Space as a Medium for Warfighting

By Wg Cdr Gerry Doyle

As soon as voyages by sea and in the air became possible, strategic thinkers began to ponder how to exploit the domains that had become accessible. Space in turn followed this trend; indeed to an extent, the thinking anticipated the availability of the technology. In this paper, the author recounts the development, principally by American theorists, and roughly in the period 1955-85, of four identifiable schools of thought relating to Military Space: the 'Sanctuary' school, the 'Survivability' school, the 'High-Ground' school and the 'Theatre' school. Each is described and analysed in its historical context, and tested for coherence and relevance today. Finally, the implications of the dominant model are analysed as far as they might affect the composition of the American armed forces, and used to highlight the unique characteristics of the Space domain.

"Space is a medium like the land, sea, and air within which military activities will be conducted ..."[1]

Introduction

In seventeen words, the author of this innocuous phrase has captured two different debates in the application of strategic theory to space. Anyone who subscribes to it is firstly concurring with the assumptions of the American 'Theatre' school of space power thought. When parsed into two phrases, the first also carries the clear implication that while space is a 'medium', it is also *separate*, distinct from land, sea and air. The second phrase introduces force to the debate, and stakes the military community's claim to the right to exercise it. This paper outlines the debate that took place in the United States in the first half of the Space Age on the proper relationship between space and military operations.

Doctrinal thinkers exist not in a vacuum, but in contention with each other. It is also fair to say that the majority of them live or work in the United States, although there are British and other contributors.[2] To understand the implications of their positions, I will briefly outline the major American schools of thought before comparing them, seeking to establish the superiority of the Theatre model over its alternatives. Then, I will consider the implications for the Theatre model of the military and legal constraints that apply in space, and look at where these make space similar or different from other domains. First, however, we look at the competing schools of thought in space power theory.

Redstone missile on the launch pad at Cape Canaveral, Florida, on May 16, 1958 and was the first Block I Tactical System missile.

Lupton's Categorisation of Space Power Thinking

The opening quote headlining this paper is representative of one of four classical explanations of how the military might interact with space. These explanations evolved separately, predominantly in the USA, sometimes in isolation and sometimes in competition. Their American roots bear on their underpinning assumptions, and a comprehensive summary of them emerged in 1998, the 40th anniversary year of America's first artificial satellite. That work was Colonel David Lupton's *On Space Warfare*.[3] In it, he proposed four different models for thinking about military space:

i. Space as Sanctuary – space is too valuable as a location for observation to risk its loss through encouraging weaponisation.

ii. Space as Vulnerability – the Survivability School – Space

assets are so fragile and vulnerable that nobody should rely on them; they will be denied you by an enemy at the earliest opportunity.

iii. Space as High Ground – The prime use of space is as a location from which to dominate lower-lying terrain. Space is thus the ideal home for a credible counter to ballistic missiles, freeing the Earth from the threat of nuclear annihilation posed by Cold War deterrence postures.

iv. Space as a Theatre – the Control School – Space is another Theatre within which military force can be applied. Power projection is a capability expected of governments, and the military should be configured to protect national assets and deny use of space to those of malevolent intent.

Installation of Explorer 1, the first United States' satellite, to its launch vehicle, Jupiter-C, January 1958.

In order to comment meaningfully on our proposition, we need to examine how each of those classifications addresses the needs of theorists.

The Titan II Intercontinental ballistic missile (ICBM) , one of the most powerful nuclear weapons fielded by the United States during the Cold War.

Sanctuary School – Description

The first tenet of the Sanctuary school is that space should be kept free of weapons. The imagery in this thinking is the tradition of not carrying weapons into church.[4] David Zeigler gives a concise account of its development using Lupton's headings.[5] Space Sanctuary theory was the dominant voice in early US debates on the military utility of space, but it is clear from Zeigler that it was not the only one. In fact, in the foreword to his book, DeBlois explains that he challenged an avowed 'space enthusiast' [Zeigler], which in this context can be read as a 'space weapons enthusiast' to make the case for Sanctuary. De Blois himself proposes a definition of military Sanctuary "...a place where aggressive

forces can be postured, but attacks in that sanctuary would change the nature of the conflict."[6] This tolerance of 'aggressive forces', but not their use, is a subtle extension of classic 'Sanctuary' thinking.

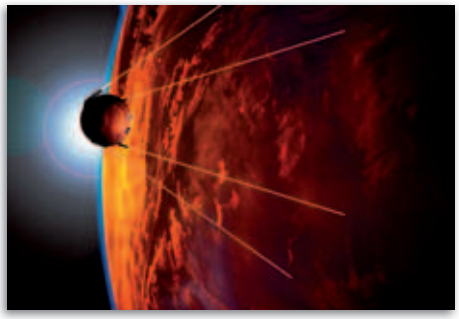
Zeigler assumes (correctly) that military capability serves the ends of policy, and therefore that capability should be assessed against policy utility and not just theoretical possibilities. He explains that there are two theoretical underpinnings to Sanctuary viewpoints; those that are direct counters to the views of weapons advocates, and those based on other models or perspectives. These reasons include potential damage to wider international interests from deployment of weapons, implications for ongoing and future arms control agreements, the possibility of encouraging an arms race in space that one could not be sure of winning, risks to US assets from debris following weapons use and continuing high costs.

Official portrait of President Dwight D. Eisenhower.

President Eisenhower, who can be thought of as the father of the Sanctuary school, arrived at his views by merging a variety of chains of thought.[7] He was the first US President who had to face Space as a theoretical (first term, 1953-7) and practical (second term, 1957-61) aspect of National Security Policy, and was plainly aware of its potential implications. Early studies on the potential of military satellites,[8] and

In 1949, the "Bumper-WAC" became the first human-made object to enter space as it climbed to an altitude of 393 kilometers (244 miles). The rocket consisted of a JPL WAC Corporal missile sitting atop a German-made V-2 rocket.

the declaration of 1957-8 as the International Geophysical Year (IGY) by the International Council of Scientific Unions, provoked both theoretical and practical studies. The USA had additionally exploited much captured material from the German WW2 V2 rocket program, and was well aware of the significance of missiles to the development of nuclear deterrence capability. The impact on the USA of the USSR being first to orbit a satellite (Sputnik 1) in October 1957 (just after the opening of IGY) can fairly be described as 'seismic'. President Eisenhower as the incumbent had to contain the aftermath, as well as trying to manage the developing military space and missile programs, without major conflict with his personal political philosophies.[9] He firstly was a stout



Russian launched the first unmanned satellite into earth's orbit, Sputnik 1 in October 1957.

exponent of 'small government', and looked askance at the near-wartime levels of mobilization of the defence-scientific-industrial complex that he feared would be needed to compete in a space arms race. Secondly, he also advocated fiscal responsibility and balanced budgets; a space weapons contest would be a serious challenge to that doctrine. Yet he also recognised that needless overmatching of the Soviet Union in the ongoing nuclear arms race would be wasteful, but that establishing the prudent minimum deterrent required detailed information on Soviet capability.[10]

NASA mission control computer room with dual IBM 7090's, apparently taken around the time of the Mercury Atlas 6 (MA-6) mission in 1962.

Thus, he crafted a policy based on peaceful exploration of space, though with military reconnaissance regarded as a 'peaceful' application. Evidence of this was his formation of the National Aeronautics and Space Administration – NASA – a *civilian* body. Eisenhower's views were influenced by his Special Assistant for Science and Technology, Dr James Killian. "Killian … noted that many scientists held "deeply felt convictions" opposing Defence Department control of the space program because they felt it would limit space research strictly to military objectives and would tar all U.S. space activity as military in nature."[11] The Sanctuary school of thought thus originates in the earliest days of spaceflight, but perhaps more importantly for its implications, also at the height of the American nuclear arms build-up in the Cold War.

Sanctuary School - Critique

Fifty years after its formulation, tenets of the Sanctuary school survive. Space-based weapons do not threaten the earth, and international treaties have placed limits on their development. Reconnaissance remains a key military use of space. Space-based surveillance still drives the operation of deterrent systems and cues the nascent counters to ballistic missiles. However, the passage of time has also blunted some of the debates that the Sanctuary school illuminated, and it is difficult to see where policy decisions have been influenced by their arguments. They have thus become descriptive rather than prescriptive.

The biggest development is the fact that, although weapons may not be based directly in space, many current terrestrial systems are implicitly and explicitly dependent on space-based capability. These include precision-guided munitions, reliant on GPS

guidance in flight and dropped from GPS-guided platforms. They also include the varieties of military capability now available from unmanned platforms, which rely implicitly on SATCOM and GPS for their safe operation. Modern command and control of military operations depends on space enabled capability. Although weapons themselves have been excluded from the Sanctuary, the moral imperatives of Sanctuary-idealists are not in the ascendant.

Technicians prepare the SATCOM V satellite for launch, image taken 13 October 1982.

Survivability School - Description

Unlike the Sanctuary model, the Survivability school lacked a champion in a senior position. Rather, it grew out of theoretical and then practical analysis of possible counters to space activity. Lupton covers the precepts of the school well himself. DeBlois and Zeigler conflate Sanctuary and Survivability, noting that they have much in common though they lead to differing conclusions, and in fact confine the great majority of their analysis to Sanctuary theory. Since the defining concept of the school is that space assets are uniquely vulnerable, Lupton proposes that 'Vulnerability' model would be a better name.[12] To qualify the theories as a true school of thought, advocates must demonstrate not only that the assets are vulnerable, but that there is something systemic in this vulnerability.

Survivability advocates note the practical possibilities of anti-satellite weapons; rudimentary systems have been in existence since the early 1960s.[13] The exact position taken by such theorists have thus varied according to the state of the art at the time of writing. Early American high-altitude nuclear tests inadvertently revealed the vulnerability of contemporary systems, most notably the 'Telstar 1' communications satellite, which was launched to great fanfare in August 1962, but which had failed catastrophically within 6 months as a result of

Telstar 1 Communications Satellite.

exposure to radiation caused by one of the nuclear test shots.[14] Although unintended, that very public failure, and damage done to other satellites by the same shot, showed the way

to a practical, albeit unselective, anti-satellite system. At this stage, the Vulnerability school believed that since there were few satellites, military or otherwise, in orbit, and since a small number of incidents had had severe impact on them, their basic premise – that space systems had a systemic weakness – was established. The mechanism of Telstar 1's failure was in fact more complex than this. It had failed because the nuclear test explosion had caused an accumulation of radioactive particles in the inner Van Allen belt surrounding the Earth, and Telstar 1's elliptical orbit passed through this band repeatedly.[15] Other failures may have been due to the direct blast from the explosion or its immediate consequences, but high-altitude nuclear explosions were far from being the all-powerful 'satellite killers' that some may have feared. Soon after this, however both the USA and the USSR began work on practical anti-satellite systems.

SS-9 Scarp ICBM loading.

The Soviet system was based on the SS-9 SCARP missile. The SS-9 existed in multiple variants, and when used as an ICBM was characterised by its ability to loft a massive warhead over long ranges. As an anti-satellite system, it would carry a smaller payload, which would manoeuvre in orbit to reach lethal proximity with its target prior to detonating and destroying its target with shrapnel.[16] Tests of the SS-9 anti-satellite were conducted between 1967 and 1973, at which point it was declared operational. Another series of tests was conducted during 1976-83, involving a version with extended capability against higher flying targets. Testing ceased in 1983 and has apparently never resumed. While there is no doubt that the system had (and has) potential in some cases, opinions on its overall effectiveness vary. Lupton asserts that it failed to achieve the required level of lethality to demonstrate systemic vulnerability, citing its limited range, the constraints of launch sites on its ability to achieve co-orbit with a variety of targets and its significant failure rate in test.[17] The generic limitations on anti-satellite systems and their applicability to SS-9 were described succinctly at the time by Kurt Gottfried and Richard Ned Lebow.[18] Zeigler simply notes the existence of the programme. There were those who felt that the system posed a credible threat, however. William Van Cleave asserts a plausible success rate for it, quoting a contemporary USAF assessment of system effectiveness, though at this distance it is difficult to judge whether there was a specific context to such claims, for example to bolster inter-service positioning.[19]

At the same time, the USA was developing and deploying anti-satellite systems to counter another SS-9 variant. This was the fractional-orbital bombardment system (FOBS) variant of the missile, designed to put a nuclear warhead briefly into low-Earth orbit prior to re-entry at the intended target site.[20] The intention from the Soviet point of view was to permit attack on the continental USA

from any direction, such as over the South Pole and across the Pacific from the South West, circumventing anti ballistic-missile systems then in development. The USA deployed two countering systems, both nuclear-tipped, labelled Programs 437 and 505.[21] Program 437 proved the more capable of the two systems and 505 was quickly withdrawn. The distinction was relative, however, as Zeigler makes clear, and for a variety of reasons, including the banning of FOBS systems, the nuclear warhead of both systems representing a potential Test Ban Treaty violation and the geographical basing constraints imposed by the intended target system,[22] the system was deactivated in 1975. Program 437 was based on the launcher portion of the Thor intermediate range ballistic missile, while Program 505 was a derivative of the Nike-Zeus anti ballistic-missile system (itself a development of a surface-to-air missile system).[23]

Nike-Zeus anti-ballistic missile.

Since these early experiments, anti-satellite systems have come and gone. The USAF tested an air-launched satellite interceptor system known as ASM-135 carried by F-15A aircraft between 1982 and 1985, including a destructive test against a US target satellite. This system was

ASAT missile ASM-135 launched from F-15.

abandoned in 1988 for a variety of reasons, including spiralling costs. More recently, the US anti ballistic-missile system was used to destroy the errant 'Flight 193' operational satellite. Separately, China conducted a destructive test on an obsolete weather satellite in January 2007. All these tests might lead one to believe that satellites are now systemically vulnerable, but I would assert that this is not the case.

Survivability School - Critique

Lupton himself could be accused of establishing the Survivability model only to destroy it[24], but his critique of it is comprehensive. All military systems (as Achilles discovered to his cost) have some vulnerability. Although there are credible instances of destruction of space systems in space, it is well nigh impossible to establish a systemic trend. Telstar 1 failed at least partly because of its unique orbit. The Soviet co-orbital weapon could only threaten systems

that it could achieve co-orbit with, and launch site constraints limit the target set substantially; similar constraints affected the US anti-satellite system. Nuclear weapons detonated in space undoubtedly would destroy satellites, but Lupton again notes that effects diminish with range. While blast debris would undoubtedly pose a threat, the radiation effects are also transient and limited by line of sight at detonation. His overall conclusion is that:"…the survivability doctrine has little to offer. It is built on the false tenet that space forces are *inherently* vulnerable. The doctrine fosters a belief in retaliation-in-kind space wars which is based on the Sanctuary school's incorrect assumptions that space wars would be total wars in that environment."[25] (emphasis added) While he does not claim that everything written to support the doctrine is inherently wrong, he plainly does not feel the case is established.

Artist interpretation of GPS satellite.

In addition, I believe that two changeshave become evident since Survivability thinking was first proposed. Many more key military and security capabilities, including most communication and navigation systems, are now established in medium-Earth orbit or higher, including in geostationary orbit, and many more of these systems are now implemented via constellations of satellites. Interference is made harder by distance in the case of medium and high orbits, and by resilience in the case of constellation-based systems. Geostationary orbit sits 22 000 miles from Earth, and is very hard to reach except via intermediate staging orbits. Complex constellations such as that supporting the GPS/NAVSTAR system would tolerate loss of individual satellites to a substantial extent before overall capability would be significantly degraded.[26] All these developments undercut the premise of *systemic* vulnerability central to the Survivability school.

High Ground Model - Description

In the same way as Sanctuary theorists can look to President Eisenhower's policies, culminating in the foundation of NASA, as the origin of their model, the 'High-Ground' school of space power theory traces its origins to arguments about ballistic missile defence, and specifically to President Reagan's

Official portrait of President R Reagan in 1981.

'Star Wars' address of 1983. That said, the title is not the most obvious analogy for the school of thought it captures. The military advantages of 'High Ground' in the terrestrial domain accrue from a variety of

Ground-based Midcourse Defense (GMD) interceptor in launch silo.

characteristics. High Ground may represent a lookout position or an obstruction to an enemy's advance as much as a position from which he can be bombarded. The space theorist leans on a variant of the last of these analogies[27] rather than the first two, compounded with a sense of the favoured policies as representing the *moral* High Ground in an ambiguous debate. Lupton captures the overall emphasis in his summary of the position: "In the high-ground view, a strategy that 'protects' a nation by holding the population hostage to the threat of mutual suicide with an attacking nation is both militarily and morally bankrupt…High-ground disciples thus argue that the basic tenet of the deterrent strategy – that there can be no effective defence against the nuclear weapon – is not only outmoded but has become dogma that inhibits the development of effective defences."[28] This led to the conclusion that space-based systems were an essential component of a system offering comprehensive protection; this is the core of President Reagan's Strategic Defence Initiative proposals.[29] Gerold Younas notes that Reagan was responding to prompting from anti ballistic-missile enthusiasts that predated the Strategic Defence Initiative, and that the 'high-ground' idea had circulated in other forms – particularly General Daniel Graham's 'high-frontier' formulation. He also notes the interest of Dr Edward Teller in the potential of directed-energy weapons that provided a technical spur to aspects of the Strategic Defence Initiative.[30]

DeBlois has a slightly different interpretation of the high-ground school of thought. He notes that: "The high-ground school advocates space as the location from which future wars will be won or lost" before continuing: "The view of using space-based ballistic missile defense to convert the current offensive stalemate of mutually assured destruction to mutually assured survival has some appeal."[31] This broader interpretation of high-ground thinking is further illustrated by the fact that of the three essays he includes in his volume ascribed to 'high-ground' thinking, two are principally concerned with the comparative practicalities of expendable and re-useable launch systems and their associated costs, suggesting that the school had developed its ideas by 1999.

High Ground Model - Critique

The fact that 'high-ground' thinking has become more diffuse with the passage of time illustrates that it

originally addressed a very specific strategic quandary; the spiralling costs of nuclear deterrence between

the USA and USSR, and moral and ethical concerns associated with it. In the end, the USSR dissolved before an operational Strategic Defense Initiative system could be developed. DeBlois's broader interpretation of high-ground principles, which overlaps significantly with the 'Theatre' school, illustrates the realisation that paradigms had shifted notably by the late 1990s. More recently, there has of course been a renewed interest in BMD systems, and of the contribution that space-based capability could make to them, but this debate is taking place against concerns about proliferation, and with a view to countering adversaries who may not subscribe to the remorseless logic of deterrence through mutually assured destruction. Thus it becomes very difficult to see how the principles of the school of thought are actually guiding policy, although in practice their concerns are being addressed.

Theatre Model - Description

The 'Theatre' or 'Control' school of space power theory maintains that space is a domain for conflict in a similar manner to other domains, and that the military should equip itself to dominate it. Its ideas arose at about the same time as the Sanctuary model, and essentially in opposition to it. Its principle proponent was General T D White USAF, the Chief of Staff of the USAF (CSAF) during 1957-1961. Gen White coined the phrase 'aerospace', and pursued an aggressive policy of equipping the USAF to dominate military space. In 1958, he said: "The United States must win and maintain the capability to control space in order to assure the progress and preeminence of the free nations . . . . This is necessary because until other ironclad methods are devised, only through our military capability to control space will we be able to use space for peaceful purposes. I visualize the control of space as the late twentieth century parallel to the age-old need to control the seas and the mid-twentieth century requirement to control the air."[32]

Official portrait of General T D White, Chief of Staff of the USAF (CSAF).

The Theatre school could be accused of initially allowing their imaginations to run away with them; Brigadier General Boushey, the USAF Deputy Director of Research, believed that the Moon might turn out to be an ideal base for ballistic missiles to threaten targets on Earth, and General White was an early enthusiast for extended duration manned military spacecraft, though he was unclear exactly what missions they might best support.[33] Realism reasserted itself via Secretary of Defense Robert McNamara's skepticism about the need for an

Official portrait of former United States Secretary of Defense Robert McNamara, 12 January 1961.

extensive military manned space program, which might duplicate NASA's work, the soaring cost of the various manned platforms and the realization that even at that early stage, the classic unmanned military missions of support to navigation, communications and reconnaissance were assuming critical importance to ground-based warfighters.

In 1960 Lt Gen R. C. Wilson, then USAF deputy Chief of Staff for Development, noted that a space system had to be judged by the criterion of its relative effectiveness and could not be developed to perform particular function unless "it offers the only means of doing the job; or . . . it is the best way to do the job and is not excessively expensive (for example, very early warning of hostile ICBM launchings) ; or . . . it offers a more economical way of doing a job (as may well be true of a communications satellite system)."[34] Futrell, commenting on Wilson's article notes"Certain programs … met the"relative ideas, concepts doctrine effectiveness" criteria: missiles, navigation and communications satellites."[35] Later, as the 1960's manned military systems fell by the wayside[36], the Theatre school considered carefully the rationale for military space operations. The USAF remained in the lead, drafting explicit Military Space Doctrine from 1977 onwards. Major General Storrie USAF testified before the House Appropriations Committee in 1983 that: "The bottom line is: space is a place; it is not a mission. We are going to continue to do those things in space that we do in theatmosphere and on the ground and on the seas. We are not going to go out and do those things in space just because the technology is there. . . . We are going to do them because we can do them better from space, or we can do them more cost-effective[ly]."[37] With this assertion that space is a place – a 'Theatre' – the USAF pinned its colours closely to the statement that frames this essay. Although new applications have arrived, their employment by the US Armed Forces follows General Storrie's prescription closely.

Theatre Model – Critique

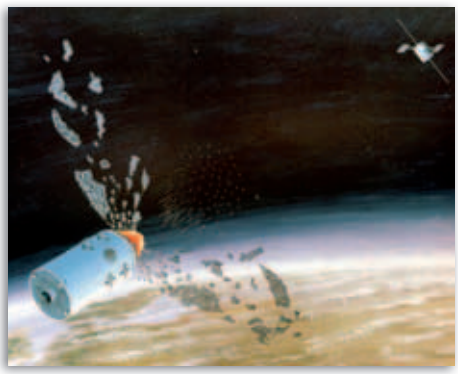
The Theatre model, after its initial dalliance with military manned systems and exotic basing options, has proven a useful basis for development of space policy, though as with all the other schools of thought, not quite in the way its originators expected. Partly this is because there has never been a period of stability in space applications – new ones are brought into service with dazzling regularity. Partly it is also because this most overtly practical school of thought has been used to justify single-service activism in the debates in the USA about configuring the military to exert influence in space. Indicative of this is the fact that one of the most articulate commentators about how space capability has expanded with time, Mr Jim Oberg, wrote a concise

summary on the subject for the now defunct US Space Command.[38]

The strength of the Theatre model remains two-fold. It closely reflects the actual US employment of space capability and, unlike the high-ground model critique above, it is easier to see that the precepts of its founding fathers have achieved influence on policy. In its broader applicability, it has also remained flexible enough to cope with new developments and new players as they gain space capability. In these respects, the assertion in the essay title is established.

Comparisons Between Models

The arguments of the Sanctuary School are so mired in Cold War Deterrence theory that they have become obsolescent if not obsolete; they presuppose a bi-polar system where the majority of 'permitted' space activity supports nuclear deterrence in one way or another. Modern expeditionary warfare employsspace for myriad activities, undercutting the premises of the theory. While space systems can indeed be vulnerable, as recent anti-satellite tests have demonstrated, no one has been able to demonstrate systemic vulnerability sufficient to validate the Survivability model. Elements of High-Ground thinking inform missile defence programmes, but again reliance on Cold War deterrence theory makes its application to contemporary counter-proliferation debates problematic. It is only the Theatre school that has proved resilient enough to cope with continuing strategic debates. While this does not render it 'future-proof' – deployment of an effective space-based anti-satellite system might provoke another paradigm shift – it shows the greatest promise for the near future.



ASAT Weapon Conception.

Space as a Medium

If the foregoing demonstrates that Space can be regarded as a medium for military operations, it begs the question of how the military should be organised for it. This is an ongoing and vibrant US debate, in which various constituent parts of the Military have argued their case for leadership over the years. References above to USAF personnel's willingness to formulate policy and doctrine proposals would suggest that they see it as a natural extension of the air domain, and this is indeed the view of many. The last major US policy pronouncement on this issue

was the report of the Rumsfeld Commission issued in 2001. In summary, as well as instituting top-level reorganisation, it gave leadership for US space operations to the USAF, although it also directed the other US services to retain cadres of space-qualified personnel.[39]

Orbital Sciences Corporation and Northrop Grumman are teamed to address NASA needs for an Orbital Space Plane.

Later studies, particularly the Congressionally-mandated Allard Commission of 2008, have explored the possibility of creating a dedicated US Space Force, separate from the other services: "the IAP considered a range of alternatives, including the establishment of a separate Space Corps within the Department of the Air Force and the creation of a new Space Department within the DoD…. We believe… that the establishment of NSSA is the logical next step, as it provides the needed focus for unifying efforts to provide space capabilities, without the costs of establishing an entirely new Corps or Department and without severing needed relationships with military and Intelligence Community users….We believe our current recommendations are responsive to current needs and provide a logical path to an even more focused organization in the future (such as a "Space Corps") if deemed necessary."[40] While policy on a Space Corps could thus be summarised as 'not yet', if this step was ever taken, it would surely finally confirm the existence of Space as a distinct medium, at least in US eyes.

Space as a Unique Medium

Although Space can thus be regarded as a putative military domain, it is worth concluding by noting the unique constraints that govern operations in it. Like all spacecraft, military satellites are governed by principles of orbital dynamics unique to space, but these are additionally exercised in a realm where territorial claims are excluded, and once it is launched, sovereignty is vested solely in the platform, and not in the location where it operates. Specific provisions of the Outer Space Treaty also regulate military operations in space. The point is not to examine every aspect of these constraints, simply to note that they are as unique to space, as those of, for example, maritime or air operations (the unique environment occupied by submarines, the particular constraints of aerodynamics) are to their domains. Space is thus 'like' air, land and sea in having unique constraints, even though the constraints themselves are specific to outer space. Finally, it would be remiss not to note that legitimacy implies compliance with the law; while we have alluded to specific treaty limitations onmilitary actions in space, any such action must also comply with military principles of proportionality, discrimination

The Ohio-class guided-missile submarine USS Georgia (SSGN 729) arrives for a routine port visit to Souda Bay.

and military advantage. In this respect at least, space is *exactly* like any other domain.

Conclusion

This essay has teased the meaning out of the proposition by situating its sentiment in a theoretical, and admittedly US-centric, schema for analysing military space operations. The 'Theatre', or 'Control' model has, I believed, proved the most durable and adaptable model offered, borne out by current US practice. Nonetheless it is important to realise both where the space domain is truly unique, and where it shares common principles with other military domains. By doing this, and by compliance with the unique physical, legal and conceptual constraints applicable to space, it can be harnessed as a force for good to promote peace and security.

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Notes

[1] The phrase appears in a memorandum by the US Secretary of Defense dated 9 July 1999. The Hon William Cohen, *Department of Defense Space Policy*. (US Department of Defense, Washington DC 1999).
[2] Professor Colin Gray, currently at Reading University has written on several space-related themes, and Dr John Sheldon is a British academic, currently working at the School

of Advanced Air Power Studies at the Air University at Maxwell AFB, Alabama, who previously co-founded the journal '*Astropolitics*'. Dr Paul Stares, whose work is cited in this essay, gained his first degree at Lancaster University, though he now works in the USA. In the UK in 2009 there are active space theorists, including Professor Mike Sheehan at Swansea University, and Professor Bhupendra Jasani at Kings' College London. The four schools of thought analysed in this paper were, however, developed and publicised mainly in the USA.

[3]David Lupton, *On space warfare : a space power doctrine*. (Maxwell Air Force Base, Ala, Air University Press 1988).

[4]Thus military guards of honour form up **outside** the nave of a church; in some traditions, ancient churches may still possess a wapenhus where weapons were stored during worship.

[5]D. W. Zeigler, "Safe Heavens: Military Strategy and Space Sanctuary." in Bruce De Blois *Beyond the paths of heaven: The Emergence of Space Power Thought* (Air University Press, Maxwell AFB, Al, 1999) 185-248.

[6]DeBlois, *Beyond the paths of heaven...* xxxi (Endnote 4).

[7]For an analysis of the influences on President Eisenhower's formulation of space policy, see part III, and especially Chapter 7, of W. A. McDougall, *... the heavens and the earth : a political history of the space age* (New York, Basic Books 1985). See also David Callahan and Fred I Greenstein *The Reluctant Racer: Eisenhower and US Space Policy* in Roger Launius and Howard E McCurdy (eds) *Spaceflight and the Myth of Presidential Leadership*, (University of Illinois Press, Urbana, IL, 1997). Subsequent chapters in Launius and McCurdy address later Presidents, up to and including George Bush in 1990, and their attitudes to US space policy.

[8]In 1946, one of the first substantive pieces of work generated by the RAND Corporation addressed the possibilities of Space (F. H. Clauser, D. Griggs et. al., "*Preliminary Design of an Experimental World-circling Spaceship*", (Douglas Aircraft Company, Santa Monica, CA, 1946). This report, and follow on work by Jimmy Lipp, one of its co-authors, set the scene for assessing the potential political implications of being the first nation to orbit a spacecraft around the Earth. Because of its historical significance, the original 1946 report has been reprinted by the RAND Corporation. See **www.rand.org** for details.

[9]Callahan and Greenstein in particular argue that Eisenhower's appreciation of space and national security was more subtle and nuanced than was appreciated at the time, basing their findings on declassification of documents since the end of his Presidency.

[10]President Eisenhower had worried specifically about the implications of limited insight into Soviet capability since assuming office in January1953. In 1954, he authorised development of the U-2 high-altitude reconnaissance aircraft, and in 1956 he approved reconnaissance balloon over-flights of the Soviet Union, both intended to fill the gap in US insight (Projects AQUATONE and GENETRIX respectively). Poor results from the balloon over-flights and, evidenced by the loss of Gary Powers' U-2 during an intrusive overflight of the USSR in 1960, the vulnerability of high-altitude aircraft, must have made space-based reconnaissance an attractive option.

[11]D. S. F Portree, "NASA's Origins and the Dawn of the Space Age." *Monographs in Aerospace History*, 1998. (**http://history.nasa.gov/monograph10/nasabrth.html** 3 December 2008).
[12]Lupton, *On Space Warfare*... 20.
[13]The USAF tested an air-launched anti-satellite system in an unarmed mode in October 1959, and the USN conducted similar experiments during 1962. See B Jasani, "Space Weapons - technical aspects." in B. Jasani (ed) *Space Weapons and International Security* (Oxford, Oxford University Press, 1987). 14-16.
[14]"Telstar." *Encyclopædia Britannica*, (**http://www.britannica.com/EBchecked/topic/586427/Telstar** 3 December 2008).
[15]R Escoffet, "In-flight Anomalies on Electronic Devices." in R. Velazco, P. Fouillat and R. A. L. Reis (eds) *Radiation Effects on Embedded Systems* (Dordrecht, Netherlands, Springer 2007). 41-42. See also J L Caton, (1995). "Joint Warfare and Military Dependence on Space." *Joint Forces Quarterly* (10) 1995: 48-53.
[16]Initially, the payload was probably developed independently of the SS-9, being intended to be launched by a rocket known as UR-200. When that was cancelled in 1963, the SS-9 was adopted as the launch vehicle.
[17]Lupton, *On Space Warfare*... 39.
[18]Kurt Gottfried and Richard Ned Lebow, *Anti-Satellite Weapons: Weighing the Risks* pp 148-152 in Long, F. A. Hafner, Donald et al (eds) *Weapons in Space* (New York: W W Norton & Co, 1986)
[19]USAF FY 85 report, cited in W. R. Van Cleave, *Fortress USSR: The Soviet Strategic Defence Initiative and the US Strategic Defence Response* (Stanford, CA, Hoover Institution Press 1986). 26.
[20]Some might argue that since a FOBS is only transiently in orbit, a counter to it is inherently an anti ballistic-missile system rather than an anti-satellite system, but this is a fine distinction. There are in any case common elements to anti ballistic-missile and anti-satellite systems. The conceptual and technical similarities and differences between these systems have been analysed by several writers; see for (a slightly dated) example Ashton B Carter, *The Relationship of ASAT and BMD Systems* in Long and Hafner, (eds) *Weapons in Space…*
[21]Zeigler, *Safe Heavens*... 196. See also Paul B Stares, *The Militarization of Space: US Policy1945-1984*, (Ithaca NY: Cornell University Press, 1985), particularly Chapter 6, for a short history of Programs 437 and 505, and the contemporary (essentially unsuccessful) SAINT and 437X Programs to develop an in-orbit satellite inspection capability.
[22]The operational missiles were deployed to Johnston Island in the Pacific Ocean to hold the SS-9 FOBS variant at risk to the greatest possible extent. This limited their effectiveness against anything else.
[23]US anti ballistic-missile and anti-satellite nomenclature of the period is potentially confusing, with similar systems gaining prototype or program names, manufacturers' names and formal US Military designators. Thus Program 505 (which was also known as *MUDFLAP*) technology re-emerged within the *Sentinel* anti ballistic-missile program, which was re-named the *Safeguard* system during the change from Johnson to Nixon administrations. *Safeguard* utilized missiles called *Sprint* and *Spartan* for short and long-range intercepts. *Spartan* and Program 505

were members of the *Nike* family of missiles, and *Spartan* was additionally designated XLIM-49A within the US Military system. (*Sprint* was never formally designated). *Safeguard* was briefly operational within the Continental USA during the 1970s to protect the Grand Forks AFB missile site. See Mark A Berhow, '*US Strategic and Defensive Missile Systems 1950-2004*' (Oxford: Osprey Publishing, 2005) 30-36 for details of *Safeguard* and *Sentinel*, and Clayton K S Chun, '*Defending Space: US Anti-Satellite Warfare and Space Weaponry*' (Oxford: Osprey Publishing, 2006) 32-33 for a brief description of Programs 437 and 505.

[24]Lupton's chapter subtitle "*A Misbegotten Offspring*" could reasonably be viewed as judgemental.

[25]Lupton, *On Space Warfare*… 52.

[26]The theoretical minimum GPS constellation for full system operation is 24 satellites. There are usually additional assets in orbit, so some losses could be tolerated without **any** loss of capability. See "USNO GPS Timing Operations." *United States Naval Observatory* (**http://tycho.usno.navy.mil/gps.html** 10 December 2008).

[27]High Ground in space used to counter the enemy's weapons, rather than to bombard him directly.

[28]Lupton, *On Space Warfare*...53.

[29]President Reagan's public address of 23rd March 1983 made no mention of space-based systems; all he said was: "I am directing a comprehensive and intensive effort to define a long-term research and development program to begin to achieve our ultimate goal of eliminating the threat posed by strategic nuclear missiles." However, the operational system was quickly envisaged to include both ground-based and space-based elements.

[30]See Gerold Younas, "The Strategic Defense Initiative." in F A Long, D. Hafner, et al, (eds) *Weapons in Space* (New York, W W Norton and Company 1986). 73

[31]DeBlois, *Beyond the Paths of Heaven*... xii.

[32]T. D White, "Space Control and National Security." *Air Force Magazine* 41:4(April 1958): 80. The magazine implies that Gen White was addressing the (US) Air Force Association's Third 'Jet Age' Conference in early 1958.

[33]For an account of General White's views and those of his contemporaries, see R F Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force 1961-1984*, (4th Printing September 2001). (Maxwell AFB, Ala, Air University Press 1989). 212-14.

[34]R. C Wilson, "Research and Development Today for Military Space Systems Tomorrow." *Air Force/Space Digest* (April 1960): 52-57.

[35]Futrell, *Ideas, Concepts, Doctrine*... 213-214.

[36]The joint USAF/USN/NASA X-15 research craft flew for the last time in 1968. By then, the X-20 Dyna-Soar manned space glider and project BLUE GEMINI, a military variant of the NASA Gemini capsule, had both been abandoned (in 1963). President Nixon cancelled the military Manned Orbiting Laboratory in 1969, and while military interest in the STS (Space Shuttle) persisted, it never fulfilled its promised utility.

[37]Department of Defense Appropriations for 1984, *House Committee on Appropriations, Defense sub-committee* (Washington DC, US Government Printing Office 1983). Pt8:475

[38]See J E Oberg, *Space Power Theory*,

(US Air Force Space Command, 1999): 119-120 for a discussion of the 'maturation' (sic) of space capability.

[39]"Secretary Rumsfeld Announces Major National Security Space Management and Organisational Initiative". (US Department of Defense, Washington DC, Office of the Assistant Secretary of Defense (Public Affairs) 2001): 2.

[40]A. Thomas Young, Lieutenant General Edward Anderson USA (Ret.), et al. *Leadership, Management, and Organization for National Security Space*, (Alexandria, VA, Institute for Defense Analysis, 2008): 26.