

## CHAPTER 2

### CURRENT AND FUTURE MILITARY USES OF SPACE

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#### WHAT IS SPACEPOWER?

“Spacepower” is literally a cosmic concept that is complex, indeterminate, and intangible. It is pregnant with a range of possibilities but it means so many different things to different people and groups that the concept is fraught with ambiguity. Confusion swirls on the semantic level because there is no commonly accepted definition or accepted wording for this concept.<sup>1</sup> There is not even agreement on basic issues such as where the atmosphere ends and space begins.<sup>2</sup> Yet, despite these weaknesses in the conceptual foundation for spacepower, a strong and widespread consensus has developed concerning the growing importance of space to global security. Indeed, this is a central theme in much recent literature such as the Space Commission Report, Barry D. Watts’ *The Military Use of Space*, Steven Lambakis’ *On the Edge of Earth*, Everett C. Dolman’s *Astropolitik* and Bob Preston’s *Space Weapons: Earth Wars*.<sup>3</sup> In addition, spacepower has figured very prominently in several of the most recent Title X wargames conducted by the US Army and Air Force.<sup>4</sup>

This paper explores the emerging consensus on space’s growing importance but takes a wide-ranging perspective on the attributes that comprise spacepower, sees the elements of spacepower as interrelated and multidimensional, and emphasizes that the determinants of space’s strategic utility go beyond just international military competition. It first looks at ways to categorize spacepower such as space activity sectors, military space mission areas, and David Lupton’s four military space doctrines. It also examines a broad range of factors that shape our perceptions and use of space. Throughout, it argues that economic factors

now shape spacepower in fundamental ways, primarily due to rapid growth in commercial space activities and the inherently dual-use nature of most space systems.

## WAYS TO CATEGORIZE SPACEPOWER

### Space Activity Sectors

The attributes of spacepower are often described using four sectors of space activity: civil, commercial, military and intelligence.<sup>5</sup> The Space Commission Report provides an outstanding, current, and comprehensive overview of the types of activities that are contained in each sector and how they contribute to national security.

#### *Civil Space Sector*

The civil space sector is approaching a long-standing goal of a permanent manned presence in space with the deployment of astronauts to the International Space Station. The US has shouldered the largest share of development and funding for this effort. Because it is an international programme, however, its benefits for scientific research, experimentation and commercial processes will be widely shared. The number of countries able to participate in manned space flight has grown substantially. In addition to the US and the USSR (now the Russian Federation), 21 other countries have sent astronauts into orbit in US and Russian spacecraft. The People's Republic of China has announced its intention to become the third nation to place human beings in orbit and return them safely to Earth. Other research and experiments in the civil sector have many applications to human activity. For example, civil space missions to understand the effects of the sun on the Earth, other planets and the space between them, such as those conducted by the Solar Terrestrial Probe missions, will help in the development of more advanced means to predict weather on Earth.

#### *Commercial Space Sector*

Unlike the earlier space era, in which Governments drove activity in space, in this new era certain space applications, such as communications, are being driven by the commercial sector. An international space industry has developed, with revenues exceeding US\$ 80 billion in 2000. Industry

forecasts project revenues will more than triple in the next decade. Whereas satellite system manufacturing once defined the market, the growth of the space industry today, and its hallmark in the future, will be space-based services. The space industry is marked by stiff competition among commercial firms to secure orbital locations for satellites and to secure the use of radio frequencies to exploit a global market for goods and services provided by those satellites. International consortia are pursuing many space enterprises, so ascertaining the national identity of a firm is increasingly complex. The calculations of financial investors in the industry and consumer buying habits are dominated by time to market, cost and price, quantity and quality. It is a volatile market.

Nevertheless, as a result of the competition in goods and services, new applications for space-based systems continue to be developed, the use of those products is increasing and their market value is growing. Space-based technology is revolutionizing major aspects of commercial and social activity and will continue to do so as the capacity and capabilities of satellites increase through emerging technologies. Space enters homes, businesses, schools, hospitals and government offices through its applications for transportation, health, the environment, telecommunications, education, commerce, agriculture and energy.

Space-based technologies and services permit people to communicate, companies to do business, civic groups to serve the public and scientists to conduct research. Much like highways and airways, water lines and electric grids, services supplied from space are already an important part of the US and global infrastructures. The most telling feature of the new space age is that the commercial revolution in space has eliminated the exclusive control of space once enjoyed by national defence, intelligence and government agencies. For only a few thousand US dollars, a customer today can purchase a photograph of an area on Earth equal in quality to those formerly available only to the super-Powers during the Cold War. Commercial providers can complement the photographic images with data that identify the location and type of foliage in an area and provide evidence of recent activity there. They can produce radar-generated maps with terrain elevations, transmit this information around the globe and combine all of it into formats most useful to the customer. This service is of increasing value to farmers and ranchers, fishermen and miners, city planners and scientists.

### *Defence Space Sector*

Space-related capabilities help national leaders to implement US foreign policy and, when necessary, to use military power in ways never before possible. Today, information gathered from and transmitted through space is an integral component of US military strategy and operations. Space-based capabilities enable military forces to be warned of missile attacks, to communicate instantaneously, to obtain near real-time information that can be transmitted rapidly from satellite to attack platform, to navigate to a conflict area while avoiding hostile defences along the way, and to identify and strike targets from air, land or sea with precise and devastating effect. This permits US leaders to manage even distant crises with fewer forces because those forces can respond quickly and operate effectively over longer ranges. Because of space capabilities, the US is better able to sustain and extend deterrence to its allies and friends in our highly complex international environment. Space is not simply a place from which information is acquired and transmitted or through which objects pass. It is a medium much the same as air, land or sea. In the coming period, the US will conduct operations to, from, in and through space in support of its national interests both on Earth and in space. As with national capabilities in the air, on land and at sea, the US must have the capabilities to defend its space assets against hostile acts and to negate the hostile use of space against US interests.

### *Intelligence Space Sector*

Intelligence collected from space remains essential to the mission of the Intelligence Community, as it has been since the early 1960s. Then the need to gain access to a hostile, denied area, the USSR, drove the development of space-based intelligence collection. The need for access to denied areas persists. In addition, the US Intelligence Community is required to collect information on a wide variety of subjects in support of US global security policy. The Intelligence Community and the Department of Defense deploy satellites to provide global communications capabilities; verify treaties through "national technical means"; conduct photo reconnaissance; collect mapping, charting, geodetic, scientific and environmental data; and gather information on natural or man-made disasters. The US also collects signals intelligence and measurement and signature intelligence from space. This intelligence is essential to the formulation of foreign and defence policies, the capacity of the President to

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manage crises and conflicts, the conduct of military operations and the development of military capabilities to assure the attainment of US objectives.<sup>6</sup>

### Military Space Mission Areas

Another important typology for describing spacepower was first adopted by the US military in the 1980s and still provides a foundational and consistent framework to categorize the military missions that contribute to spacepower.<sup>7</sup> Under this typology, space support is a very broad category that contains all activities that enable military space mission accomplishment. Space support includes the development and acquisition of all military space hardware and software; all the infrastructure required to launch, track, and command military space systems; and all the personnel and the education and training systems required to sustain military space activities. **Force enhancement** is the primary emphasis of today's military space forces. This mission refers to all military space activities that help to increase the war-fighting effectiveness of terrestrial forces and is sometimes referred to as "space support to the war fighter". Table 1 lists current and near-term space systems most closely associated with six force enhancement missions. There is widespread consensus on the elements that constitute these two military space mission areas and general agreement that the United States should perform these types of missions from space.

By contrast, there is much less consensus on the types of functions that would be required for space control and force application or on the need for the US military to perform such missions. **Space control** "operations provide freedom of action in space for friendly forces while, when directed, denying it to an adversary, and include the broad aspect of protection of US and US allied space systems and negation of adversary space systems".<sup>8</sup> The use of anti-satellite (ASAT) weapons is one commonly discussed space control mission, but a wide range of missions—including conventional or unconventional attacks on terrestrial tracking, telemetry, and command (TTC) facilities—would also fall into the space control area. The final category, **Force application** "would consist of attacks against terrestrial-based targets carried out by military weapons systems operating in or through space. The force application mission area includes ballistic missile defence and force projection. Currently, there are no force application assets operating in space".<sup>9</sup> Most military space activities fit into one of

these four categories and, of course, most of today's military space activities are in the first two categories: space support and force enhancement.

**Table 1:** Force Enhancement Mission Areas, Primary Orbits, and Associated Space Systems<sup>10</sup>

Geodesy	Environmental Monitoring	Communications	Position, Velocity, Time and Navigation	Integrated Tactical Warning and Attack Assessment	Intelligence, Surveillance and Reconnaissance
Low Earth Orbit (LEO)	Polar LEO	Geostationary Orbit (GSO)	Semi-synchronous Orbit	GSO and LEO	Various
Landsat	Defense Meteorological Support Program (DMSP), National Polar-Orbiting Operational Environmental Satellite System (NPOESS)	Defense Satellite Communications System (DSCS) II, DSCS III, Ultra-High Frequency Follow-on (UFO), MILSTAR, Global Broadcasting System (GBS), Advanced Extremely High Frequency (AEHF), Wideband Gapfiller Satellite (WGS)	Global Positioning System (GPS)	Defense Support Program (DSP), GPS, Space-Based Infrared System (SBIRS) High and Low	Legacy Systems, Future Imagery Architecture (FIA), Integrated Overhead Signals Intelligence Architecture (IOSA)

### Lupton's Four Military Space Doctrines

The four military space doctrines developed by David Lupton in *On Space Warfare* provide an important and comprehensive way to analyse the

strategic rationale behind military space activities (they are summarized in Table 2).<sup>11</sup>

**Table 2:** Attributes of Military Space Doctrines

	<b>Primary Value and Functions of Military Space Forces</b>	<b>Space System Characteristics and Employment Strategies</b>	<b>Conflict Missions of Space Forces</b>	<b>Appropriate Military Organization for Operations and Advocacy</b>
<b>Sanctuary</b>	- Enhance Strategic Stability - Facilitate Arms Control	- Limited Numbers - Fragile Systems - Vulnerable Orbits - Optimized for NTMV mission	- Limited	NRO
<b>Survivability</b>	Above functions plus: - Force Enhancement	- Distributed Networks - Redundancy - Hardening - On-Orbit Spares	- Force Enhancement - Degrade Gracefully	Major Command or Unified Command
<b>Control</b>	- Control Space - Significant Force Enhancement	- Crosslinks - Manoeuvre - Less Vulnerable Orbits - Stealth - Reconstitution Capability - defence - Convoy - 5Ds	- Control Space - Significant Force Enhancement - Surveillance, Offensive, and Defensive Counterspace	Unified Command or Space Force
<b>High Ground</b>	Above functions plus: - Decisive Impact on Terrestrial Conflict - BMD		Above functions plus: - Decisive Space-to-Space and Space-to-Earth Force Application - BMD	Space Force

The **sanctuary** doctrine builds on President Dwight Eisenhower's concepts of "open skies" and "space for peaceful purposes" by emphasizing that space systems are ideal for monitoring military activity, providing early warning to reduce the likelihood of surprise attack, and serving as National Technical Means of Verification (NTMV) to enable and enforce strategic arms control. The basic tenet of the sanctuary doctrine is that space surveillance systems make nuclear wars less likely. Sanctuary doctrine is closely linked to deterrence theory and the assumption that no meaningful defence against nuclear attack by ballistic missiles is possible. Sanctuary doctrine advocates believe that overflight and remote sensing enhance stability and that space must be kept a weapon-free zone to protect the critical contributions of space surveillance systems to global security. **Survivability**, Lupton's second space doctrine, emphasizes broad utility for military space systems, not only at the strategic level emphasized in the sanctuary doctrine, but also at the tactical level of space support to the war fighter that has emerged as the most important force enhancement mission since the end of the Cold War.

The survivability doctrine also differs from the sanctuary doctrine because it highlights space system vulnerabilities and questions whether space can be maintained as a sanctuary due to ongoing technological improvements in systems such as ASAT weapons. Lupton's **control** doctrine is analogous to military thinking about sea or air control and asserts the need for control of space in order to apply spacepower most effectively. Thus, the control doctrine sees space as similar to other military environments and argues that both commercial activities and military requirements dictate the need for space surveillance, as well as offensive and defensive counterspace capabilities. Lupton's final doctrine, **high ground**, argues that space is the dominant theatre of military operations and is capable of affecting terrestrial conflict in decisive ways. As a primary example of such capability, the high-ground doctrine points to the potential of space-based ballistic missile defence (BMD) to overturn the dominance of offensive strategic nuclear forces.

### Sea-power and Air-power Analogies

Another direct and obvious set of factors shaping our perceptions of spacepower are the oft-invoked analogies between spacepower and sea-power or air-power. There is, of course, a rich literature on sea-power and air-power theory. Seminal theorists who developed important perspectives

on military operations in these two mediums include: Alfred Thayer Mahan, Julian Corbett, Giulio Douhet, William “Billy” Mitchell, and John Warden.<sup>12</sup> Some of the key concepts that these theorists developed or applied to the air and sea mediums are command of the sea, command of the air, sea lines of communication, common routes, choke points, harbour access, concentration and dispersal, and parallel attack. Several of these concepts have been appropriated directly into various strands of embryonic space theory; others have been modified slightly, then applied. For example, Mahan and Corbett’s ideas about lines of communication, common routes, and choke points have been applied quite directly onto the space medium. Sea-power and air-power concepts that have been modified to help provide starting points for thinking about spacepower include harbour access and access to space, and command of the sea or air and space control.<sup>13</sup> But, of course, to date no comprehensive spacepower theory has yet emerged that is worthy of claiming a place alongside the seminal sea-power and air-power theories listed above.<sup>14</sup>

There are also many fundamental questions concerning the basic attributes of the space medium and how appropriate it is to analogize directly from sea-power or air-power theory when attempting to build spacepower theory. Few concepts from sea-power theory translate directly into air-power theory—why should we expect either sea-power or air-power theory to apply directly for the distinct medium of space? Questions concerning the attributes of space and the proper way to build space doctrine are also at the heart of the disagreements between the Air Force and the rest of the DoD over whether air and space should be treated as a seamless operational medium (defined as aerospace by the Air Force) or regarded as distinct air and space mediums (as seen by the rest of DoD).<sup>15</sup>

[M]any of the problems with the aerospace concept and the development of space-power theory and doctrine have already been thoughtfully addressed in this [*Aerospace Power*] journal over the years. Dennis Drew, Charles Friedenstien, and Kenneth Myers and John Tockston published three of the best analyses during the 1980s.<sup>16</sup> These interrelated articles build on Drew’s doctrine-tree model—the idea that doctrine should grow out of the soil of history, develop a sturdy trunk of fundamental doctrine, branch out into doctrine for specific environments, and only then attempt to sprout the organizational doctrine analogous to “leaves”. This approach provides a comprehensive way to examine the aerospace concept and the Air Force’s first official space doctrine, Air Force Manual (AFM) 1-6, *Military Space Doctrine*,

released in 1982.<sup>17</sup> Friedenstein finds that “there is no doctrinal foundation for the term *aerospace*” (emphasis in original) and critiques the Air Force for attempting to produce “leaves on a nonexistent branch” because it had not developed environmental doctrine before issuing the organizational doctrine in AFM 1-6.<sup>18</sup> Myers and Tockston strongly critiqued the Air Force’s tendency to “force-fit” space doctrine into the mold of air doctrine and argued that the three major characteristics of space forces are in fact emplacement, pervasiveness, and timeliness.<sup>19</sup>

Thus, despite several efforts to appropriate or adapt key concepts from sea-power and air-power theory, we are currently still adrift without a comprehensive spacepower theory to guide us and would be wise to cast our nets more widely and beyond traditional national security considerations.

## DOES SPACEPOWER CONSTITUTE A REVOLUTION IN MILITARY AFFAIRS?

As with virtually everything else associated with spacepower, there is a wide range of opinion on this question. In order to address this question, we must first engage the issue of revolutions in military affairs (RMAs) more generally. During the 1990s, discussion of RMAs became a cottage industry within strategic studies and defence policy analysis. Unfortunately, to this analyst at least, it is unclear whether this whole endeavour has generated more light than heat. Nonetheless, in order to continue we need some working definition of RMA and some sense of what constituted past RMA.

This paper adopts the definition of RMA advanced by Dr. Andrew Krepinevich and his Center for Strategic and Budgetary Assessments (CSBA). They define an RMA as a major discontinuity in military affairs.

They are brought about by changes in militarily relevant technologies, concepts of operation, methods of organization, and/or resources available, and are often associated with broader political, social, economic, and scientific revolutions. These periods of discontinuous change have historically advantaged the strategic/operational offense, and have provided a powerful impetus for change in the international system. They occur relatively abruptly—most typically over two-to-three decades. They render obsolete or subordinate existing means for conducting war.<sup>20</sup>

CSBA makes the case that there have been “at least a dozen cases of revolutionary change in the conduct of war: Chariot, Iron Age Infantry, Macedonian, Stirrup, Artillery/Gunpowder, Napoleonic, Railroad, Rifle, Telegraph, Dreadnought/Submarine, Air Superiority/Armored Warfare, Naval Air Power, and Nuclear Weapons”.<sup>21</sup> Brief descriptions of the six most recent RMAs help to clarify the concept further:

*The Napoleonic Revolution.* During the last decade of the eighteenth century, a social and political revolution in France transformed war. The advent of universal conscription—the *levée en masse*—dramatically expanded the size of armies and increased their reconstitutability. Equally important, the new conscript armies—composed of literate citizen soldiers—had a fundamentally different relationship to the societies from which they were drawn. All-weather roads and a new form of military organization—the corps—transformed logistics, and mass column assaults and mobile artillery transformed tactics.

*The Railroad, Rifle, and Telegraph Revolution.* The commercial development of the railroad and telegraph and the military development of the breech-loading rifle between 1840 and 1870 revolutionized war on land. The railroad revolutionized logistics, the rifle transformed tactics, and the telegraph fundamentally changed strategic command and control. With the advent of the railroad and telegraph, time, i.e., speed of mobilization, became a critical measure of military effectiveness. The large-scale movements of armies made possible by the new industrial infrastructure also gave birth to a new level of war—the operational level. By often giving statesmen a better sense of the overall military situation than that possessed by senior commanders in the field, the telegraph also transformed civil-military relations.

*The Dreadnought/Submarine Revolution.* The advent of steam propulsion and metal construction in naval shipbuilding ushered in a period of near constant technological change during the last decades of the nineteenth century. The completion in 1906 of the H.M.S. Dreadnought—the world’s first all-big gun, turbine-driven battleship—provided existential evidence of another revolution in military affairs. With its uniform main armament—

ten 12-inch guns—Dreadnought could outshoot any older warship. A principal impetus of the Dreadnought Revolution—the submarine—proved to be equally revolutionary. As a result of the increasing threat that these new weapons posed to battlefleets, the long-standing naval strategy of close blockades of enemy ports had to be abandoned. Even more important, the “hierarchy of power” in naval warfare, which had been established with the advent of the capital ship more than three centuries earlier, had been severely undermined.

*Armored Warfare/Air Superiority.* The stunning victory of German forces over the French, British, Dutch, and Belgian armies in May-June 1940, marked another departure in land warfare. From then on, the unit of account in measuring any army's strength would no longer be the number of soldiers it had under arms. While the development of armored warfare depended upon the maturation of the dominant technology—the tank—technology itself was not sufficient to effect the revolution. Several other developments—in supporting technologies (e.g., tank radios), organization (combined arms formations and supporting air arms), operational concepts (deep penetrations on narrow fronts and air superiority), and climate of command (mission-oriented tactics, or *Auftragstaktik*)—were essential components of the transformation launched by the blitzkrieg.

*Naval Air Power.* World War II also saw a transformation of war at sea. With the advent of naval air power, fleets that formerly could not engage their enemy unless they were in visual range could now hurl blows at one another from distances of hundreds of miles. Moreover, whereas naval battles had previously been characterized by gunnery duels, destructive force could now be delivered in great pulses of power. As with armored warfare, the breakthroughs in carrier warfare depended upon a number of developments: modifying airplanes so that they were rugged enough to withstand the problems associated with landing and taking off at sea, developing techniques to manage space on a crowded deck, employing carriers in combined strike forces to attack land and sea targets, etc. By the autumn of 1943, when American building programs began to amass the sheer numbers of platforms required for sustained large-scale carrier operations,

the transformation of war wrought by the ascendance of naval air power had become complete.

*The Nuclear Revolution.* The detonation of atomic bombs over Hiroshima and Nagasaki provided evidence of another military revolution. Far exceeding the prophecies of even the most zealous pre-war strategic bombing theorists, subsequent developments in intercontinental ballistic missiles and nuclear fusion brought the prospect of nearly instantaneous destruction of whole societies into the strategic calculus. As with previous revolutions, the advent of nuclear weapons saw the emergence of new warfighting doctrines and military organizations. In the minds of most strategists, however, the sole purpose of the new weapons had shifted from warfighting to deterrence.<sup>22</sup>

The question, however, remains whether the military and strategic contributions of spacepower to date constitute an RMA. Some analysts make the case that spacepower's contributions in the Gulf war (the first space war) already mark it out as an RMA. Others make the case that, regardless of its specific performance in any individual war, spacepower *is* the RMA.<sup>23</sup> It is probably more useful, however, to view the current relationship between spacepower and RMAs in two primary ways: first, in terms of spacepower's pre-eminent **contributions** that enable the global reconnaissance, precision strike RMA that first emerged in the Gulf war; and, secondly, in terms of spacepower's **autonomous** but nascent potential for a space weaponization RMA.

Many systems combine into the system of systems that create the global reconnaissance, precision strike RMA that has more clearly emerged and become increasingly powerful over the course of the past decade. Some of the more important systems for this RMA include: modern communications, command, control, computers, intelligence, surveillance, and reconnaissance (C<sup>4</sup>ISR) systems, stealth platforms, and precision weapons. Spacepower makes the single most comprehensive and important contribution to this RMA. Among other things, spacepower fuels this RMA with 24/7 global ISR, it binds it together with communications connectivity, and it enables precision strike via GPS. In many cases, space provides the best or even the only medium from which to make these enabling contributions. In sum, it is clear that spacepower has now moved well beyond merely enhancing terrestrial forces and has become the single

most important contribution that enables the global reconnaissance, precision strike RMA.

Space weapons also hold the potential to revolutionize warfare in even more powerful and fundamental ways. They could operate from the lowest tactical level up through the grand strategic level, could provide nearly instantaneous and simultaneous global strikes, and might even minimize the power of offensive nuclear forces. Such systems would create an RMA at least as profound as the six cases of modern RMAs discussed above. The path to space weaponization, however, still contains many extremely difficult political, fiscal, and technical challenges. Moreover, before starting down the path to space weaponization, we must avoid the fallacy of the last move by anticipating that such powerful weapons will almost inevitably provoke countermeasures in the unending dialectic between offensive and defensive weapons. Cumulatively, the breadth and depth of the challenges for space weapons to overcome mean that this RMA may not emerge for some time to come—despite all its potential. As emphasized in the *Space Commission Report*, space weaponization is probably inevitable over the long run. How and when weaponization occurs is likely to be shaped more by political factors than by technological considerations.

## MILITARY SPACE COOPERATION: OPPORTUNITIES AND CHALLENGES

Military space cooperation, like most space issues, is a complex and contentious issue area. Examining opportunities and challenges in military space cooperation may help to illuminate several of the most likely paths forward for future space activity and highlight the security implications of these developments.

### Space Weaponization

At a fundamental level, virtually all issues of space strategy and military space cooperation are shaped by the spectrum of views on the utility of weaponizing space. Major questions include: whether space will be weaponized, how and when that might happen, which States and other actors might be most interested in leading or opposing weaponization, and how any of these space weaponization issues might best be controlled. At

the political level, there is, of course, a broad spectrum of opinion on these issues but most of the major tenets in mainstream views on weaponizing space can usefully be grouped into four major camps: space hawks, inevitable weaponizers, militarization realists, and space doves.<sup>24</sup>

### Space Hawks

Adherents to this camp believe that space already is or holds the potential to become the dominant source of military power. Accordingly, they believe that the United States should move quickly and directly to develop and deploy space weapons in order to control and project power from this dominant theatre of combat operations. According to Republican Senator Bob Smith of New Hampshire, for example, concerted development of space weapons by the United States “will buy generations of security that all the ships, tanks, and airplanes in the world will not provide ... Without it, we will become vulnerable beyond our worst fears”.<sup>25</sup> In addition, space hawks often point to space-based BMD as a potentially decisive weapon capable of fundamentally reordering the strategic balance. Space hawks tend to oppose virtually all space-related arms control and are lukewarm at best on military space cooperation because of the potential of these activities to slow or derail rapid and direct space weaponization.

### Inevitable Weaponizers

This group believes that space, like all other environments man has encountered, will eventually be weaponized. They differ from space hawks in two important ways: they are not convinced that space weaponization would be beneficial for US or global security, and they are unsure that space will prove to be the decisive theatre of combat operations. The *Space Commission Report* is a good example of this camp: “We know from history that every medium—air, land and sea—has seen conflict. Reality indicates that space will be no different. Given this virtual certainty, the United States must develop the means both to deter and to defend against hostile acts in and from space.”<sup>26</sup> Inevitable weaponizers take a nuanced view of space arms control and cooperation. They generally support confidence- and security-building measures (CSBMs) and other cooperative mechanisms designed to slow military competition and channel it in predictable ways. But they are less supportive of broad efforts to ban space weapons because they see them as futile or even dangerous due to their potential to lull the

United States into complacency or otherwise cause it to be outmanoeuvred by States that successfully circumvent space weaponization accords.

#### Militarization Realists

Members of this camp oppose space weaponization because they believe US security interests are best served by the status quo in space. They believe that the United States has little to gain but much to lose by weaponizing space because it is both the leading user of space and, enabled by this space use, the dominant terrestrial military Power. Militarization realists also believe that if the United States takes the lead in weaponizing space, it would become easier for other States to follow due to lower political and technological barriers. For these reasons, militarization realists believe that “fighting *into* space looks feasible and we should plan for the eventuality. Fighting *in* space shows little promise, while fighting *from* space looks impractical for the foreseeable future, with or without treaties” (emphasis in original).<sup>27</sup> Militarization realists support space-related arms control and cooperation that precludes other States from weaponizing or even militarizing space. Most of them believe, however, that this support must be balanced against the increased attention that formalized arms control efforts could draw to the United States’ already formidable space-enabled force enhancement capabilities and the political, military, and arms control fallout this increased scrutiny might cause. Informal cooperation might be one of the best ways to circumvent this potential difficulty.

#### Space Doves

Finally, a wide range of organizations and viewpoints can be grouped together in the space dove camp because they all oppose space weaponization for a variety of reasons including moral, arms control, conflict resolution, stability, and ideology arguments. Most space doves also oppose any militarization of space beyond the limited missions they see as stabilizing—national technical means (NTM) of arms control verification, early warning, and hotline communications—because they see any military missions beyond these as the “slippery slope” to space weaponization. Most space doves emphasize how destabilizing most space militarization and all space weaponization would be. “Unlike the strategy for nuclear weapons, there exists no obvious strategy for employing space weapons that will enhance global stability. If the precedent of evading destabilizing situations is to continue—and that is compatible with a long history of US foreign

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policy—one ought to avoid space-based weapons”.<sup>28</sup> They also highlight the deep roots of President Eisenhower’s “space for peaceful purposes” policy and argue that, especially in the post-Cold War era, there is no rationale for space weaponization that is strong enough to overturn the basic strategic logic the United States developed at the opening of the space age. Space doves support space arms control and cooperation more strongly than any other camp. Since they do not believe the United States (or other States) would reap strategic benefits from weaponizing space, they are not overly concerned about the numerous arms control challenges identified by the other camps. Moreover, like Paul Stares, most space doves would not support using two-track approaches to space arms control.<sup>29</sup>

These ingrained but fundamentally divergent perspectives on space weaponization, space’s strategic utility, and the role for space arms control are likely to make it quite difficult to craft cooperative approaches or even to establish a dialogue concerning the interrelationships between space and security. It is difficult to see a clear cooperative path forward for the United States or the global space community. The realist lens in global politics and Graham Allison’s rational actor (Model I) lens in domestic politics portend a rocky path forward.<sup>30</sup> Likewise, it is also difficult to see clear lines of military space cooperation through regimes or epistemic communities or by applying Graham Allison’s Models II and III to the multiplicity of organizations and individuals that contribute to the pulling and hauling of governmental decision-making within a pluralist democracy such as the United States. Clearly, it would be a formidable challenge to provide enough incentives and assemble coalitions capable of pushing forward any camp’s preferred vision for space competition or cooperation. Given this environment, it seems unlikely that the United States can or will provide strong or consistent leadership for military space cooperation. It is more likely that the United States would move forward in response to external space arms control initiatives or trigger events related to the weaponization of space.<sup>31</sup>

On the technical side of the equation, space arms control and formalized cooperation designed to control the weaponization of space face all of the problems that plagued previous attempts to develop these control mechanisms. The most serious of these problems include: disagreements over the proper scope and object of negotiations; basic definitional issues about what a space system is and how it might be categorized as offensive or defensive and stabilizing or destabilizing; and

questions concerning how any agreement might be adequately verified. These problems relate to a number of very thorny specific issues such as: whether the negotiations should be bilateral or multilateral and formal or informal; what satellites and other systems should be covered; whether the object should be control of space weapons or CSBMs for space; which types of CSBMs such as rules of the road or keep-out zones, for example, might be most useful and how these might be reconciled with existing space law such as the Outer Space Treaty (OST); and verification problems such as how to address residual ASAT capabilities or deal with the significant military potential of even a small number of covert ASAT systems.

New space system technologies, the growth of the commercial space sector, and new verification and transparency technologies interact with these existing problems in complex ways. Some of the changes would seem to favour arms control and cooperation, such as better radars and optical systems for improved space situation awareness and verification, technologies for better space system diagnostics, and the stabilizing potential of microsatellite-based distributed and robust space architectures. Many other trends, however, would seem to make space arms control and cooperation even more difficult. For example, stealthy microsatellites might be used as virtually undetectable active ASATs or passive space mines; the proliferation of space technology has radically increased the number of significant space actors, and these ranks now include a number of important non-State actors; and growth in the commercial space sector raises issues such as how quasi-military systems should be protected or negated and the unclear security implications of emerging markets for dual-use systems. Cumulatively, just as with the political factors that animate the four space camps discussed above, it is hard to see many technical factors that would clearly advance space arms control and cooperation designed to control space weaponization.

### Recent Space-Related Arms Control and Regulation Issues

With the end of the Cold War, many formal arms control efforts have been de-emphasized, and most space-related arms control efforts are no exception. There have been, nonetheless, some very important space-related provisions in recent treaties and agreements. Moreover, the recent growth in commercial space activity undoubtedly creates an opportunity, if

not a need, for expanded regulation and control in this area. This section briefly reviews some of the most important recent developments.

### Strategic Arms Reduction Treaty (START) I and II

The 1991 START I is a bilateral treaty between the United States and the Soviet Union designed to reduce the number of deployed strategic offensive arms (warheads and delivery vehicles) maintained by each.<sup>32</sup> Several of the broad provisions in START I build on previous arms control treaties. For example, START I repeats the NTM provisions first contained in the ABM Treaty but also relies on extensive OST verification protocols to assure compliance.<sup>33</sup> In addition, START I strengthens the OST prohibition on the placement of weapons of mass destruction in outer space. Article V, paragraph 18, of the Treaty prohibits each party from producing, testing, or deploying systems, including missiles, for placing nuclear weapons or any other kinds of weapons of mass destruction into Earth orbit or a fraction of an Earth orbit.<sup>34</sup> This is an important provision designed to ban fractional orbital bombardment systems such as the one successfully tested by the Soviet Union from 1965 to 1971.<sup>35</sup>

START I has many new implications for military space operations as well. There are several restrictions on the use of intercontinental ballistic missiles (ICBMs) or submarine-launched ballistic missiles (SLBMs) as space-launch boosters. For example, the Treaty places restrictions on the number, type, and location of ICBMs and SLBMs used to boost objects into the upper atmosphere or space, and limits the number and location of space-launch facilities used to support such launches.<sup>36</sup> Objects launched by ICBMs or SLBMs into the upper atmosphere or space are also subject to the Treaty's telemetry requirements. In a major departure from past practice, the Treaty requires the party conducting any peacetime launch of an ICBM or SLBM to make on-board technical measurements, broadcast all telemetric information obtained from such measurements in a way that allows full access to the information, and then provide a recording and analysis of those data to the other party. For objects delivered by ICBMs or SLBMs into the upper atmosphere or space, the telemetry provisions only apply until the object(s) being delivered are either in orbit or have achieved escape velocity.<sup>37</sup> Furthermore, advance launch notification must be made to the other treaty party whenever an ICBM or SLBM is used as a booster for delivering objects into the upper atmosphere or space. Such notification is provided in accordance with the provisions of START I and the Ballistic

Missile Launch Notification Agreement.<sup>38</sup> START I might also affect ongoing space control and force application initiatives. For example, if the planned space operations vehicle was designed with a conventional strike capability, it might be held accountable under START I limitations on heavy bombers equipped for nuclear armaments other than long-range nuclear air-launched cruise missiles. No exhibition would be required, but the vehicle's distinguishing features would be listed in the START memorandum of understanding. In addition, the facility where the vehicle is based would have to be declared as a heavy bomber base but would not be subject to inspection unless it contained a weapons storage area. A determination of treaty applicability, if any, would be subject to discussion between the parties.<sup>39</sup>

The 1993 START II between the United States and the Russian Federation further reduces the number of deployed strategic offensive arms mandated by START I. All of the provisions of START I applicable to outer space described above also apply to START II. This Treaty is not in force, and it currently appears to have been completely superseded by the more comprehensive strategic arms control agreement signed in Moscow by Presidents George W. Bush and Vladimir V. Putin on 24 May 2002.<sup>40</sup> Factors currently weighing against START II entering into force or even serving as the basis for further negotiations include: the level at which the "floor" for deployed strategic offensive arms should be set, the proper relationship between strategic offensive and strategic defensive force in President Bush's "new strategic triad" and a world without the ABM Treaty, and the Bush Administration's seemingly limited enthusiasm for formal arms control.

Finally, in addition to the notifications required by the START Treaties and the Ballistic Missile Launch Notification Agreement, the United States and the Russian Federation have recently signed two new agreements expanding launch notifications to include all space launch vehicles. On 4 June 2000 at the Moscow Summit, President Clinton and Russian President Putin signed a memorandum of agreement to establish a Joint Data Exchange Centre (JDEC) in Moscow to share early warning information on missile and space launches.<sup>41</sup> Once JDEC is completed and commences operations, the two countries are supposed to exchange information obtained from their respective ground- and space-based early warning systems on US and Russian space launches (with rare exceptions) including time of launch, generic missile class, geographic area of the launch, and

launch azimuth. Eventually this exchange of data will also include data-sharing on detected space launches of other States. On 16 December 2000, US Secretary of State Madeline K. Albright and Russian Foreign Minister Igor Ivanov signed a memorandum of understanding establishing a Pre- and Post-Missile Launch Notification System (PLNS) for launches of ballistic missiles and, with rare exceptions, space launch vehicles, identifying launch window, time of launch, generic missile class, geographic area of the launch, and launch azimuth.<sup>42</sup> The PLNS Information Centre will be an Internet-based system operated as part of JDEC. Both agreements provide for the voluntary notification of satellites forced from orbit and certain space experiments that could adversely affect the operation of early warning radars, and both agreements leave open the possibility of negotiations on future data-sharing on missiles that intercept objects not located on Earth's surface. JDEC and PLNS are among the most detailed and comprehensive space-related CSBMs ever negotiated. They are designed to enhance stability by limiting flexibility and clandestine operations. The wide spectrum of opinion on the utility of these latest agreements is another excellent illustration of how fundamental disagreements on military space strategy can colour all subsequent analysis.<sup>43</sup>

### High-Resolution Commercial Imagery and Deception

Digitized data streams designed to produce imagery are ideally suited for deception. This is because digitized data must always be mathematically processed to create images, and this processing is subject to manipulation in a variety of ways—many of which are not available for manipulating film images. As Steven Livingston explains:

Mathematically altering the value of the pixels alters *seamlessly* the representation. "Since it is purely a mathematical process, the source images can be altered fundamentally and undetectably before and/or during their production." Elements can be added or subtracted, changed in color, brightness, or contrast. Changes are made not by altering the computer code that produces the image, and not in the image itself as in analog manipulation. In fact, it is more accurate perhaps to say that no image exists beyond the mathematical equations that create a particular array of pixels. The equations are the image. Therefore as computer processors become faster and more powerful, so too does the ability to alter digital information.<sup>44</sup>

The phrase “altered fundamentally and undetectably” is absolutely loaded with implications. For starters, it means that virtually **anything** can be added, subtracted, or changed in digital imagery (or to any digital information) and that even experts cannot necessarily detect these changes. The possibilities for deception through manipulating digital imagery are literally unlimited. Perhaps even more alarmingly, all of this can happen in real time as the data stream is converted into manipulated imagery. It is no wonder that the digital age creates a number of legal conundrums and that the veracity of digitized information is increasingly being questioned in courtrooms.<sup>45</sup> At the very least, as “No More Secrets” summarizes, “[c]ommercially available high-resolution satellite imagery will trigger the development of more robust denial and deception and anti-satellite countermeasures”.<sup>46</sup> Given this potential for deception, the USG and the news media should adopt a “dual phenomenology” requirement as a way to attempt to confirm the veracity of digitized imagery.

### Control of High-Resolution Commercial Imagery

There are clearly a number of complex interdependencies that have and will continue to shape the global high-resolution commercial remote sensing market. The United States should continue to study and evaluate the evolution of this market to ensure that its policy objectives are being met. Regulatory mechanisms such as shutter control that the United States has put in place appear to provide an equitable balance between economic considerations and national security concerns. These mechanisms should also be self-regulating to a large degree. If the United States overuses shutter control, it may drive potential customers to foreign imagery providers; but such a control is required before the United States can create incentives for its high-resolution commercial remote sensing industry to dominate the global market. This area also offers the potential for novel means of control and exploitation. The requirement for imagery providers to use only USG approved encryption devices that allow USG access during periods of shutter control, especially when coupled with the potential to use digital data for deception, certainly presents some interesting possibilities for control and exploitation by leaving systems operating rather than shutting them off.

Finally, the United States should carefully and continuously re-evaluate whether the benefits that Presidential Decision Directive (PDD-) 23 is designed to create, such as greater transparency and market pre-eminence,

do, in practice, actually outweigh the costs such as the use of these data for nefarious ends. So far the United States has attempted to shape the world market via mostly economic benefits rather than security considerations. It should rebalance that equation towards national security, perhaps by formal arms control restrictions on high-resolution commercial remote sensing, if the benefits do not outweigh the costs. If it becomes prudent to move in this direction, there are a number of unilateral and multilateral regulation and control options that the United States could pursue.<sup>47</sup>

In the latest developments in this area, during the campaign against terrorism in Afghanistan thus far, the National Imagery and Mapping Agency (NIMA) established a commercial “agreement of assured access” with the Space Imaging Corporation, reportedly for US\$ 1.9 million per month. Under the terms of this agreement, Space Imaging could not sell or share its Afghanistan theatre imagery with anyone except the USG without NIMA approval until after 5 January 2002, and the contract could be extended beyond that date.<sup>48</sup> This agreement opens many interesting issues related to the utility of limiting information dissemination for public diplomacy, the media, and exploitation of enemy information channels. It also raises the issue of whether this agreement using market mechanisms has set a precedent that might well make it more difficult to invoke formal shutter control in the future.

### Global Utilities

Because of all the growth in space systems and the services they provide, some analysts believe they should now be considered in a new way as global utilities that provide an essential foundation that enables the global information infrastructure. In some ways, the concept of global utilities is just another recognition of how much the commercial space sector has grown and how important it has become; but it is also clear that the global information infrastructure as it currently exists simply could not function without space systems and the services they provide. This section attempts to define what global utilities are and then discusses arms control and regulatory mechanisms that might help to protect and enhance these essential services.

Global utilities have been defined as: “Civil, military, or commercial systems—some or all of which are based in space—that provide communication, environmental, position, image, location, timing, or other

vital technical services or data to global users.”<sup>49</sup> To date, all space-based global utilities provide information services, but they are analogous to Earth-bound utility services that provide a foundation for modern life such as water and electricity. And like these Earth-bound utility services, space-based global utilities may be subject to regulation and control at the local, state, national, and international levels. Two recent relatively minor failures illustrate just how embedded global utilities have become in the global information infrastructure. In 1996, a controller at the Air Force GPS control centre accidentally put the wrong time into just one of the 24 satellites, and this erroneous signal was broadcast for just six seconds before automatic systems turned the signal off. That momentary error caused more than 100 of the 800 cellular telephone networks on the US East Coast to shut down, and some took hours or even days to recover.<sup>50</sup> In May 1998, “40-45 million pager subscribers lost service; some ATM and credit card machines could not process transactions; news bureaux could not transmit information; and many areas lost television service—all because of the loss of *one* satellite” (emphasis in the original).<sup>51</sup> Clearly, space systems have become an increasingly important part of the global information infrastructure, but questions remain about how they should be regulated and protected.

How global utilities should be controlled and regulated is a complex issue that depends on a number of factors such as the specific systems in question, the services they provide and the primary users. Communication satellites are already subject to significant control and regulation at the international level through the International Telecommunication Union (ITU) and in the United States through the Federal Communications Commission (FCC). This high level of regulation for communication satellites is justified both because of the threat of harmful interference in the radio spectrum and due to the lucrative nature of these services. Other areas within the commercial space sector that have yet to demonstrate much profitability such as high-resolution remote sensing are also subject to regulation and control, but it is generally at a lower level. The United States provides other global utility services such as meteorological data and GPS timing signals free to all users worldwide as a public good. Given the current range of existing regulation and control for global utility services, it is not clear what national security or economic objectives would be served by attempting to regulate these services in the same or even similar ways.

In addition, the United States should consider how global utilities might best be protected and fostered as an enabling technology within the global information infrastructure. Unfortunately, no clear or easy answers stand out, and there is a wide range of views on the best path forward. Despite the many threats detailed above, to date there has been almost “no demand from the operators of commercial communication satellites for defence of their multibillion-dollar assets”.<sup>52</sup> The current lack of support from industry for protection of global utilities is particularly disappointing to the United States Space Command (USSPACECOM) because during the late 1990s, it had attempted to advance the argument that such protection was needed and would be demanded as space commercialization grew.<sup>53</sup> Some analysts believe that a multilateral approach to protection for global utilities would be best and argue that this function should be performed by an international organization such as the United Nations. This approach would, however, likely be filled with all the political, economic, and technical difficulties that have plagued almost all international space efforts. The rocky path of the International Space Station certainly does not inspire confidence in this approach to providing protection for global utilities. At the opposite end of the spectrum are those who advocate that the US military, and the Air Force in particular, should take on the global utility protection mission regardless of international opposition or a lack of support from industry. On top of the political opposition to this approach, creating a viable defense for global utilities also faces daunting economic and especially technical challenges such as those posed by a high-altitude nuclear detonation. Based on the technologies currently being examined, only a robust space-based system would stand much chance of providing an effective defence against the most threatening attacks on global utilities.<sup>54</sup>

### **Spectrum Crowding, Orbital Debris and Space Traffic Control**

The final contentious area examined in this paper is related to the cumulative effects of greater use of space. Current and projected use of space is creating challenges particularly in the areas of crowding of the radio spectrum for space, orbital debris, and the possible need for space traffic control. This section discusses these issues and outlines some potential control and regulation mechanism that might help to address them.

Recent growth in commercial space activity has exacerbated crowding of the radio spectrum for space applications and there are currently

significant pressures on portions of the spectrum now allocated to military uses. In particular, today there is a great deal of pressure to move DoD out of the 1755 to 1850 MHz band in order to auction it off for third-generation communications applications. It is not clear, however, that US national security or even economic interests would benefit from moving DoD out of this band. As the General Accounting Office report on this issue makes clear, more study is required, and, in particular, the issue must be carefully reconsidered in the light of the radically reduced bandwidth requirements that will undoubtedly accompany the economic recession the global economy seems to be entering. More generally, the increasing pressure on the radio spectrum due to more commercial use of space has been somewhat balanced by the use of new technologies and different orbits that lessen the effects of increased use. For example, modern satellites in GSO have only two degrees of spacing between them (versus three or more degrees in the past) for most systems providing fixed satellite services. Likewise, increasing use of non-GSO communication satellite networks may decrease the pressure on overcrowding GSO in terms of spectrum and spacing. In sum, then, current trends for the space radio spectrum do not augur major changes in the current regulatory structure. Moving ITU to auctions for its coordination/registration process would undoubtedly produce greater efficiency and generate income, but these benefits would need to be weighed against the equal access concerns of the developing world and the fact that there currently seems to be little support for moving in this direction.

Orbital debris may represent the single, most potentially useful window of opportunity for cooperative space arms control and regulation for the United States and the global spacefaring community through 2015.<sup>55</sup> The National Aeronautics and Space Administration (NASA) defines "orbital debris" as "any man-made object in orbit about the Earth which no longer serves a useful purpose".<sup>56</sup> Human space activity has generated a lot of debris: there are over 9,000 objects larger than 10cm and an estimated 100,000-plus objects between one and 10cm in size.<sup>57</sup> The largest single source of this debris has been intentional and unintentional satellite explosions on orbit.<sup>58</sup> Orbital debris generally moves at very high speeds relative to operational satellites and thereby poses a risk to these systems due to its enormous kinetic energy.<sup>59</sup> Only three collisions between operational systems and orbital debris are known to have occurred thus far, but concerns about this hazard are growing due to the increasing number of operational space systems and the five per cent growth rate in LEO orbital

debris each year.<sup>60</sup> There is even concern about the potential for orbital debris “chain reactions” due to collisions in big-LEO communication satellite constellations or due to the debris clouds that could be created by use of kinetic energy ASATs in LEO.

Since the 1980s, the United States has led the world in publicizing the risks due to orbital debris and it has made programmes to mitigate debris an increasingly important part of its overall space policy.<sup>61</sup> There is, however, undoubtedly more the United States could do on the orbital debris front. The United States should explore several options such as unilaterally pledging not to create space debris through testing or operations of any ASAT system, creating strict unilateral regulations that mandate debris mitigation for US commercial space operators (perhaps as part of a “space worthiness licence”), multilateral efforts to “clean up” debris using lasers and other techniques, and creating strict multilateral regulations for debris mitigation. These and other creative approaches should be explored vigorously in order to ensure that man’s increasing use of space does not impose unacceptable risks on this activity.

Finally, due again to the increasing use of space, the United States must consider the need for, and implications of, space traffic control systems (STCS) that could be analogous to current air traffic control systems. The idea for such a system is obviously related to the orbital debris problem discussed above, but it goes well beyond just this problem to include a wide range of factors such as: how space traffic might coordinate and be approved for specific orbital positions, how space traffic would be located and tracked, sanctions and liability for non-compliance and collisions under an STCS, and how such a regime might be established and funded. As with many space-related issues, the technology to at least begin implementing such a system appears to be closer at hand than is the political will to begin down this path. For example, the Ballistic Missile Defense Organization’s Midcourse Space Experiment (MSX) satellite launched in April 1996 is the only operational space-based surveillance instrument. It has found some “150 objects in the last three years that were completely lost” and demonstrated the potential value of space-based sensors to an STCS.<sup>62</sup> Likewise, GPS positioning signals could be used very accurately to locate many space systems and a transponder-like system aboard space systems could automatically provide these data in response to queries from the STCS.<sup>63</sup> On the political side of the equation, however, the United States must consider very carefully how its objectives in space might benefit or be

harmed via the creation and operation of an STCS. It is not obvious that an air traffic control model is the appropriate regime for space, or that the political and financial costs of creating and operating such a system (many of which would likely be borne by the United States) would be outweighed by its benefits. Most of the benefits would seem to be in the commercial and civil space sectors while the potential drawbacks might be most severe for the military and intelligence sectors. The United States most likely would not, for example, want the ephemeris on its military and intelligence-gathering satellites to be pre-approved and available worldwide through an STCS. At the very least, since an STCS could be such a powerful tool for denial, deception and even targeting, the United States must think through very carefully exactly what type of control regime would be most appropriate for space and how such a regime would operate in practice.

## Notes

- <sup>1</sup> This paper uses *spacepower* as one word; it is also commonly expressed as two words. United States Air Force Chief of Staff Thomas D. White first used the word *aerospace* in 1958, and the concept that air and space form a seamless operational medium has been the foundational component of Air Force thinking about space ever since. Unfortunately, however, the Air Force is primarily talking to itself by using this word in this way because none of the other services or DoD offices use the word *aerospace* according to the Air Force's definition. *Aerospace*, for example, is only used as an adjective describing industry in the *Space Commission Report* and the word does not even appear in the DoD current space policy statement (Department of Defense Directive 3100.10, *Space Policy*, 9 July 1999).
- <sup>2</sup> Prior to the opening of the space age, the United States, in particular, was very reluctant to define where space began. The Eisenhower Administration's highest priority space policy was expressed in NSC-5520 of May 1955. This policy was designed to distinguish between aerial and satellite overflight and to establish the legitimacy and legality of the latter. It called for using the civilian face of the United States' International Geophysical Year scientific satellite programme as a "stalking horse" to establish the precedent of legal overflight in order to open up the closed Soviet State to photo reconnaissance via the secret WS-117L spy satellite system. The term *stalking horse* is taken

- from R. Cargill Hall, "Origins of US Space Policy: Eisenhower, Open Skies, and Freedom of Space", in *Exploring the Unknown: Selected Documents in the History of the US Civil Space Program*, John M. Logsdon (ed.), Vol. 1, *Organizing for Exploration*, Washington, D.C.: NASA History Office, 1995, pp. 213-29. The United States has not subsequently revisited the issue of where space begins in the light of the changed geopolitical context and declassification of satellite reconnaissance. By using unclassified sources, primarily at the Eisenhower Library, Walter A. McDougall was the first to break through the veil of secrecy surrounding early US space policy in *The Heavens and the Earth: A Political History of the Space Age*, New York: Basic Books, 1985. His book won the Pulitzer Prize for History in 1986.
- <sup>3</sup> Barry D. Watts, *The Military Use of Space: A Diagnostic Assessment*, Washington, D.C.: Centre for Strategic and Budgetary Assessments, February 2001; Steven Lambakis, *On the Edge of Earth: The Future of American Space Power*, Lexington: University Press of Kentucky, 2001; Everett C. Dolman, *Astropolitik: Classic Geopolitics in the Space Age*, London: Frank Cass, 2002; and Robert Preston et al., *Space Weapons: Earth Wars*, Santa Monica: RAND Corporation, 2002.
  - <sup>4</sup> Military use of commercial satellites was a major issue in the 1998 Army After Next wargame and space weaponization, deterrence and pre-emption, and space-to-Earth force application were all critical parts of the Air Force's Schriever 2001 and Future Concepts 2001 wargames. See, for example, "Air Force gains insights from first space wargame", *Air Force News Archive*, available from [http://www.af.news/Jan2001/n20010129\\_0124.shtml](http://www.af.news/Jan2001/n20010129_0124.shtml).
  - <sup>5</sup> Many US Government documents list three rather than four space sectors. Upon closer examination, however, these documents reveal the important contributions of each of the four sectors discussed above. For example, the most recent National Space Policy discusses civil, national security (defence and intelligence) and commercial sectors: National Science and Technology Council, "Fact Sheet: National Space Policy", Washington, D.C.: The White House, 19 September 1996. The term "space sectors" was first used as an organizing typology in President Jimmy Carter's 1978 National Space Policy: National Security Council, "Presidential Directive/NSC-37: National Space Policy", Washington, D.C.: The White House, 11 May 1978.
  - <sup>6</sup> *Space Commission Report*, pp. 10-14.

<sup>7</sup> This section and the next are adapted from Peter L. Hays, James M. Smith Alan R. Van Tassel, and Guy M. Walsh (eds), *Spacepower for a New Millennium: Space and US National Security*, New York: McGraw-Hill, 2000, pp. 3-6.

<sup>8</sup> *Joint Doctrine for Space Operations* (Joint Publication 3-14), Washington, D.C.: The Joint Staff, 9 August 2002, IV-5, JP-14 (p. IV-6-IV-8) describes space control as follows:

“b. **Missions.** Space control operations include surveillance of space, protection, prevention, and negation functions. These operations change in nature and intensity as the type of military operations changes. Prevention efforts can range from deterrence or diplomacy to military action. If prevention efforts fail, protection and negation functions may be performed to achieve space superiority. Negation focuses on denying an adversary’s effective use of space. Prevention, protection, and negation efforts all rely on the ongoing surveillance of space and Earth to make informed decisions and to evaluate the effectiveness of their efforts.

- **Surveillance of Space.** Situational awareness is fundamental to the ability to conduct the space control mission. It requires: robust space surveillance for continual awareness of orbiting objects; real-time search and targeting-quality information; threat detection, identification, and location; predictive intelligence analysis of foreign space capability and intent in a geopolitical context; and a global reporting capability for friendly space systems. Space surveillance is conducted to detect, identify, assess, and track space objects and events to support space operations. Space surveillance is also critical to space support operations, such as placing satellites in orbit. Further, space situational awareness data can be used to support terrestrially-based operations, such as reconnaissance avoidance and missile defence.

- **Protection. Active and passive defensive measures** ensure that US and friendly space systems perform as designed by overcoming an adversary’s attempts to negate friendly exploitation of space or **minimize adverse effects** if negation is attempted. Such measures also provide some protection from space environmental factors. Protection measures must be consistent with the criticality of the mission’s contribution to the war fighter and are applied to each component of the space system, including launch, to ensure that no weak link exists. Means of protection include, but are not limited to, ground facility protection (security; covert facilities; camouflage,

concealment, and deception; mobility), alternate nodes, spare satellites, link encryption, increased signal strength, adaptable waveforms, satellite radiation hardening and space debris protection measures. Furthermore, the system of protection measures should provide unambiguous indications of whether a satellite was under attack or in a severe space weather environment when any satellite anomaly or failure occurs. Finally, attack indications could be so subtle or dispersed that individually, an attack is not detectable. At a minimum, a common fusion point for possible indications from all USG satellites should be provided to allow centralized analysis.

- **Prevention.** Measures to preclude an adversary's hostile use of US or third party space systems and services. Prevention can include military, diplomatic, political, and economic measures as appropriate.

- **Negation.** Measures to **deceive, disrupt, deny, degrade, or destroy** an adversary's space capabilities. Negation can include action against the ground, link, or space segments of an adversary's space system.

- **Deception.** Measures designed to **mislead** the adversary by manipulation, distortion, or falsification of evidence to induce the adversary to react in a manner prejudicial to their interests.

- **Disruption. Temporary impairment** (diminished value or strength) of the utility of space systems, usually without physical damage to the space system. These operations include the delaying of critical, perishable operational data to an adversary.

- **Denial. Temporary elimination** (total removal) of the utility of an adversary's space systems, usually without physical damage. This objective can be accomplished by such measures as interrupting electrical power to the space ground nodes or computer centres where data and information are processed and stored. For example, denying US adversaries position navigation information could significantly inhibit their operations.

- **Degradation. Permanent partial or total impairment** of the utility of space systems, usually with physical damage. This option includes attacking the ground, control, or space segment of any targeted space system. All military options, including special operations, conventional warfare, and information warfare are available for use against space targets.

•• **Destruction. Permanent elimination** of the utility of space systems. This last option includes attack of critical ground nodes; destruction of uplink and downlink facilities, electrical power stations, and telecommunications facilities; and attacks against mobile space elements and on-orbit space assets.”

<sup>9</sup> Ibid., p. IV-10.

<sup>10</sup> Satellites in LEO fly in the region of less than 100 miles to several hundred miles altitude and complete each orbit in approximately 90 minutes. Polar LEO is ideal for many spy satellite and weather applications because from this orbit satellites can look down on all parts of the Earth several times each day as the Earth rotates beneath and they can also be aligned in Sun Synchronous Orbits that arrive overhead the same location at the same time each day. Satellites in Semi-Synchronous Orbit are located at approximately 12,500 miles altitude and complete an orbit every 12 hours. GSO is located approximately 22,300 miles above the equator, a location where the satellites’ orbital velocity matches Earth’s rate of rotation and the satellite appears to remain motionless above the same spot—a very valuable attribute for communications satellites. NPOESS is a system that is currently being jointly developed by the National Oceanic and Atmospheric Administration (NOAA) and DoD that will merge their separate meteorological satellite systems into one system scheduled for its first launch in 2005. The AEHF programme is developing the successor to the MILSTAR system and currently plans its first launch in 2006. The WGS is scheduled to launch a satellite in 2004. It is designed to bridge the gap between the current DSCS and GBS systems and a future advanced wideband system. For more information, see the Air Force Association’s “Major Military Satellite Systems” web page at [http://www.afa.org/magazine/space/satellite\\_systems.html](http://www.afa.org/magazine/space/satellite_systems.html).

<sup>11</sup> Lt. Col. David E. Lupton, *On Space Warfare: A Space Power Doctrine*, Maxwell Air Force Base, Alabama: Air University Press, June 1988.

<sup>12</sup> Several of these individuals were quite prolific; the following list represents their best known works: Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660-1783*, Boston: Little, Brown, 1980; Julian S. Corbett, *Some Principles of Maritime Strategy*, Eric J. Grove (ed.), Annapolis: Naval Institute Press, 1988, first published 1911; Giulio Douhet, *The Command of the Air*, Richard H. Kohn and Joseph P. Harahan (eds), Washington, D.C.: Office of Air Force History, 1983, first published 1921; William Mitchell, *Winged*

*Defense: The Development and Possibilities of Modern Airpower—Economic and Military*, New York: Dover, 1988, first published 1925; and John A. Warden III, *The Air Campaign: Planning for Combat*, Washington, D.C.: National Defense University Press, 1988. On the importance of these works see Jon Tetsuro Sumida, *Inventing Grand Strategy and Teaching Command: The Classic Works of Alfred Thayer Mahan Reconsidered*, Washington, D.C.: Woodrow Wilson Centre Press, 1997; Philip S. Meilinger (ed.), *The Paths of Heaven: The Evolution of Airpower Theory*, Maxwell Air Force Base, Alabama: Air University Press, 1997; and David R. Mets, *The Air Campaign: John Warden and the Classical Airpower Theorists*, Maxwell Air Force Base, Alabama: Air University Press, April 1999.

- 13 Virtually all of these concepts are applied throughout the Chief of Staff-directed year-long study by Air University that is published as *SPACECAST 2020*, Maxwell Air Force Base, Alabama: Air University, 1994. See also, for example, Arnold H. Streland, "Clausewitz on Space: Developing Military Space Theory through a Comparative Analysis", Air Command and Staff College research paper, April 1999; and Charles H. Cynamon, "Protecting Commercial Space Systems: A Critical National Security Issue", Air Command and Staff College Research Paper, April 1999.
- 14 In 1997, Howell M. Estes III, then Commander-in-Chief of CINCSPACE, attempted to remedy the lack of a comprehensive spacepower vision or theory by commissioning Dr. Brian R. Sullivan to write a book on spacepower theory. This project was taken over by James Oberg and published as *Space Power Theory*, Washington, D.C.: Government Printing Office, 1999. On the enduring nature of strategy and problems with developing spacepower theory, see also Colin S. Gray and John B. Shelton, "Spacepower and the Revolution in Military Affairs: A Glass Half-Full", in *Spacepower for a New Millennium*, pp. 239-258; and Colin S. Gray, *Modern Strategy*, Oxford: Oxford University Press, 1999, pp. 243-267. The 2001 publications by Watts, Lambakis, and especially Dolman (*The Military Use of Space, On the Edge of Earth* and *Astropolitik*) will undoubtedly go a long way towards filling the yawning spacepower theory gap in the literature.
- 15 Hays and Mueller, "Going Boldly—Where?", p. 37.
- 16 Lt. Col. Dennis M. Drew, "Of Leaves and Trees: A New View of Doctrine", *Air University Review*, Vol. 33, No. 2, January-February 1982, pp. 40-48; Lt. Col. Charles D. Friedenstien, "The Uniqueness of Space Doctrine", *Air University Review*, Vol. 37, No. 1, November-

December 1985, pp. 13-23; and Col. Kenneth A. Myers and Lt. Col. John G. Tockston, "Real Tenets of Military Space Doctrine", *Airpower Journal*, Vol. 2, No. 4, Winter 1988, pp. 54-68.

- 17 The Air Force published AFM 1-6 on 15 October 1982 and its release was designed to coincide closely with the stand-up of Air Force Space Command on 1 September 1982. For a detailed critique of AFM 1-6, see Peter L. Hays, "Struggling towards Space Doctrine: US Military Space Plans, Programs, and Perspectives during the Cold War", unpublished Ph.D. dissertation, Fletcher School of Law and Diplomacy, Tufts University, May 1994, pp. 400-422.
- 18 Friedenstein, pp. 21-22.
- 19 Myers and Tockston, p. 59. A more up-to-date and outstanding blueprint for developing space doctrine is provided by Maj. Robert D. Newberry, *Space Doctrine for the Twenty-First Century*, Maxwell Air Force Base, Alabama: Air University Press, October 1998.
- 20 Available from the Center for Strategic and Budgetary Assessments web site, [http://www.csbaonline.org/2Strategic\\_Studies/1Revolution\\_in\\_Military\\_Affairs/Revolution\\_Military\\_Affairs.htm](http://www.csbaonline.org/2Strategic_Studies/1Revolution_in_Military_Affairs/Revolution_Military_Affairs.htm).
- 21 Ibid.
- 22 Ibid.
- 23 Gray and Shelton, "Spacepower and the Revolution in Military Affairs", in *Spacepower for a New Millennium*, pp. 239-258. Emphasis in original.
- 24 The four camps are presented from a US national security perspective; they could also be used for analysis at the global security level. There are also many strands of thought within any of these camps, and some of them might even be contradictory. The four camps are similar to the four space doctrines discussed in Lt. Col. David E. Lupton, *On Space Warfare: A Space Power Doctrine*, Maxwell Air Force Base, Alabama: Air University Press, June 1988 and have been derived from the schools of thought about space weaponization discussed in Lt. Col. Peter Hays and Dr. Karl Mueller, "Going Boldly—Where?", *Aerospace Integration, the Space Commission, and the Air Force's Vision for Space*, *Aerospace Power Journal*, Vol. 15, No. 1, Spring 2001, pp. 34-49. The growing importance of commercial space activity adds a new dimension to this analysis that few of the traditional approaches seem well prepared to incorporate or even address. For a groundbreaking analysis that advocates using economic criteria to separate traditional military space functions from more regulatory functions that would be performed by a new US Space Guard (modelled after the Coast

- Guard), see Lt Col Cynthia A. S. McKinley, "The Guardians of Space: Organizing America's Space Assets for the Twenty-First Century", *Aerospace Power Journal*, Vol. 14, No. 1, Spring 2000, pp. 37-45.
- <sup>25</sup> Sen. Bob Smith, "The Challenge of Space Power", *Airpower Journal*, Vol. 13, No. 1, Spring 1999, p. 33. Prominent space hawk groups include High Frontier, the Heritage Foundation, and the Centre for Security Policy.
- <sup>26</sup> *Report of the Commission to Assess United States National Security Space Management and Organization*, Washington, D.C., 11 January 2001, p. x. Hereafter *Space Commission Report*. Most US space policy, military space doctrine, and military officers probably fall into this camp.
- <sup>27</sup> Maj. William L. Spacy II, United States Air Force, "Does the United States Need Space-Based Weapons?", *CADRE Paper 4*, Maxwell Air Base, Alabama: Air University Press, September 1999, p. 109. See also Maj. David W. Zeigler, "Safe Heavens: Military Strategy and Space Sanctuary", in Col. Bruce M. DeBlois (ed.), *Beyond the Paths of Heaven: The Emergence of Space Power Thought*, Maxwell Air Force Base, Alabama: Air University Press, September 1999, pp. 185-245.
- <sup>28</sup> Lt. Col. Bruce M. DeBlois, "Space Sanctuary: A Viable National Strategy", *Aerospace Power Journal*, Vol. 12, No. 4, Winter 1998, pp. 41-57. This article is one of the most comprehensive and persuasive expositions of the space dove camp.
- <sup>29</sup> Paul B. Stares, *The Militarization of Space, U.S. Policy 1945-1984*, Ithaca: Cornell University Press, 1985.
- <sup>30</sup> Model I (rational actor), Model II (organizational process) and Model III (bureaucratic politics) are commonly used lenses for examining governmental decision-making that were developed by Graham T. Allison in *Essence of Decision: Explaining the Cuban Missile Crisis*, Boston: Little, Brown and Company, 1971.
- <sup>31</sup> See, in particular, the outstanding analysis of trigger events for space weaponization in Barry D. Watts, *The Military Use of Space: A Diagnostic Assessment*, Washington, D.C.: Center for Strategic and Budgetary Assessments, February 2001, pp. 97-106. Watts argues that: "There are at least two paths by which orbital space might become a battleground for human conflict. One consists of dramatic, hard-to-miss trigger events, such as the use of nuclear weapons to attack orbital assets. The other class involves more gradual changes such as a series of small, seemingly innocuous steps over a period of years that would, only in hindsight, be recognized as having crossed the boundary from

force enhancement to force application. For reasons stemming from the railroad analogy ... the slippery slope of halting, incremental steps toward force application may be the more likely path of the two." Watts discusses high-altitude nuclear detonations, failure of nuclear deterrence, and threats to use nuclear ballistic missiles during a crisis as the most likely dramatic trigger events. He illustrates what he considers the most likely of the gradual paths to weaponization by using the development and military implications of railroads as an analogy for space:

"First, orbital mechanics makes satellites more like railroads than aircraft or capital ships; secondly, the main function of these orbital railroads is to collect and transport information to users on Earth, particularly information about enemy forces and capabilities. If this information collection-and-transport use is the main value of satellite systems, then it follows immediately that there are a lot more ways to interrupt space-based or space-dependent information flows than physically destroying satellites. For instance, if an enemy happened to be deriving military information about American force deployments from commercial satellites, an entirely non-lethal solution would be to use diplomatic pressure to cut off the opponent from further information. Other approaches could range from jamming vulnerable segments of the information chain to using terrestrial forces to interdict the satellite ground stations or other nodes through which the information was being routed.

These possibilities have an important implication for our understanding of space warfare. If a terrestrial attack on an adversary's satellite ground station can deny use of certain space-dependent information, then it is plausible to argue that capabilities for space warfare exist today, even though lethal weapons are not currently deployed in orbital space.

It is not difficult to foresee, then, how nations could begin gradually sliding down a slippery slope towards the weaponization of near-Earth space without being fully cognizant of the eventual end state. Over a period of years nations could engage in numerous activities short of outright weaponization that, in the long run, could lead to an environment in which the deployment and use of weapons in or from space would emerge as a logical and natural next step. Consider the following activities:

- using Earth-based lasers to dazzle the optical arrays of electro-optical imaging reconnaissance satellites whenever they appear above the horizon;
- active jamming of imaging radar satellites;
- widespread jamming of GPS location and timing information;
- positioning satellites in orbit in close proximity with the satellites of one's military, economic or political competitors;
- the use of satellites with active, high-power radars to degrade the electronics of adversary satellites; and
- capturing or corrupting the data streams to or from competitors' satellites."

<sup>32</sup> Treaty between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms (START I), signed on 31 July 1991, entered into force on 5 December 1994. Most of the discussion and analysis on START I and II below is drawn directly from T. W. Billick, "Arms Control Implications for Military Operations in Space", pp. 24-30. Lt. Col. Billick developed his outstanding analysis after working on START I and II issues while serving at the Nuclear and Counterproliferation Directorate on the Air Staff.

<sup>33</sup> See "Article-by-Article Analysis of Treaty Text" online, Internet, available from <http://www.state.gov/www/global/arms/starthtm/start/abatext.html#IX>.

Paragraph 2 of Article IX in START I is adopted verbatim from paragraph 2 of Article XII of the ABM Treaty and is essentially identical to subparagraph 2(a) of Article XII of the Intermediate-range Nuclear Forces (INF) Treaty. It prohibits each Party from interfering with the national technical means of verification of the other Party operating in accordance with paragraph 1 of Article IX. This means, for example, that a Party cannot destroy, blind, jam, or otherwise interfere with the national technical means of verification of the other Party that are used in a manner consistent with generally recognized principles of international law. Note that while paragraph 2 of Article IX prohibits interference with national technical means, the prohibition on interference with inspectors during inspections is in the Inspection Protocol.

<sup>34</sup> Ibid.

<sup>35</sup> See the discussion of the Fractional Orbital Bombardment System (FOBS) in the OST regime section above.

- <sup>36</sup> START I, Article IV of Paragraph 4 provides limits on ICBMs and SLBMs used for delivering objects into the upper atmosphere or space. The parties recognized that such use of ICBMs and SLBMs is valid and economical, but they also recognized that such use must be limited because such missiles could also be used for their original purpose of weapons delivery. In order to limit the potential for breakout, paragraph 4 limits each Party to no more than five space launch facilities, which are defined as specified facilities from which objects are delivered into the upper atmosphere or space using ICBMs or SLBMs. Paragraph 4 also provides that these facilities may not overlap ICBM bases; limits each Party to a total of no more than 20 ICBM or SLBM launchers at those facilities, of which no more than 10 may be silo and mobile launchers, unless otherwise agreed; and limits the number of ICBMs or SLBMs at a given space launch facility to no more than the number of launchers at that facility. Space launch facilities are not subject to inspection. The number of space launch facilities and the number of launchers at those facilities may be increased or decreased if the parties agree. Such changes would not require an amendment to the Treaty. These treaty provisions also affect tensions in the commercial space sector between launch service users such as satellite builders and launch service providers. In general, the former have advocated greater use of deactivated ballistic missiles for space launch while the latter do not support such use because it has the potential to flood the market with deactivated ballistic missiles used as space launchers.
- <sup>37</sup> START I, Article X, and the Telemetry Protocol. During the Cold War, the United States invested billions of dollars in intelligence-gathering equipment designed primarily to obtain telemetry data on Soviet ballistic missiles. Gathering and analysing this information was among the most difficult intelligence challenges of the Cold War.
- <sup>38</sup> Agreement between the United States of America and the Union of Soviet Socialist Republics on Notification of Launches of Intercontinental Ballistic Missiles and Submarine-Launched Ballistic Missiles (Ballistic Missile Launch Notification Agreement), signed in Moscow on 31 May 1988, entered into force on 31 May 1988.
- <sup>39</sup> START I article-by-article legal analysis makes specific reference to the national aerospace plane in describing the treaty definition of *airplane* and the treaty prohibition against flight-testing, equipping, and deploying nuclear armaments on an airplane that was not initially constructed as a bomber but has a range of 8,000km or more or an

integrated platform area over 310 sq m. However, the parties did not reach agreement on the applicability of the treaty to future non-nuclear systems. During the negotiations, the United States stated its view that a future non-nuclear system could not be considered a new kind of strategic offensive arm and, thus, would not be subject to the Treaty. The Soviet Union did not accept this view. The parties agreed, in the Second Agreed Statement, that, if “new kinds” of arms emerge in the future and if the parties disagree about whether they are strategic offensive arms, then such arms would be subject to discussion in the Joint Compliance and Inspection Commission. Of course, if one party deploys a new kind of arm that it asserts is not subject to the Treaty, and the other party challenges this assertion, the deploying party would be obligated to attempt to resolve the issue. There is, however, no obligation to delay deployment pending such resolution.

<sup>40</sup> Treaty between the United States of America and the Russian Federation on Further Reduction and Limitation of Strategic Offensive Arms (START II), signed on 3 January 1993. The US Senate provided its advice and consent to ratification of START II on 26 January 1996. The Russian Duma completed ratification on 14 April 2000 with conditions. US Senate review of the modified treaty is pending.

<sup>41</sup> Memorandum of Agreement between the United States of America and the Russian Federation on the Establishment of a Joint Centre for the Exchange of Data from Early Warning Systems and Notifications of Missile Launches was signed in Moscow and entered into force on 4 June 2000. According to the fact sheet released about it:

This agreement—which is the first time the United States and Russia have agreed to a permanent joint operation involving U.S. and Russian military personnel—is a significant milestone in ensuring strategic stability between the United States and Russia. It establishes a Joint Data Exchange Center (JDEC) in Moscow for the exchange of information derived from each side’s missile launch warning systems on the launches of ballistic missiles and space launch vehicles. The exchange of this data will strengthen strategic stability by further reducing the danger that ballistic missiles might be launched on the basis of false warning of attack. It will also promote increased mutual confidence in the capabilities of the ballistic missile early warning systems of both sides. The JDEC will build upon the successful establishment and operation during the millennium rollover of the temporary joint center for Y2K Strategic Stability in Colorado Springs. The JDEC will be staffed 24 hours a

day, seven days a week, with American and Russian personnel. The JDEC is also intended to serve as the repository for the notifications to be provided as part of an agreed system for exchanging pre-launch notifications on the launches of ballistic missiles and space launch vehicles. This agreement is currently being negotiated separately.

Online, Internet, available from <http://www.clw.org/coalition/summit060400launch.htm>.

At least implicitly, JDEC is one response to the potentially dangerous weaknesses the United States perceives in the post-Cold War Russian Federation strategic early warning system. The most chilling example of this took place on 25 January 1995 when the Russian strategic command and control system was activated after computers mistakenly identified a Norwegian research rocket launch as an attacking US Trident II SLBM. Reportedly, the Russians raised their nuclear alert status and President Boris Yeltsin was prepared to activate his nuclear launch codes out of the Russian version of the "football" before the situation was reassessed and the alert status decreased back to normal several minutes later. See Nikolai Sokov, "Could Norway Trigger a Nuclear War? Notes on the Russian Command and Control System", Program on New Approaches to Russian Security Policy Memo Series, memo No. 24, online, Internet, available from <http://www.fas.harvard.edu/~ponars/POLICY%20MEMOS/Sokovmemo2.html>; and Center for Security Policy Decision Brief, 21 November 2000, "Clinton Legacy Watch #50: Stealthy Accord With Russia Threatens to Foreclose US Space Power", online, Internet, available from <http://www.security-policy.org/papers/2000/00-D91.html>.

<sup>42</sup> Memorandum of Understanding on Notifications of Missile Launches, signed on 16 December 2000.

<sup>43</sup> On the spectrum of opinion concerning JDEC and PLNS see, for example, John Steinbruner, "Sharing Missile Launch Data", Pugwash, online, Internet, available from <http://www.pugwash.org/publication/nl/nlv38n1/essay-steinbruner.htm>; and "National Security Alert", Center for Security Policy, 8 December 2000, online, Internet, available from <http://www.security-policy.org/papers/2000/00-A44.html>.

<sup>44</sup> Steven Livingston, "Transparency or Opacity? Technology and Deception Operations", paper presented at the International Studies Association Annual Convention, Chicago, 21-24 February 2001.

Livingston's quotation is from Don E. Tomlinson, *Computer Manipulation and Creation of Images and Sounds: Assessing the Impact*, Washington, D.C.: The Annenberg Washington Program, 1993. See also Ivan Amato, "Lying with Pixels", *Technology Review*, July/August 2000.

- <sup>45</sup> Kimberly Amaral, "The Digital Imaging Revolution: Legal Implications and Possible Solutions", online, Internet, available from <http://www.umassd.edu/Public/People/KAmaral/Thesis/digitalimaging.html>.
- <sup>46</sup> Dehqanzada and Florini, *No More Secrets*, p. viii.
- <sup>47</sup> On 9 June 1999, the Canadian Ministries of Foreign Affairs and Defence announced that they had formed an interdepartmental team of experts charged with developing new "access control" legislation to control Canadian commercial remote sensing satellites. The principles guiding the interdepartmental team are very similar to PDD-23, and the process of drafting and implementing the policy is expected to take up to two years. The News Release and a Backgrounder are online, Internet, at [http://198.103.104.118/minpub/Publication.asp?FileSpec=/Min\\_Pub\\_Docs/101271.htm](http://198.103.104.118/minpub/Publication.asp?FileSpec=/Min_Pub_Docs/101271.htm). Unlike many other dual-use technologies (pharmaceutical plants, for instance), high-resolution remote sensing systems are limited in number, expensive to build, and very difficult to launch or operate covertly. They could, therefore, be more easily controlled than many other types of dual-use technology.
- <sup>48</sup> Kerry Gildea, "NIMA Extends Deal with Space Imaging for Exclusive Imagery Over Afghanistan", *Defense Daily*, 7 November 2001, p. 2; "Eye Spy", *The Economist*, pp. 10-16, November 2001; and Pamela Hess, "DoD Won't Release Pix Until 5 Jan", *Washington Times*, 7 November 2001. In addition, the French Ministry of Defence barred SPOT Image from selling or distributing images of Afghanistan and the surrounding regions to anyone except that Ministry. "Shutter Control for SPOT Over Afghanistan", *Space Newsfeed*, 28 October 2001, online, Internet, available from <http://www.spacenewsfeed.co.uk/2001/28October2001.html>. These decisions have left Cyprus-based ImageSat International as the only company able to provide one-metre commercial imagery of Afghanistan and the surrounding region. Barbara Opall-Rome, "US Data Purchase Opens Doors for ImageSat", *Space News*, 22 October 2001, p. 6.
- <sup>49</sup> Lt. Gen. Bruce Carlson, United States Air Force, "Protecting Global Utilities: Safeguarding the Next Millennium's Space-Based Public Services", *Aerospace Power Journal*, Vol. 14, No. 2, Summer 2000, p. 37. For a more detailed discussion of why GPS does not fit exactly

into existing categories of “natural monopoly”, “public good”, “utility”, or “dual-use technology” see Scott Pace et al., *The Global Positioning System: Assessing National Policies*, Washington, D.C.: RAND Critical Technologies Institute, 1995, pp. 184-189.

<sup>50</sup> Carlson, loc. cit., p. 38. All modern “digital compression” telecommunication protocols such as time division multiple access or code division multiple access require highly accurate timing signals to operate.

<sup>51</sup> Ibid., p. 37. The PanAmSat Corporation’s *Galaxy 4* satellite failed on 19 May 1998.

<sup>52</sup> John M. Logsdon, “Just Say Wait to Space Power”, *Issues in Science and Technology*, Spring 2001; online, Internet, 24 April 2001, at [http://www.nap.edu/issues/17.3/p\\_logsdon.htm](http://www.nap.edu/issues/17.3/p_logsdon.htm).

<sup>53</sup> USSPACECOM perhaps made this “Flag Follows Trade” argument most strongly in *Long Range Plan: Implementing USSPACECOM Vision for 2020*, Peterson Air Force Base, Colorado: USSPACECOM, Director of Plans, March 1998.

<sup>54</sup> Carlson, loc. cit., p. 41.

<sup>55</sup> Planetary defence or the effort to track and eventually defend against potentially life-threatening Near Earth Objects (NEOs) that might impact Earth is another high-profile window for cooperation on a space-related issue, but it does not appear to be a traditional control or regulation effort and is not discussed in this essay. For more information about planetary defence, see, for example, “Preparing for Planetary Defense: Detection and Interception of Asteroids on Collision Course with Earth”, *SPACECAST 2020*, online, Internet, at <http://www.au.af.mil/Spacecast/app-r/app-r.doc>; *Air Force 2025* research paper, “Planetary Defense: Catastrophic Health Insurance for Planet Earth”, online, Internet, at <http://www.au.af.mil/au/2025/volume3/chap16/v3c16-1.htm>; and Brig. Gen. S. Pete Worden, “NEOs, Planetary Defense and Government: A View from the Pentagon”, online, Internet, at <http://www.spaceviews.com/2000/04/article2a.html>.

<sup>56</sup> “Frequently Asked Questions about Orbital Debris”, NASA-Johnson Space Centre, Space Science Branch, online, Internet, at <http://orbitaldebris.jsc.nasa.gov/faq/faq.html>.

<sup>57</sup> Ibid.

<sup>58</sup> The European Space Agency estimates that 44% of the catalogued orbit population (larger than 10cm) originated from the 129 on-orbit fragmentations recorded since 1961. See European Space Agency,

"Introduction to Space Debris", online, Internet, at <http://www.esoc.esa.de/external/mso/debris.html>; and the Aerospace Corporation's "What is Orbital Debris?" web site at <http://www.aero.org/cords/orbdebris.html>. Until fairly recently, several spacefaring States (the Russian Federation in particular) routinely blew up their satellites at the end of their useful life. Inadvertent mixing of propellant and oxidizer and overpressurization of residual fuel or batteries are the most common causes of unintentional explosions.

<sup>59</sup> In LEO (less than 2,000km altitude) the average relative velocity at impact is 10km per second. At this speed: "An aluminum sphere 1.3mm in diameter has damage potential similar to that of a .22-calibre long rifle bullet. An aluminum sphere 1cm in diameter is comparable to a 400lb safe travelling at 60mph. A fragment 10cm long is roughly comparable to 25 sticks of dynamite." In GSO, average relative velocity at impact is much lower (about 200m per second) because most objects in the geostationary ring move along similar orbits. See "What are the Risks of Orbital Debris?", online, Internet, at <http://www.aero.org/cords/debrisks.html>.

<sup>60</sup> Aerospace Corporation, "What is the Future Trend?", online, Internet, at <http://www.aero.org/cords/future.html>. The space shuttle must infrequently (every year or two) manoeuvre away from known orbital debris. Critical components on the International Space Station have been designed to withstand the impact of debris up to 1cm in diameter.

<sup>61</sup> Historic Space Policy documents are available from the Air War College's Gateway, online, Internet, at <http://www.au.af.mil/au/awc/awcgate/histpol.htm>. The first emphasis on orbital debris in National Space Policy came in President Reagan's 11 February 1988 National Space Policy and by the Clinton Administration's 19 September 1996 National Space Policy, mitigation of orbital debris was a major intersector guideline:

"(7) Space Debris

(a) The United States will seek to minimize the creation of space debris. NASA, the Intelligence Community, and the DoD, in cooperation with the private sector, will develop design guidelines for future government procurements of spacecraft, launch vehicles, and services. The design and operation of space tests, experiments and systems, will minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness.

(b) It is in the interest of the U.S. Government to ensure that space debris minimization practices are applied by other spacefaring nations and international organizations. The U.S. Government will take a leadership role in international fora to adopt policies and practices aimed at debris minimization and will cooperate internationally in the exchange of information on debris research and the identification of debris mitigation options."

<sup>62</sup> Leonard David, "Eye in Sky to Track Space Junk", *Space.com*, 7 November 2000, online, Internet, at [http://www.space.com/business/technology/space\\_trafficcontrol\\_001102.html](http://www.space.com/business/technology/space_trafficcontrol_001102.html).

<sup>63</sup> For a detailed discussion of STCS (especially the technical requirements for such a system), see "Space Traffic Control: The Culmination of Improved Space Traffic Operations", *SPACECAST 2020*, online, Internet, at <http://www.au.af.mil/Spacecast/app-d/app-d.html>.