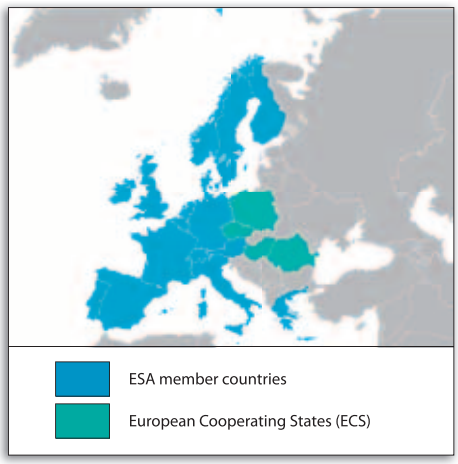
The importance of space to the UK is no longer just a military issue, but has grown to involve nearly every aspect of its society. Speaking of its nation's dependency on space, a report issued in 2007 by the UK House of Commons Science and Technology Committee expressed concern that the public remains largely unaware of the tremendous benefits space provides to their everyday lives:

Space is becoming an increasingly important sector for the UK. Satellites are able to aid navigation, supply data about the Earth and its climate, deliver mobile communications and broadcasting, and provide vital information for disaster relief and humanitarian aid . . . When one answers the phone, watches television, uses GPS in a car, makes a financial transaction, or searches for a map on the internet, one might be benefiting from space.

MoD publications acknowledge the comprehensive importance of space as well. An early working copy of the draft *FASOC* explains that space has now become a 'critical element of the national infrastructure' and has rapidly grown in importance in recent years to have become a 'national security issue' for the entire country.[17] Space no longer matters just to the military, as it has evolved to become 'increasingly central to the UK economy and, as such, an increasingly important target for those who wish to counter UK influence and prosperity. Its considerable utility and immense commercial potential imply that the UK will need to exploit and protect both'.[18] Access to space-based capability has become an essential and irreversible aspect of prosperity and national security to the UK.

UK Military Presence in Space

In 2006 the government of the UK spent £207.61 million ($384 million) on all space activities, an amount that represented only 0.038 per cent of its



European Space Agency (ESA) members map.

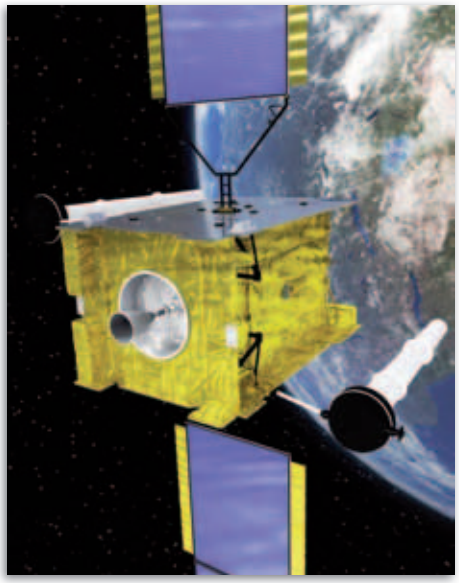
total budget. Europe is estimated to spend a combined total of €5 billion ($6.2 billion) annually on all space activities, which includes civilian, military, national and cooperative expenditures.[21] By comparison, the unclassified portion of the US's *military* space budget alone for 2006 was $22.5 billion (up from $19.5 billion in 2005), and accounts for an estimated 90 per cent of the world's total spending on military space programmes.[22] A study funded by the European Space Agency (ESA) in 2003 concluded that the ratio between European and American expenditures in space is '1 to 2.6 in the commercial market; 1 to 3 in meteorology; 1 to 4 in civil institutional demand; 1 to 30 in the military area'.[23]

'Space' is defined in *RAF Strategy* as 'those capabilities that are delivered from or through space-based assets (e.g. satellite surveillance and communications) or those capabilities used in the surveillance of space'.[24]

Space-based capability does not just consist of satellites in orbit; it also encapsulates launch and ground control facilities and communication links between the satellites and earth. Although the UK's physical presence in space may appear insignificant when compared to the estimated 100 military and 150 commercial satellites the US has in orbit, it does have a small collection of satellites that represent the cutting edge of technology available. For imagery, the UK has TopSat, a low-cost concept demonstration earth observation micro-satellite launched in 2005. The system provides high-level resolution that can be downloaded in near real-time by a mobile ground station, processed and passed on to commanders to provide valuable situational awareness of the evolving battlefield.[26] TopSat was built in the UK by a consortium of companies that was led by QinetiQ and included Surrey Satellite Technology Ltd.

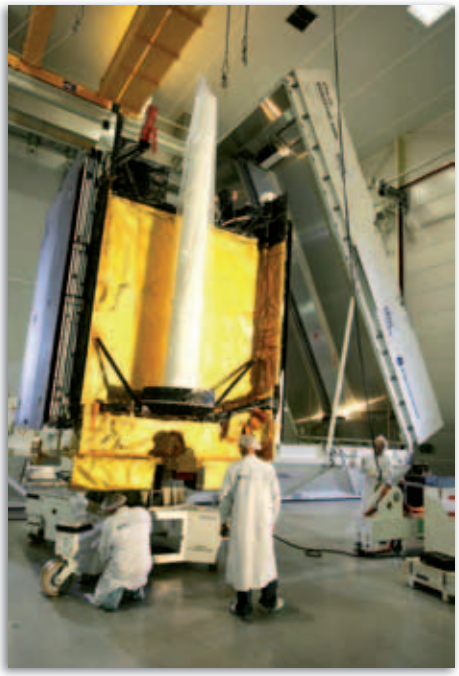
Technician in clean area with RALCam space camera.

(SSTL), considered to be a world leader in both the development and manufacturing of small satellites.[27] At a cost of £14 million,[28] TOPSAT is reputed to 'represent the best resolution per mass of any satellite launched to date'.[29] TopSat is a prime example of how the quality of satellite imagery is rapidly increasing while at the same time costs are decreasing, making such capabilities more affordable to countries like the UK than ever before.



Skynet 5A.

In addition to its single imagery satellite, the UK recently added to its inventory of dedicated military satellites with the launch of Skynet 5A and 5B in 2007 and 5C in 2008.[30] The satellites are the latest in a series that provide strategic communications to all branches of the UK's Armed Forces[31](the system includes terrestrial control centres, as well as antennas and terminals on military aircraft, ships and vehicles).[32] Unlike earlier generations of the Skynet series, the MoD contracted the Skynet



Skynet 5B.

5 system through a Private Finance Initiative (PFI) between Paradigm Secure Communications and EADS Astrium. Skynet is the 'highest power X-band satellite system in orbit' and provides the military with secure UHF and SHF communications from South America to the Far East.[33] This capability has become increasingly valuable to the UK due to the expanded expeditionary posture of its forces, and the surge of demand by unmanned aerial vehicles on secure satellite bandwidths.

Topsat and Skynet represent the extent of the hardware operated exclusively for the MoD in orbit, although as a member of the ESA the UK participates with varying degrees of interest and commitment in a number of different projects. The ESA's Ariane 5 series of rockets were used to launch all three of the Skynet 5 satellites,[35] although the UK does

not rely exclusively on the ESA for its launching needs, as TopSat was launched into orbit aboard a Cosmos rocket from Plesetsk Cosmodrome, Russia.[36] The UK depends primarily on US systems to provide for the remainder of its military space-based needs. The UK plays a contributing role in this capability, including the radar facility at RAF Fylingdales, part of the Ballistic Missile Early Warning System (BMEWS).[37] In other areas it relies entirely on US systems, such as the US Global Positioning Satellite (GPS) constellation, which provides essential PNT benefits to both the civilian and military sectors. The UK has exceptional access to the intelligence gathered from the US constellation of SIGINT, ELINT and COMINT satellites,[38] although the details of this access are classified.

Ariane 5's 25th consecutive success June 12, 2008 with Skynet 5C/Turksat 3A.

Space: Security for the Nation

Much of the UK military's terrestrial-based capability has grown irreversibly interlinked with assured access to space. The Defence Vision for space clearly expresses the country's need 'to have sufficient assured access to space-based capability to maximize and sustain military effectiveness across Defence'. [39] It is assured access that matters above all else, and despite language found in *RAF Strategy* that the UK intends 'to lead in the development and application of space-based capabilities to maximize military effectiveness across defence',[40] there is little contemporary debate occurring about whether the UK needs to significantly increase its investment in space-based capability. Publications like *RAF Strategy* instead stress the importance to the country of not underestimating the 'close links with US space-based capabilities'.[41] Due primarily to the prohibitively high costs associated with such assets, as long as the US continues to share with the UK the benefits of its own access to space, there will likely be little demand from within the UK for the country to get significantly more involved.

The *SDR* was updated in 2002 with a *New Chapter* which acknowledged that the attacks of September 11, 2001 had created a need for an updated, more global approach to UK security.[42] This *New Chapter* reaffirmed the UK's commitment to updating its armed forces by ensuring they had both the right equipment and the right capability to meet the uncertain challenges of the future.

This strategy of reliance is questioned in the 2002 update to the 1998

Strategic Defence Review (SDR). The *Supporting Information & Analysis* section of this *New Chapter* reviews the negative nation-wide responses the Government had received about the UK continuing to rely on the US to provide it with critical capability and emphasises that 'role specialization would leave the UK vulnerable'.[43] The benefits of the 'special relationship' are balanced against the dangers of becoming a 'deputy to the US's world policeman'.[44] The 2003 update to the *SDR*, entitled *Delivering Security in a Changing World*, however, concedes that the UK intends only to get involved in large scale operations if it is part of a coalition led by the US and therefore relieves itself of the requirement to 'generate large-scale capabilities across the same spectrum'.[45] The 2003 update reiterates the importance of remaining interoperable with its partner of choice,[46] yet includes the need for the country to remain ready to act autonomously in 'multiple concurrent Small to Medium Scale operations', as well as the requirement to function as a 'lead or framework nation' if necessary.[47]

Despite the UK's acknowledgement of the importance of retaining an ability to act independently without the assistance of the US, there is growing evidence that the military is moving away from being a balanced force at any spectrum. The military's limited physical presence in space is the starkest example of this imbalance. Additionally, there is no full-time, organised cadre of military space experts, no budget in MoD dedicated specifically to military space,[48] and the Government presently lacks a 'broad, pan-government Space Policy, Strategy or Vision'.[49] One of the Chief of the Air Staff's Strategic Priorities is to 'harmonize our air power capability, concepts and doctrine with those of the US forces'.[50] Yet in the process of becoming the 'partner of choice for the United States Air Force', what potential sacrifices in autonomy is the country prepared to make in order to ensure that the US continues to provide it with access to its space-based capability?

Christina Goulter writes about the benefits of the special relationship between the USAF and the RAF in her article 'Air Power and Expeditionary Warfare', and concludes:

In an uncertain world, which is increasingly dangerous, flexibility comes from having a full spectrum of capabilities, unless you are very certain of your alliance partners and their ability to assist you. Financial realities mean that Britain will remain dependent on the US . . . but the Services need to guard against being too proud of their ability to do conflicts and other interventions on the cheap.[52]

An example of the UK attempting to conduct an operation 'on the cheap' may be seen in the Falklands War of 1982, which was the last time the UK was involved in a major conflict without the US by its side.[53] Michael Clarke writes in *British Air Power* that during the war the 'operational limitations of UK air power . . . became painfully apparent'[54] as significant gaps in the RAF's ability to support the UK maritime and land components were revealed. Clarke contents that it was only through 'luck and fortune' that the British were victorious, and also that the mistakes of the Argentineans blinded them from learning lessons 'in anything other than a superficial way'.[55] One

Marines disembarking in a Sea King helicopter Falkland Islands 1982.

of these timeless lessons is the unpredictability of diplomatic or military support from an alliance or coalition partner in matters considered to be of little strategic interest to the partner nation. In the case of the Falklands War, initial diplomatic approval from the US was slow, and it was not until later in the war that the British were offered US assistance.[56]

The EU has recognised the potential high price of sharing in the benefit of US space assets. A study funded by the ESA in 2003 concluded:

. . . the strong US tendency to consider space as an essential element of US military dominance and to make military operations increasingly dependent on space assets and technologies diminishes the possibility that the United States will generously share these same assets and technologies with its allies, except on an ad hoc and limited basis and in exchange for full compliance with US political, economic and strategic and operational priorities.[57]

The UK may be considered an exception to this 'ad hoc' sharing, but some continental members of the EU may contend that this is because the UK has acquiesced to US dominance. There is a distinct difference between how the UK and much of continental Europe views its relationship with the US with regards to space security. The UK has been identified as having 'a hesitation to develop European military space systems'.[58] In its dealings with the ESA, the MoD has made it clear that space assets of military utility are to be funded by nations independently, or provided for collectively by countries sharing their independent capabilities - but never to be funded from intergovernmental agency budgets such as the ESA.[59]

Galileo System Test Bed – Version 2/B in orbit.

This philosophy has reappeared recently in the UK's reluctance to get fully involved in the Galileo project, which has dual military and civil use potential. The US state department has been opposed to the project from the beginning, arguing that

there is no need for a redundant navigation system, and that it would make the US and its allies vulnerable to precision attack from potential enemies.[60] Speaking of the strategic value of the Galileo to Europeans, however, Jacques Chirac contended that failure to proceed with the project 'would eventually turn the EU into an industrial and economic vassal of the United States.'[61] Along with many other ESA members, France has long believed in the importance of Europe moving away from dependence on the US to provide for its civil or military space needs.[62]

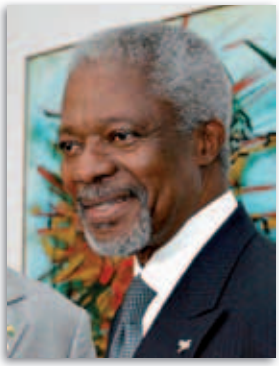
Will the special relationship between the US and the UK remain strong enough to weather future storms, and can the UK remain confident that the US will continue to provide it with access to the space-based capability deemed so crucial to its national security? The draft *FASOC* predicts that 'the US is likely to remain our chief ally, at least in the medium term, and access to senior levels within the USAF will be critical in providing influence and remaining aware of emerging US strategic direction'.[63] Publications on the other side of the Atlantic also support this view. The *National Security Strategy of the United States of America* expresses the strong commitment of the country to its allies in Europe, and in particular to its special relationship with the UK. In unequivocal language it proclaims:

Europe is home to some of our oldest and closest allies. Our cooperative relations are built on a sure foundation of shared values and interests. These democracies are effective partners, joining with us to promote global freedom and prosperity. . . Just as in the special relationship that binds us to the United Kingdom, these cooperative relationships forge deeper ties between our nations.[64]

Language from the two nations' official publications, as well as the recent positive rhetoric of it leaders, validate the security of the 'special relationship'. Assessing the long-term survivability of the 'special relationship', however, is well beyond the scope of this article. The importance of this survivability to the security of UK, however, is especially pertinent when considering space-based capability. The tremendous costs and long lead times associated with the development of an autonomous military space-based capability is a demanding endeavour that would likely require the country to begin preparation before a potential requirement for it to become self-sufficient begins to materialize. This article does not to imply that the US will abandon one of its closest allies, nor does it propose that the UK should begin preparing for this possibility today by becoming *significantly* more involved in space-based capability. Yet as the importance of space to the UK's military and overall national security are assessed only to continue growing in importance, the country must acknowledge the potential risk it is accepting by continuing to defer the decision to get more involved.

Space Presence and Diplomatic Power

In addition to the potential long-term security disadvantages of the UK continuing to rely on the US to provide it with access to space, the country also risks an erosion of its diplomatic power as its involvement in space is potentially diminishing relative to established and emerging



United Nations Secretary-General Kofi Annan 1 January 1997 to 1 January 2007.

Photographer's: Ricardo Stuckert/ABr. Nov.2003

space powers. The UK has long recognised that diplomacy alone, without the ability to back it up with military force when necessary, can only go so far in carrying out the nation's will. It is an underpinning theme of 1998 *SDR*, where the UN Secretary General is quoted as saying that 'you can do a lot more with diplomacy backed up by firmness and force'.[65] As such, the UK has stressed the importance of its armed forces being 'able to fight and win in modern conventional war'.[66] Yet with nothing more than a relatively insignificant involvement in space, the UK risks losing diplomatic power as well.

As with present control of the land, maritime, and air environments, control of the space environment in the future will not be limited to military means alone. The importance of diplomacy in determining how space is to be regulated must not be overlooked. So-called space power is not reserved exclusively to those nations that have a physical presence in space, although countries with limited or no presence in space have historically had little say in how the region is regulated. In some cases, their concerns have been completely ignored. The regulation of space has historically been governed by the principle that space is to be reserved for the benefit of all mankind, and not economically monopolised by any one nation or entity, or used for any kind of military purpose. Elements of these principles can be found in the OST (1967), UN Resolution 34/68 (1968), the Conventions on Liability (1973) and the Conventions on Registration (1976).[67]

These treaties and resolutions were all successfully agreed upon in the UN, despite the fact that the majority of the nations of the world, including most of the countries that participated in the ratification processes, had little or no physical involvement in space at the time. Those countries with relatively insignificant physical space presence had only minor influence over how the more involved countries, such as the US and, at the time, the USSR, were making use of space for their own security interests. To the benefit of these lesser involved countries, however, provision of the OST stated that outer space 'shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind'.[68] Such language may have been encouraging at the time to those nations who were in no position to utilize the potential economic or military benefits of space presence. It did not, however, deter those countries who already had a presence in space from increasing that posture, which included gaining even greater control over the more valuable space orbits, such as the finite 'fixed point capacity',[69] geostationery orbits over the equator. According to Dolman, these orbits remain today 'undoubtedly the most commercially lucrative of the

terrestrial orbits'.[70]

The value of the equatorial geostationery orbits has not been lost to the countries immediately beneath them, and in 1976 a collection of them consisting of Brazil, Columbia, Ecuador, Indonesia, Kenya, Uganda, and Zaire declared that their sovereign territory extended vertically to include the geostationery orbits as well.[71] In what became known as the 'Bogota Declaration', the equatorial nations proposed what they considered to be a more equitable distribution of the wealth afforded by such orbits; namely, that this wealth should be the exclusive property of the countries immediately beneath them. The proposal was in direct opposition to the tenets of the OST, which held that no one nation or group of nations could reserve for themselves any territorial claim in outer space. Of note is the non-reaction the space-faring nations gave to the Bogota Declaration at the time. As the equatorial countries were largely uninvolved in space, their concerns were summarily ignored. The Bogota Declaration today remains unaccepted by the international community.[72]

Another example of how a lack of involvement in space can limit a country's diplomatic power is the resolution put forward during the Plenipotentiary Conference of the International Telecommunications Union (ITU) in Nairobi in 1982. The ITU was formed in order 'to enable the growth and sustained development of telecommunications and information networks, and to facilitate universal access so that people everywhere can participate in, and benefit from, the emerging

International Telecommunications Union (ITU) Flag.

information society and global economy'.[73] The ability of the ITU to accomplish this mission was challenged during their 1982 conference, when a collection of countries with limited involvement in space joined together to object to the 'first come first served' nature of allocating scarce space resources.[74] Even though their point may have been valid - that those countries involved in space at the time were helping themselves to an unfair share of economic benefits afforded by space, their concerns were largely ignored due to the fact that collectively they had very little physical presence in space.[75]

The relationship of physical presence to diplomatic power can also be illustrated by examining the behaviour of those countries involved in the exploration and regulation of Antarctica, a continent that has many similarities to outer space due to its inhospitable nature and future economic potential.[76] Using language that would be echoed a decade later in the OST, the 67 countries that participated in the International Geophysical Year (IGY) of 1957-58 agreed that Antarctica was not to be used for military purposes. Their agreement further stipulated that the continent would not be subjected

to sovereign claims, but instead would be reserved exclusively for international scientific purposes, despite the fact that seven of the participating countries had pre-existing territorial claims in the continent (Argentina, Australia, Chile, France, New Zealand, Norway, and the UK) - claims that continue to this day.[77] The justifications for these claims are based on a variety of different reasons, which include discovery, exploration, physical presence and geographic proximity. Five additional participants of the

Test of Vanguard launch vehicle for U.S. International Geophysical Year (IGY) program to place satellite in Earth orbit. Malfunction in first stage caused vehicle to lose thrust after two seconds and vehicle was destroyed.

IGY had similar territorial interests but elected not to make officialclaims (Belgium, Japan, South Africa, the US and the USSR). All seven of the claimant states and a few of the non-claimant states have continued to seek ways to keep their options on the continent open by what Dolman refers to as 'symbolic claiming', which includes such activities as 'leaving flags and named plaques, establishing post offices and issuing stamps, assigning civil servant staffs, and other symbolic gestures of the claiming nation on the territory in question'.

The activity of 'symbolic claiming' was seen again in August of 2007 when Russian explorers planted a Russian flag on the sea floor at the North Pole, a region that is projected to be of considerable value as global warming may make its vast oil, gas and mineral reserves more economically accessible.[81] Like Antarctica, the North Pole is internationally recognised as not belonging to any one nation, although this has not stopped countries in close proximity to the region from proclaiming some type of ownership.[82] Five countries have laid claims to portions of the area, including Denmark,

President George W. Bush of the United States and President Vladimir Putin of Russia, exchange handshakes Thursday, June 7, 2007, after their meeting at the G8 Summit in Heiligendamm, Germany.

Canada, Norway, Russia and the US.[83] President Vladimir Putin has repeatedly expressed the need for his country to secure its 'strategic, economic, scientific and defence interests' in the region.[84] In 2001 the Russians attempted to make the case before a UN commission that the region was an extension of the Lomonosov Ridge and therefore a part of their continental territory.[85] The claim was rejected due to insufficient evidence, but this has not stopped the Russians from carrying out their 'symbolic claiming' of the region.

The act of planting a Russian flag at the North Pole is another example of how countries often use symbolic gestures to back up territorial claims that are not recognised by the international community or condoned by international treaties. In response both the Americans and the Canadians have criticised the Russians,[86] perhaps recognising that the seemingly trivial act has historical precedent and may be laying the groundwork for future Russian claims in the area. The Canadians have backed up their words by initiating a military build up in the region which has included the reactivation of Cold War early warning stations as well as announcing plans to set up a cold-weather training base 400 miles from the North Pole.[87] The Russians responded in kind by flying bombers in the Arctic region for the first time since the Cold War, and are reported to have placed orders for three new submarines.[88] The reaction of the Western countries to Russian activity in the Arctic suggest they are worried that if such claims go unchecked, there may be little they can do in the future to prevent Russia from taking control of an even greater portion of the world's oil and natural gas reserves.

The Russian icebreaker Yamal, Canadian icebreaker Louis S. St. Laurent and the Coast Guard Cutter Polar Sea rendezvous near the North Pole.

What does activity in the polar regions have to do with outer space, and more specifically, the UK? Potential future disputes involving space are likely to be resolved the same way contemporary terrestrial disputes are being handled. In the case of the North Pole, it is likely that the UN will attempt to have the final say in who will get the right to extract the region's valuable natural resources. Like potential disputes involving outer space, the decision may have significant impact on both the physical and economic security of the countries involved. Activity in the North Pole, however, suggests that regional countries are literally pre-positioning themselves in order to gain the maximum possible diplomatic leverage in the region in the event these disputes cannot be settled amicably in the UN. Provisions

of the OST specifically state that outer space, including the moon, is 'not subject to national appropriation or claim of sovereignty'.[89] This did not stop both the Americans and the Soviets from planting flags on the moon shortly after the ratification of the OST. Although provisions of the OST continue to be respected by the international community, there is growing concern that the lucrative potential of outer space may cause increasing pressure on the treaty in the future.[90]

Geologist-Astronaut Harrison Schmitt, Apollo 17 Lunar Module pilot, is photographed next to the American Flag during extravehicular activity (EVA) of NASA's final Apollo lunar landing mission.

As trivial as flag planting and cold-weather training bases may at first appear, in the arena of geopolitics, physical presence has historically equated to genuine influence. There is no reason to believe that future diplomatic efforts regarding space will be any different. In the case of the UK and its approach to space, the implication is clear. In absolute terms the UK's presence may be identified as both strong and growing, especially when its commercial activities are factored in. In relative terms, however, the country's presence is simply not keeping pace with established space powers such as the US or emerging space powers such as China and India. As Klein explains;

Lesser space powers can gain diplomatic influence by establishing a notable presence in space and then subsequently proposing international treaties or laws that advance their interests on relevant issues . . . those with the most presence in outer space and space-based activities will have the greatest chance of shaping international laws and regulations.[91]

Klein would argue that UK policy is firmly placing the country in the category of those countries making deliberate choices to become weaker as space powers.

As its relative standing diminishes, the UK risks having an increasingly limited say in how space will be regulated in the future. At present, the impact of this potentially weakened political leverage may seem insignificant and not worth the price of further investment, similar to how control of the Arctic was viewed when oil prices were relatively low and global warming was a theory not yet taken seriously. Yet the potential value of this diplomatic leverage should not be overlooked, especially considering how the importance of space to a country's security and prosperity are only expected to grow in the future. By allowing itself to become increasingly marginalized in terms of space diplomacy, the UK is placing the future security of its country in the hands of other, more involved space powers. In broader terms, this decreased diplomatic power will also undermine the UK's ability to live up to its vision of

strengthening international peace and stability as well as being a force for good in the world.[92] The diplomatic power afforded by space presence is an important factor that must be kept in mind as the country considers its future involvement in space.

Affordable Options for UK Space Investment

The final portion of this article will present three recommendations for the UK to become more involved in space-based capability that do not involve significant increases in funding. The country has made considerable progress in recent years acknowledging the importance of such capability as well as maintaining a semblance of national capability despite tremendous budgetary pressure, but the rapidly increasing importance of space to the country's security - combined with the potential negative consequences of its over-reliance on the US to provide for it - demand that the country at least marginally step up its efforts. This article will not, however, propose that the UK should *significantly* increase its military space-based capability. Similarly, it should not get caught up in the so-called renaissance of manned and robotic space exploration - or for that matter any 'Scramble for Space' activities discussed in DCDC's *Strategic Trends Programme* that have national prestige as a motivating factor, as such endeavours are costly and will provide only limited military utility.[93] The focus of any expansion of space-based capability should be first on the preservation and possible modest expansion of the country's space expertise and infrastructure, followed by becoming more involved in cooperative efforts with the US in order to strengthen the 'special relationship' and overcome the rising threats to space-based assets.

Create a Permanent Cadre of Space Experts

While the issue of significantly increasing the number of its military space-based platforms may be a moot point in the UK, there is an acknowledged need for an increased level of awareness at all levels of the military of the benefits of space-based capability. In order to accomplish this, the UK should formally create a permanent cadre of military space experts. A supporting essay in the current *FASOC* outlines some of the future challenges to the RAF regarding space-based capability, which it argues will increasingly include the integration and exploitation of space-related information in order to support the commander's decision making process.[94] The supporting essay recommends the creation of such a 'cadre of space expertise' in order 'to integrate space into all relevant stages of operational planning and execution'.[95] Such a cadre would be available to serve in 'front-line, headquarters and reachback elements'.[96] The effective integration of space expertise throughout the tactical, operational and strategic levels would ensure that commanders at all levels are properly informed of the space component contribution.

The draft *FASOC* continues with the recommendation for a 'cadre of space-aware personnel' in order to educate all users of space-based products.[97] As the benefits of military space have percolated down to the lowest tactical levels of military operations and are no longer considered to be

strictly the domain of the strategic level, such 'user of space products' arguably now include most members of the military, regardless of level or branch. The draft *FASOC* emphasises the importance of fostering a sense of 'air mindedness' in the users of air and space, which is 'achieved through focus on delivery of Air Power in formal and continuing training, exercises, evaluation and operations. It is built as shared culture, ethos, values and experience'.[98] These same characteristics apply to space as well, and a full-time cadre of space experts would ensure that a culture of 'space awareness' is promoted throughout the armed forces.

There is evidence that progress is being made. In order to address the lack of operational-level focus of UK military space activities, in August 2008 the RAF stood up a Space Operations Coordination Centre (SpOCC) at Headquarters Air Command in High Wycombe.[99] The SpOCC is modelled after the US Joint Space Operations Center, which is the 'focal point for the operational employment of worldwide joint space forces, and enables the Commander, JFCC SPACE . . . to integrate space power into global military operations'.[100] In addition to being a focal point for space activities, the SpOCC ensures that a Recognised Space Picture (RSP) is disseminated to all levels of the military that require it. The integration of the SpOCC at the headquarter level is also intended to improve integration with key allies, particularly the US, and is seen as an important step in the UK's continuing efforts to establish itself as a credible presence in the international space community.[101]

The establishment of a SpOCC at Headquarters Air Command is an important first step, yet more remains to be done. Although a high degree of military space expertise can be found scattered throughout the RAF, including those serving in USAF military space exchange positions, the personnel are not structured within any type of officially recognised or sponsored organisation. This should be rectified as a matter of priority. The military could also do more to

Headquarters Air Command, RAF High Wycombe.

promote the educational development of these experts. The creation of a dedicated cadre will enable the military to preserve and organise its expertise, as well as spread awareness throughout all levels and branches of the armed forces. The sponsored education of its personnel will encourage further thought on military space, as well as promote the growth of this expertise in future generations of airmen.

Having such an organisation in place will also benefit the UK in the event that predicted future warfare in space becomes a reality. Eliot Cohen has speculated on the implications such an expansion of warfare might involve, arguing that it would rapidly change the way militaries fight:

The opening of space to full-fledged warfare would be as large a change as the opening of the air was during the First World War. New organizations, new operational conditions, new incentives to strike first, new ways of war, will blossom overnight.[102]

Vickers Vimy, british bomber in WWI 1918.

Although such significant events are not expected to happen anytime in the near future, the MoD's attitude regarding the structuring and development of its space expertise would put it at a decided disadvantage should such predictions come true. The formation of an official cadre of space experts now would lay the groundwork and therefore significantly reduce the time required for a potential rapid future expansion of space awareness and capability should such a need arise.

Recommit to Local Industry

Another example of how the UK could increase its involvement in military space-based capability without significant additional investment would be to recommit itself to the growth of its micro-satellite industry. Such an approach would have the benefit of providing low-cost and effective solutions while at the same time benefiting the national economy. According to Taylor Dinnerman, writing for *The Space Review*:

Britain is, indeed, lucky that its entrepreneurial juices have not entirely dried up. Unlike other European states, whose governments have invested massively in space technology and who are struggling to replicate America's military space infrastructure, the UK has achieved potential military space independence largely through the efforts of small entrepreneurs.[103]

An excellent example of such small entrepreneurial success is the UK's TopSat programme. A partnership of the British National Space Centre (BNSC) and the MoD purchased TopSat at a price of £14 million from a QinetiQ-led consortium of British companies, including SSTL, which developed and manufactured the satellite.[104] The project was praised by the Chief Scientific Advisor to the MoD, Professor Roy Anderson, as 'the cutting edge of scientific innovation' as it reflected 'the UK's leading research capability in this

highly competitive field'.[105] TopSat was part of the BNSC's Micro Satellite Applications in Collaboration (Mosaic) programme, which funded three demonstration missions to test micro-satellite technology between 2000 and 2005.[106] According to the BNSC website, small satellites:

. . . could have a huge impact on the future of space missions and significantly reduce the cost of using satellite technology on earth. It's therefore vital for our economy that we maintain our momentum and remain one of the world's leading manufacturers of this technology.[107]

Two Technicians working on TopSat RAL.

This momentum has remained strong, despite the UK government's lack of significant follow-on investment in local companies like SSTL after the TopSat project. Surrey Satellites has built 27 satellites since its inception in 1985, and has another 13 on order.[108] Despite progress made in expanding its share of the international commercial satellite market, SSTL experienced a sharp decline in profits in 2007 and found itself in need of funding and loan guarantees that the University of Surrey has been increasingly unable to provide in recent years.[109] In April 2008 it was announced that Europe's largest aerospace company, Astrium, had begun negotiating to purchase a majority share in SSTL in order to allow the company to continue its success as a small-satellite builder. As of today Astrium owns 99 per cent of the company's shares, with the University of Surrey owning the remaining 1 per cent. Although Astrium has assured the British Government and the MoD that Surrey SSTL's 'corporate culture would not be overwhelmed in the Astrium bureaucracy', the purchase is a potential indication of how lack of British national interest is pushing its local industry to turn elsewhere to maintain profitability and provide opportunities for future growth.
The potential economic benefits of an increase in government support to the domestic UK space industry are immense. European Aeronautic Defence and Space Company (EADS, of which Astrium is a subsidiary) published a review in October 2006 outlining the present and projected future benefits of the space industry to the UK economy. The review makes a compelling argument that future growth will be limited unless the government becomes more involved. The UK space industry has grown at over 10 per cent a year since 1999 - four times the rate of the overall economy - and the review predicts that it has the potential to grow at an even faster rate over the next decade with the emergence of new technologies and applications.[112] The UK space industry is one of the country's most profitable sectors, estimated to be worth approximately $115 billion.[113] The industry directly contributed

approximately £2.4 billion to the UK GPD in 2004/2005, employing a total of 17,560 people.[114] In fifteen years the industry is predicted to be worth approximately $1 trillion, expected to have experienced up to a 15 per cent per annum growth in the telecom and navigation markets, and is predicted to deliver a 60 per cent increase in direct contributions to GDP.[115] This enormous growth and profitability has been supported by substantial levels of investment in research and development (R&D). In 2004/2005 R&D in the UK space industry amounted to £300 million, which ranks the industry 'alongside the most R&D intensive sectors in the UK today'.[116]

The future looks bright for the UK space industry, but the EADS report stresses that continued profitability and growth will only be possibleif the industry sees a corresponding increase in government investment along with what it receives from industry:

. . . continued high levels of investment by industry and capital markets will only be sustainable, in the face of competitive pressures from developed and emerging economies such as China and India, in conjunction with complementary investment by Government. This will enable UK space to develop the next generation of disruptive technologies in advance of those completing economies.[117]

The report provides specific recommendations about how the government can get more involved, which includes an investment of £30 million per year for advanced telecoms R&D, and £20 million per year for the creation of a national satellite Research and Technology fund.[118] The report also encourages the UK government to recognise formally the scientific, economic and security benefits of the ESA, and recommends that the UK budget 'reflect a GDP based contribution as the norm' to the organization.[119] It likewise advocates full contributions to ESA projects GMES (Global Monitoring for Environmental and Security) and Aurora. Whether or not the government chooses to implement these specific recommendations remains to be seen.

Artist's impression of Sentinel-1, the first Earth observation satellite to be built for Europe's Global Monitoring for Environment and Security (GMES) programme.

The recommendations of EADS are understandable considering they represent the view of a private company with much to gain should the UK choose to get more financially involved. However, the recent dip in profits experienced by SSTL, along with the fact that they have sought financial support outside the country by merging with EADS, demonstrates the continued volatility of the industry and supports the view that the predicted future economic prosperity of the local UK industry may remain tenuous

if the government chooses not to increase its level of involvement. The BNSC also reinforces the EADS report by emphasising that there is 'a need for greater investment across government in developing space technologies'.[120] The House of Commons 2007 *Space Policy* also identifies this need, stating that 'to remain competitive it is necessary for the UK also to invest strategically . . . the UK space industry describes Government support as "critical"'.[121] While serving as Chancellor of the Exchequer, Gordon Brown stated that 'we in government recognise that to support manufacturing achievement, we have a role to play . . . Success does not happen by accident. It happens by design'.[122] The Minister of State for Science and Innovation, Ian Pearson, has also expressed the Government's commitment to local industry in order

Minister of State for Department for Science and Innovation Ian Pearson.

for the UK to remain 'at the forefront of the evolving space scene'.[123] By more seriously accepting the growing importance of the space industry to the overall UK economy and choosing to get more involved, the government will be safeguarding this irreplaceable national asset.

In addition to the clear economic benefits of a renewed UK commitment to its local satellite industry, even a small increase in the number of its military satellites would also produce significant operational benefits to the country. The House of Commons 2007 *Space Policy* acknowledges that 'the UK's traditional dependence upon space data from the United States could be reduced if the UK had an independent small satellite capability'. This view is reflected in a report from QinetiQ, which claims that 'a constellation of three or four TopSat satellites could image almost any point on the earth at least once a day, subject to cloud conditions, opening up the potential for quick response imagery which is extremely cost effective to deliver'.[125] At a price of £14 million each, it would not be impractical for the Government to purchase more (although it is important to bear in mind that this cost represents only the satellite and does not include launch or operational costs).

The UK has wisely prioritised its efforts thus far into a modest number of imagery and communications satellites, but as the costs of technology continues to decrease it is realistic to predict that in the near future the country should be able to afford a realistic expansion of its presence in space. In addition to more imagery satellites like TopSat, examples of this might include the addition of synthetic-aperture radar (SAR) or infared (IR) to its imaging capabilities, or possibly even launching ELINT, SIGINT, or COMINT satellites. Additional communication satellites would help as well, especially considering that demand for bandwidth is only expected to increase as the country purchases more UAVs that

are dependent on satellites for control and imagery dissemination. Increasing its military presence in space would 'break the total dependence on foreign satellite intelligence'[126] the UK suffers from and help the country maintain sovereignty over its own capabilities and courses of action. Such an increase will also be necessary if the country is to retain diplomatic leverage in resolving potential future conflicts regarding space.

A RAF Reaper at Kandahar Airfield in Afghanistan.

Become an Integral Part of US Operationally Responsive Space

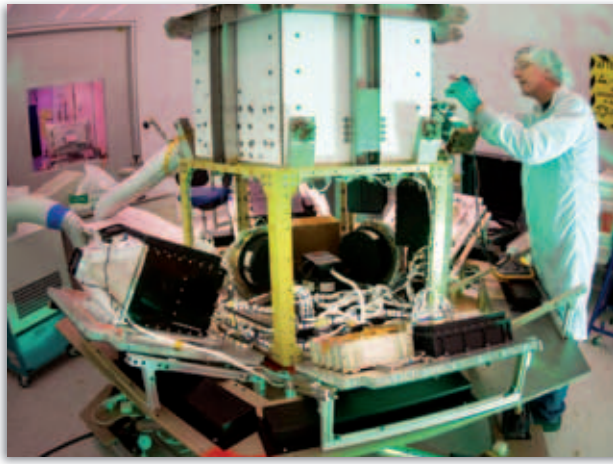
The importance of the survival of the UK's independent and financially sound micro-satellite industry to the national security becomes even more evident when placed in context with the growing vulnerabilities to space-based capabilities. The UK should explore options to protect not only its own access to national space assets, but help to ensure that its ally of choice, the US, retains access to theirs. At present, there is no better way for the country to do this than by becoming directly involved in the US Operationally Responsive Space (ORS) project. The DoD has succinctly defined ORS as 'assured space power focused on timely satisfaction of the Joint Force Commander's needs'.[127] As such, the goal of the ORS project is to seek out methods ' to improve the responsiveness of space capabilities to meet national security requirements'.[128]

Achieving the full spectrum of ORS will require the US to deliver capabilities across three separate tiers, which include keeping abreast of space technological and operational innovations (Tier 1), rapidly expanding or adapting its existing space capabilities as required to meet emerging operational needs (Tier 2), and responding in a timely manner should such critical space capabilities be suddenly denied (Tier 3).[129] Satisfying unexpected spikes in demand or gaps in coverage will be an important aspect of ORS, but the growing concern now is developing the ability to respond rapidly to both kinetic and non-kinetic adversarial space denial attacks. Responses to non-kinetic attacks are an integral part of ORS, and US capabilities in this area are classified. The recent USAF attempts at the creation of a separate US Cyber Command is one indication of how seriously the military is taking the emerging non-kinetic threats to its space-based assets, ground control centres,and communication links. Reponses to kinetic attacks, however, will likely require the US to physically replace its targeted satellites in a timely manner - an ability it lacks.[130] In order to meet these Tier 3 requirements the US is pursuing the development of 'complementary, more affordable, small satellite/ launch vehicle combinations and associated ground systems that can be deployed in operationally relevant timeframes'.[131]

Tier 3 ORS requirements will require the US to launch off the shelf

satellites quickly (with timetables ranging anywhere from less than a year to within a few hours of the demand being identified) and at a low cost (less than $20-$25 million for the entire package, including launch, payload, and initial operational costs).[132] Dr James Wertz, president of Microcosm and general chairman of the first five Responsive Space Conferences, argues that such technology has existed for over 20 years, and that the British company SSTL has been leading the world in terms of producing both rapid (typically launching satellites with technology less than a year old) and cost-effective solutions (building both communications and observation satellites at costs less than $10 million).[133] Speaking of the US's lack of progress in this field, he laments that 'if we can't do much better for $20-25 million with today's technology than what the British did a decade ago for $10 million, we certainly can't claim to be a technology leader in space'.[134] He also points out that other space powers may be marching ahead of the US in terms of ORS, with the Russians claiming to have possessed the capability 'for years' and the Chinese having recently announced the near-term goal of being able to launch satellites within a few hours of demand.[135]

The US is working on satellite designs that will meet the demanding time and expense requirements of ORS. The most recent design to reach completion is Raytheon's TacSat-3, which is the latest in a USAF series designed 'to help demonstrate the feasibility of the "responsive-space" concept', according to Raytheon Vice President Brian Arnold.[136] The challenge to Raytheon will be to build the launch-on-demand satellite, which consists of, off the shelf components, within a 15 month timetable and at a cost not to exceed $15 million. According to Arnold, the intent of the project is to develop a satellite that can be kept in storage and launched on demand within three to seven days in order to meet the requests of field commanders.



Martin Leahy performs voltage and continuity tests on a tactical satellite, known as Tactical Satellite-3, at the Space Vehicle Directorate at the Air Force Research Laboratory, Kirtland Air Force Base, N.M.

The US was able to create the first TacSat satellite, which was launched in 2007, in 12 months at a cost for less than $10 million.[138] Despite this success, however, a review conducted by the US Government Accountability Office (GAO) concluded that the challenges of providing responsive and tactical space capabilities to the warfighter are being hindered by the lack of a low-cost, small launch capability in addition to 'limited collaboration between the science and technology and the acquisition communities - as well as the acquisition community's tendency to expand requirements after program start'.[139] Even though the DoD has

TacSat-3 Launches from NASA's Wallops Flight Facility on May 19, 2009.

heavily invested in space assets for more than two decades, the report concludes that it has been 'challenged to deliver its major space acquisitions quickly and within estimated costs'.[140] The good news according to the report, however, is that the ultimate success of the programme could create 'opportunities for small, innovative companies to compete for DoD contracts and thereby increase competition and broaden the space industrial base'.[141] This could have important corollary benefits to the UK satellite industry as well.

The importance of ORS to the US, as well as to those allies like the UK with whom the US shares the benefits of its space-based capabilities, should not be underestimated. On April 28, 2008, the US Deputy Secretary of Defence approved the US Implementation Plan for ORS, which directs the military to 'allocate billets and assign personnel to fully staff the ORS Office' in order to meet the demands of 'on-demand space support, augmentation or reconstitution'.[142] One of the missions of the office will be to 'leverage interactions across a broad range of government partners in the United States and with our allies',[143] although of note to the UK is that nowhere in the 'staffing' or 'way ahead' section of the plan is there any mention of the need to involve their allies in the planning or implementation process. The official creation of an ORS Office in the US indicates that the country is no longer just acknowledging the need to improve the responsiveness of their space-based capabilities, but is now moving swiftly forward in order to achieve full operational status in the near future. If the UK chooses not to become fully engaged in ORS soon, it will become increasingly more difficult for it to rise above its present status as a passive, non-contributory participant in the programme.

Now is the time for the UK to get more involved. Even though the concept of ORS is not new, the US project is still in its early stages and at present there remain genuine opportunities for the UK to join in partnership with the US and become an integral part of the team that will make ORS a reality. Just as the UK appears to be headed in the right direction with regards to the development of a permanent cadre of space personnel, there is evidence that the country is beginning to take ORS more seriously as well. Official UK publications are talking more and more about the importance of ORS to the country's security.

At a minimum, the UK should have exchange officers directly involved in the ORS Office in order to contribute to its success, as well as keeping the MoD informed of developments. The presence of UK space expertise will contribute to the US's transition

from the initial to the full operational stages of ORS. In addition to getting more of its uniformed personnel involved in the US ORS project, the UK is also in a unique position to offer its ally of choice technologically advanced and cost-effective solutions to at least some of its ORS challenges. As a world leader in micro-satellite technology, the country is perfectly suited to satisfy the small satellite requirements of ORS. Speaking of the potential value of utilising existing expendable launch vehicles as opposed to the creation of a new Space Operational Vehicle (SOV), USAF Lt. Col Kendall Brown argues that 'failure to meet low-cost goals

Computer graphic of Lockheed Martin X-33 Reusable Launch Vehicle. For a variety of reasons X-33 was cancelled in February 2001.

and the detrimental effect of cost overruns and schedule delays will surely doom the ORS program, especially in light of strains on the Air Force budget caused by aircraft-recapitalization needs'.[144] The same can be said of the US relying exclusively on its own resources, industries, and expertise in order to meet the corresponding satellite development requirements of ORS.

SSTL has already demonstrated its ability to produce reduced cost, rapid-response satellites tailored to meet its customers' needs. The modular design of its Geostationery Minisatellite Platform (GMP), which was used in the development of ESA's first GIOVE (Galileo In-Orbit Validation Element) satellite, is a perfect example of how the company is rapidly approaching the technological expertise necessary to meet the more demanding response time and reduced cost requirements of ORS.[145] GMP was supported through the MOSAIC Small Satellite Initiative of the BNSC,[146] demonstrating that the partnership between UK's government and industry is proven and remains ready to meet the demands of future projects. As such, the government is perfectly poised to renew its partnership with industry.

In addition to helping its ally of choice, becoming an essential part of US ORS would also produce significant military, political and economic benefits to the UK itself. According to the *FASOC*, the ISTAR requirements of its own forces demand that the Joint Commander 'be able to call upon operationally responsive air and space-based sensor systems to provide specific intelligence needs'.[147] The document further recognises the political benefits of ORS as it offers 'significant potential . . . for influence with allies as the UK could offer a national and complementary space capability'.[148] Securing ORS satellite contracts would help the country retain 'sovereignty over key skills in military satellite technology'[149] and ensure the future vitality of its local satellite industry, which will produce significant benefits to the wider UK economy. Creating an effective ORS programme would also safeguard

the tremendous advantages access to space provides to an ever expanding portion of the UK economy. Joining with the US to make ORS a reality would greatly enhance the RAF's vision of remaining 'a world-class Air Force and the partner of choice for the United States Air Force'.[150]

Conclusion

Assured *access* to space is vital to the security and prosperity of the UK. The tremendous benefits provided by space-based capabilities, however, have also created certain vulnerabilities that potentially undermine the security of the entire nation. These vulnerabilities are not unique to the UK, but the country's decision to rely ever more heavily on the US to provide it with access to space-based capabilities, combined with the relative decline in the UK's space presence, carries with it a potentially negative impact to future UK security and autonomy. The first tenet of the UK Defence Vision is to 'defend the UK and its interests'.[151] *The National Security Strategy for the United Kingdom*, published in March of 2008, repeats this objective by unambiguously stating that 'providing security for the nation and for its citizens remains the most important responsibility of government.'[152] Much more needs to be done in terms of space-based capability to ensure this security, although to suggest that the UK should significantly increase its space budget at a time when it is struggling to sustain its present level of military commitments throughout the world - let alone prepare its personnel and *terrestrial*-based equipment for possible future conflicts - is entirely unrealistic and irresponsible as it would distract the country from near-term, affordable solutions that are within its current grasp. Future UK security and autonomy are likely to be adversely effected if the development of its expertise, infrastructure and capabilities remain a low priority. The country should recommit itself to its Defence Vision and National Security Strategy by creating a permanent cadre of military space experts, recommitting to the future economic vitality of its local satellite industry, and becoming a founding and integral part of the team that will make ORS a reality. The lead times and costs associated with this future expertise, prosperity and capability require the UK to make these important decisions today in order not only to remain a 'First Division' force for good in the world, but more importantly to ensure the very security of its own people.

Bibliography

Books

Alves, Pericles Gassparin (ed.), *Evolving Trends in the Dual Use of Satellites* (New York: United Nations, 1996).

Boot, Max, *War Made New* (New York: Gotham Books, 2006).

Dolman, Everett Carl, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002).

Durch, William J., *National Interests and the Military Use of Space* (Cambridge, Mass: Ballinger, 1984).

Gray, Colin A., *Another Bloody Century* (London: Orion Books, 2005).

Hall, R. Cargill and Neufeld, Jacob (eds.), *The US Air Force in Space: 1945 to the Twenty-First Century* (Washington, DC: USAF, 1998).

Handberg, Roger, *Seeking New World Vistas: The Militarization of Space* (Westport: Praeger, 2000).

Harvey, Brian, *Europe's Space Programme: To Ariane and Beyond* (Chichester, Praxis Publishing, 2003).

Hill, C.N., *A Vertical Empire: The History of the UK Rocket and Space Programme, 1950-1971* (London: Imperial College Press, 2001).

Johnson-Freese, Joan, *Space as a Strategic Asset* (New York: Columbia University Press, 2007).

Khalizad, Zalmay and Shapiro, Jeremy (eds.), *Strategic Apraisal: United States Air and Space Power in the 21st Century* (Santa Monica, CA: Rand Corporation, 2001).

Klein, John J., *Space Warefare: Strategy, Principles and Policy* (London: Routledge, 2006).

Lambakis, Steven, *On the Edge of Earth: the Future of American Space Power* (Lexington, KY: The University Press of Kentucky, 2001).

Lambright, W. Henry (ed.), *Space Policy in the Twenty-First Century* (Baltimore, MD: John Hopkins University Press, 2002).

Monaghan, David, *The Falklands War: Myth and Countermyth* (London: Macmillan Press Ltd).

O'Hanlon, Michael E., *Neither Star Wars nor Sanctuary: Constraining the Military Uses of Space* (Washington, DC: Brookings Institution Press, 2004).

Postnote, 'Military Uses of Space', Parliamentary Office of Science and Technology, Number 273, December 2006.

Prior, Annie (ed.), *Britain's Aviation Heritage, Celebrating 90 Years of the Royal Air Force* (London: St. James House, 2008).

Royal United Services Institute for Defence and Security Studies, *The Impact of Space upon Military Operations, RUSI Conference, 12-13 June 2003* (London: RUSI, 2003).

Snow, Peter and Dan. *The World's Greatest Twentieth Century Battlefields* (UK: BBC Books, 2007).

Spires, David N., *Beyond Horizons: A Half Century of Air Force Space Leadership* (Washington D.C.: U.S. Government Printing Office, 1998).

Spires, David N., *Orbital Futures: Selected Documents in Air Force Space History Volume I and II* (Peterson AFB, CO: US Air Force Space Command, 2004).

Temple, L. Parker, *Shades of Gray: National Security and the Evolution of Space Reconnaissance* (Reston, VA: American Institute of Aeronautics and Astronautics, 2005).

Till, Geoffrey, *Seapower* (London: Frank Cass, 2004).

Walker, James and Hooper, James T., *Space Warriors: The Army Space Support Team* (Washington, DC: US Government Printing Office, 2004).

Wirbel, Loring, *Star Wars: US Tools of Space Supremacy* (London: Pluto Press, 2003).

Wynne, Michael W., *Implementation Plan for Operationally Responsive Space* (Washington D.C.: Department of Defence, 2008).

Pamphlets

Carey, Steven D., *An Executive Guide to Space: A Starting Point for Understanding Space in the New*

Millennium (Santa Monica, CA: Rand Corporation, 2000).

EADS Space, *Case4Space Summary Report* (Hertfordshire, UK: EADS Space, 2006).

Federation of American Scientists, *Ensuring America's Security: Report of the FAS Panel on Weapons in Space* (Washington, DC: Federation of American Scientists, 2004).

Gibson, Robert D., *Space Power: The Revolution in Military Affairs* (Carlisle Barracks, PA: Army War College, 2001).

Krepon, Michael and Clary, Christopher, *Space Assurance or Space Dominance? The Case Against Weaponizing Space* (Washington, DC: The Henry L. Stimson Centre, 2003).

Silvestri, Stefano, 'Space and security policy in Europe', European Union Institute for Security Studies, 2003.

United States Government Accountability Office, *DoD Needs a Department wide Strategy for Pursuing Low-Cost, Responsive Tactical Space Capabilities* (Washington D.C.: US Government Accountability Office, 2006).

Articles

Clarke, Michael, 'The Political Context of Air Power in the United Kingdom', in Gray, Peter W. (ed.), *British Air Power* (London: The Stationery Office, 2003), pp.1-20.

Cohen, Eliot, 'Technology and Warfare', in Baylis, John (ed.), *Strategy in the Contemporary World* (Oxford: Oxford University Press, 2007), 141-159.

Fredriksson, Brian E., 'Space Power in Joint Operations: Evolving Concepts', *Air & Space Power Journal*, Vol. 18, No. 2, Summer 2004, pp.85-95.

Gates, David, 'Air Power: The Instrument of Choice?', in Gray, Peter W. (ed.), *Air Power 21: Challenges for the New Century* (London: The Stationery Office, 2000), pp.23-39.

Gleason, Michael P., 'European Union Space Initiatives: The Political Will for Increasing European Space Power', *Astropolitics*, Vol. 4, No. 1, Spring 2006, pp.7-41.

Goulter, Christina, 'Air Power and Expeditionary Warfare', in Gray, Peter (ed.), *Air Power 21: Challenges for the New Century* (London: The Stationery Office, 2000), pp.183-207.

Grant, Rebecca, 'There When it Counts', *Air Force Magazine*, Vol. 90, No. 12, December 2007, pp.70-73.

Grier, Peter, 'The Combination that Worked: CENTCOM's Franks Says Air and Space Power have been Pivotal in Afghanistan', *Air Force Magazine*, Vol. 85, No. 4, April 2002, pp.30-32.

Harter, Lt Col, Mark E., 'Ten Propositions Regarding Space Power: The Dawn of a Space Force', *Air & Space Power Journal*, Vol. 20, No. 2, Summer 2006, pp.64-78.

Hyten, John and Uy, Robert, 'Moral and Ethical Decisions Regarding Space Warfare', *Air & Space Power Journal*, Vol. 18, No. 2, Summer 2004, pp.51-60.

Nicoll, Alexander (ed.), 'Space security, growing dependence brings vulnerability', *Space Security*, Vol. 14, Issue 03, 3 April 2008, pp.1-2.

O'Grady, Jeremy (ed.), 'The battle for the Arctic', *The Week*, 26 April 2008, p.11.

Tellis, Ashley J., 'China's Military Space Strategy', *Survival*, Vol. 49, No. 3, Autumn 2007, pp.41-72.

Tellis, Ashley J., 'Don't Panic About Space Weapons', *Wall Street Journal*, 22 February 2008, p.A15.

Dissertations and Research Papers

Davies, Philip (et. al.), 'A Modular Design for Rapid-Response Relecons and Navigation Missions', AIAA 2nd Responsive Space Conference, Los Angeles, CA, 19-22 April 2004.

Janicik, Jeffrey, 'Implementing Standard Microsatelllites for Responsive Space', AIAA 1st Responsive Space Conference, Redondo Beach, CA, 1-3 April 2003.

Harper, S.A., 'What is Meant by Harmonisation and What are the Implications for the RAF?', *Royal Air Force Air Power Review*, Vol. 11, Number 1, Spring 2008, pp.70-105.

Presley, M.A. 'Challenges to American Military and Economic Dominance in Space', Dissertation Thesis (University of Cambridge Centre of International Studies, 2007).

Reuter, Jonathan, 'A Worldwide Desire for the Peaceful Use of Space Did Not Prevent its Militarization. Will Moral, Ethical and Legal Arguments Prevent its Weaponization?' Defence Research Paper (JSCSC, 2007).

Web Pages

Amos, Jonathan, 'British Skynet satellite launched', BBC News, 12 March 2007, **http://news.bbc.co.uk/1/hi/sci/tech/6434773.stm**, accessed 11 May 2009.

Antarctic Connection, 'The International Geophysical Year (1957-1958)', **http://www.antarcticconnection.com/antarctic/science/igy_research.shtml**, accessed 11 May 2009.

Arianespace, Launch Status, **http://www.arianespace.com/site/launchstatus/status_sub_index.html**, accessed 20 May 2008.

BBC News, 'EADS seeks Surrey Satellite deal', 7 April 2008, **http://surrey-satellite.feed24.com/go/52217831**, accessed 17 May 2008.

BBC News, 'Russia plants flag under N Pole', 2 August 2007, **http://news.bbc.co.uk/1/hi/world/europe/6927395.stm**, accessed 11 May 2009.

British National Space Centre (BNSC), 'Our Planet, Mosaic', **http://www.bnsc.gov.uk/content.aspx?nid=5685**, accessed 11 May 2009.

Brown, Kendall K., 'Is Operationally Responsive Space the future of access to space for the US Air Force?', *Air & Space Power Journal*, Summer 2006, **http://www.airpower.maxwell.af.mil/airchronicles/apj/apj06/sum06/brown.html**, accessed 26 May 2008.

De Selding, Peter B., 'Astrium's Assurances Sealed Deal for SSTL Acquisition', *Space News Business Report*, 14 April 2008, **http://www.space.com/businesstechnology/080414-busmon-astrium-sstl.html**, accessed 17 May 2008.

Dinerman, Taylor, 'Future British Military Space Policy', *The Space Review*, 12 April 2004, **http://www.thespacereview.com/article/129/1**, accessed 11 May, 2009.

EUMETSAT, **http://www.eumetsat.int/Home/index.htm**, accessed 11 May 2009.

Federation of American Scientists,

Ballistic Missile Early Warning System (BMEWS), **http://www.fas.org/spp/military/program/nssrm/initiatives/bmews.html**, accessed 11 May 2009.

Garamone, Jim, 'CENTCOM charts Operation Iraqi Freedom Progress' American Forces Press Service, 25 March 2003, **http://www.defenselink.mil/news/newsarticle.aspx?id=29230**, accessed 3 May 2008.

International Telecommunication Union, Home Page, **http://www.itu.int/net/about/mission.aspx**, accessed 11 May 2009.

Morris, Chris, 'EU Rebuffs US over Satellite Project', BBC News, 8 March 2002, **http://news.bbc.co.uk/1/hi/world/europe/1862779.stm**, accessed 11 May 2009.

QinetiQ, 'New era of low-cost Earth observation dawns as first images received from TopSat', 19 December 2005, **http://www.qinetiq.com/home/newsroom/news_releases_homepage/2005/4th_quarter/TopSat_first_image.html**, accessed 11 May 2009.

Russo, Arturo, 'Launching the European Telecommunications Satellite Programme', *Beyond the Ionosphere: The Development of Satellite Communications*, NASA History Series, SP-4217 (Washington D.C.: NASA History Office, 1997), **http://history.nasa.gov/SP-4217/ch10.htm**, accessed 11 May 2009.

Surrey Satellite Technology, Ltd., 'Management and Ownership', **http://www.sstl.co.uk/About_SSTL/Management_and_Ownership**, accessed 11 May 2009.

Telegraph.co.uk, 'British hackers attack MoD satellite', 4 March 1999, **http://www.telegraph.co.uk/connected/main.jhtml?xml=/connected/1999/03/04/ecnhack04.xml**, accessed 4 May 2008.

United Press International, 'On-demand intel satellite sensor delivered', 12 June 2007, **http://www.upi.com/Security_Terrorism/Briefing/2007/06/12/ondemand_intel_satellite_sensor_delivered/3096/**, accessed 11 May 2009.

Vandenberg Air Force Base, US Air Force Fact Sheet, 614th Space Operations Group, **http://www.vandenberg.af.mil/library/factsheets/factsheet.asp?id=4687**, accessed 11 May 2009.

Wertz, James R., 'It's time to get our ORS in gear', *The Space Review*, 7 January 2008, **http://www.thespacereview.com/article/1032/1**, accessed 11 May 2009.

The White House, *The National Security Strategy of the United States of America*, March 2006, **http://www.whitehouse.gov/nsc/nss/2006/nss2006.pdf**, accessed 22 May 2008.

XE.com Historic Currency Rates Tables, **http://www.xe.com/ict/**, accessed 27 May 2008.

Official Publications

British National Space Centre, *UK Space Activities 2007* (London: Crown, 2007).

British National Space Centre, *UK Civil Space Strategy: 2008-2012 and Beyond* (London: Crown, 2008).

Cabinet Office, *The National Security Strategy of the United Kingdom: Security in an Interdependent World* (London: The Stationery Office, 2008).

Department of Defense, *Plan for*

Operationally Responsive Space: A Report to Congressional Defense Committees (Washington D.C.: National Security Space Office, 2007).

Development, Concepts, and Doctrine Centre (DCDC), *Joint Doctrine Publication 0-01.1, United Kingdom Glossary of Joint and Multinational Terms and Definitions* (London: The Stationery Office, 2006).

Development, Concepts, and Doctrine Centre (DCDC), *The DCDC Global Strategic Trends Programme 2007-2036* (London: The Stationery Office, 2007).

Directorate of the Air Staff, *AP 3000: British Air Power Doctrine, Third Edition* (London: The Stationery Office, 1999).

Great Britain, The Secretary of State for Defence, *Delivering Security in a Changing Word, Defence White Paper* (London: The Stationery Office, 2003).

Great Britain, The Secretary of State for Defence, *Delivering Security in a Changing World, Future Capabilities* (London: The Stationery Office, 2004).

Great Britain, The Secretary of State for Defence, *Delivering Security in a Changing World, Supporting Essays* (London: The Stationery Office, 2003).

Great Britain, The Secretary of State for Defence, *The Strategic Defence Review* (London: The Stationery Office, 1998).

Great Britain, The Secretary of State for Defence, *The Strategic Defence Review: A New Chapter* (London: The Stationery Office, 2002).

Great Britain, The Secretary of State for Defence, *The Strategic Defence Review: A New Chapter, Public Discussion Paper* (London: The Stationery Office, 2002).

Great Britain, The Secretary of State for Defence, *The Strategic Defence Review, Supporting Essays* (London: The Stationery Office, 1998).

Great Britain, The Secretary of State for Defence, *The Strategic Defence Review: A New Chapter, Supporting Information & Analysis* (London: The Stationery Office, 2002).

House of Commons Defence Committee, *Delivering Front Line Capability to the RAF, Third Report of Session 2005-06* (London: The Stationery Office, 2006).

House of Commons Defence Committee, *Ministry of Defence Annual Report and Accounts 2006-07* (London: The Stationery Office, 2008).

House of Commons Science and Technology Committee, *2007: A Space Policy: Government Response to the Committee's Seventh Report of Session 2006-07, Volume I* (London: The Stationery Office, 2007).

House of Commons Science and Technology Committee, *2007: A Space Policy: Government Response to the Committee's Seventh Report of Session 2006-07, Volume II* (London: The Stationery Office, 2007).

House of Commons Science and Technology Committee, *2007: A Space Policy, Seventh Report of Session 2006-07* (London: The Stationery Office, 2007).

Royal Air Force, *Delivering Effect- the Utility of Airpower, A Think Piece by DAS* (London: Directorate of Air Staff, Draft).

Royal Air Force, *Future Air and Space Operational Concept* (London: Directorate of Air Staff, 2005).

Royal Air Force, *Future Air and Space Operational Concept* (London:

Directorate of Air Staff, CDEC Draft for Publication, 2008).

Royal Air Force, *Future Air and Space Operational Concept* (London: Directorate of Air Staff, CDEC Early Circulation Draft, 2007).

Royal Air Force, *Royal Air Force Strategy 2006* (London: Directorate of Air Staff, 2006).

United States Air Force, *Air Force Strategic Plan 2006-2008* (Washington D.C.: US Government Printing Office, 2006).

Notes

[1]Dolman, Everett Carl, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002), p.8.
[2]Till, Geoffrey, Seapower (London: Frank Cass, 2004), p.17.
[3]House of Commons Science and Technology Committee, *2007: A Space Policy, Seventh Report of Session 2006-07* (London: The Stationery Office, 2007), p.9.
[4]Klein, John J., *Space Warfare: Strategy, Principles and Policy* (London: Routledge, 2006), p.155.
[5]ibid., p.116.
[6]*Royal Air Force Strategy*, op.cit., p.1.
[7]Postnote, 'Military Uses of Space', Parliamentary Office of Science and Technology, Number 273, December 2006, pp.3-4.
[8]Nicoll, Alexander (ed.), 'Space security, growing dependence brings vulnerability', *Space Security* Vol. 14, Issue 03, 3 April 2008, p.1.
[9]Telegraph.co.uk, 'British hackers attack MoD satellite', 4 March 1999. Available from: **http://www.telegraph.co.uk/connected/main.jhtml?xml=/connected/1999/03/04/ecnhack04.xml** [Accessed 4 May 2008]
[10]Garamone, Jim, 'CENTCOM Charts Operation Iraqi Freedom Progress', American Forces Press Service, 25 March 2003. Available from: **http://www.defenselink.mil/news/newsarticle.aspx?id=29230** [Accessed 3 May 2008]
[11]Nicoll, op.cit., p.1.
[12]Gray, Colin A., *Another Bloody Century* (London: Orion Books, 2005), p.291.
[13]Royal Air Force, *Future Air and Space Operational Concept* (London: Directorate of Air Staff, 2005), p.2.
[14]*FASOC* (CDEC 2008 Draft for Publication), op.cit., p.13.
[15]*Royal Air Force Strategy*, op.cit., p.6.
[16]House of Commons Science and Technology Committee, op.cit., p.10.
[17]Royal Air Force, *Future Air and Space Operational Concept* (London: Directorate of Air Staff, CDEC Early Circulation Draft, 2007), p.2.
[18]ibid.
[19]XE.com Historic Currency Rates Tables, Available from: **http://www.xe.com/ict/** [Accessed 27 May 2008]
[20]*2007: A Space Policy*, op.cit., p.11.
[21]Johnson-Freese, Joan, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), p.188.
[22]ibid.
[23]Silvestri, Stefano, 'Space and security policy in Europe', European Union Institute for Security Studies, p.4.
[24]Royal Air Force, *Royal Air Force Strategy*, (London: Directorate of Air Staff, 2006), p.12.
[25]Boot, Max, *War Made New* (New York: Gotham Books, 2006), p.426.
[26]Prior, Annie (ed.), *Britain's Aviation Heritage, Celebrating 90 Years of the Royal Air Force* (London: St. James House, 2008), p.67.
[27]BBC News, 'EADS seeks Surrey Satellite deal', 7 April 2008. Available from http://surrey-satellite.feed24.com/go/52217831 [Accessed 17 May 2008]

[28]Dinerman, Taylor, 'Future British Military Space Policy', The Space Review, 12 April 2004. Available from: **http://www.thespacereview.com/article/129/1** [Accessed 10 May 2008]
[29]Prior, op.cit., p.67.
[30]Johnson-Freese, op.cit., p.67.
[31]Prior, op.cit., p.65.
[32]Amos, Jonathan, 'British Skynet satellite launched' BBC News, 12 March 2007. Available from: **http://news.bbc.co.uk/1/hi/sci/tech/6434773.stm** [Accessed 17 May 2008]
[33]Prior, op.cit., p.65.
[34]Amos, op.cit.
[35]Arianespace, Launch Status. Available from: **http://www.arianespace.com/site/launchstatus/status_sub_index.html** [Accessed 20 May 2008]
[36]QinetiQ, 'New era of low-cost Earth observation dawns as first images received from TopSat', 19 December 2005. Available from: **http://www.qinetiq.com/home/newsroom/news_release_homepage/2005/4th_quarter/TopSat_first_image.html** [Accessed 17 May 2008]
[37]Federation of American Scientists, Ballistic Missile Early Warning System (BMEWS). Available from: **http://www.fas.org/spp/military/program/nssm/initiatives/bmews.html** [Accessed 17 May 2008]
[38]Johnson-Freese, op.cit., p.184-5.
[39]*Royal Air Force Strategy*, op.cit., p.12.
[40]ibid.
[41]ibid.
[42]Great Britain, The Secretary of State for Defence, *The Strategic Defence Review: A New Chapter* (London: The Stationery Office, 1998), p.12.
[43]Great Britain, The Secretary of State for Defence, *The Strategic Defence Review: A New Chapter, Supporting Information & Analysis* (London: The Stationery Office, 2002), p.20.
[44]ibid.
[45]Great Britain, The Secretary of State for Defence, *Delivering Security in a Changing World, Defence White Paper* (London: The Stationery Office, 2003), p.7.
[46]ibid., p.8.
[47]ibid., p.7.
[48]Postnote, 'Military Uses of Space', Parliamentary Office of Science and Technology, Number 273, December 2006, p.1.
[49]*FASOC* (CDEC 2008 Draft for Publication), op.cit., p.1.
[50]Royal Air Force Strategy, p.5.
[51]ibid., p.1.
[52]Goulter, Christina, 'Air Power and Expeditionary Warfare', in Gray, Peter (ed.), *Air Power 21: Challenges for the New Century* (London: The Stationery Office, 2000), p.207.
[53]ibid.
[54]Clarke, Michael, 'The Political Context of Air Power in the United Kingdom', in Gray, Peter W. (ed.), *British Air Power* (London: The Stationery Office, 2003), p.7.
[55]ibid.
[56]Snow, Peter and Dan, *The World's Greatest Twentieth Century Battlefields* (UK: BBC Books, 2007), p.219.
[57]Silvestri, op.cit., p.29.
[58]Postnote, op.cit., p.2.
[59]ibid., p.3.
[60]Morris, Chris, 'EU rebuffs US over satellite project', BBC News, 8 March 2002. Available from: **http://news.bbc.co.uk/1/hi/world/europe/1862779.stm.** [Accessed 26 April 2008]
[61]ibid.
[62]Johnson-Freese, op.cit., p.171.
[63]*FASOC* (CDEC 2008 Draft for Publication), op.cit., p.7.
[64]The White House, *The National Security Strategy of the United States of America*, March 2006, pp.38-39. Available from: **http://www.**

whitehouse.gov/nsc/nss/2006/nss2006.pdf [Accessed 20 May 2008]
[65]Strategic Defence Review, op.cit., p.53.
[66]ibid.
[67]Dolman, op.cit., p.88.
[68]ibid., p.129.
[69]ibid., p.64.
[70]ibid.
[71]ibid., p.134.
[72]ibid.
[73]International Telecommunication Union, Home Page. Available from: **http://www.itu.int/neet/about/mission.aspx** [Accessed 26 April 2008]
[74]Klein, op.cit., p.119.
[75]ibid.
[76]Dolman, op.cit., p.120.
[77]Antarctic Connection, 'The International Geophysical Year (1957-1958)'. Available from: **http://www.antarcticconnection.com/antarctic/science/igy_research.shtml** [Accessed 4 May 2008]
[78]Dolman, op.cit., p.121.
[79]ibid.
[80]ibid.
[81]O'Grady, Jeremy (ed.), 'The battle for the Arctic', *TheWeek*, 26 April 2008, p.11.
[82]BBC News, 'Russia plants flag under N Pole', 2 April 2008. Available from: **http://news.bbc.co.uk/1/hi/world/europe/6927395.stm** [Accessed 4 May 2008]
[83]O'Grady, op.cit., p.11.
[84]BBC News, 'Russia plants flag under N Pole' op.cit.
[85]ibid.
[86]ibid.
[87]O'Grady, op.cit., p.11.
[88]ibid.
[89]Dolman, op.cit., p.130.
[90]Nicoll, op.cit. p.2.
[91]Klein, op.cit., p.118.
[92]Great Britain, *Delivering Security in a Changing World*, op.cit., p.20.
[93]Development, Concepts, and Doctrine Centre (DCDC), *The DCDC Global Strategic Trends Programme, 2007-2036* (London: the Stationery Office, 2007), p.66.
[94]*FASOC* (2005 Edition), op.cit., p.22.
[95]ibid.
[96]ibid.
[97]*FASOC* (CDEC 2008 Draft for Publication), op.cit., p.2.
[98]ibid., p.8.
[99]ibid., p.25.
[100]Vandenberg Air Force Base, US Air Force Fact Sheet, 614th Space Operations Group. Available from: **http://www.vandenberg.af.mil/library/factsheets/factsheet.asp?id=4687** [Accessed 15 May 2008]
[101]*FASOC* (CDEC 2008 Draft for Publication), op.cit., p.25.
[102]Cohen, Eliot, 'Technology and Warfare', in Baylis, John (ed.), *Strategy in the Contemporary World* (Oxford: Oxford University Press, 2007), p.157.
[103]Dinerman, op.cit.
[104]QinetiQ, op.cit.
[105]QinetiQ, op.cit.
[106]British National Space Centre (BNSC), 'Our Planet, Mosaic'. Available from: **http://www.bnsc.gov.uk/content.aspx?nid=5685** [Accessed 17 May 2008]
[107]ibid.
[108]De Selding, Peter B., 'Astrium's Assurances Sealed Deal for SSTL Acquisition' *Space News Business Report*, 14 April 2008. Available from: **http://www.space.com/businesstechnology/080414-busmon-astrium-sstl.html** [Accessed 17 May 2008]
[109]ibid.
[110]Surrey Satellite Technology, Ltd., 'Management and Ownership, **http://www.sstl.co.uk/About_SSTL/Management_and_Ownership** [Accessed 10 May, 2009]

[111]De Selding, op.cit.
[112]EADS Space, *Case4Space Summary Report* (Hertfordshire, UK: EADS Space, 2006), p.4.
[113]ibid., p.1.
[114]ibid., p.4.
[115]ibid., p.7.
[116]ibid., p.5.
[117]ibid., p.20.
[118]ibid., p.21.
[119]ibid.
[120]Postnote, op.cit., p.2.
[121]House of Commons Science and Technology Committee, op.cit., p.59.
[122]EADS Space, op.cit., p.21.
[123]British National Space Centre, *UK Civil Space Strategy: 2008-2012 and Beyond* (London: Crown, 2008), p.3.
[124]House of Commons Science and Technology Committee, op.cit., p.35.
[125]QuinetiQ, op.cit.
[126]EADS Space, op.cit., p.21.
[127]Department of Defense, *Plan for Operationally Responsive Space: A Report to Congressional Defense Committees* (Washington D.C.: National Security Space Office, 2007), p.2.
[128]ibid.
[129]*Plan for Operationally Responsive Space*, op.cit., p.2.
[130]Wertz, James R., 'It's time to get our ORS in gear', The Space Review, 7 January 2008. Available from **http://www.thespacereview.com/article/1032/1** [Accessed 25 May 2008]
[131]*Plan for Operationally Responsive Space*, op.cit., p.2.
[132]Wertz, op.cit.
[133]ibid.
[134]ibid.
[135]ibid.
[136]United Press International, 'On-Demand intel satellite sensor delivered', 12 June 2007. Available from: **http://www.upi.com/Security_Terrorism/Briefing/2007/06/12/ondemand_intel_satellite_sensor_delivered/3096/** [Accessed 27 May 2008]
[137]United Press International, op.cit.
[138]United States Government Accountability Office, *DoD Needs a Departmentwide Strategy for Pursuing Low-Cost, Responsive Tactical Space Capabilities* (Washington D.C.: US Government Accountability Office, 2006), p.1.
[139]ibid.
[140]ibid., p.20.
[141]ibid., p.20.
[142]Wynne, Michael, 'Implementation Plan for Operationally Responsive Space' (Washington D.C.: Department of Defence, 2008), p.1.
[143]ibid., p.2.
[144]Brown, Kendall, 'Is Operationally Responsive Space the future of access to space for the US Air Force?' *Air & Space Power Journal*, Summer 2006. Available from: **http://www.airpower.maxwell.af.mil/airchronicles/apj/apj/sum06/brown.html** [Accessed 26 May 2008]
[145]Davies, Philip (et. al.), 'A modular design for rapid-response telecons and navigation missions', AIAA 2nd Responsive Space Conference, Los Angeles, CA, 19-22 April 2004, p.2.
[146]ibid.
[147]*FASOC* (2005 Edition), p.11.
[148]ibid., p.4.
[149]EADS Space, op.cit., p.21.
[150]*Royal Air Force Strategy*, p.1.
[151]ibid., p.3.
[152]Cabinet Office, *The National Security Strategy of the United Kingdom, Security in an Interdependent World* (London: The Stationery Office, 2008), p.3.