

# THE STRATEGIC RATIONALE FOR BRITAIN IN SPACE

## ISSUES, OPPORTUNITIES AND CHALLENGES

JOHN B SHELDON

**Not only will space become an even more important domain of military capability in the future, it will be an increasingly crowded arena. Britain's space strategy has lagged behind those of its allies, with the UK reliant on foreign capability for mission-critical tasks such as satellite imagery and positioning. Despite the era of budget austerity, John B Sheldon argues that the time has come for a thorough rethink of British priorities in space.**

Many reading this might plausibly argue that now is not a good time for Britain to think about acquiring new satellites, or to be even rethinking its space policy and the assumptions that underpin it which might, in turn, conceivably lead to new acquisitions. After all, the findings of the recent National Security Strategy (NSS) and the Strategic Defence and Security Review (SDSR), as well as the wider austerity measures instituted across the whole of government, do not bode well for large government-funded projects.

Space power is 'the ability in peace, crisis, and war to exert prompt and sustained influence in or from space'.<sup>1</sup> Its relevance in modern statecraft is increasing – both in terms of numbers of actors and the deepening of its pervasiveness throughout most, if not all, functions of modern society.<sup>2</sup> Until recently, the United Kingdom maintained a low-key, almost utilitarian national space security policy and, in the opinion of this author, has not articulated a plausible and sustainable vision of what role space power might play in supporting foreign and defence policy aims, as well as its role in advancing and protecting British interests in general. This is despite the fact that the UK, like all developed

modern states, is highly dependent upon space power for everything from defence and foreign policy through to the day-to-day functioning of cellular telecommunications, financial transactions, logistics, transportation networks and other critical infrastructure.<sup>3</sup> One reason, perhaps, for this low-key policy approach and lack of vision is that the UK has relied so heavily on US space capabilities,<sup>4</sup> supplemented to a large degree by utilising European and commercial space systems as needed. The exception to this dependency, of course, is the Skynet military satellite communications system run for the Ministry of Defence (MoD) by Paradigm Secure Communications Ltd.<sup>5</sup>

This article makes the strategic case for more expansive British space power by defining the strategic attributes of space power and how they support, advance and defend British interests. The essay then offers some thoughts on assumptions about space for UK policy-makers to consider. The focus here is primarily on space and national security, though it must be noted that given the inherent dual-use nature of most space technologies, much of the ensuing discussion can apply to both civil and commercial space issues and technologies.

### Signs of Life?

Despite the new austerity measures and a hitherto lack of space policy vision (perhaps even seriousness), there are several signs that the UK is beginning to understand the vital role that space power plays in today's world. It is also increasingly recognising the advantages that it brings to those who seek to wield power in this domain, and the resulting British deficiencies and capability gaps.

First is the creation, by the previous government, of the UK Space Agency (UKSA) on 1 April 2010.<sup>6</sup> The creation of the UKSA, along with prior implementation of the UK Civil Space Strategy,<sup>7</sup> signals a policy shift that brings disparate space activities across numerous government departments and agencies under the umbrella of a single agency. So far the policy focus is on increasing space revenues exponentially over the next two decades,<sup>8</sup> a laudable goal that, if successful, should inevitably expand the UK's presence in space, and as a result will make space more strategically important in the eyes of policy-makers. The UKSA has just funded Surrey Satellite Technology Ltd to define a satellite project called TechDemoSat-1, which will provide a test-bed for a number of innovative sensors that might conceivably contribute to a decision



A window on the world: the International Space Station floats above the Earth's horizon. Space power provides innumerable terrestrial advantages. Courtesy of AP Photo/NASA.

on whether the UK requires its own high-resolution imaging satellite.<sup>9</sup> The creation of the UK Space Agency also separates UK military space from other government space activities, though it is understood that the MoD shall work with the UKSA for co-ordination purposes.<sup>10</sup> In any case the MoD stands to gain a great deal from technology programmes like TechDemoSat-1.

Second is an explicit recognition by senior military commanders that Britain's reliance on third parties (be they allies or commercial entities) for a large number of its space capabilities is not necessarily an optimum solution for UK space needs, and that the rapid growth in the number of actors in space poses both strategic opportunities and challenges. For example, in a speech earlier this year to the International Institute for Strategic Studies, Chief of the Air Staff Air Chief Marshal Sir Stephen Dalton argued that 'the extent to which the UK relies almost entirely on third party capabilities is a potential cause for concern'.<sup>11</sup> Recognising that the budget environment in the foreseeable future

will likely see the UK remain reliant on these third parties, Sir Stephen went on to say that, 'we should cast the net more widely in looking for partners, and also monitor the technological developments that may offer affordable space capabilities'.<sup>12</sup> What Sir Stephen refers to here is the UK reliance on third parties for its positioning, navigation and timing needs, space-based surveillance, reconnaissance and intelligence, and other capabilities.<sup>13</sup>

Lastly, a short passage toward the end of the SDSR that many readers of the document might have understandably skipped over (or not given much thought) provides another indication that thinking on national security and space is changing. The passage in question refers to a commitment by the government to devise:<sup>14</sup>

[A] National Space Security Policy which will coherently address all aspects, both military and civil, of the UK's dependence on space; assure access to space; help mitigate risks to national infrastructure; focus future

investment and research on national priorities, opportunities, and sovereign capability requirements; and encourage co-operation with UK industry and with international partners. Examples of these risks include the potential effects of interference, cyber attack, physical damage, and electromagnetic pulse (whether natural or deliberate) on satellites or their ground stations critical to our security and the economy.

The deliberations for this policy should be the basis for a fundamental rethink on the UK approach to a number of national security space issues. Such a re-examination should be based on an audit that provides an accurate picture of the extent to which national security is reliant upon space systems; a comprehensive risk assessment of who provides what satellite services and to what extent; and a fundamental understanding of the role and limits of space power in UK national security. Once understanding has been achieved on these key issues, policy-makers should then ask what the UK must absolutely

provide for itself in order to meet vital national security goals, and what can be left to allies and/or commercial entities, or a British contribution to an international partnership, for the rest. Allies of the UK, including the US, are facing or about to face similarly constrained budgets, and access to allied systems will increasingly depend upon what the UK can offer its partners in return. More often than not the quid pro quo required will be what Britain can contribute to a global space-based imaging capability, or space situational awareness, rather than the traditional bargaining chips of special forces or niche intelligence assets.

These shifts in space policy and thinking are critical if Britain is to take on a leading space power role appropriate to a power of its status, economic standing, global interests and ambitions. With the exception of space science, the UK lags well behind G8 and most G20 counterparts in terms of range and numbers of space capabilities at its disposal. This is not to suggest that prestige alone justifies large investments in what are ultimately expensive technology programmes – though prestige is often too lightly dismissed as a foreign policy tool. Rather, it would appear that British official thinking is beginning to understand that being the space laggard (which, to be frank, is the reputation it has earned abroad despite possessing a world-class space industry) is not only bad for economic competitiveness, but might also have significant national security implications as well.

While necessary, this shift in thinking is not a sufficient condition for truly significant policy change. Policy debates about space power often revolve around actual technology and its industrial and economic implications; this is fine if the policy aim is to prop up a struggling space industry in a tough global economy (ironically making many a country's so-called space policy in actual fact an extension of its industrial policy). But often lacking from these policy debates is an understanding of the geostrategic attributes of space power that, in turn, help make the strategic, rather than industrial or prestige, case for space.

### **Strategic Attributes of Space**

There are four geostrategic attributes of space power: first, space is the ultimate high ground; second, space provides global access; third, space allows global presence; and fourth, space enhances strategic depth. These four geostrategic attributes interact with each other to bring out the technological attributes of space power that include versatility, ubiquity, and permanent and continuous operation. When taken together, these attributes make a persuasive strategic case for space power as an instrument of state power. Wielded with these attributes in mind, space power is a critical component and enabler of diplomatic and economic power, as well as land, sea, air and cyber power, and so provides the state with a crucial strategic advantage.

### *The Ultimate High Ground*

Space has often been dubbed the 'ultimate high ground', a label that has almost become the *leitmotif* of space power. Obviously, the virtues of high ground predate the space age. Sun Tzu,<sup>15</sup> Jomini<sup>16</sup> and Clausewitz all advocated the utility of the high ground in war.<sup>17</sup> For space power, this means that a presence in Earth orbit confers several advantages: the ability to see a large number of approaching threats; certain types of space-based weapons (which, to be clear, is not necessarily advocated here); and a wider view of the Earth's surface.<sup>18</sup>

### *Global Access*

This geostrategic attribute of space power flows directly from the benefits derived from occupying the ultimate high ground of space. Essentially, through a combination of orbital mechanics, the Earth's rotation, a legal regime based on the 1967 Outer Space Treaty that denies any sovereign claims in space,<sup>19</sup> and continuing technological advances, satellites are able to visually access any point on the surface of the Earth. Access to a combination of government-owned and commercial imaging satellites, for example, makes timely images of just about any location around the world possible. For GPS and satellites in geosynchronous orbit – such as communications, meteorological and

early warning satellites – persistent and instantaneous global coverage is provided. This is of particular value in regions in which British forces are expected to operate where there may be poor or even non-existent infrastructure, or which are remote and otherwise inaccessible to terrestrial communications systems.<sup>20</sup> Equipped with a few basic technologies – a satellite telephone, GPS receiver or a laptop with internet access – anyone can access space power anywhere around the world.

### *Global Presence*

The third geostrategic attribute of space power is global presence, and this attribute is conditional upon the occupation of the orbital high ground and the exercise of global access. Operating a variety of satellites in different orbits confers a constant presence that sea and air power can provide only intermittently. Space power is always the 'first on the scene', be it satellite imagery of troop movements, development of an illicit nuclear weapons programme, or the detection of a heat plume of a launched ballistic missile. Space power provides a global set of eyes and ears for those able to wield it. The true extent of a state's access and presence from space, however, is the product of the range of its terrestrial power projection capabilities. A state's space power is only as useful as the extent of its diplomatic presence and networks, and the upper range limits of its land, sea and air power, as well as its ability to deploy and use ballistic missiles. Without such terrestrial capabilities, the attribute of global presence merely allows a country to passively watch events unfold without being able to actually shape or influence them. The UK still possesses power projection capabilities including a worldwide diplomatic and economic presence, and interests that can provide strategic meaning to the global presence afforded by space power. Indeed, so long as Britain possesses global interests and aspirations, it stands to benefit from the global presence attribute of space power.

### *Enhanced Strategic Depth*

The final geostrategic attribute provided by space is that of enhanced strategic

depth, and is directly related to the attributes described above of the ultimate high ground, global access and global presence. Essentially, space power can provide a global presence that can be turned into strategic depth – the ability to trade space for time. The type of strategic depth proposed here is one on the vertical flank that can augment, or even enhance, depth along the horizontal flank on Earth, and it can apply to states of varying geographical contexts. Satellites performing duties such as ballistic missile early warning, reconnaissance and signals intelligence are examples of space capabilities able to exploit this geostrategic attribute by providing early indications of a wide range of activity across the globe. Communications satellites can also exploit this attribute by providing a level of redundancy in complex terrestrial telecommunications infrastructure composed of coaxial, fibre-optic, microwave and radio links. For the UK, exploiting this attribute can contribute a great deal to the maritime security of the country, monitoring the proliferation of weapons of mass destruction, and the overall aim of the National Security Strategy, which is ‘to prevent conflict and avert threats beyond our shores’.<sup>21</sup>

These four geostrategic attributes, in turn, enable and enhance the following attributes that are provided by space technologies: versatility, ubiquity and continuous operation.

### *Versatility*

Most satellites are dual-use and able to provide simultaneous service to a wide variety of users. High-resolution imaging satellites can provide imagery for applications ranging from military planning and battle damage assessment, through to urban and environmental planning. Satellite navigation systems, such as GPS, are critical for the use of precision-guided munitions. Yet they can simultaneously provide positioning, navigation and timing data across the globe that is crucial to logistics, financial transactions and telecommunications. Given the constrained budgets likely for the foreseeable future, any proposed satellite programme that will require government funding will likely have

to prove its dual-use applicability across a range of policy functions. Outside of a long-term, existential threat to the UK that might conceivably require satellites for Britain’s national security apparatus’s sole use, a national space security policy will be co-ordinated very closely with the civil space policy in order to better acquire dual-use satellite systems.

### *Ubiquity*

The versatility of satellites, in conjunction with the global access and presence that space confers, leads to the attribute of ubiquity. By the time the armed forces, emergency services, diplomats or aid workers are on the scene, the satellite has been there all along and is waiting to be used. There are very few places on Earth, if any, where satellites cannot be accessed. In other words, space power is ubiquitous and this attribute can be leveraged by the UK for a large number of foreign, defence and economic policy interests.

### *Continuous Operation*

Lastly, satellites are always ‘on’ and in constant operation. Given that the average lifetime of a modern, Western-built communications satellite is anywhere from ten to fifteen years, this is an impressive feat; other satellite functions such as imaging and navigation also have long operational life expectancies in orbit. The reconnaissance satellite that captures critical intelligence imagery of the Iranian nuclear programme does not shut down once its orbit has left Iran behind. The same satellite will carry on capturing imagery of other targets as it orbits the globe, even if the intelligence gathered does not capture the newspaper headlines the following week. GPS is always available to use. The UK stands to benefit from the timely responsiveness of satellites across the spectrum of conflict, and in support of other policy interests.

These attributes suggest that space power is more than just the relaying of information from point-to-point through space. There is real strategic value to be gained from the purposeful and comprehensive use of space power that

in turn can only enhance and enable other, more traditional forms of state power. The practice of space power, however, does not take place outside of an international political context, and it is an overview of this context to which we next turn.

## **The Strategic Context of Space**

Far from being the pristine sanctuary espoused by some, space is a congested, contested, competitive and complex environment in which to operate.

### *Congestion*

Along with the established space powers of the United States, Russia, China, India, Japan and France, countries such as South Africa, the United Arab Emirates, Iran, Kazakhstan, Nigeria, Argentina, Brazil, Sweden, Italy and South Korea – to name but a selection – have all established space programmes and a presence in orbit. They are all able to take advantage of the strategic attributes of space. At present, there are at least fifty countries around the world that have established a space agency and developed and launched satellites, or are at least in the process of doing so.<sup>22</sup> Commercial interests and international organisations also operate their own satellites. Add to this the growing problem of space debris, and it becomes quickly apparent that space is not only congested, but also something of a mess, as illustrated by the collision of an Iridium satellite and a defunct Russian satellite over the Arctic Circle in early 2009.<sup>23</sup>

### *Contestation*

As well as being congested, space is often contested: states, and even non-state actors, attempt or actively deny, disrupt and interfere with the space systems of others. By far the most common form of disruption is jamming signals from satellites or hijacking the signal for another use. Examples abound, and include the jamming of Farsi-language television broadcasts into Iran from Europe;<sup>24</sup> Libya jamming the signals of a commercial communications satellite that was being used by dissidents to broadcast anti-regime propaganda;<sup>25</sup> and the outlawed religious group Falun

Gong jamming Chinese satellite signals during nationwide evening television broadcasts throughout China.<sup>26</sup> There is also evidence to suggest that a number of countries are acquiring and developing counter-space capabilities designed to deny, disrupt and even destroy the space capabilities of others.<sup>27</sup> The most obvious example of this kind of activity is the Chinese anti-satellite test in January 2007.<sup>28</sup> That space is contested should not really come as a surprise. First, security in space is always a reflection of security on Earth. Tensions and crises between actors are bound to see those tensions and crises played out in orbit. Second, a growing number of countries (to include the UK) are becoming increasingly dependent upon space power for military and economic purposes, and this reliance makes satellites an attractive target that can ostensibly cause major disruption to command and control functions and to modern networked economies.

### Competition

Where contested space implies an element of hostility in interactions, competitiveness implies an economic and political outlet for the natural and even healthy competition of the kind that always occurs between rival firms and states. Numerous corporations operating constellations of communications satellites compete for markets on a daily basis, and a growing number of companies operating high-resolution imaging satellites are doing the same. Similar commercial competition takes place for the myriad space services that are essential for the functioning of modern society. Competition also takes place between states for the purposes of prestige in areas such as human spaceflight and space exploration, as well as in large satellite projects such as the current international competition in satellite navigation, with Europe (Galileo), Russia (GLONASS), China (Compass), India (IRNSS), and Japan (QZSS) all developing, or intending to develop, systems that will rival the US GPS system. Policy-makers should constantly assess the strengths of the UK space industry in order to ensure Britain's commercial competitive edge in space.

### Complexity

The issues of space as a congested, contested and competitive arena all combine to make it a complex policy issue. Military, civil and commercial boundaries in space will continue to blur; increased competition, both commercial and national, will lead to greater congestion. Competition, along with the growing dependency on space and a widening recognition of its strategic attributes, means that space will continue to be contested in a large number of ways. There are areas of space governance where international co-operation makes eminent sense, but which will be exceedingly difficult to achieve for fear of giving up some competitive advantage. An example of this is space situational awareness for space debris mitigation and collision avoidance. Other issues, such as attempts at space weapons arms control, may defy attempted international co-operation and will further compound competition and contestation.

It is in this evolving environment that policy-makers must assess, find and establish Britain's place in space. Ideally, this exercise should take place within the framework of a real strategic sense of Britain's place in the world, though this is unlikely to happen anytime soon despite the publication of the NSS and the SDSR.<sup>29</sup> Instead, this article shall presume to question several assumptions and illuminate a few guiding points of opportunities and challenges for policy-makers.

### Policy Assumptions for Britain in Space

A solid intellectual foundation for national space security policy is needed if Britain is serious about meeting the opportunities and challenges posed by space in the twenty-first century. This foundation can only be laid if long-held assumptions about Britain and its role in space are subjected to rigorous interrogation.

The first, and perhaps biggest, assumption of UK national space security policy is that most of Britain's military space needs in the future will continue to be provided for by the US. To be clear, denying this is not to imply that the

special relationship between the UK and the US is over, or on a slope of inevitable disrepair. Rather, the character of the relationship is in flux due to a number of trends on both sides of the Atlantic. First, from an American perspective, Europe is no longer regarded to be as geopolitically important as the Asia-Pacific. As America's geopolitical focus shifts away more and more from Europe, so too will its allocation of resources and capabilities, including space capabilities. This is compounded by a defence budget crunch that is about to take place in the US that will have severe implications for the funding of its national security space systems. These satellites are already under great operational strain and are oversubscribed by US users. The issue here is not that the UK will be deliberately denied access to US systems, but that as US space resources contract under budgetary pressures and a changed geopolitical emphasis, Britain's timely access to those systems becomes less of a priority. The time to start addressing this shortfall in access to capability is now. The UK can start by asking itself what must *absolutely* be done autonomously in space, and then cast the net wider for alternate partners in space in order to better guarantee access to critical capabilities that are either beyond the reach of the UK alone, such as satellite navigation, or not as vital to national security but still bring strategic value. This process has already begun with the recent Anglo-French defence co-operation agreement of November 2010. The agreement recognises space security as a shared security challenge, and commits both countries to explore the potential for co-operation in developing joint military satellite communications.<sup>30</sup>

Second, even if it is assessed that Britain should not expand its role in space, policy-makers and commanders still cannot escape the strategic consequences of space power. With more state and non-state actors acquiring sophisticated space capabilities with each passing year, one certain aspect of the twenty-first century strategic environment will be the preponderance of actors with access to space power. UK foreign and defence policy will have

to contend with the space power of adversaries in the coming decades. Whether it is the continuation of irregular war or a return to great power conflict, space power will play a significant, if not critical role, in future wars. As a result, British forces will be fighting adversaries either equipped with, or with ready access to, high-resolution imaging satellites that can observe force movements and dispositions; satellite navigation and communications capabilities that enable the delivery of long-range precision-guided munitions; and sophisticated command and control. This reality will have unavoidable strategic, operational, tactical and acquisition implications for the UK.

Lastly, the assumption that conflict in space can be ameliorated by arms control, disarmament or a misplaced application of deterrence, will be shown to be wishful thinking. As already described above, space power will play a critical role in twenty-first century conflict because of the strategic attributes it brings to those who wield it, and because of the perceived efficiencies it brings to the application of the military instrument throughout the spectrum of conflict. Because more and more actors can and will derive military and economic power from space power, it is inevitable that space will be further contested and will even become an arena of conflict. This prospect of conflict in space has many understandably concerned and as a result there is no shortage of arms control and even disarmament proposals under consideration in an attempt to prevent it. Alas, none of these measures will work unless all states give up the benefits of space power for the sake of a peaceful space environment. Because, however, states seek to maximise and advance their security and economic interests in an anarchical international system, none are likely to forego the benefits of space power. Arms control and disarmament initiatives will fail because of a number of problems – including even attempting to define a space weapon since any number of existing technologies, ranging from ballistic missiles through to malware that can infect satellite software, can achieve a deleterious strategic effect. Because of the variety of means that are capable

of attacking space systems, verification of any arms control or disarmament initiative will be wholly unreliable, or superseded by new technological innovations that render any initiative irrelevant. Lastly, because arms control and disarmament seek to control or ban only the instruments of space war, the underlying political tensions that would cause such a conflict would not be addressed. As a result, crises and stress in international politics will only shatter any arms control or disarmament initiative as all sides rush to ensure that they are able to access space in conflict, something that will be largely achieved by denying the other side access to its space capability.

Similarly, the notion that attacks against space systems can be deterred is also deeply flawed. To deter implies that there are states and other actors who need *deterrence*, and for deterrence to have any prospect of success those actors must be identified. The problem for deterrence in Britain today is that, as Patrick Porter points out, there are no clearly identifiable enemies to deter.<sup>31</sup> The problem with attempting to deter aggression against space capabilities is that it misses the strategic point of deterrence overall: to deter war. There are many things a responsible state can do to *dissuade* attacks against its satellites that range from physically protecting satellites through anti-jamming technologies, hardening and distributed placements in orbit, through to training a space-dependent military to operate in a space-deprived environment for mission assurance.<sup>32</sup>

### Conclusion

No one is suggesting that the UK be able to do everything in space, simply because it does not have to. There has been, however, a utilitarian if not complacent view of national space security policy among senior policy-makers and politicians. Despite budgetary austerity, Britain finds itself having to re-examine many of its core assumptions about space power and what they mean for national security. There are many options that the UK can pursue in order to assure its access to space power in the twenty-first century. Doing nothing

and maintaining the status quo is most certainly another option, but will be harmful to Britain's strategic status and its ability to respond to twenty-first century threats.

There are several policy recommendations to make. First, in order to enhance British access to allied high-resolution satellite imaging, it must develop its own high-resolution imaging satellite that can in turn provide greater access to the satellite imaging networks of those allies, including France, Germany and Italy. Second, the development of this capability will allow the UK to better leverage the strategic attributes of high ground, global access, global presence, vertical strategic depth, versatility, ubiquity and continuous operation to critically enhance and support reduced yet still potent terrestrial capabilities. Third, given the challenges of a congested, contested, competitive and complex space environment, it is essential that Britain expands its role in space in order to exert a greater influence on how space is governed. The most effective way for Britain to do this is to help foster norms of behaviour in space based on best practice in space operations. Arms control and disarmament initiatives, in comparison, are not as likely to succeed or endure in a world where geopolitical realities are in flux, satellites are vulnerable to myriad threats and space technologies improve and disseminate at rapid speed. Fourth, increased space capability, along with a leading role in shaping norms of behaviour in space, will make the UK a more attractive partner for other states with space capabilities, and so widen Britain's access to partner capability, increasing and diversifying space access. Finally, it should be recognised that so long as modern states like Britain are dependent upon satellites, then conflict in space is an ever-present likelihood. The UK should prepare for such a contingency by protecting its space capabilities, pre-arranging access to allied space capabilities, and developing its own capabilities, tactics and doctrine for terrestrial-based counter-space operations that seek to deny any adversary the means of disrupting UK access to its space power.

Space power will be critical if Britain is to maintain a leading global role in the twenty-first century, and policy-makers must now assume that UK access to space will be predicated on a significant presence there. ■

John B Sheldon (BA (Hons), MA, Hull; PhD, Reading), is Professor of Space and Cyberpower Strategic Studies at the US Air Force's School of Advanced Air and Space Studies, Maxwell Air Force Base, Alabama. A British citizen, he served in the Foreign and Commonwealth Office before taking up an academic career.

The views expressed in this essay are solely those of the author and do not necessarily reflect the views of the School of Advanced Air and Space Studies, Air University, US Air Force, US Department of Defense or the US government.

## NOTES

- 1 Colin S Gray and John B Sheldon, 'Spacepower and the Revolution in Military Affairs: A Glass Half-Full,' in Peter L Hays, James M Smith, Alan R van Tassel and Guy M Walsh (eds), *Spacepower for a New Millennium: Space and U.S. National Security* (New York: McGraw-Hill, 2000), p. 254.
- 2 See, for example, OECD, *Space 2030: Tackling Society's Challenges* (Paris: OECD, 2005).
- 3 UKspace, *Security & Defence Case4Space: Space Secures Prosperity* (London: UKspace, 2009).
- 4 *Ibid.*, pp. 30–33.
- 5 See Paradigm Secure Communications Ltd, <<http://www.paradigmsecure.com/>>.
- 6 Peter B de Selding, 'New Government Space Agency to Centralize British Space Efforts,' *Space News*, 29 March 2010, p. 11.
- 7 British National Space Centre, *UK Civil Space Strategy: 2008–2012 and Beyond* (London: BNSC, 2008).
- 8 Michael A Taverna, 'Cosmic Dream?', *Aviation Week & Space Technology*, 19 July 2010, p. 126.
- 9 Frank Morring Jr, 'British Bird', *Aviation Week & Space Technology*, 25 October 2010, p. 18.
- 10 Robert Wall and Douglas Barrie, 'Soft Launch', *Aviation Week & Space Technology*, 29 March/5 April 2010, p. 36.
- 11 Stephen Dalton, 'Dominant Air Power in the Information Age: The Comparative Advantage of Air and Space Power in Future Conflict', speech to the IISS, London, 15 February 2010, <<http://www.iiss.org/recent-key-addresses/air-chief-marshall-sir-stephen-dalton/>>, accessed 26 October 2010.
- 12 *Ibid.*
- 13 See UKspace, *op. cit.*, pp. 30–33.
- 14 HM Government, *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, Cm 7948 (London: The Stationery Office, October 2010), p. 65.
- 15 Sun Tzu, *The Art of War*, translated and with an introduction by Samuel B Griffith (Oxford: Oxford University Press, 1971), p. 125.
- 16 Antoine Henri de Jomini, *The Art of War* (London: Greenhill Books, 1996 [1838]), p. 167.
- 17 Carl von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1984), p. 352.
- 18 The most useful orbits of Earth are low-Earth orbit (LEO) ranging from 200 to 2,000 km altitude; medium-Earth orbit (MEO) ranging from 19,000 to 24,000 km altitude; and geosynchronous orbit (GEO) at 35,786 km altitude.
- 19 Officially called the 'Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies', signed by the then-USSR, the US and the UK on 27 January 1967. See *United Nations Treaties and Principles on Outer Space* (New York: United Nations, 2002), pp. 3–8, especially Article II on p. 4.
- 20 This can also apply to relief operations after natural disasters. See, for example, Michael A Taverna, 'Back to the Future: Satellite Systems Could Aid in Global Tsunami Alerts', *Aviation Week & Space Technology*, 31 January 2005, p. 53.
- 21 HM Government, *A Strong Britain in an Age of Uncertainty: The National Security Strategy* (London: The Stationery Office, 2010), p. 9.
- 22 See, for example, Ben Perreau, 'Is There Any Country That Doesn't Have a Space Program?', *Wired*, 16 June 2008.
- 23 Becky Ianotta and Tariq Malik, 'U.S. Satellite Destroyed in Space Collision', *Space.com*, 11 February 2009.
- 24 Luke Baker, 'EU Ready to Act on Iran Satellite Jamming – Draft', *Reuters*, 19 March 2010.
- 25 *BBC News*, 'Libya Jamming "Exposed Vulnerability"', 13 January 2006.
- 26 Florence Chan, 'Falungong Sabotages Chinese Satellite TV', *Asia Times Online*, 26 March 2005.
- 27 National Air and Space Intelligence Center, *Challenges to U.S. Space Superiority*, NASIC-1441-3894-05 (Wright-Patterson Air Force Base, Ohio: NASIC, March 2005).
- 28 *BBC News*, 'China Confirms Satellite Downed', 23 January 2007.
- 29 Patrick Porter, 'Why Britain Doesn't Do Grand Strategy', *RUSI Journal* (Vol. 155, No. 4, August/September 2010), pp. 6–12; *Guardian*, 'Security Strategy: The Age of Uncertainty', 19 October 2010.
- 30 *Number10.gov.uk*, 'UK-France Summit 2010 Declaration on Defence and Security Co-operation', 2 November 2010.
- 31 Porter, *op. cit.*, p. 7.
- 32 On this, see John B Sheldon, 'Space Power and Deterrence: Are We Serious?', *Policy Outlook* (Washington, DC: George C Marshall Institute, November 2009).