A Frontier Too Far: Is There Credible Justification for the United States to Weaponize Space?

By Wg Cdr Johnny Stringer RAF

The United States has, since Eisenhower, honoured the notion of space as a sanctuary, militarized but not weaponized. However, technological advances, neo-conservative strategists, increasing military and commercial dependence on space systems and fear of 'near peer' rivals have challenged this position. This paper contends that current threats do not provide a strategic imperative for the US to weaponize space, but that the maintenance of space superiority and the need to cater for uncertainty requires activity across the 4 core space power roles. Moreover, the importance of continued space superiority for the US and her allies makes an informed, rational debate on weaponizing space all the more urgent.

Space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man, and only if the United States occupies a position of pre-eminence can we help decide whether this new ocean will be a sea of peace or a new, terrifying theatre of war. [1]

It's politically sensitive, but it's going to happen. Some people don't want to hear this, and it sure isn't in vogue...but - absolutely - we're going to fight in space. We're going to fight from space and we're going to fight into space. [2]

Introduction

For almost 50 years, a mixture of formal treaties and informal consensus has guided spacefaring and space power nations in their approach to the military uses of space. Within the United States, a key principle established by President Eisenhower and honoured by all his successors has been that space should be militarized but not weaponized. Space based assets support conventional terrestrial conflict and underpin the security and assurance of nuclear deterrence, but weapons systems capable of delivering offensive effects from space have been neither manufactured nor deployed. However, this policy is under considerable pressure from both advocates of space weapons and those who reject outright any military use of space or space-based assets. Within policy and lobby groups, opinion is becoming increasingly polarised.

The last 20 years have witnessed a quickening of the pace in space weapons development and advocacy; indeed, the United States Air Force (USAF) leadership declared in 1996 that the Service was transitioning from an air force into an 'air and space force', and ultimately would become a 'space and air force'.[3] In November 2003, the 'USAF Transformation Flight Path' [4] set out an evolving space Operational Concept (CONOPS) in which space-based weapons and supporting systems architectures would enable the US to establish and maintain dominance of the 'Ultimate High Ground'. The US could become the first and probably only 'space hegemon'. The response in academia and the domestic and international political communities has been one of deep unease, although opposition has been largely and surprisingly uncoordinated. Fears of a new arms race in outer space have strengthened calls by Russia and China (amongst others) for an outright ban on weaponizing space; to date, the US has refused to sign any such treaties and is increasingly concerned by the perceived strategic challenge of her 'near peer' space power rivals. The traditional view of space as sanctuary shapes much of the current debate, and underpins the 4 broad schools of space power thinking identified by David Lupton: the 'sanctuary school'; the 'survivability school'; the space control school'; and the 'high ground school'.[5] Within all these schools, an admixture of moral justification, realpolitik, historical precedent, faith in technology and perceived strategic need inform to a greater or lesser extent the differing perspectives.

This paper will contend that there is no compelling strategic case either now or in the near future for the United States to weaponize space, but that prudent Research and Development (R&D) activity is required to provide flexibility against future uncertainty. To support

this thesis and provide the necessary context for assessment, 'space weapons' will be defined before examining the 4 core space power missions: 'Space Support'; 'Space Control'; 'Force Enhancement'; and 'Force Application'. For the US, reliance on on-orbit assets will be shown to underpin terrestrial military supremacy whilst generating significant commercial income; the importance of the commercial sector to future US space strategy will be highlighted, and the extant treaties and legal guidance governing space activity outlined. It will be seen that moral justification has been claimed by diametrically opposed opinion. The paper will then assess the practical considerations shaping possible space weaponization, including the most viable technologies that would enable the deployment of offensive space weapons systems – be they space or terrestrially based.

US reliance on space assets will be shown to represent an operational – and possibly a future strategic – centre of gravity. Moreover, the threat to continued US military and commercial space dominance is real and encompasses a variety of potential actors. In particular, the challenge posed by China will require careful handling, but should not blind the US to other, less obvious opponents. However, these do not threaten to cause sudden and dramatic strategic shock, nor deny the US the continued ability to dominate the high ground of space. Instead, the most likely brake on weaponizing space will be financial; in the near term; this paper contends that the necessary exceptional expenditure is unwarranted, given current American military capabilities. Space weapons will have to justify their inclusion in a future force mix based on cost, unique capability and – ultimately – political acceptability. To date, there are clear and enduring strategic imperatives for the continued militarization of space, but 'technology push', rather than convincingly supported 'strategic pull', has informed the pro-weaponizing viewpoint. More worryingly, the current debate over weaponizing space will be shown to be both ill-defined, debilitatingly polarised and poorly articulated; there is a pressing requirement for more informed and rigorous global public dialogue. To contribute to this process, this paper will advance a strategically coherent approach to the high frontier, centred on mutually supporting activity in the 4 core space power roles.

Defining 'Space Weapons'

There is no agreed definition of 'Space Weapons';[6] for some, the term 'mean[s] things intended to cause harm that are based in space or that have an essential element based in space'.[7] Although useful, this would exclude nuclear-tipped ballistic missiles used in the Anti-SATellite (ASAT) role, any Airborne Laser (ABL) concept, or other land or sea based systems capable of engaging targets in space. USAF Space Command (AFSPC) defines space weapons as 'weapons systems operating from or through space which hold terrestrial targets at risk', whilst including their capabilities – if not specifically naming them – as also being employed for the offensive counter space mission.[8] A precise definition of 'space weapons' and their intended purpose(s) is more than mere semantics; it defines and assists the context of the weaponizing debate. For the purpose of this paper, space weapons are defined as 'Space, land, sea or air-based weapons systems capable of offensively engaging targets in space, and/or space-based systems capable of engaging terrestrial targets'.

The 4 Core Space Power Roles

USAF Space Command – operating under United States Strategic Command

– defines its mission as the defence of the US '..through the control and exploitation of space'.[9] Unsurprisingly, AFSPC's 4 'primary mission areas' map directly to the 4 core space power roles of 'Space Support', 'Force Enhancement', 'Space Control', and 'Force Application'. These 4 roles will be considered in turn; it will be seen that the space weaponization debate - for all bar the pure 'space as sanctuary' school - revolves largely around the last 2 of these roles:

Space Support. 'Space support involves capabilities to provide critical launch and satellite control infrastructure, and capabilities and technologies that enable the other mission areas to effectively perform their missions'.[10] There are now a number of nations or commercial organisations providing 'space lift', ranging from the traditional spacefarers of the US and Russia, through the European Space Agency to newer entrants such as China and the US Orbital Corporation. Of note is the age of current US national launch systems: the Shuttle, and the Titan and Delta family of rockets do not provide the US with a truly modern, reliable and more affordable means of accessing space. In short, the US risks being overtaken in launch capability, with attendant military and commercial risks.

Force Enhancement. 'Space force enhancement provides capabilities that contribute to maximizing the effectiveness of military air, land, sea and space operations'. The provision of capabilities derived from space-based assets that increase the effectiveness of military air, land, sea and space operations.[11] These capabilities include: positioning, navigation and timing assistance from the Global Positioning System (GPS); satellite communications; environmental monitoring; Intelligence, Surveillance,(Target Acquisition and) Reconnaissance (ISR); and Command and Control (C2).[12] As with space launch capability, much of the US national satellite infrastructure is ageing. Improvements are planned to the GPS system – in part driven by the rival European 'Galileo' programme – but US national satellites are few in number and expensive to build; they must repay their investment in long operating lives but in so doing risk technological obsolescence. To address this shortfall, and in tandem with overhauling national launch capability, USAF officials are pushing the notion of 'responsive space' to address the problem identified by outgoing USAF Chief of Staff General John Jumper in Autumn 2005: 'It costs so much to launch a satellite that, when you launch it, you have to pile everything you can on it...why don't we make space launch easier… [so that] we don't mind if [the satellites] only stay operational for months?' [13]

Space Control. '[The ability] to attain and maintain a desired degree of space superiority by allowing friendly forces to exploit space capabilities while negating an adversary's ability to do the same';[14] it is sometimes referred to as 'Counterspace', and prefixed with either 'Defensive' or 'Offensive'. Space control encompasses a number of potential approaches to maintaining space superiority. Although 'offensive counterspace' includes the 'hard kill' aspects of deliberate satellite degradation and destruction, there are a variety of 'soft' options open to the US: satellite up- and downlinks can be jammed; ground stations can be attacked; and most prosaically, potentially damaging commercial imagery can be bought, as occurred during operations over Afghanistan in 2001-02.[15]

Force Application. '[The capability] to execute missions with weapons systems operating from or through space which hold terrestrial targets

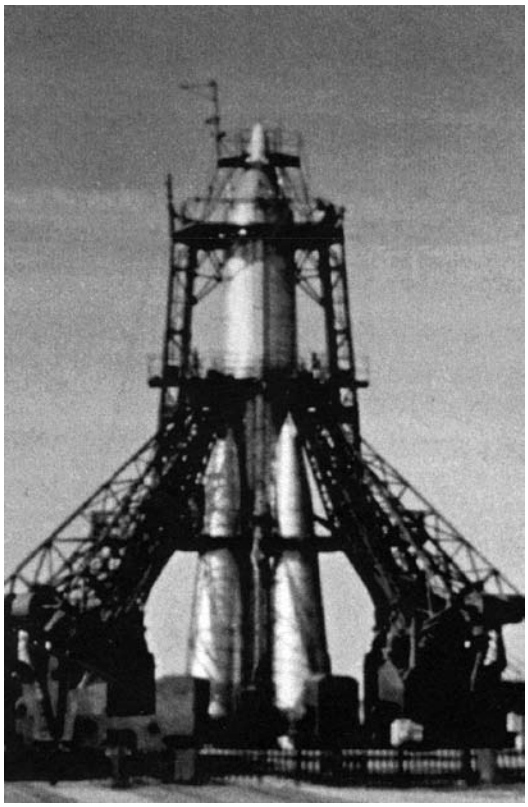
at risk'.[16] 'Force Application' is the most contentious of the 4 core space power roles. To opponents of space weaponization, the ability to hold terrestrial targets at risk illustrates the true purpose of space-based weapons. They are not about space superiority, but earth superiority: 'Space domination is a hegemonic concept. Its essence is monopolization of space and denial of others' access to it. It aims at using outer space for strategic objectives on the ground'.[17] The technologies and concepts that would underpin force application will be discussed later, but it is interesting to note how definitions of this particular role have become blurred. By including weapon systems that merely pass through space, the AFSPC definition confuses militarized space and weaponized space, further stating that 'Space force application includes nuclear deterrence, missile defence, conventional strike and counterair.'[18] The inclusion of 'nuclear deterrence' does not feature in other definitions of the role, and is usually grouped within other 'militarized space' missions or roles; whether this is wilful obfuscation or not, it does not aid objective debate. Additionally, ABM systems that are terrestrially based do not fit obviously into the force application role; rather, any latent ASAT capability could more properly place them in the 'space control' category, albeit not for their primary purpose. Once again, this distinction is important and explains why the US has felt able to deploy Ground Based Interceptors (GBI) at two sites in the US; such systems do not lay the Administration open to charges of weaponizing space and are thus politically acceptable.

The Commercial and Military Importance of Space

Space is a key environment for both civilian and military users; indeed, much of the commercial, personal and military infrastructure of 21st century existence is increasingly dependent on and enabled by space based systems. In 1998, revenue from the global satellite industry totalled $12.4Bn; by 2003, commercial space revenue had increased to $90Bn. In the US alone, the commercial space industry was worth over $95Bn in 2002.[19] In the military sector, modern Western 'network-centric' warfighting is predicated on unfettered access to space. Space based surveillance assets, some of which were originally used to provide security and early warning that underpinned the nuclear deterrents of the US[20] (and USSR), now support conventional warfighting at the tactical level. The GPS constellation provide exceptional '4-D' navigational accuracy (x, y, z axes and time) to support and synchronise battlespace movement, whilst being integral to the targeting process and accurate delivery of satellite-guided munitions, such as the Joint Direct Attack Munition (JDAM); in Afghanistan during 2001-02, over 5000 JDAMs were delivered.[21] As Lambeth has noted, the GPS constellation is '..a particularly glaring US space vulnerability...thanks to our extraordinary dependence on that system'.[22] Imaging satellites provide the commander with an array of intelligence 'product', whilst satellite communications (SATCOM) support increasingly voracious voice, data and imagery transmission needs whilst enabling C2; in Operation Iraqi Freedom, coalition military SATCOM usage peaked at 2.4 gigabits per second[23] and the coalition remained reliant on buying spare civilian satellite capacity to cope with demand.

This use of civilian systems for military purposes illustrates a key aspect of satellites; practically all civilian satellites can be seen as 'dual use' systems, whether they be remote sensing (eg earth imaging) or dedicated to communications. This poses difficult

questions for 'offensive counter-space' proponents of space control; when is a satellite providing a military service for a potential or actual opponent, and when is it employed on purely civilian tasks? To further complicate the picture, the cost of access to space and of the satellites that are put there have driven extensive international collaboration and cooperation; space is not an environment where systems are exclusively either 'theirs' or 'ours'. A recent example of this was the launch onboard a Russian Cosmos 3M rocket of UK, Chinese, Russian and Iranian 'small satellites' in March October 2005. In 2006, 50 nations possessed active space programmes. Moreover, nominally 'Western' satellites can provide sub-1 metre resolution images to any commercial organisation or private individual. The recent product launch of 'Google Earth' brings access via the internet to an impressive array of imagery product; US military commanders have already voiced their concerns that this and similar access provides their opponents with a damaging warfighting enabler. [24]



The launch of Sputnik in 1957 established the notion of freedom of territorial overflight by spacecraft of all nations

Space – the Legal Framework

Further difficulties arise when space is assessed from a legal perspective. The launch of Sputnik in 1957 established the notion of freedom of territorial overflight by spacecraft of all nations, aping the existing freedom of passage embodied in maritime law and refuting the notion of usque ad coelum ('as far as the sky') within air law that extended a state's territorial rights into the 3rd dimension – the airspace above its borders. In short, spacecraft have freedom of innocent passage outside of the earth's atmosphere. Additionally, precedent from the Treaty of the Antarctic (1956) has informed legal understanding of space, culminating in the most significant formal codification of 'space law', the 1967 Outer Space Treaty (OST).

The OST outlines the key broad principles pertaining to man's use of space, amongst which the following impact most obviously on any weaponizing of space: outer space shall only be used for peaceful purposes; outer space cannot be claimed as national sovereign territory; and 'no nuclear or any other kinds of weapons of mass destruction' may be placed in earth orbit or on the Moon. An impressive feat of logic enables 'peaceful purposes' to include space-based surveillance systems and the right to self-defence under Article 51 of the UN Charter. Three further legally ratified treaties (and one that is unratified – The Moon Treaty of 1979) guide the behaviour of states in space and their responsibilities: the 'Agreement of States

on the Moon and Other Celestial Bodies (1968); the Convention on International Liability for Damage Caused by Space Objects (1973); and the Convention on Registration of Objects Launched into Outer Space (1976). Additionally, the Limited Test Ban Treaty (1963) prohibits all nuclear detonations in space, whilst the Anti-Ballistic Missile (ABM) Treaty (1972) banned the development, testing or deployment of sea, land, air or space-based ABM systems, other than at 2 fixed sites in the then USSR and the US.

The US response to this legal framework has been contentious yet has provided freedom of manoeuvre. The ABM Treaty limited options and had been problematic for President Reagan's Strategic Defence Initiative; President Bush's first Administration unilaterally abrogated the treaty in 2002, judging correctly that Russian objections would be sufficiently muted. The OST is arguably less problematic; if US space weapon systems remain clear of the nuclear sphere, nothing in the OST prevents the weaponizing of space.

The future commercial uses of space are yet to be fully determined, but commercial exploitation beyond current data and imaging purposes is a certainty. In 2008, Virgin Galactic will take the first fare-paying passengers into 'near space'; the age of mainstream 'space tourism', heralded by Dennis Tito's fee-paying journey into space in 2001, will have arrived. Asteroids and other bodies could be mined for their mineral content, whilst production in space and eventually colonisation will be a reality, if not for some decades yet. The legal framework that will guide and direct such activity remains nascent, but basic tenets of what could loosely be termed 'space law' have already been the subject of debate. The 'Commons' of the sea, land and air had been subject in Roman times to the distinct Latin principles of *res communis* (a thing for everyone) and *res nullius* (a thing for no one); however, these had been blurred by John Locke's view that the 'admixture of labour' to the latter conferred ownership rights to the labourer. As Dolman has noted, 'The vast and untold resources of space would belong to those first finders who admixed their labour to the extraction therof.'[25]

However, this view of the ownership and exploitation of the 'Commons of Space' brought protests from non-spacefaring nations, who demanded a return from others efforts despite little or no financial contribution or actual participation on their own part.[26] In truth, it is difficult to envisage any spacefaring nation willingly accepting such a proposition. It is more likely that increasingly significant private sector investment in space – and the leverage that such commercial financial commitment brings – will put pressure on national governments to support and protect space assets with the 'hard' power of weaponry, rather than the 'soft' power of legislation and lawyers.[27] The realist school – noting the previous exploitation of the other 3 environments and the creation of environmentally-specific military forces within them – thus sees the development of a military Service(s) and supporting infrastructure within space as inevitable. The paper will return to this theme in its later consideration of strategic imperatives guiding US space strategy.

Space Dominance and Morality

> If [the US is] forced to flight-test or deploy space weapons by the actions of others, that is deeply regrettable. If we take the lead in doing so, that is reprehensible.[28]

Debate over the potential weaponization of space has generated more heat than light; apocalyptic scenarios are invoked by both pro- and anti-weaponizers, with

hyper-realists and liberals, hawks and doves exchanging insults from behind irreconcilable intellectual positions. For the author of 'Arming the Heavens', space weapons can be directly linked to the Nazis;[29] for Baker Spring, 'Arms control advocates…have [pointed to] an idealized outcome by defining the starting point in fictional terms.'[30] Moral justification is claimed by both sides: viz, '..the United States is the morally superior choice to control and seize space, and.. it should endeavour to do so as soon as possible'.[31] In truth, and unsurprisingly, there are considerable shades of intellectual grey between those at the monochromatic extremes of the debate - Upton's 'space as sanctuary' and 'space as high ground' schools.

It has been impossible to attain any international consensus on preventing the weaponization of space; as has been noted previously, the OST and related treaties proscribe certain types of weapons systems from being placed in orbit, and may infer by association prohibitions on other systems. They do not, however, specifically ban them. The United Nation's Conference on Disarmament 'Prevention of an Arms Race in Outer Space' committee has been stalemated on the issue since 1998; Russia and China have been in the vanguard of attempts to gain agreement on an outline framework outlawing all space weapons, despite the USSR deploying a co-orbital ASAT system during the Cold War and consistent rumours of Chinese ASAT programmes.

Disagreement over the morality or otherwise of space weapons have further hindered debate. Speaking in 2001, the Canadian Foreign Affairs Minister stated 'The big red line we all have is the weaponization of outer space, which would be immoral, illegal, and a bad mistake'.[32] A utilitarian philosopher could posit the opposite; if certain weapons provided for the greatest good for the greatest number, then surely they would indeed be moral? The asymmetric edge that current space systems offer the US and her allies allow the prosecution of increasingly precise warfare, limiting casualties on both sides and amongst non-combatants. The Global Network Against Weapons and Nuclear Power in Space may contend that '..satellite systems that identify and direct war on the earth, which essentially allow for 'full spectrum dominance' are not acceptable in our view',[33] but theirs is an extreme and currently ineffectual voice. It would be inconceivable for nations to voluntarily withdraw space-based systems that enable and enhance terrestrial warfighting capability; the dual-use aspects of nominally commercial/ civilian satellites would make it impossible. A more measured assessment within the sanctuary school favours a comprehensive approach to preventing the weaponization of space, including confidence-building measures, the use of existing legal recourse, and treaty negotiations: 'There needs to be the clear, overarching goal of creating a legally binding space security regime and embedding an unequivocal taboo on the deployment or use of weapons in and from space.'[34] Thus, the concept of weaponizing space has - across the spectrum of opinion - seen morality and ethics used to support divergent strategic options.

Space Weapons – Advantages and Limitations

From a scientific and physical viewpoint, space-based weapons have much to commend them. Any system outside earth's atmosphere is at a position of relevant advantage regarding earth's gravity well,[35] whilst earth-based missiles must consume considerable amounts of fuel to overcome their disadvantageous position at the bottom of the well.[36] (This limitation does not

apply to directed energy weapons). Space-based systems should have more time to react to sensed launch events, decide as to whether they constitute threats, and engage that threat early in its flight profile. This is of particular use during a ballistic missile's boost phase, prior to deployment of multiple independent warheads. For strike systems, the effect of gravity imparts significant velocity to a descending munition or vehicle for minimal initial energy expenditure, allowing smaller delivery systems to be employed, and with effect a product of kinetic energy rather than or in addition to an explosive warhead. The vantage point offered by space-basing allows a significant geographical area to be held 'at risk', although this is offset in part by the need to place space weapons in Low Earth Orbit (LEO); the attendant 'absentee ratio' mandates the requirement for multiple systems to offset the transient coverage offered by a single system, due to LEO orbital mechanics.[37]

However, space weapons – and particularly those based in space – have several significant disadvantages, quite beyond the technical maturity of some current concepts and the sheer effort involved in placing systems in orbit. The supporting ISR infrastructure must be reliable and all-sensing, particularly when supporting ABM intercepts or ensuring accuracy and status of terrestrial targets prior to engagement. Of course, if a purposefully hegemonic US was to weaponize space regardless of international opinion, such considerations would be largely irrelevant. Satellites are also inherently predictable due to their orbital path; 'satellite savvy' opponents already predict the overflight of reconnaissance satellites and conceal activity accordingly. The corollary is the ease with which one's own satellites could be targeted by a suitably equipped adversary; of note, the USSR maintained 2 ground-based laser sites at Sary Shagan and Dushanbe during the Cold War that would have been capable of engaging US satellites – weather permitting. [38]

If an opponent could not physically attack or degrade any future US space weapons system(s), there are other methods that could be employed to ensure the likelihood of at least some penetration or survivability of one's own weapons or satellites. The USSR has already tested or is developing ballistic missiles – such as the Topol-M – with enhanced thrust motors that limit the burn time during the boost phase, complicating the detection and tracking process for ABM defences. Manoeuvrable Independent Re-entry Vehicle (MARV) warheads greatly increase the possible impact area, and/or force the continual adjustment of flight profiles for high altitude and terminal phase interceptions. The use of decoys is a known tactic to enhance warhead survivability. Laser attack systems could be countered by wavelength reflective coatings and/or spinning the missile or component body to limit the concentration of laser energy on any fixed spot; however, the effectiveness of these counter-measures against very high powered lasers is uncertain. Satellites can be moved away from potential co-orbital ASAT threats, although at the cost of using precious and irreplaceable on-board fuel. If all else fails, simply saturating any ABM system could do the trick.

The physical destruction of an opponent's space-based systems, missiles or warheads in space creates one final and potentially self-defeating problem: space debris.[39] To date, only one satellite has been known to have been destroyed by extremely high velocity space debris, the French craft 'Cerise', through collision in 1996 – for connoisseurs of irony – with the second

stage from an Ariane rocket launched in 1986. However, between 1981 and 1996, 55 windscreen panes were replaced on the Shuttle fleet following impact with space debris; the 'big space' school of collision avoidance is offset in part by the relatively high density of satellites on a few orbital paths. As the biggest single user of space, and with no current scientifically plausible means of removing extant space debris, the US undoubtedly has the most to lose from fielding destructive ASAT systems; an opponent's satellite may be destroyed, but at an increased risk to one's own constellations. This logic applies equally to other nations that own or are reliant on space-based assets, and may serve to limit development of destructive ASAT systems or techniques.

Space Weapons - Candidate Technologies

Directed Energy Weapons (DEW) – Lasers. The most attractive DEW is the laser, offering speed of response and engagement, and the variety of potential effects that can be created – from disruption of onboard sensors and control processes, to outright destruction. However, both suffer from fundamental limitations that limit their utility. Chemical lasers require fuelling, and thus have a finite capacity or number of firings. The effectiveness of the laser reduces at the square of the range to target, requiring space-based systems to be placed in LEO and thus rendering them more vulnerable to attack from earth-based systems.[40] Finally, laser energy suffers from distortion whilst passing through the atmosphere; this must be anticipated during targeting, tracking and laser firing. Lasers do however offer flexibility in basing, as demonstrated by the USAF's ABL programme and Space Based Laser (SBL) concept, and the US Army's land-based Mid-Infrared Advanced Chemical Laser (MIRACL).

Kinetic Energy Weapons. Kinetic Energy (KE) weapons rely solely on the energy released by their own mass during a high velocity impact, whether that be with a space or terrestrial based target. The 'Brilliant Pebbles' concept for engaging ballistic missiles, and the proposed Mach 10+ tungsten penetrators (colloquially known as 'Rods from God') for use against targets on earth illustrate the span of potential utility. Both are relatively lightweight, although the latter would have to contend with extreme heating caused by atmospheric entry. KE weapons also include GBI and other 'direct ascent' weapons such as the USAF's ASAT air-launched missile of the 1980's.

Nuclear Weapons. The potential use of nuclear weapons in space has been possible since the fielding of the first nuclear-tipped ballistic missile. The 3 damage mechanisms would be: direct destruction from detonation; 'electronic destruction' from the attendant and intense electro-magnetic pulse (EMP); or degradation or destruction from charged particles. In 1962, the US 'Starfish' test of a one megaton nuclear warhead 250 miles above Johnson Island in the Pacific (inadvertently) destroyed 7 friendly satellites over a 7 month period, and left the Van Allen radiation belts charged until the early 1970's.[41]

DEW - High-Powered Microwave (HPM) Weapons. HPM weapons produce short-lived but very high bursts of energy, able to disable or permanently destroy sensitive satellite electronics. The 'warhead' required to produce the HPM waveform could be fitted in a small satellite and be effective out to hundreds of metres.[42] HPM weapons offer the attractions of minimal size, technological simplicity, potential for multiple-engagements and 'tuneable' effect. They also offer 'plausible deniability' in their employment.

Space Mines and other Conventional Explosives. The potential to use space mines to cripple or destroy satellites is a further 'hard kill' option; similarly, otherwise innocuous 'small sats' or their larger brothers could be used as explosive 'mules', to be detonated when adjacent to a target space system. The obvious drawback with such weapons is the creation of space debris, and the ability to trace ownership and thus responsibility for the attack. They undoubtedly represent the least advanced end of the space weapons spectrum, but their potential employment cannot be ignored.

Current and Future USAF Space Weapons Development

The USAF Transformation Flight Plan proposed a future development path for the Service, with a heavily revised Space CONOPS as a key element. Three epochs are envisaged: a near-term out to 2010; a mid-term from 2010 to 2015; and a long-term, from 2015 onwards.[43] The systems envisaged across all 3 epochs are both comprehensive and ambitious, designed to ensure continued US dominance of space across all 4 core space power roles. ASAT capabilities would be enhanced with the development of an air-launched missile for use against targets in LEO. Laser development efforts would focus on the ABL and ground-based lasers, but using space-based systems where appropriate, all with their reach significantly enhanced via airship relay mirrors.

The Counter Satellite Communications System (CCS), designed to deny or disrupt an opponent's access and control over their own communications has already been declared operational.[44] Passive system developments would include the Rapid Attack Identification Detection and Reporting System (RAIDRS), designed to identify any attack against a space system.

The Transformation Flight Plan supports continued development of high speed air and space craft; in the near term, the most significant US effort focuses on FALCON – Force AppLication from the CONtinental United states. This Mach 10 vehicle would take-off and land from earth, but be able to deliver kinetic and non-kinetic effect anywhere on the globe within 1 hour. Recent press speculation contends that the US has possessed a similar capability for some years – the so-called 'Black Star' two stage to orbit mother ship and orbiter.[45] Whether the reality is more mundane is a moot point; conceptually, such a system would offer the US unrivalled global strike.

The Financial Quandary

The one certainty over weaponizing space is that it would not be cheap. Realistic forecasts are almost impossible to achieve, although the de-scoping of President Reagan's 'Strategic Defense Initiative' and its mutation over the last 20+ years into a more limited Ballistic Missile Defense programme indicates both the technological challenges and the sheer cost of development and acquisition. Dolman believes (albeit with no supporting justification), that 'Three to five trillion dollars..might just turn the trick'. [46] Unfortunately, by 2025 it is estimated that federal budget expenditure on social security and Medicare/ Medicaid provision will represent 13% of GDP;[47] current fiscal pressure, exacerbated by the costs of the war in Iraq, have caused President Bush to raise the US budget deficit ceiling to in excess of $5 Trillion.[48]

The Strategic Imperatives for Weaponizing Space

'At this moment in history, the United States is in position to take the mantle of hegemony and provide [economic prosperity and liberal democracy] for all humankind. As part of the strategy

for such a collective good provision, the United States must seize physical control of low-Earth orbit and station weapons there with the capacity to engage and destroy targets in space, in the atmosphere, and on the surface of Earth'.[49]

The reliance placed by the US on space-based assets, and the future commercial opportunities offered in space have been outlined previously. For the US, space represents an operational centre of gravity: '[a] capability..from which a nation, an alliance, a military force or other grouping derives its freedom of action, physical strength or will to fight'.[50] The protection of this CoG is therefore vital to success in the military sphere; it is sensible to presume that increasing commercialisation of space will make it a strategic CoG for the US in due course. As Lambakis has noted, 'The United States' expanding, boundless trust in space-based assets to perform a full spectrum of military, civil, scientific, and commercial activities parallels its growing inability to act on Earth without them'.[51] Secure access to space and secure assets in space are thus vital to US national security.

The launch of a Russian satellite. During the Cold War, the chief rival to American dominance in space was the Soviet Union. However, by 1999 the Russian space programme was chronically underfunded

It is, therefore, surprising that the importance of space is not more fully codified within US strategic thinking. Current US National Space Policy dates back to 1996 and the Clinton administration;[52] although work is ongoing to update that document under Secretary of State Rice, it is not expected to be released in the near future. In the meantime, the intellectual vacuum that has resulted has been filled by a variety of papers, plans and visions. Arguably, the report of the 'Commission to Assess United States National Security Space Management and Organization' (the 'Space Commission'), released in January 2001, has provided the most significant direction for policy in the interim. Chaired by Donald Rumsfeld prior to his appointment as Secretary of Defense, the commission undertook a comprehensive analysis of US space activity and the threats posed to US space dominance. Some of its language was emotionally charged, with warnings of an impending 'space Pearl Harbour' designed to heighten awareness of US vulnerabilities and provoke wider debate; 'We are on notice, but we have not noticed'.[53] However, the recommendation that the Air Force should 'organize, train, and equip for prompt and sustained offensive and defensive space operations'[54] has justified subsequent USAF thinking and is clearly embodied within the Transformation Flight Plan.

Understanding the Threat

The potential threats to US space systems encompass the talented computer hacker at one extreme and the near peer competitor at the other, and across the groupings of state and non-state actors. Both pose the necessary capability and intent to threaten US space systems. Additionally, US commercial dominance is challenged by the growing number and capability of other space faring nations.

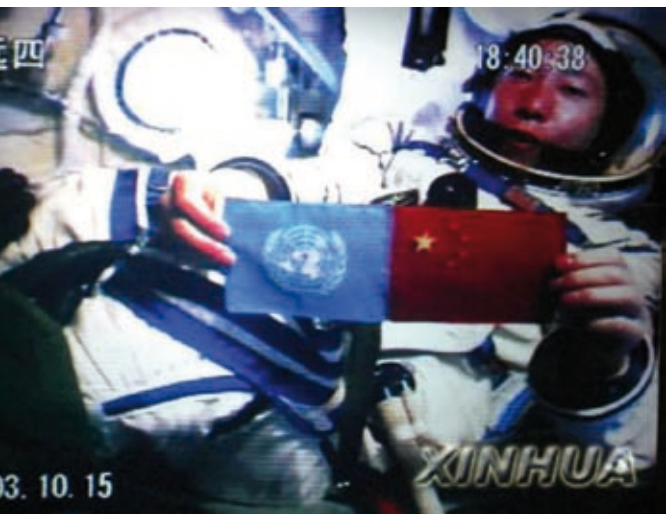
Russia. During the Cold War, the chief rival to American dominance in space was the Soviet Union. However, by 1999 the Russian space programme was chronically underfunded; 70% of her 130 active satellites were operating beyond their planned service lives, and during the Kosovo campaign Russia was unable to monitor NATO's operations over Serbia.[55] Russian expansion into the commercial sector may offset hardship elsewhere, but there is currently no national funding to seriously rival American space dominance; in 2001, the Russian Federation's space budget was $193M, half of the minimum needed by the space agency Rosaviakosmos. In an attempt to ensure an asymmetric response, the Russians have sought to increase the survivability of their Strategic Nuclear Forces through MARV warheads and enhanced boost rockets. It is also conceivable that previous R&D of co-orbital ASATs and ASAT lasers could be re-started, although there is no open source evidence to confirm any current active programmes. Instead, Russia has sought to ban space weapons through international law, whilst observing a unilateral moratorium on deploying ASATs since 1983. It is unlikely however that she would stand by idly if America sought to deploy such weapons.[56]

India. The Indians represent an interesting example of a relatively recent entrant into the community of spacefaring nations. Indian satellite capabilities include imaging and communications, and she possesses the means to launch both her own spacecraft and those of other nations; in time, this may well become a flourishing commercial offshoot. India has no plans to develop offensive space weapons, although the 'Avatar' reusable space plane concept is indicative of a forward-looking space power that sees the clear potential to use space for the more overt support of national security.

The European Space Agency (ESA). The Space Commission identified the need for the US to 'Promote government and commercial investment in leading edge technologies to assure that the U.S. has the means to master operations in space and compete in international markets'.[57] With the exception of mastering operations in space, this statement could equally describe the approach taken by the European Space Agency (ESA). France is the prime mover behind and within ESA, but despite the emphasis in the French '2001-05 Strategic Plan' on the military utility of satellites, it is the commercial market that most energises French thinking.[58] For the United Kingdom, the recently published 'Future Air and Space Operational Concept' notes the ISR contribution provided by satellites; moreover, 'adaptable, affordable small satellite technology providing wide area coverage is a realisable UK aspiration.'[59] It is highly unlikely that the French, British or their European colleagues within ESA would envisage the development of their own space weapons; put simply, there is no strategic benefit or requirement that would drive such a programme.

China. For US policy makers, China represents a number of difficulties. Her economic potential remains largely untapped, but once harnessed

will undoubtedly enable the Chinese to challenge US global trading pre-eminence; Chinese GDP is forecast to treble over the next 20 years.[60] Her nuclear weapons, although low in number and at a reduced state of readiness, have the strategic range to reach the US. Additionally, concerns over human rights and the environment, the enduring impact of Tiananmen Square, and the disputed status of Taiwan all serve to complicate relations between the two nations; for some, China is more 'strategic competitor' than 'strategic partner'.[61] Against this backdrop, US concerns over Chinese space capability can be understood.



China is set to become a major space power pursuing regional and intercontinental objectives. It could be the world number two in space by 2020

China's space programme ('Project 921) is undoubtedly ambitious; the French Centre National d'Etudes Spatiales has forecast that 'China is set to become a major space power pursuing regional and intercontinental objectives. It could be the world number two in space by 2020'.[62] In the last 2 years, the Chinese have conducted two manned Shenzou flights; the second mission included orbital manoeuvring, real time voice and video streaming, and re-entry to within 1 km of planned landing spot, all achievements with clear military utility. The commercial and military benefits of space are clear to the Chinese. The Chairman of China's National People's Congress, Wu Bangguo, stated upon the return of Shenzhuo-6 that 'It [Project 921] is of great significance in elevating China's prestige in the world and promoting China's economic, scientific and national defence capabilities, and its national cohesiveness'.[63] The Chinese military aspire to a national space infrastructure to support terrestrial warfighting, effectively mirroring the US model. China is a partner in the European 'Galileo' programme, and is enhancing its indigenous launch capabilities to support both commercial and military space activity.

Publicly, China remains in the vanguard of those seeking to ban weapons in space and prohibiting attacks against space-based assets. Privately, the position is far less certain. Alexander Neill has suggested that the traditional Chinese tactic of biantan bianda ('attacking whilst negotiating') could be in play, and that little is known of the military Chinese space programme.[64] Certainly, numerous American strategists have identified the need for China to neutralise the United States's space superiority as a prelude to success in any future conflict in the Taiwan Straits.[65] Although much of their analysis has been conducted without reference to the rest of the strategic environment, or rests on the notion of inevitability,[66] O'Hanlon is right to argue that 'It is doubtful that the United States could operate its space assets with impunity, or count on completely dominating military space operations in such a scenario.' [67]

Non-State and Irrational Actors. Current official US thinking on the threat posed to its space systems appears focused on the national capabilities of

rational state actors. An area that is under-researched is the threat posed by non-state actors – a seeming oversight, given the focus of 'the Long War' against international terrorism. Although it is stretching credibility to imagine Al-Qaeda possessing the capability to physically interfere with US assets in space, the US could be vulnerable to computer network attack that blighted part of its satellite constellations. Krepon contends that most terrorist organisations would rather attack terrestrial targets – thus achieving both impact and mass casualties – than attempt to interfere with space-based assets.[68] However, this argument ignores the immense damage that can be caused to a nation's financial well-being by targeted terrorist action, something well understood by the IRA in their attacks against the City of London in the early-mid 1990s. Computer hackers have already attempted to get into US satellite control systems, and the ability to interfere with satellite up- and down-links is well proven. Concerted terrorist action that interfered with satellite command and control could have significant implications for military capability and commercial life; it should not be easily discounted.

Proponents of space weapons point to one final potential threat – the irrational actor. In this scenario, US space assets are deliberately targeted to provide an asymmetric advantage against the superior American opponent, or as a last chance 'roll of the dice' by a regime with nothing left to lose. The irrational actor is unconcerned by likely international reaction nor the damage done to the space environment by his actions. Although such a scenario cannot be discounted, it is highly improbable, and would be reliant on the capability to put a rudimentary (probably nuclear) ASAT into space. The response from the US would be immediate and massive. US Space Policy 'considers the space systems of any nation to be national property..purposeful interference with space systems shall be viewed as an infringement on sovereign rights'.[69] It is also likely that any attack against space capabilities that would reduce US combat effectiveness would concomitantly increase the risk to American servicemen's lives, inviting proportionally greater response and increasing losses on one's own side. It would be a 'lose-lose' option.

Is a Threat Required?

Even if there were no threat to assured US space access and capabilities, neo-conservative strategists such as Dolman and Spring believe the US should place weapons in space regardless. For Dolman, it would guarantee and uphold the imposition of US-style liberal democracy, ensuring benefits for the citizens of a grateful globe from the largesse of a benign hegemon.[70] Clearly, this manifestation of US strategic munificence would not be shared by all; an irrevocably subverted international system is unlikely to be accepted by friend and foe alike. Those, like Spring, from the 'weaponization is inevitable' school may in time be proved right; Gray for one believes that 'Spacepower and space warfare is coming. The only issues are how and when.'[71]

However, the previous assessment of possible threats to US space capabilities does not justify a 'Manhattan Project'-type effort on the part of the current or near future Administration. Indeed, the negative consequences of such a programme would be threefold. Firstly, it is almost inconceivable that other nations would allow the US to weaponize space unchallenged; it is likely they would develop similar weapons systems or counter-measures to negate the asymmetric American advantage. Attempts at preventing further nuclear proliferation could

Maintaining US Spacepower

'Given the dependence of US military forces on space-based assets…it is critical that the Pentagon find ways to protect those assets. I believe that weapons will go into space. It's a question of time. And we need to be at the forefront of that'.[77]

The following options for enhancing US capability across the core space power roles are consistent with all extant treaties and obligations. Importantly, they seek to maintain the maximum freedom of manoeuvre across the relevant lines of development without unnecessary limitations. Specifically, by being consistent with all extant space law, they reject the need for additional treaty negotiation or abrogation. Krepon, O'Hanlon[78] and others see merit in the US engaging in treaty obligations that would prohibit the deployment of space weapons. However, the damage caused internationally by the US abrogation of the ABM Treaty acts as a cautionary note against over-hasty and policy-limiting arms control legislation. The US can maintain freedom of action and the moral high ground by continued informal and unilateral restraint that in time could evolve into more formalised 'rules of the road' in space. Wherever possible, commercial and military space capabilities have been given equal prominence – an essential element where systems are capable of 'dual use'. It will be contended that the US can achieve much and risk little without yet weaponizing space. This section constitutes a realpolitik approach to Dolman's envisaged astropolitik domain.[79]

Space Support. The United States has consistently under-invested in space launch systems; consequently, its fleet of current systems is expensive, elderly and insufficiently reliable to provide the regular access envisaged by USAF's 'responsive space' concept. The enforced recently announced 2 month delay to July 2006 for the next launch of Shuttle[80] mission STS-121 launch merely reinforcesd the extent of the problem that has afflicted both Titan and Delta launches periodically during the 1980s and 1990s.[81] Overhauling launch capability should be viewed as an urgent requirement, with heavy launch systems such as the Enhanced Expendable Launch Vehicle augmented by more novel solutions. A key driver must be reduced acquisition and launch costs, matched to greater reliability; the obvious commercial benefit would be to make US launch capacity attractive to civilian operators and rival the (currently) cheaper launch costs elsewhere.

Space Control. The space control role and the maintenance of assured friendly access to space-based capabilities dictate a holistic approach. Additionally, it is an area where the US must demonstrate a deft political touch to ensure that '..innovative strategic theory with clear policy relevance [is not] impeded by harassment from essentially irrelevant, but potent, controversies.'[82] The military uses of space are understood and supported by many who equally and vehemently oppose the need for force application from space. Put bluntly, the US has the opportunity to build a consensus view that is currently lacking.

The deployment of offensive systems to provide space control represents an unnecessary raising of the ante, although the US can use to its advantage in debate the earlier development by the Soviet Union of just such systems, and the latent utility of nuclear ballistic missiles. Given the self-defeating nature of creating space debris through kinetic hard kill of satellites, the US should concentrate

on passive defensive measures of its own systems. Currently, only high value satellites such as the DSP and MILSATCOM series are hardened against enemy ASAT attack; consideration should be given to hardening all critical military or dual use satellites. Reductions in launch cost and the potential for large yet affordable constellations of 'small sats' offer protection through redundancy; the US would not be reliant on a few, high value satellites but could call on the capabilities available within many. Clearly, any denial options that are open to the US may equally be available to her opponents. Satellite up- and down-links must be protected, even as the US should seek to jam or interrupt those that may be used against her. Satellite C2 systems must be protected against CNA, whilst multiplicity in ground stations offers redundancy against physical attack. If all else fails, the US could buy satellite imagery product to reduce the coverage available to others. The variety of options open to the US in ensuring her own access to space and the denial of that to others indicates the inflexibility of solely offensive action against enemy satellites; offensive denial through space weapons represents a poor and selective interpretation of available options, and would be politically damaging.

Force Enhancement. The essential 'Force Enhancement' role is well understood across all levels of warfare, and the US must maintain and develop the current technological edge that it provides to own and friendly forces. Unfortunately, many current systems are approaching the end of their useful lives; replacing them will cost c $60Bn during the next decade,[83] money that will have to be found from a USAF budget struggling to procure and support conventional air breathing systems. Space assets must 'buy themselves' into the force mix; namely, they must offer similar capabilities available through other means at significantly cheaper cost, or offer a step change in capability. Given this, any move of air breathing C4ISR capability into space (such as the replacement of the Boeing E3 AWACS fleet by Space Based Radar) should be programmed against current system obsolescence. Even then, prudence dictates a residual air breathing capability may still be required to offer redundancy.

The use of civilian systems in support of the military should continue; indeed, the military must seek to actively leverage off the commercial sector and its spare capacity where practicable to reduce costs and promote redundancy. This should be incorporated within the notion of 'responsive space'; advances in 'small sat' technology should help turn vision into reality.

Force Application. Any proposed future development path of space weapons for the force application role could be situated purely on the relatively straightforward aspects of feasibility, cost and actual requirement. Using the methodology of 'buying themselves in' to a future force mix outlined above, space weapons could be assessed alongside conventional alternatives. However, assessment must be reconciled with the political ramifications of weaponizing space; as Lambeth has noted, '..the United States retains the power of the initiative in this respect.'[84] The most effective means of maintaining this position would be to continue R&D into the most practical technologies examined earlier; in the near term, lasers and other DEW offer the most promise. Such a strategy ensures continual understanding of 'the art of the possible' and represents a prudent insurance policy. Failure to maintain the technical wherewithal to deploy space weapons would represent

a deliberate choice not to plan for unknown future outcomes; it would thus invite strategic shock through well-intentioned but utterly unsupported good faith in other nations. A benign and optimistic view of international relations is no foundation for national security policy.

One promising concept for continued development and potential deployment is that of the hypersonic 'space plane'. The conventional take-off and landing characteristics of FALCON-type concepts, and their use of both air and space as mediums for flight, blur the line between militarized and weaponized space. As such, the delivery of kinetic or non-kinetic effect from such a vehicle could be seen more in the context of 'earth wars', rather than 'star wars'. There would undoubtedly be significant domestic and international debate over deployment of such a system, but one could equally argue that the Shuttle is conceptually almost identical. If nothing else, the debate should be had.

Conclusion

Twenty years on from the Strategic Defence Initiative, the United States possesses the technological capability to implement the development, production and deployment of space weapons. The epochs envisaged by the Transformation Flight Plan are not a generation away; they are the near term. It is a sobering thought. The neo-conservative think-tanks' views of a benign American global hegemony – underwritten by space-based weapons – cannot be dismissed as mere 'arrogance'. The US is uniquely placed to dominate space and earth if she so chooses; it is incumbent on those who do not share that view to provide a rational, evidential and convincing rebuttal.

This paper has argued that there is no clear strategic imperative for the United States to weaponize space, and that the threats posed by a raft of nations and other actors do not – in the near term – require Eisenhower's principle of 'militarized, not weaponized' space to be superseded. Conventional US military capabilities – further maximized by 'space force enhancement' – are unmatched; America is not approaching a 'tipping point' where her current space-derived asymmetric edge requires the added contribution of space weapons. Instead, extant capability in 3 of the 4 core space power roles should be either enhanced or upgraded; in the case of 'force application', the need to provide a 'hedge'[85] against future uncertainty is more than sufficient justification for continued R&D activity.

Space-based systems represent a military and, increasingly, a commercial centre of gravity for the United States; failure to provide for their continued security would be to ignore a vital national interest and to compromise both national security and de facto that of her increasingly space-reliant allies.

What is equally apparent is the pressing need for a rational and considered debate regarding the weaponization of space; current discussion and analysis relies on ill-informed yet entrenched dogmatism and the simplistic, selective and subjective treatment of a complex and multi-faceted issue. For Mueller:

'The polarization of the space weaponization debate…discourages real dialogue among those who favor different military space policies. Many of the debate participants appear to be interested only in preaching to their fellow believers, treating their adversaries' arguments so dismissively that they cannot possibly change the minds of those who view the

issues differently from themselves. The marketplace of ideas breaks down when contending camps turn inward from healthy competition to mercantilist isolationism'.[86]

It is difficult to disagree with this depressing but accurate assessment. That discourse has sunk to this low is due to more than the usual animosity felt between those holding mutually exclusive positions on space policy and strategic necessity. There is a clear need for better definition and articulation of that policy and strategy within the current Administration.

'..what one can say about the current US space strategy is that it most certainly is not decisive, guiding, or illuminating. In a word, it is not strategic'.[87]

As US National Space Policy approaches its tenth anniversary without overhaul this year, the strategic environment has altered so radically in the intervening period that its continued value must be questioned. The vacuum created by outdated policy has been filled by a diverse assortment of – amongst others - would be-strategists, technophiles, arms control campaigners and single-issue zealots. The 'Space Commission' report could have acted as a catalyst for informed debate to support a process of continual evaluation and development of space policy and American space strategy. That it has not represents more than a missed opportunity; it marks a failure to adequately engage nationally and internationally on a key policy area. Space weapons are more than just another way of waging warfare; their deployment - by unilateral choice or clear strategic necessity - would be emblematic of American hegemonic political power within the international system. For the United States, it is a vitally important strategic issue.

Bibliography

Books

De Blois, Bruce (2002), Beyond the Paths of Heaven: the Emergence of Space Power Thought (Hawaii: University Press of the Pacific).
Dolman, Everett (2002), Astropolitik. Classical Geopolitics in the Space Age (London: Frank Cass).

Grossman, Karl (2001), Weapons in Space (New York: Seven Stories Press).

O' Hanlon, Michael (2004), Neither Star Wars Nor Sanctuary: Constraining the Military Uses of Space (Washington: Brookings Institute Press).

Hays, Peter (with Smith, van Tassel and Walsh, editors) (2000), Spacepower for a New Millenium. Space and US National Security. (New York: McGraw-Hill).

Krepon, Michael (with Clary, Christopher) (2003), Space Assurance or Space Dominance? The Case Against Weaponizing Space (Washington: Henry L. Stimson Center).

Lambeth, Benjamin (2003), Mastering the Ultimate High Ground. Next Steps in the Military Uses of Space (Santa Monica: RAND).

Johnson, Dana (with Pace and Gabbard) (1998), Space: Emerging Options for National Power (Santa Monica: RAND).

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

Preston, Bob (with Johnson, Edwards, Miller and Shipbaugh) (2002), Space Weapons, Earth Wars (Santa Monica: RAND).

UK Joint Doctrine and Concepts Centre (JDCC), (March 2004 Edition), JWP 5-00 Joint Operations Planning (Shrivenham: JDCC).

Papers

Abbey, George and Lane, Neal (2005), United States Space Policy: Challenges and Opportunities (Cambridge MA: American

Academy of Arts and Sciences)

British National Space Centre (1999), United Kingdom Space Strategy 1999-2002: New Frontiers (London: BNSC Information Office).

Directorate of the Air Staff UK MOD (2005), Future Air and Space Operational Concept (Northolt: RAF No 1 AIDU).

Donnelly, Thomas (with Kagan and Schmitt) (2000), Rebuilding America's Defenses: Strategy, Resources and Forces for a New Century (Washington: Project for the New American Century).

Silvestri, Stefano (December 2003), 'Space and Security Policy in Europe: Executive Summary', European Union Institute for Security Studies Occasional Paper No 48. (European Union Institute for Security Studies: Paris)

Spacy, William (1999), Does the United States Need Space-Based Weapons? (Maxwell: Air University Press).

Weiss et al (2004), Ensuring America's Space Security: Report of the FAS Panel on Weapons in Space – Draft (Washington: Federation of American Scientists).

Articles

Belote, Howard (Spring 2000), 'The Weaponization of Space: It Doesn't Happen in a Vacuum', Aerospace Power Journal, Vol XIV No ,1 pp.46-52

Dueck, Colin (October 2004), 'Ideas and Alternatives in American Grand Strategy, 2000-2004', Review of International Studies, Vol 30 No 4.

Gale, William and Orszag, Peter (December 2004), 'The US Budget Deficit: on an Unsustainable Path', New Economy (c/o Brooking Institute), pp.236-242.
Grenier, John (Spring 2001), 'A New Construct for Air Force Counterspace Doctrine', Aerospace Power Journal, Vol XVI No 3 pp. 17-23.

Hays, Peter and Mueller, Karl (Spring 2001), 'Going Boldly – Where? Aerospace Integration, the Space Commission, and the Air Force's Vision for Space', Aerospace Power Journal, Vol XV No 1, pp.34-49.

Hitchens, Theresa (2003), 'Monsters and Shadows: Left Unchecked, American Fears Regarding Threats to Space Assets Will Drive Weaponization', UNIDIR: Making Space for Security? pp. 15-32.

Hyten, John and Uy, Robert (Summer 2004), 'Moral and Ethical Decisions Regarding Space Warfare', Air & Space Power Journal, Vol XVIII No 2, pp. 34-49.

Hyten, John (Fall 2002), 'A Sea of Peace or a Theatre of War? Dealing with the Inevitable Conflict in Space', Air and Space Power Journal, Vol XVI No 3, pp. 78-92.

Johnson, Rebecca (2003), 'Security Without Weapons in Space: Challenges and Options', UNIDIR: Making Space for Security? pp. 53-66.

Neill, Alexander (November 2005), 'Project 921: China's Quest to Conquer Space', RUSI Newsbrief, Vol 25, No 11, pp. 128-130.

Sirak, Michael (5-12 Oct 2005), 'Battle for Space', Jane's Defence Weekly pp. 24-29.

Tirpak, John (July 2004), 'Securing the Space Arena', Air Force Magazine, Vol 87, No 7, pp.30-35

Wolff, Johannes (2003), ' 'Peaceful Uses' of Outer Space has Permitted its Militarization – Does it Mean its Weaponization?', UNIDIR: Making Space for Security? pp. 5-14.

Zhang, Hui (December 2005), 'Action/ Reaction: U.S. Space Weaponization and China', Arms Control Today, Vol 35, No 10, pp. 6-11.

Internet Sources

www.afa.org
http://www.afa.org/magazine/archve.asp .
http://www.afa.org/magazine/March2006/0306space.asp accessed 15 Mar 06.

www.af.mil
www.af.mil/library/posture/ AF_TRANS_FLIGHT_PLAN-2003.pdf accessed 3 Feb 06.
www.af.mil/factsheets/factsheet.asp?id=155 accessed 9 Jan 06.

www.airpower.maxwell.af.mil http://www.

airpower.maxwell.af.mil/airchronicles/back.htm Articles accessed Jan – Mar 06.

www.armscontrol.org
http://www.armscontrol.org/act/2004_11/Krepon.asp accessed 20 Feb 06.

www.aviationnow.com/avnow
http://www.aviationnow.com/avnow/search/autosuggest.jsp?docid=591587&url=http%3A%2F%2Fwww.aviationnow.com%2Favnow%2Fnews%2Fchannel_awst_story.jsp%3Fview%3Dstory%26id%3Dnews%2F030606p1.xml accessed 10 Mar 06.

www.cbo.gov
http://204.157.14.2/ftpdocs/70xx/doc7069/03-14-presidentsbudget.pdf accessed 14 Mar 06.

www.cdi.org http://www.cdi.org/program/document.cfm?DocumentID=2885&StartRow=11&ListRows=10&appendURL=&Orderby=D.DateLastUpdated&ProgramID=68&from_page=index.cfm accessed 29 Jan 06.

http://www.cdi.org/friendlyversion/printversion.cfm?documentID=2080 accessed 27 Jan 06

http://www.cdi.org/friendlyversion/printversion.cfm?documentID=1745 accessed 3 Feb 06.

www.defenselink.mil
http://www.defenselink.mil/pubs/space20010111.html accessed 29 Jan 06.

www.globalsecurity.org/space http://www.globalsecurity.org/space/library/news/2005/space-050322-rianovosti01.htm accessed 3 Feb 06.

www.gwu.edu
www.gwu.edu/~spi/spaceforum/ TotemandTabooGWUpaperRevised%5B1%5D.pdf accessed 17 Mar 06.
http://www.gwu.edu/~spi/spaceforum/Dolmanpaper%5B1%5D.pdf accessed 27 Feb 06.

www.heritage.org
http://www.heritage.org/Research/NationalSecurity/hl877.cfm accessed 29 Jan 06.

www.jamesoberg.com http://www.usatoday.com/printedition/news/20050614/oplede14.art.htm accessed 10 Mar 06.

www.nasa.gov http://www.nasa.gov/pdf/144747main_shuttle_update_trans_20060314.pdf accessed 15 Mar 06.

www.newamericancentury.org
www.newamericancentury.org/RebuildingAmericasDefenses.pdf accessed 15 Mar 06.

www.ostp.gov/NSTC/html/fs/fs-5.html accessed 1 Mar 06.

www.space.com
http://www.space.com/news/garwin_spaceweapons_041108.html accessed 31 Jan 06.

www.space4peace.org
www.space4peace.org/statement/gnobj.htm accessed 2 Feb 06.

www.stimson.org
http://www.stimson.org/wos/?SN=WS20050210773 accessed 23 Feb 06.

www.unidir.org
http://www.unidir.ch/bdd/fiche-periodique.php?ref_periodique=1020-7287-2003-1-en accessed 28 Jan 06.

Notes

1 President John F.Kennedy. Speech at Rice University, 12 September 1962.
2 General Joseph Ashy, Commander-in-Chief US Space Command, 1997. From Dolman (2002), p.151
3 Lambeth (2003), p.2
4 www.af.mil/library/posture/ AF_TRANS_FLIGHT_PLAN-2003.pdf
5 DeBlois (2002), pp.xi-xii
6 Jane's Defence Weekly, (5-12 Oct 2005) p.27
7 Preston (2002), p.23
8 http://www.af.mil/factsheets/factsheet.asp?id=155
9 Id.
10 Id.
11 Id.
12 Id.
13 http://www.afa.org/magazine/March2006/0306space.asp
14 http://www.af.mil/factsheets/factsheet.asp?id=155
15 O'Hanlon (2004), p.38
16 http://www.af.mil/factsheets/factsheet.asp?id=155
17 Wang Xiaoyu, in Grossman (2001), p.24

18 AFSPC definition, October 2005
19 Abbey and Lane (2005), p.3
20 Eg Defence Support Program (DSP) early warning satellites.
21 O'Hanlon (2004), p.3
22 Lambeth (2003), p.103
23 O'Hanlon (2004), p.4
24 Insurgents 'using Google Earth', Daily Telegraph, 18 December 2005.
25 Dolman (2002), p.99
26 Ibid, p.101
27 Author's private correspondence with LTC (Ret'd) Mike Wills USAF.
28 Krepon, quoted in Jane's Defence Weekly (5-12 Oct 05) p.26.
29 Grossman (2002), p.63-66
30 http://www.heritage.org/Research/NationalSecurity/hl877.cfm, p.1
31 http://www.gwu.edu/~spi/spaceforum/Dolmanpaper%5B1%5D.pdf, p.1
32 Author's note: since submission of this paper, the Chinese have successfully demonstrated ASAT capability in a test conducted in Jan 07. See: http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2007/01/23/wchina123.xml
33 Hyten and Uy (2004) p.34
34 www.space4peace.org/statement/gnobj.htm
35 Johnson (2001), p.57
36 Dolman (2002), p.71
37 http://www.gwu.edu/~spi/spaceforum/Dolmanpaper%5B1%5D.pdf p.7
38 Preston (2002), p.26
39 Hitchens (2003), p.26
40 www.timesherald.com/site/news.cfm?BRD=1672&dept_id=33380&newsid=7150352&PAG=461&rfi=9
41 Spacy (1999), pp.11-21
42 O'Hanlon (2004), p.69
43 Ibid, pp.69-70
44 www.af.mil/library/posture/ AF_TRANS_FLIGHT_PLAN-2003.pdf pp.69-93.
45 'Securing the Space Arena', Air Force Magazine, Vol 87, No 7.
46 http://www.aviationnow.com/avnow/search/autosuggest.jsp?docid=591587&url=http%3A%2F%2Fwww.aviationnow.com%2Favnow%2Fnews%2Fchannel_awst_story.jsp%3Fview%3Dstory%26id%3Dnews%2F030606p1.xml
47 http://www.gwu.edu/~spi/spaceforum/Dolmanpaper%5B1%5D.pdf, p.25
48 Gale and Orszag (December 2004), p.238
49 http://news.bbc.co.uk/2/hi/middle_east/4827248.stm
50 http://www.gwu.edu/~spi/spaceforum/Dolmanpaper%5B1%5D.pdf , p.2
51 JWP 5-00, pp.2-6
52 Lambakis (2001), p.112
53 www.ostp.gov/NSTC/html/fs/fs-5.html
54 http://www.defenselink.mil/pubs/space20010111.html, p.30
55 Lambeth (2003), p.82
56 Lambakis(2001), p.160
57 Jane's Defence Weekly (5-12 October 2005), p.28
58 http://www.defenselink.mil/pubs/space20010111.html , p.8
59 Hitchens (2003), p.28.
60 FASOC (2005), pp.21-22
61 http://www.defenselink.mil/news/Jul2005/d20050719china.pdf p.20
62 Condoleezza Rice, from Dueck (October 2004), p.524
63 Hitchens (2003), p.24
64 RUSI News Brief (November 2005), p.129
65 Ibid, pp.129-130
66 For example, O'Hanlon (2004), Ch.4 and Krepon (2001), pp.52-54
67 http://www.heritage.org/Research/NationalSecurity/hl877.cfm pp.3-5
68 O'Hanlon (2004), p.103
69 Krepon (2003), pp.44-47
70 www.ostp.gov/NSTC/html/fs/fs-5.html pp.1-2
71 http://www.gwu.edu/~spi/spaceforum/Dolmanpaper%5B1%5D.pdf, p.4
72 Gray, in Hays (2000), p.248
73 Air Force Magazine (April 2005), p.36
74 Mueller: www.gwu.edu/~spi/spaceforum/TotemandTabooGWUpaperRevised%5B1%5D.pdf p.21
75 Bull, quoted in Krepon (2003), p.127
76 Lambeth (2003), p.156
77 http://www.usatoday.com/printedition/news/20050614/oplede14.art.htm
78 Peter Teets, USAF Executive Agent for Space, Aerospace Daily, 7 March 2002.
79 O'Hanlon (2004), pp.105-117
80 Dolman (2002), Ch.6
81 http://www.nasa.gov/pdf/144747main_shuttle_update_trans_20060314.pdf
82 Lambakis (2001), pp.113-114
83 Gray, in Hays (2000), p.239
84 Lambeth (2003), p.145
85 Ibid, p.118
86 Krepon (2003) and O'Hanlon (2004).
87 www.gwu.edu/~spi/spaceforum/ TotemandTabooGWUpaperRevised%5B1%5D.pdf p.20
88 Dolman (2002), p.156