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ROYAL AIR FORCE

AIR POWER REVIEW

Volume 12 Number 2 Summer 2009

SPACE SPECIAL

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Wg Cdr Clive Blount

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Maj Stephen Jones, USAF

China's Military Space Strategy
Flt Lt Kenny Fuchter

Space as a Medium for Warfighting
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Book Reviews
Gp Capt Ian Shields
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Letters
Dr David Jordan

Viewpoint
Dr Mark Hilbourne

Centre for Air Power Studies

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The Royal Air Force Air Power Review is produced under the auspices of the Director of Defence Studies (RAF). The publication aims to support the British armed forces in general and the Royal Air Force in particular by developing thinking about the application of air power. The intention is to provide a forum for high quality and academically credible articles on air and space power, with the objective of stimulating debate and promoting the evolution of air and space power thinking within the broader military and academic communities. Authors are, therefore, encouraged to challenge accepted norms and offer novel conclusions; consequently, the views expressed in this journal are not endorsed by either the Editor or the Royal Air Force and do not represent statements of official policy.

Feedback from readers is most welcome and encouraged; those wishing to make comments both positive and negative or make suggestions for how APR can better meet the needs of the broad air power community can do so by clicking on the 'Feedback' button on the Air Power Review page of the RAF CAPS website.[1]

Contributions from both Service and civilian authors are sought which will contribute to existing knowledge and understanding of the subject. Any topic will be considered by the Air Power Review Management Board and a payment of £200 will be made for each article published. Articles should be original and preferably unpublished, although important papers of particular merit will not be precluded.

Articles should comply fully with the style guide published at the RAF Centre for Air Power (RAF CAPS) website, www.airpowerstudies.co.uk; essentially they should be between 2,000 and 10,000 words in length, list bibliographical references as end-notes, and state a word count. Lengthier articles may be published in instalments and contributions from serving military personnel must be made in accordance with 2008DIN03-020.

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View of the Apollo 9 Lunar Module "Spider," in a lunar landing configuration, as photographed from the Command/Service Module on the fifth day of the Apollo 9 earth-orbital mission. The landing gear on the Lunar Module has been deployed. Note Lunar Module's upper hatch and docking tunnel. The EVA foot restraints known as the "Golden Slippers" are visible on the porch of the Lunar Module (LM). They allowed Lunar Module pilot Russell "Rusty" Schweickart to securely stand on the porch during his EVA thus allowing him free use of his hands.

Foreword

On 21 July 1969, Neil Armstrong became the first man to walk on the moon, when he stepped off the Apollo 11 lunar module and on to the dusty surface of the Sea of Tranquillity. Whilst the grammatical correctness of what he then said continues to be debated by those with too much time on their hands, this act was 'just one small step' - albeit a significant one - in the ongoing history of the exploration of space. As air power practitioners, we should be increasingly interested in space and must determine how best to exploit its unique capabilities. Whether space is conceived in terms of a seamless continuum with the air environment, as *far air* or aerospace, or, as it is defined in the new, fourth edition of *AP3000* (itself retitled as *British Air and Space Doctrine*, to reflect the growing importance of space) as a unique environment in its own right, what is certain is that space is now critical to every sort of combatant - from the most technologically advanced air force using precision weaponry and secure communications, to an Afghan insurgent with an AK47 assault rifle and a mobile phone.

This 'Space Special' *Air Power Review* marks the fortieth anniversary of the lunar landing by considering contemporary space issues and their influence on the current and future utility of air and space power. In the first article, Wing Commander Clive Blount provides a useful review of the Apollo programme, not only covering the technical achievements and milestones but also revealing the political motivations behind the space race. After the Soviet Union won the first round, by putting the first man in space on 12 Apr 1961, the United States, led by President Kennedy, was determined not to let them win the second. Some of the decisions taken during this period could be described as either bold or reckless; undoubtedly, some of the accidents that occurred were a direct result of the speed and urgency of the programme. Nevertheless, exceptional technological advances were achieved, putting the US in a dominant position in the exploitation of space for decades to come.

In his very generously titled article 'Can the UK Remain a First Division Player in Military Operations', Major Stephen Jones USAF examines the UK's military, security and social requirements for access to space, highlighting the UK's disproportionate reliance on US space capability and products. He argues that the UK is punching below its weight in comparison with other nations of similar size and ambition and, looking ahead, suggests that the UK's ability to act

independently will be compromised if it continues to shelter under the US's space umbrella. He explores some alternative and very pragmatic options for securing indigenous capabilities that are consistent with the UK's current commitment of military resources and the concomitant economic constraints.

The theme of the importance of space in the context of international security is revisited by Flight Lieutenant Kenny Fuchter, but set against what might now be regarded as the second most powerful space nation: China. His article elucidates China's Space strategy and discusses the tensions and manoeuvring between the US and China, based on the perceived motivations of each other. His assessment of the space capabilities that China is known to possess, or be developing, makes for sobering reading. Finally he reviews the global implications of China's massive investment in space, postulates the start of a new space race and considers the consequences for the UK.

Wing Commander Gerry Doyle, in his article 'Space as a Medium for Warfighting' reviews the American debate on the relationship between space and military operations, looking at the differing views of those who see space as a sanctuary, a vulnerability, as high ground, or as a theatre for military operations. He addresses the military and legal constraints that apply in space and contrasts these to the other environments. Overall, this article provides a very useful insight into the doctrinal and strategic thinking that has shaped the US approach to the military exploitation of space.

The final article, from Professor Michael Sheehan, looks at the evolution of US military space doctrine again, focusing particularly on counter-space operations and providing a useful counterpoint to the issues raised by Wing Commander Doyle. He considers the weaponization of space, describing how the US viewed space as a sanctuary until the end of the Cold War, when the change in the strategic context resulted in a reduction in the fear of a trip-wire response to the deployment of weapons in space and a shift in perspective from the view of space as a sanctuary, to space as high ground to be exploited. He then reviews current US space doctrine in the light of the experiences of operations in Iraq and Afghanistan.

The final sections of this edition include, in place of the usual historic book review, a *tour d'horizon* of the works of the very influential Colonel John Boyd, famous for his theory of the Observe-Orientated-Decide-Act decision loop, by Air Commodore Neville Parton. This is followed by

Astronaut Buzz Aldrin, lunar module pilot, walks on the surface of the Moon near the leg of the Lunar Module (LM) "Eagle" during the Apollo 11 exravehicular activity (EVA). Astronaut Neil A. Armstrong, Commander, took this photograph with a 70mm lunar surface camera on 20 July, 1969.

a 'Viewpoint' from Mark Hilborne, who takes a very contemporary look at UK space policy, including the outcomes of the UN Conference on Disarmament in May this year, the ongoing posturing of North Korea, President Obama's announcement of the setting up of a White House office on cyberspace security and, closer to home, the possible implications of the selection of a British astronaut for the European space programme. All of these issues will provide the context that shapes the development of UK space policy in forthcoming years.

The Editorial board is confident that the changes made to *Air Power Review* in recent years have reinforced its position as a leading forum for exposing and debating the most relevant, contemporary air power topics. However, we do not wish to rest on our laurels and, therefore, seek your views - positive or negative – and ideas for further improvements. To facilitate this, a 'feedback' button may now be found on the *Air Power Review* page of the *Royal Air Force Centre for Air Power Studies* website[1] . Please select this to make your views known – I encourage you to use it.

D DEF S (RAF)

[1] http://www.airpowerstudies.co.uk

Notes on Contributors

Wing Commander Clive Blount joined the RAF in 1980 and is a fast-jet navigator. He completed flying tours in Germany and the UK, including instructional and test-flying tours, and has completed staff tours in the MOD, a major NATO headquarters, and with HQ ARRC in Kosovo. He commanded RAF Gibraltar, has served as an ACSC tutor and recently undertook a year of study via a Tedder Fellowship - gaining an MPhil in International Relations at the University of Cambridge. Wg Cdr Blount is currently XO of the AWC Test and Evaluation Division at Boscombe Down in Wiltshire and is responsible for the flight trials of Mission Systems. He is also currently engaged in part-time study for a PhD with King's College, London, looking at decision-making in the Kennedy and Macmillan governments with regard to the crises in SE Asia.

Major Stephen R. Jones, USAF, is a Senior Pilot with over 2,800 hours in the B-1 Bomber and MQ-1 Predator. He has completed five overseas tours and flown in Operation Southern Watch, Enduring Freedom and Iraqi Freedom. Major Jones has logged 540 combat hours in the B-1 and was a member of the team that developed, tested, and employed the first Unmanned Aerial Vehicle in history to fire offensive weapons against enemy combat forces. He personally conducted 18 AGM-114 Hellfire strikes. Major Jones earned a BA with Highest Honours from the University of California at Berkeley; and an MA with Merit from Kings College, London. He graduated with Distinction from British Advanced Command and Staff College and currently instructs Air Campaign Planning at the Air Warfare Centre, RAF Cranwell.

Flight Lieutenant Kenny Fuchter is a serving Royal Air Force officer. An MLitt graduate in Strategic Studies, at the University of Aberdeen in 2007, he was awarded a Portal Fellowship in 2008. He is currently undertaking research for his PhD, into China's aerospace strategy and the implications for the UK. He has served operationally in Turkey, Oman, Kuwait, Iraq and Afghanistan, in support of many of the RAF's fixed wing and rotary aircraft types.

Wing Commander Gerry Doyle is the RAF desk officer for Space and ISTAR within the Development, Concepts and Doctrine Centre at Shrivenham. By profession a pilot, he has concentrated in the last two years

on developing conceptual thinking relating to Space within the UK MOD, and in producing a UK Military Space Primer (intended for publication during 2009). Highlights of his tour have included participation in the space-based USAF Schriever V wargame during March 2009. This paper draws on work undertaken at Swansea University during 2008-9 as a part-time student enrolled in the 'War in Space' module of their taught MA programme, studying under Professor Michael Sheehan, who has also contributed a paper to this edition of *Air Power Review*.

Michael Sheehan is Professor in Politics and International Relations having previously worked at the University of Aberdeen, where he was Director of the Scottish Centre for International Security, and at the International Institute for Strategic Studies in London. He joined Swansea University, Department of Politics and International Relations in 2004. His current research focuses on the military use of outer space, particularly the arms control issues surrounding anti-satellite systems, and on the military space policies of the European Union. He is continuing his research into the meaning of the concept of security in the contemporary world. He has published in a wide variety of journals and has written 12 books on security.

Man on the Moon: Forty Years On

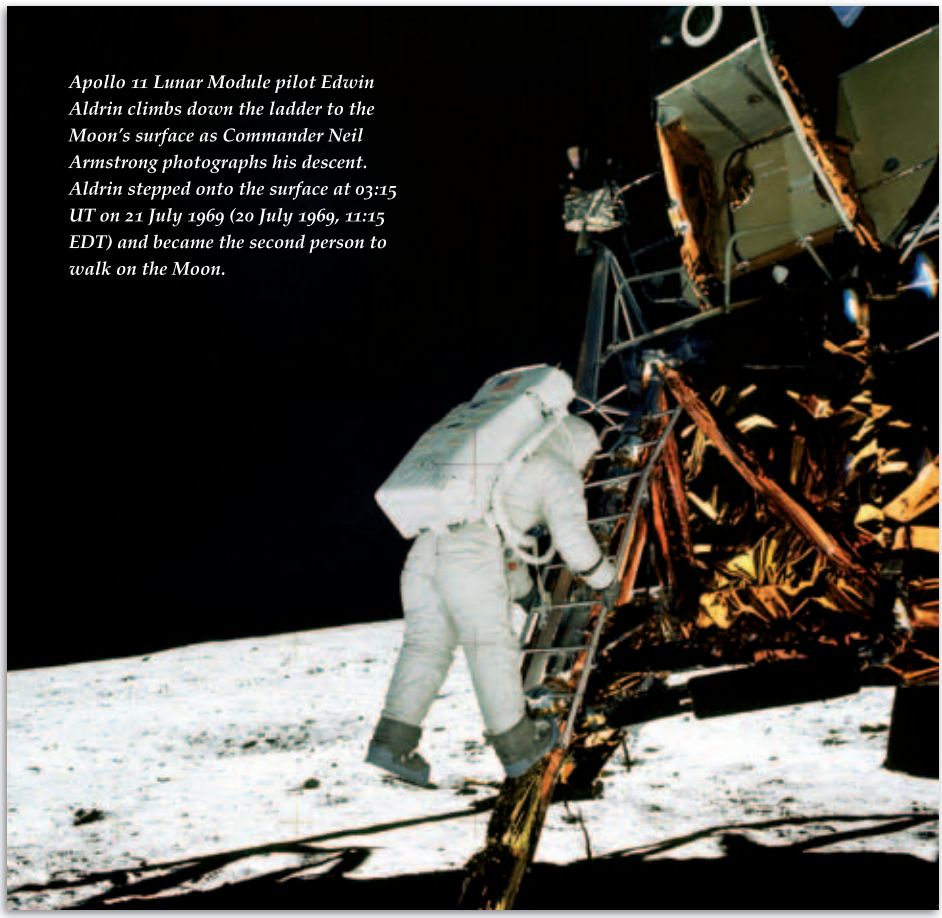
By Wg Cdr Clive Blount

The *Apollo* programme to put an American on the moon succeeded in this aim some forty years ago this June. This article celebrates the technological achievement and supreme effort of the people involved in the programme but also provides some interesting insights into the political motivation for going to the Moon in the first place, the appetite for risk, and the degree of political control of technical decisions. It describes the highlights of the *Apollo* programme, but also puts the undoubted technical successes into the historic context of: the America of the 1960s and the Cold War, and, in doing so, asks the question why such an ambitious programme of Government procurement proved such a resounding success – a minor miracle to our eyes in an era when modern large public procurement efforts are rarely successful and on time. The article ends by discussing why manned interplanetary exploration ended so abruptly, and sums up the 'balance sheet' of the supreme achievement that was the *Apollo* programme.

'In the past 30 years, no human being has set foot on another world, or ventured further upward into space than 386 miles, roughly the distance from Washington, DC to Boston, Massachusetts. America has not developed a new vehicle to advance human exploration in space in nearly a quarter-century. It is time for America to take the next steps'

George W Bush, 14 January 2004

Very few undertakings - even those considered momentous at the time they happen - survive the cynical examination of history unscathed to inspire a continuing sense of awe and wonderment. The NASA programme to conduct manned exploration of the Moon - the *Apollo* 11 landing of which, some forty years ago, is commemorated by this issue of Air Power Review - is, however, one of those outstanding events; a pinnacle of human achievement that remains breath-taking in its audacity, and captures the imagination of each succeeding generation. Ironically, as evinced by George W Bush's speech at the opening of this article, *Apollo* did not lead to further manned interplanetary exploration, Moon 'bases' and exploitation of the Moon's resources, or even any further manned scientific exploration of the Moon after the six *Apollo* landings.

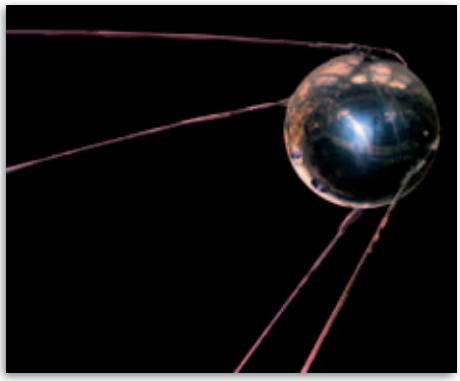


Apollo 11 Lunar Module pilot Edwin Aldrin climbs down the ladder to the Moon's surface as Commander Neil Armstrong photographs his descent. Aldrin stepped onto the surface at 03:15 UT on 21 July 1969 (20 July 1969, 11:15 EDT) and became the second person to walk on the Moon.

Man has remained firmly in earth orbit. However, it can be argued that the achievements of NASA in those early years has led to an increasing awareness of, and dependence on, space in the daily life of our planet, a dependence which the other authors in this 'space' issue of APR will no doubt examine in depth.

My original aim in this article was to describe the *Apollo* programme as a celebration of the technological achievement, and to commemorate the supreme effort of the people involved. My research, however, provided some interesting insights into the political motivation for going to the Moon in the first place, the appetite for risk, and the degree of political control of technical decisions. I will now, then, describe the highlights of the *Apollo* programme, but will also attempt to put the undoubted technical successes into the historic context of the America of the 1960s and the Cold War, and, in doing so, investigate why such an ambitious programme of Government procurement proved such a resounding success – a minor miracle to our eyes in an era when modern large public procurement efforts seem destined to fail… or at least be delivered very late! I will finish by asking why manned interplanetary exploration ended so abruptly, and by summing up the 'balance sheet' of the supreme achievement that was the *Apollo* programme.

Although tentative steps had been made by the United States towards a space exploration programme - including Robert Goddard's early experimental rockets in the 1920s, and the rounding up into American research programmes of German



Russian satellite Sputnik 1 launched 4th October 1957.

rocket scientists at the end of the Second World War - it was the successful launch of the modest *Sputnik I* satellite by the Soviet Union, on 4th October 1957, that galvanised the United States into what became the 'Space Race'. However, the then president, Dwight D Eisenhower, appeared to remain calm, and, possibly with the benefit of knowledge of the secret programmes being run by the Army and Navy, refused to acknowledge the Soviet effort as anything more than a 'ball in the sky'. He was also privy to a deal of intelligence about the Soviet Union that clearly demonstrated the United States' technical and military superiority over the communist bloc. But it was the public perception that was all important and the Soviet success with *Sputnik* became a gift for the democratic opposition, led by house majority leader Lyndon B Johnson. Johnson triggered a masterful campaign of scaremongering that was eventually to lead to the election-winning claims of 'the missile gap' used by presidential challenger John F Kennedy during the 1960 campaign. Johnson was at the forefront of an attack on Eisenhower that ranged from accusations of unilateral

disarmament, to that of allowing America to become 'so hedonistic, so addicted to frivolity, that they will have turned to mush'.[1] The 'Space Race' thus became a political weapon - not just about East versus West but also within domestic politics.

British Prime Minister Harold Macmillan visited Eisenhower on 23rd October 1957 and his memoirs provide an interesting insight into the effect *Sputnik* had on the American psyche. He found that the impact of *Sputnik* had 'been something akin to Pearl Harbour. The American cocksure-ness is shaken'.[2] In one his greatest contributions as Prime Minister, Macmillan was able adroitly to use this American loss of confidence to rebuild the transatlantic relationship, a relationship that had been lying in tatters since the Suez débâcle, and to rebuild British influence in the United States to, arguably, its post-war high. A major result of this achievement was the repeal of the McMahon Act - which had hitherto prevented release of US nuclear secrets – ushering a new period of co-operation on nuclear issues across the Atlantic.

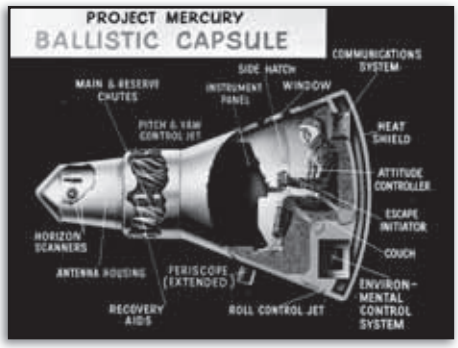
The US eventually followed *Sputnik* with a scientific satellite of its own, *Explorer*, on 31st January 1958, which, boosted by its own motor into a much higher orbit that the Russian satellite, was able to gather vital radiation data in the area named after the director of the experiment, James Van Allen. Although a degree of national honour was regained, there was deep concern in the United States that the Soviet launch capability was much more powerful – with the ensuing security implications if these rockets were used for military payloads. In response, Eisenhower set up the Advanced Research Project Agency (ARPA) to co-ordinate national research and, on 2nd April 1958, established the National Aeronautics and Space Agency (NASA).

United States satellite Explorer 1 launched on 31st January 1958.

X15 mounted to B52 pylon in flight circa 1965.

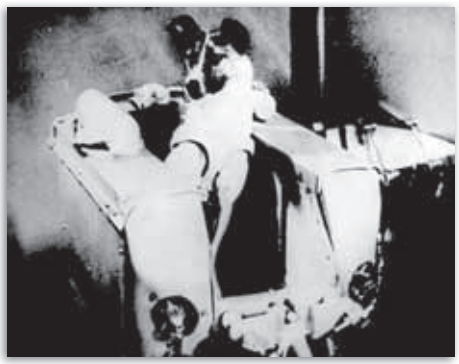
Momentum now increased to develop a craft that could put a man into space. It had long been assumed that the first spacecraft would be a development of the trend of 'higher' and 'faster' experimental aircraft - such as NASA's highly successful X15. However, time was now pressing - if the Soviets were to be 'beaten' - so a 'manned satellite' or 'capsule' was

developed as part of the 'Man in Space, Soonest' (MISS)[3] programme



- announced to the world as project *Mercury* in December 1958. NASA did however start to consider more ambitious targets during 1959, with work beginning on developing techniques that could eventually lead to a lunar landing. 1960 was, however, an election year and all parties were aware that, although Eisenhower had ordered the acceleration of the US space programme and had authorised spending to develop the *Saturn* booster, significant spending on space was likely to be delayed until after the election. As stated previously, Kennedy used the perceived Soviet superiority in space and missile technology to good effect during his election campaign:

'The first man-made satellite to orbit the earth was named Sputnik, the first living creature in space was [the dog] Laika. The first rocket to the Moon carried a red flag. The first photograph of the far side of the Moon was made with a Soviet camera. If a man orbits the earth this year his name will be Ivan'.[4]



Laika in Sputnik 2 circa 1957.

He expanded the 'race' metaphor even further: '...we cannot run second in this vital race. To ensure peace and freedom, we must be first'.[5]

In fact, as Vice President Richard Nixon protested, the United States was not behind at all - with some 26 Satellites and 2 space probes launched since Sputnik, compared to the 6 satellites and 2 probes of the Soviets. Eventually elected, this space race mentality and the notion of a

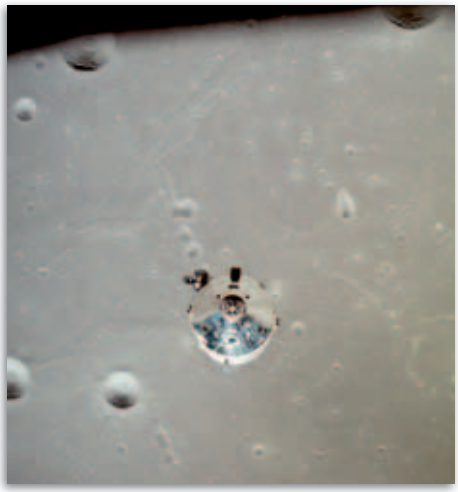
Cosmonaut Yuri Gargarin being taken to Vostok 1.

'missile gap' were to haunt Kennedy throughout the early stages of his presidency as he became faced with a series of ever more testing issues. The deep south was embroiled in turmoil over racial segregation, the crisis in Laos was threatening to trigger off the 'domino effect' in South East Asia[6] and the disastrous invasion of Cuba at the 'Bay of Pigs' left the incoming administration appearing very weak in the face of communist aggression.

To cap it all, just one week before the Bay of Pigs fiasco, the Soviet Cosmonaut Yuri Gagarin became the first man into space, conducting a full orbit. The ballistic, sub-orbital, *Mercury* flight by the first American in space, Alan Shepard, did little to reset the balance. On 25th May 1961, Kennedy gave his famous speech to Congress, billed as his second 'State of the Union' address, in which he committed the Nation to a 'great new enterprise' with the words:

'I believe that this nation should commit itself, before this decade is out, to landing a man on the Moon and returning him safely to the earth... '.[7]

Once Kennedy had issued the challenge, the NASA scientists had to develop mission profiles that could meet the stated goal while minimizing risk to human life, cost, and whilst not asking the impossible of emerging technology or, indeed, the fledgling astronauts. Four modes of lunar mission were considered: the **Direct Ascent Option** (A Huge Rocket travelling directly to the Moon; landing and returning as a unit); the **Lunar Surface Rendezvous** (Using two spacecraft in succession – one as a 'tanker' of fuel to enable the launch from the Moon of the other); **Earth Orbit Rendezvous** (Using multiple rockets each carrying various parts of a direct ascent spacecraft into earth orbit. After docking, the spacecraft would have landed on the Moon as a single unit) and **Lunar Orbit Rendezvous** (LOR) (A single spacecraft composed of modular parts would be launched into lunar orbit. A command module would remain in that orbit, while a landing vehicle would descend to the Moon and then return to the command module). We now know the latter, LOR, was eventually selected. Primarily, this was because it required only a small part of the overall spacecraft to land on the Moon, thereby minimizing the mass to be launched from the Moon's surface for the return trip - and therefore the size of spacecraft and amount of fuel that would be required.



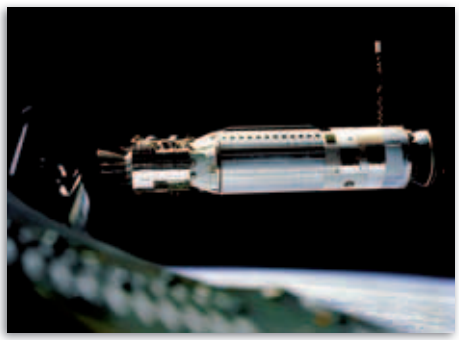
Command Module Columbia over Craters Taruntius K, Taruntius P, and Dorsum Cayeux in north central Mare Fecunditatis (Sea of Fertility).

In 1961, however, direct ascent was generally the mission mode that had the most support within NASA, as the prospect of performing in-orbit rendezvous, never mind actually docking, in Lunar Orbit, was a very tall order - especially as we must remember that neither had been attempted in Earth orbit at this stage. (In fact an American was yet to even achieve an orbital flight!) However, the debate raged among NASA's forward-thinking scientists and engineers and, on 11th July 1962, NASA's formal selection of LOR was announced. This was a fundamental decision that enabled the eventual success of Apollo; space historian, James Hansen confirms this:

'Without NASA's adoption of this stubbornly held minority opinion in 1962, the United States may still have reached the Moon, but almost certainly it would not have been accomplished by the end of the 1960s, President Kennedy's target date'.[8]

On thing was certain; whichever mode was selected to get to the Moon, it was clear that a number of techniques would have to be developed alongside the hardware, and it was this development activity that formed the bulk of the objectives set for the follow-on to *Mercury* – Project *Gemini*. The *Gemini* spacecraft was larger than the *Mercury* capsule and carried two astronauts. An number of milestones were achieved during the programme, including in-orbit rendezvous (*Gemini 6/7*), Extra-vehicular Activity - 'Spacewalk' - (*Gemini* 4 onwards), Docking (*Gemini* 8) and record breaking long duration flights of 8 days (*Gemini 5*) followed by 2 weeks (*Gemini 7*). It was also during these *Gemini* flights that most of the leading astronauts that were eventually to go to the Moon gained their early space experience.

On June 3, 1965 Edward H. White II became the first American to step outside his Gemini spacecraft and let go, effectively setting himself adrift in the zero gravity of space.



Armstrong and Scott performed the first successful docking of two spacecraft, joining the Gemini to the Agena target vehicle.

President Kennedy signs Proclamation 3504, authorizing the Naval quarantine of Cuba- 23 October 1962.

Less than a year after Kennedy's challenge, with the *Mercury* programme still in its early stages, Kennedy faced one of the biggest foreign policy challenges of the era - the Cuban missile crisis. For the now famous 'thirteen days' in October 1962 the world 'held its breath' on the brink of what was potentially to become the first superpower nuclear exchange. Kennedy handled the crisis masterfully and faced Khrushchev down, following this with other successes over Berlin and nuclear weapon testing. Suddenly the Soviets looked less threatening - the need to

demonstrate mastery in the expensive arena of space exploration started to lose its urgency. In addition, the cold war focus was moving away from direct confrontation between the superpowers, evinced by the increasing US involvement in the burgeoning crisis in Southeast Asia.[9] Then, on 22nd November 1963, NASA lost its single greatest protector when John F Kennedy was assassinated.[10]

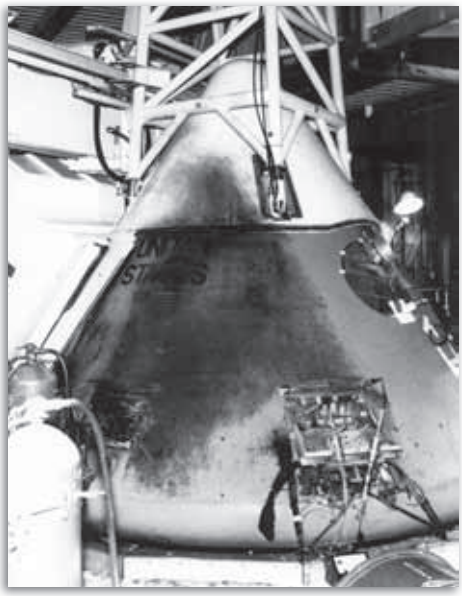
The race to place a man on the Moon within the decade now became further complicated as questions began to be asked about the massive requirement for federal funding of the programme – with the usual 'pork barrel' politics of allocating major projects in the constituencies of key politicians. In particular, there was focus on the decision to build the Manned Spacecraft Centre in Texas, home state of the now president, Lyndon B Johnson. Questions were asked about the allocation of a significant amount of work to the construction company Brown and Root, who had been supporters of Johnson. As Piers Bizony says, in 1967 a young Republican Senator was outspokenly critical:

'Why such a huge contract has not been adequately audited is beyond me. The potential for waste and profiteering is substantial' [11]

40 years later, the young senator – then Secretary of Defense Donald Rumsfeld - was less critical of the government activities of Brown and Root (now part of the Haliburton Group) in Iraq!

Secretary of Defense Donald Rumsfeld.

Although it appeared to outsiders that the programme was progressing well, as the mid-60s dawned fundamental problems were appearing, with a number of significant technical and programme management challenges. In particular, relations between North American - a major contactor – and NASA were particularly strained, with a plethora of programme and quality control issues emerging. In addition, NASA senior management became convinced that innovative new management procedures could save the day - whereas the effort involved in incorporating these new techniques merely distracted key personnel from the key engineering issues. The 'idea' of Apollo rapidly became out of synch with the harsh technical realities on the ground. As the first manned flight of Apollo approached, NASA personnel, particularly the astronauts, became increasingly frustrated



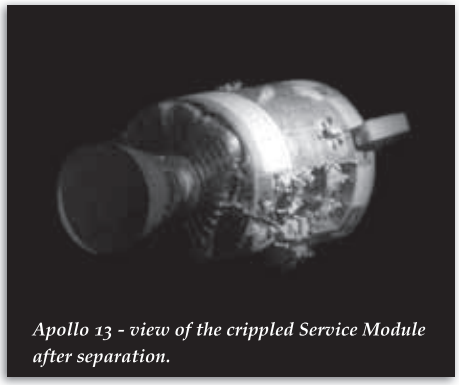
Apollo 1's Command Module a day after fire.

with the number of technical issues and work-rounds associated with the spacecraft. The problems came

catastrophically to a head on 27th January 1967 when, whilst undergoing ground testing on the launch pad, an electrical fire in the capsule rapidly became a conflagration in the pressurized 100 per cent oxygen environment destroying the capsule and killing the three crew.

The Apollo 1 fire represented a watershed in the programme. NASA were allowed to conduct the enquiry but were now obviously in a spotlight; the fire had destroyed confidence in the agency across America. Despite the fact that 9,400 US soldiers were killed in Southeast Asia that year, on a 'mission whose management was uncertain, whose purpose was undefined, and whose execution was flawed'[12] , the death of the astronauts was taken as evidence of high incompetence within the agency. While establishing responsibility for the accident was far from straightforward, a major conclusion was that: 'deficiencies existed in Command Module design, workmanship and quality control.[13]

After the fire and the subsequent enquiry it is little short of miraculous that the programme was able to regain its demanding timeline with only 21 months elapsing before manned flights recommenced. Major changes in organization and approach were implemented and a series of unmanned launches tested out the command module and its *Saturn* boosters. It is a testament to the thoroughness of the reorganization that, three years later, when *Apollo* 13 executed an emergency shutdown of the command module after a crippling explosion in the service module *en route* to the Moon, water condensation gathered for four days but did not cause any shorts or sparking when the spacecraft was powered up to enable re-entry. Moreover, it was possible for investigators to establish the cause of the explosion from the comprehensive engineering documentation, limited photography and telemetry alone without access to the service module itself.



Apollo 13 - view of the crippled Service Module after separation.

Apollo 7 S-IVB rocket stage in Earth orbit on October 11, 1968. Cape Canaveral and Merritt Island, Florida, can be seen beyond the left side of the lower end of the S-IVB.

Apollo 7 heralded a return to manned flight with a successful comprehensive 11-day engineering test flight in earth orbit launched on 11th October 1968. However, by mid-1968, it became clear that Lunar

Module (LM) development was behind the main programme, and it was unlikely that Grumman would be able to provide a flight-ready vehicle in time for *Apollo* 8 - the mission was designed to test the LM in earth orbit before subsequent missions reached for the Moon. Director of the *Apollo* Spacecraft Programme Office, George Low, proposed that, rather than perform another simple earth orbiting mission, they send *Apollo* 8, without LM, around the Moon over Christmas. Initially greeted with some skepticism – Webb was reported to have reacted with the words: 'Are you out of your mind? You're putting our Agency and the whole *Apollo* project at risk!'[14] The stress of the personal grilling suffered by Webb during the *Apollo* 1 enquiry, some accusations of corruption and Lyndon Johnson's announcement that he would not seek a second term in office led political appointee Webb to resign and, on 12th November 1968, his replacement, Tom Paine, announced his courageous decision that *Apollo* 8 would be going around the Moon.

On 21st December *Apollo* 8 was launched to take the first humans on an interplanetary voyage; what astronaut leader, Deke Slayton was later to describe as 'the greatest single gamble in space flight then, and since.'[15] On Christmas Eve, *Apollo* 8 entered Lunar Orbit and passed behind the Moon for the first time of its ten eventual orbits. The crew was busy with many tasks - including an examination of possible landing sites for future missions[16] - but also found time for two activities that were to have political implications. The first was a reading from Genesis,

Rollout to the launch pad of the Apollo 8 Saturn V on October 9, 1968.

with the crew wishing '…. A merry Christmas, and God bless all of you - all of you on the good earth.'[17] There were many objections to the use of the religious text in a US government funded mission - although Burrows suggests it was a deliberate slight at the 'godless commies.'[18] What we were seeing, however, was the early development of the concept of the world as an ordered whole, on a fragile planet, which resonated deeply worldwide. The other activity - the taking of the famous 'Earthrise' photograph - is now considered to have given considerable impetus to the burgeoning environmental movement that had been boosted by the recent publication of such books as Silent Spring by Rachel Carson[19] and the increasing number of man-made ecological disasters - such as the *Torrey Canyon* grounding only a year earlier. The 'Global Village' was emerging in world consciousness.

Apollo 9, launched on 3rd March 1969, was an earth orbit check out of the

View of the Apollo 9 Lunar Module "Spider" in a lunar landing configuration photographed by Command Module pilot David Scott.

LM, before *Apollo* 10 performed a full rehearsal of the Moon landing mission; with the LM descending to within some 47,000 ft above the Moon's surface. The LM at the stage was still too heavy to land on the Moon and a rapid weight

At 9:32 a.m. EDT, the swing arms move away and a plume of flame signals the liftoff of the Apollo 11 Saturn V space vehicle and astronauts Neil A. Armstrong, Michael Collins and Edwin E. Aldrin, Jr. from Kennedy Space Center Launch Complex 39A.

loss programme was in progress at Grumman in order to meet the next Mission. In the latter stages of his presidency, Johnson had grown increasingly disillusioned with the space programme and the newly elected President, Richard Nixon, remained at arm's length, publicly, from the programme. When *Apollo* 11 was launched, Nixon was not present at the launch, leaving the VIP box to his vice president, Spiro Agnew, and ex-president Lyndon Johnson.

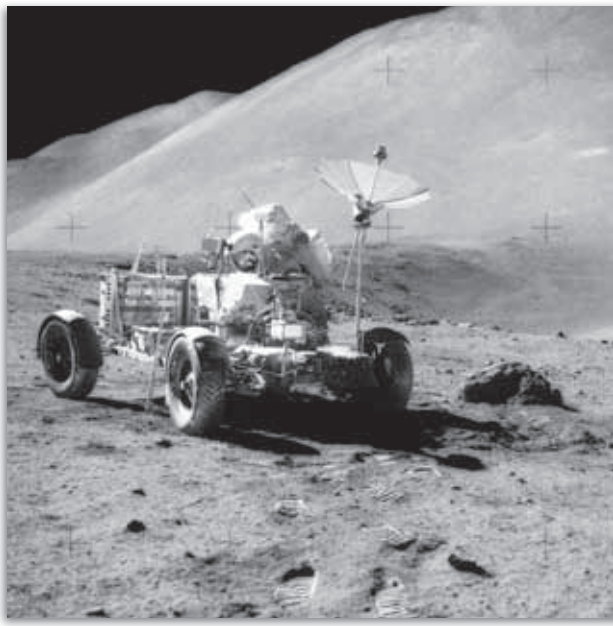
At 15:17hrs (Houston time) on 20th July 1969, the *Apollo* 11 Lunar Module *Eagle* touched down on the Moon after a nail-biting approach, and with

approximately 20 seconds of fuel remaining. After about six hours of checks and a foreshortened rest period, Commander Neil Armstrong made that 'one small step for [a] man'

Astronaut Alan L. Bean, Lunar Module pilot for the Apollo 12 lunar landing mission, holds a Special Environmental Sample Container filled with lunar soil collected during the extravehicular activity (EVA).

onto the Moon's surface at around 21:55. He was followed by Buzz Aldrin and they together walked on the Moon's surface for some two and a half hours. President Nixon was now keen to be associated with the success and was able to speak with the astronauts on the surface of the Moon directly from the oval office.

Now Kennedy's challenge had been met, it was time to make the major scientific leaps of the *Apollo* programme. The aim was for crews to spend increasingly longer on the lunar surface and to explore further from the LM. The crew of *Apollo* 12 spent just short of 8 hrs walking on the lunar surface and conducted a full set of scientific experiments. The saga of *Apollo* 13 has now taken its place in space history but, at the time of the launch, the public interest and excitement had waned. The television broadcasts from the spacecraft in trans-planetary space were not carried by any of the major news networks. All this changed, of course, when the explosion occurred - leaving the world watching in suspense for some 63 hours before the incredible teamwork and technical ingenuity demonstrated by NASA and the spacecraft contractors brought the astronauts home safely.[20] The remaining missions increased the amount of scientific work exponentially, with the addition of



David R. Scott, Commander of Apollo 15, works at the Lunar Roving Vehicle (LRV) during the third lunar surface extravehicular activity (EVA) of the mission at the Hadley-Apennine landing site.

the lunar rover on *Apollo* 15 enabling long distances to be traversed on the lunar surface. *Apollo* 17 was without doubt the acme of manned space exploration with a total of 22 hours spent outside the LM on the lunar surface and some 19.3nm travelled in the rover. This mission also saw the first of the 'non-pilot' astronauts, geologist Jack Schmitt, walk on the

Moon. Despite the outstanding success of the mission, the newly-elected Republican administration's distrust of 'big government' federal spending, the strains of Vietnam, reduced public interest and, possibly most importantly, the emergence of possible détente with the Soviets, conspired to drastically reduce NASA's budget. The commander of *Apollo* 17, Gene Cernan, thus became the last man to stand on the Moon.

Following the success of the *Apollo* program, NASA planned several new missions for the, now surplus, *Apollo* hardware. The *Apollo Applications Program*, proposed up to thirty earth orbital missions, primarily using the space designed for the

Geologist-Astronaut Harrison H. Schmitt is photographed standing next to a huge, split boulder at Station 6 on the sloping base of North Massif during the third Apollo 17 extravehicular activity (EVA-3) at the Taurus-Littrow landing site.

lunar module in the *Saturn* rocket to carry scientific equipment. Only two of the planned missions were implemented: the *Skylab* space station (May 1973 – February 1974), and the *Apollo-Soyuz* Test Project (July 1975).

Skylab Orbital Workshop in Earth orbit as photographed from the Skylab 4 Command and Service Modules (CSM) during the final fly-around by the CSM before returning home. The Skylab Orbital Workshop fulfilled its mission before being deorbited in 1978.

Skylab's fuselage was constructed from the second stage of a Saturn IB, and the station was equipped with the *Apollo* Telescope Mount, based on a LM. Astronauts were ferried into orbit in an *Apollo* command module; the station itself had been launched with a modified Saturn V Booster. Skylab's last crew left orbit on 8th February 1974, and the space station itself returned to Earth in 1979 - by which time it had become the oldest operational *Apollo* component. NASA also developed a programme to identify possible 'spin-offs' from spacecraft development in the NASA 'Technology Utilization Programme' whose aim was:

'To identify and hold up to the light the many items of space technology that could be or had been adapted for uses in the civilian economy. By 1973 some 30,000 such uses had been identified and new ones were rolling in at a rate of 2,000 a year'.[21]

Photograph from the Apollo spacecraft in Earth orbit during the Apollo-Soyuz Test Project (ASTP) mission. It shows the Soviet Soyuz spacecraft contrasted against a black-sky background with the Earth's horizon below.

The Apollo programme was successful in achieving the explicit aim declared by Kennedy and more. The programme captured the imagination of the nation and it became a supreme national effort. At the peak of *Apollo* production, in 1967, over 400,000 people were engaged working on an aspect of the *Apollo* programme.[22] This National support eased the massive allocation of federal funds required for success, although it remained, very much, a programme of the cold war, designed to assert US superiority over communism. As the Cold War 'thawed' in the latter stages of the programme, funding and support became increasingly problematical. In its latter stages it became rapidly overtaken by the war in Vietnam in the public consciousness.

So what did it all cost? The NASA budget reached an annual peak of $5.1 Billion in 1964 where it remained for some 4 years.[23] In 1964, James Webb, as NASA administrator, in effect held sway over 5 per cent of the entire federal budget.[24] The eleven-and-a-half year programme:

'….. cost $23.5 Billion, landed 12 men on the Moon, and produced an overwhelming amount of evidence and knowledge. Technologically, it generated hardware systems several orders of magnitude more capable that their predecessors'.[25]

Although the colossal material cost of the *Apollo* programme is stunning, we should not forget that there was also a cost in human life. Astronauts Gus Grissom, Ed White and Roger Chaffee were burnt to death in the *Apollo* 1 Fire and no less tragically; Astronauts Elliot See, Charlie Basset and CC Williams were killed in T38 Flying Accidents whilst in training for Space Missions.

Apollo 1 Saturn V Apollo 204 Command Module Fire tragically killed Astronauts Gus Grissom, Ed White and Roger Chaffee.

NASA administrator George Low

summed up the all-enveloping endeavour that was *Apollo* with the words; 'There will never be another *Apollo* in anyone's life'[26] and looking back it does all seem slightly unreal. Going to the Moon has, at face value, changed little for a large number of human beings. In 2002, Arthur C Clarke was asked which event in the Twentieth Century he would never have predicted. He replied,"That we would have gone to the Moon and then stopped".[27] So why did the Americans stop? Well, essentially, for the same reason that the programme was so successful in the first place. The *Apollo* programme was a *political* programme - through and through. It was successful because the political impetus to beat the Soviets enabled mobilization of a massive national effort in terms of both funding and manpower. However, within two years of his 'before this decade' speech, Kennedy had faced Khrushchev down over Cuba and Berlin and made progress limiting the nuclear arms race; America was regaining its mastery of world affairs. Once the political rationale had gone, there was insufficient scientific or technological impetus to keep the huge national momentum behind the programme going. 'The greatest feat of human exploration had been undertaken for exactly the wrong reason'.[28] Nevertheless, in my view, the Apollo programme remains the greatest human adventure of the last 1000 years and will remain so until circumstances enable someone to take on George Bush's challenge at the opening of this article – whether it is again America remains to be seen.

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

By Maj Stephen Jones

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

Introduction

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

Everett C. Dolman, *Astropolitik*[1]

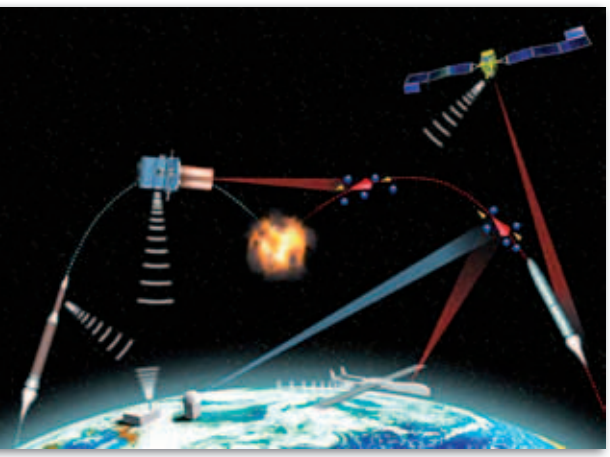
Astronaut Buzz Aldrin saluting the United States flag during an Apollo 11 Extravehicular Activity (EVA) on the lunar surface.

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

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

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

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



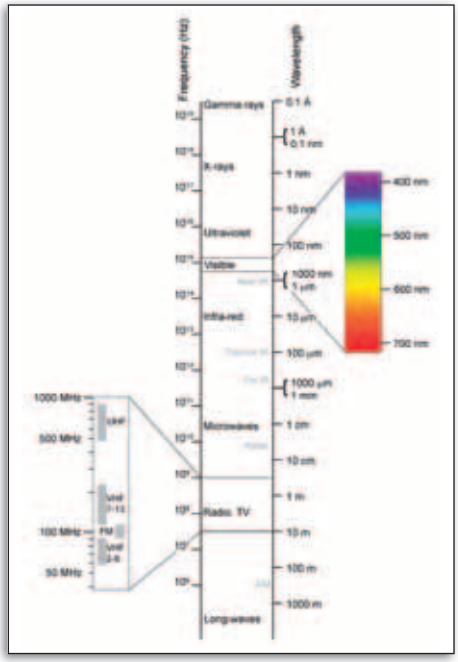
Missile defence scenario.

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

Space: Limitations and Inevitabilities

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

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



Electromagnetic spectrum.

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

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

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

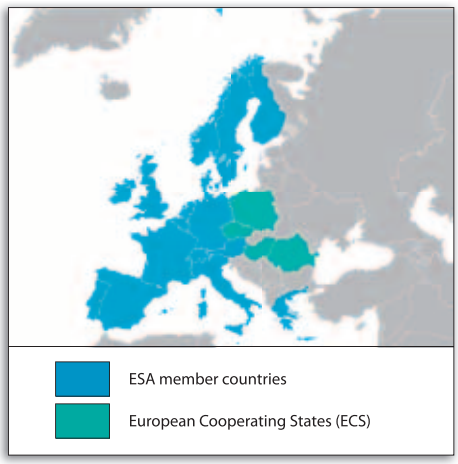
The importance of space to the UK is no longer just a military issue, but has grown to involve nearly every aspect of its society. Speaking of its nation's dependency on space, a report issued in 2007 by the UK House of Commons Science and Technology Committee expressed concern that the public remains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

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

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

UK Military Presence in Space

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



European Space Agency (ESA) members map.

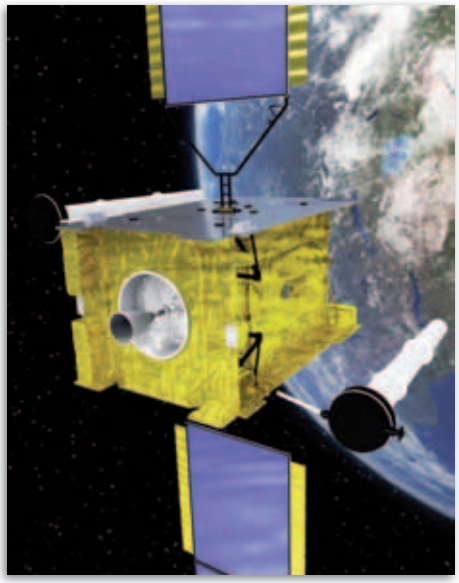
total budget. Europe is estimated to spend a combined total of €5 billion ($6.2 billion) annually on all space activities, which includes civilian, military, national and cooperative expenditures.[21] By comparison, the unclassified portion of the US's *military* space budget alone for 2006 was $22.5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

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

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

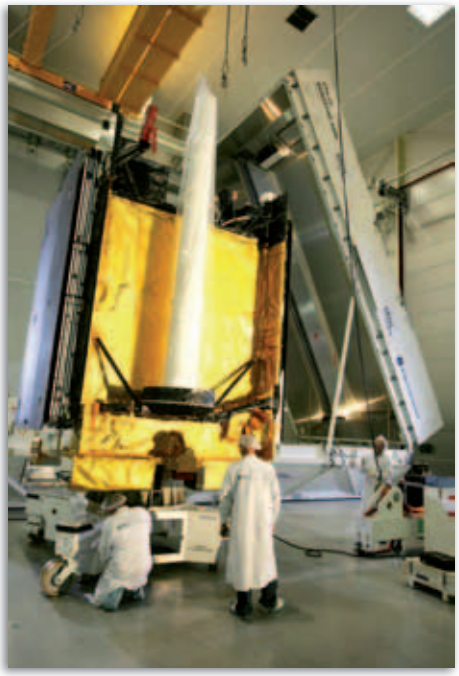
Technician in clean area with RALCam space camera.

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



Skynet 5A.

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



Skynet 5B.

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

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

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

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

Space: Security for the Nation

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

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

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

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

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

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

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

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

Marines disembarking in a Sea King helicopter Falkland Islands 1982.

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

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

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

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

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

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

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

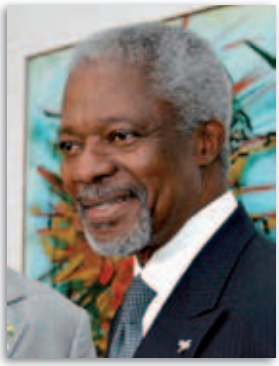
Will the special relationship between the US and the UK remain strong enough to weather future storms, and can the UK remain confident that the US will continue to provide it with access to the space-based capability deemed so crucial to its national security? The draft *FASOC* predicts that 'the US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

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

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

Space Presence and Diplomatic Power

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



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

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

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

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

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

terrestrial orbits'.[70]

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

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

International Telecommunications Union (ITU) Flag.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Affordable Options for UK Space Investment

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

Create a Permanent Cadre of Space Experts

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

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

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

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

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

Headquarters Air Command, RAF High Wycombe.

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

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

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

Vickers Vimy, british bomber in WWI 1918.

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

Recommit to Local Industry

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

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

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

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

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

Two Technicians working on TopSat RAL.

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

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

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

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

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

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

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

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

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

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

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

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

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

A RAF Reaper at Kandahar Airfield in Afghanistan.

Become an Integral Part of US Operationally Responsive Space

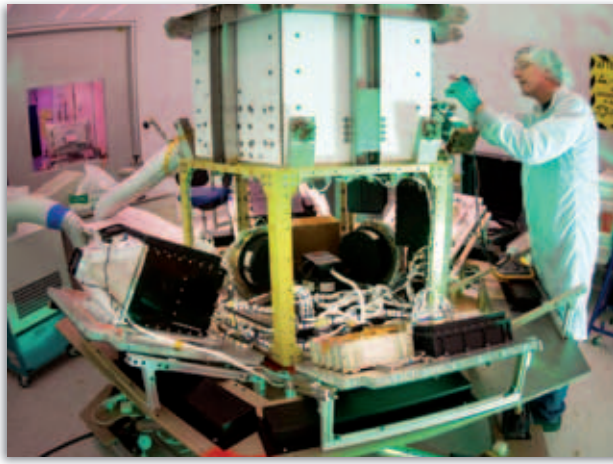
The importance of the survival of the UK's independent and financially sound micro-satellite industry to the national security becomes even more evident when placed in context with the growing vulnerabilities to space-based capabilities. The UK should explore options to protect not only its own access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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

Conclusion

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

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China's Military Space Strategy

By Flt Lt Kenny Fuchter

Whilst the UK's military is becoming increasingly reliant on space, space itself has become a contested environment. China in particular has burgeoning military space programmes, including anti-satellite and directed energy weapons. Numerous Chinese writings on space doctrine and strategy highlight these growing capabilities. Although the primary target for these programmes is the US, close linkages between UK and US space based capabilities could mean, that the ability of the UK's military to operate, may be affected in any future China-US conflict. China may also provide an indication of other countries, such as Russia, Iran and North Korea's future developments. This paper considers the implications of China's military space strategy, both in the wider context and for the UK, and argues in its conclusion that the UK is in danger of falling behind other nations, in terms of space operations, and cannot afford to ignore the issue.

Introduction

'Space is a contested environment - though many people still don't believe this.'

Brigadier General John E. Hyten, Director of Requirements, US Space Command, Sep 08[1]

On 11 Jan 2007, a medium range ballistic missile was launched from the Xichang space facility in Sichuan province China. Several minutes later the missile deployed a Kinetic Kill Vehicle (KKV) that subsequently slammed into an ageing Chinese weather satellite that was travelling at 7.42km per second, approximately 864 km

China Xichang Satellite Center; The launch of Tianlian I-01 satellite (a Data Relay & Tracking Satellite); The newly developed Long March 3C Carrier Rocket.

above the surface of the Earth.[2] The satellite intercept occurred along the ascent trajectory of the missile's flight meaning that the systems were so accurate that there was no requirement to exploit the booster's descent trajectory to give the kill vehicle more time to both observe the target and manoeuvre as necessary.[3] In a dramatic manner China had announced to the world that it had technology that far surpassed the erstwhile Soviet Union and more importantly sent a significant message to the US over its hitherto assumed dominance in space.

Although the US and its allies in Asia, (particularly Taiwan and Japan[4]) may have been the target for this message the implications are far wider. It is not just the US that relies on space for its current military operations. The UK's reliance on space is increasing and could be a critical vulnerability unless the weaknesses of space are understood. As noted in the key Future Air and Space Operational Concept (FASOC) in Practice document:

'We must ensure that threats to our space capability are identified, understood and either neutralized or mitigated.'[5]

It goes on to add:

'Fundamental to this is building on our existing space situational awareness and then delivering a Recognized Space Picture for Defence. The UK's data exploitation and missile warning capabilities cement our close links with US space-based capabilities; this linkage should not be underestimated.'[6]

Close linkages with US space-based capabilities could potentially mean that the ability of the UK's military to operate might be affected in any future China-US conflict. China's burgeoning capabilities may also provide an indicator of what other countries with space programmes, such as Russia, Iran and North Korea, could develop in future. The wider

implications of China's race for space need also to be considered. The aim of this paper is to consider these critical areas by firstly examining China's space strategy, utilising available Chinese sources where possible. To place this in context China's space programmes will then be explored. From these two areas an assessment of the implications of China's space strategy for the UK will then be extrapolated.

China's Space Strategy

China's military space strategy is obfuscated (deliberately) by a lack of transparency, which makes ascertaining what strategy exists problematic. Indications can be gleaned from the available Chinese sources but to what extent these represent the official views of the Peoples Liberation Army (PLA) leadership remains unclear. However, a number of sources are available which when analysed together can provide a flavour of China's attitudes towards military operations in space.

Flag of the Peoples Liberation Army (PLA).

Two of the most reputable institutes are the PLA's Academy of Military Science (AMS) and the National Defence University (NDU). AMS is considered the primary research centre for military doctrine, which in China is developed by military researchers and academics rather than warfighters, as in the West.[7] From these institutes publications and other journals and sources such as *China Military Science, China Aerospace* and the *Peoples Liberation Army Daily* an understanding of how the PLA envisages the utilisation of space can be developed.

Chinese ASAT Intercept.

The anti-satellite (ASAT) test clearly demonstrated a capability, but what is less clear whether China has a specific military doctrine to go along with these rapidly developing capabilities.[8] China does not appear to have a dedicated space campaign; rather space operations form an integral component of all campaigns[9] and space is viewed as another operational domain along with Land, Sea, Air and Cyberspace. In Chinese terms the key to any campaign is information dominance, which it sees as key to operational success against more conventionally powerful adversaries.[10] China defines this strategy as 'Informationalized War' and it underpins much of China's current military thinking. In the 2006 Defence White Paper it was

noted that:

'To effectively fulfil its historic mission in the new stage of the new century, the PLA is speeding up the revolution in military affairs with Chinese features and enhancing in an all-round way its capabilities of defensive operations under conditions of informationization.' [11]

It is recognised that this will take time to achieve, indeed China's aim is to lay the foundation by 2010, make major progress by 2020 and reach the goal of being capable of winning informationized wars by the mid Twenty-First Century.[12] To understand China's space strategy it is therefore necessary to have an understanding of informationalized war. China's latest Defence White Paper, released on 21Jan 09, outlined the strategic guideline of 'Active Defence':

'It takes into overall consideration the evolution of modern warfare and the major security threats facing China, and prepares for defensive operations under the most difficult and complex circumstances. Meeting the requirements of confrontation between war systems in modern warfare and taking integrated joint operations as the basic approach, it is designed to bring the operational strengths of different services and arms into full play, combine offensive operations with defensive operations, give priority to the flexible application of strategies and tactics, seek advantages and avoid disadvantages, and make the best use of our strong points to attack the enemy's weak points. It endeavours to refine the command system for joint operations, the joint training system and the joint support system, optimize the structure and composition of forces, and speed up the building of a combat force structure suitable for winning local wars

Peoples Liberation Army soldiers on parade.

in conditions of informationization.'[13]

In practical terms, although the concept of informationalized war was introduced formally into the PLA only in 2004, having replaced the strategy of war under 'high tech' conditions, its key function of gaining information superiority had been advocated earlier. For example in the NDU book Science of Campaigns published in 2000 it was noted that the aim in conflict was:

'. . . to cut off the enemy's observation, decision-making, and troop command and control capabilities at critical times and in areas related to overall campaign operations, while maintaining our own command and control ability, thus allowing us to seize information superiority, to establish strategic and campaign superiority, and to create conditions to win the decisive battle.'

In addition,

'. . . whoever receives, transmits, and uses information more frequently in real-time, more accurately, and more effectively has more chances to win the war. Moreover, the one who has the control over collecting information generally usually can achieve better cost-effectiveness in war. Therefore, the primary task of modern campaigns has become seizing information superiority and taking away the enemy's capability

of acquiring information.' [14]

Fundamental to this strategy is space, as a recent PLA Daily and National Defence News article noted:

'Information dominance cannot be separated from space dominance. We can say that seizing space dominance is the basis for winning informationalized war.' [15]

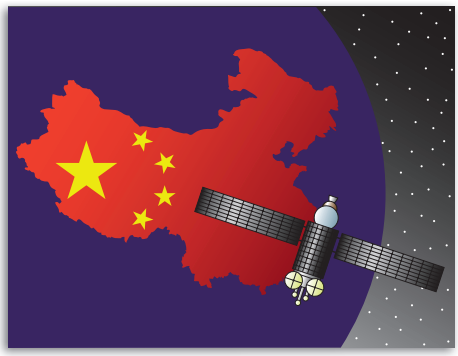
This point was emphasised by Major General Liu Jixian in a China Military Science journal article when he observed "whoever controls space controls initiative in war." [16] When describing space control in the Beijing Military Science Press book Space Warfare, published in 2001, it was noted that:

'Space control is seen as the further development of air control as the development of space technology allows space vehicles to transit through space as well as to strike terrestrial targets from space. It maximizes one's own space forces and limits, weakens, damages, and denies the application of enemy space forces. Space control theory also emphasizes the support and safeguarding of ground, sea, and air operations through the control and utilization of space. To gain space control has become one of the essential conditions to gain air, sea, land and electromagnetic control.' [17]

By 2006 this had been developed further, as outlined by Major General Cai Fengzhen when writing on integrated aerospace operations and how space control relates to the PLA's theory on outer space operations:

'Space control is the capability of one belligerent in a state of war, in a specified period of time, in a defined area of space, to carry out its own operations with freedom whilst hindering or preventing an enemy from carrying out its own operations or using space.' [18]

Having observed US led operations from the first Gulf War to current operations in Iraq and Afghanistan, PLA researchers have argued that it is inevitable that the main battlefield for informationalized war is being driven into outer space and to meet that challenge the Chinese military must build up its military space power.[19] Indeed Pollpeter has demonstrated that analysis of Chinese sources of varying authority has consistently derived two main conclusions: space warfare is inevitable and China must prepare for space war by integrating space into military operations and by



developing its own space weapons.[20] By the mid 1990s the requirement to reduce satellite vulnerability, acquire ASAT capabilities and to develop the capability to strike first at enemy space capabilities had been identified.[21] Consequently China's contemplation of the military usage of space has focused on two broad areas: firstly, how to use space to increase its offensive capability, and secondly how to use space to deny space capabilities to adversaries.[22]

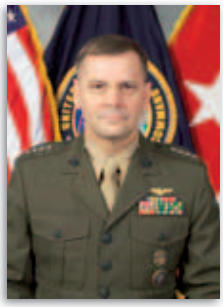
China's space doctrine is evolving and is driven by study of US military publications on space warfare and counter space operations.[23] Whilst China has also made use of Soviet-era and contemporary Russian thinking,

it is developments in the US that cause the PLA the greatest concern, and indeed, it is the US that is singled out in much of the literature as a potential adversary.[24] The possibility of a US backed Taiwanese declaration of independence is still identified as the single greatest threat to Chinese national security, despite the election last year of a more pro-Chinese President in Taiwan. US influence in the Asia-Pacific region is seen by China as the most important factor in destabilising regional security[25] and global competition as China's economy and resource requirement grows in the 21st Century is also seen as inevitable.

In developing their own doctrine Chinese officials and researchers have noted a number of US military planning documents that explicitly envision the control of space through the use of weapons either in or delivered from space.[26] By 1997, in its *Vision for 2020* document, US Space Command had observed that:

'Just as land dominance, sea control and air superiority have become critical elements of current military strategy, space superiority is emerging as an essential element of battlefield success and future warfare.'[27]

The US Air Force in its "Transformation Flight Plan" report, published in 2003, listed a number of space weapon systems desirable in the event of a space war,[28] whilst the 2004 "Counterspace Operations Doctrine" defined the intention to achieve and maintain space superiority – the "freedom to attack as well as the freedom from attack" – in space.[29] The US National Space Policy, introduced in 2006, directed the Secretary of Defence to "develop



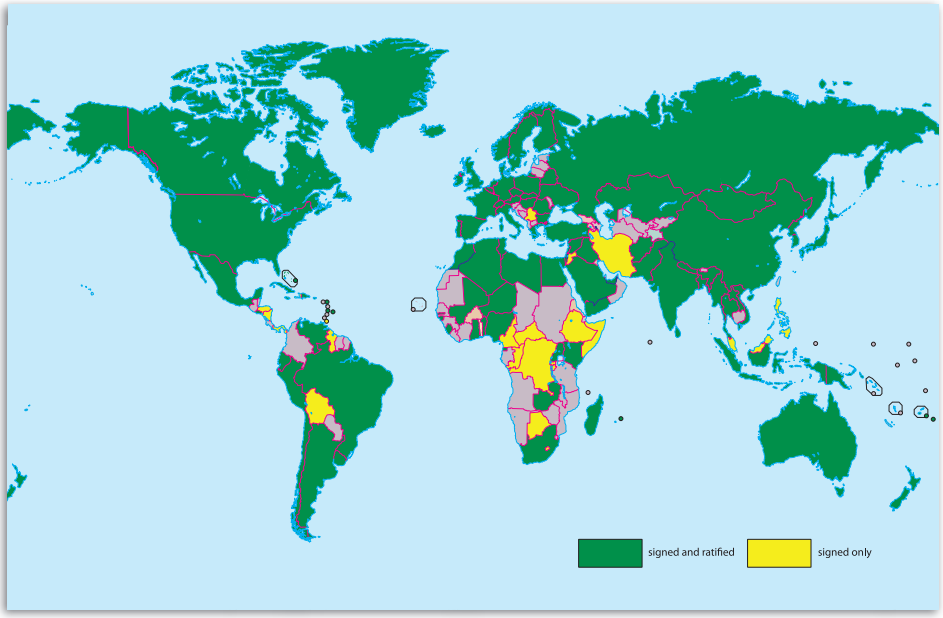
General James E. Cartwright, Commander, U.S. Strategic Command.

capabilities, plans and options to ensure freedom of action in space and, if so directed, deny such freedom of action to adversaries."[30] A recent statement by General James Cartwright, Commander US Strategic Command to the Strategic Forces Subcommittee, Senate Armed Service Committee backed up these policies:

'We must ensure U.S. freedom of operation in space and cyberspace, connectivity sufficient to exercise global command and control, integrated missile defense, and upon order, provide kinetic or non-kinetic global strike.'

'Freedom of action in space is as important to the United States as freedom to operate in the air and sea'.[31]

China is particularly concerned over the implications that the US missile defence network will have on the viability of its own strategic nuclear deterrent, especially if that defence system ends up being space based.[32] The fact that elements of this system will be based in Japan is also cause for disquiet in Beijing, which views Japans own burgeoning space programmes as a further area of concern. These concerns are probably why China's stance on banning weapons in outer space has been consistent since 1985, when it first introduced a working paper to the U.N. Conference on Disarmament[33] and why China is both a signatory of



World Map showing members of the Outer Space Treaty.

the Outer Space Treaty and a member of the UN Committee on the Peaceful Uses of Outer Space. Although seemingly at odds with the ASAT test, it has been argued that this test may have been aimed at coercing the United States into negotiating a space weapons treaty, and was a response to the US documents and statements outlined above.[34] Whilst this is a possible factor, the breadth and sophistication of China's anti-access and battlespace-denial programmes would, when taken together, readily undermine this notion.[35]

Whilst realising that the US has a significant qualitative and quantitative advantage over China's conventional forces, particularly in terms of command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR), PLA strategists believe that neutralizing or destroying U.S. space assets will deny American forces the advantage they have, and make them more vulnerable to China's less-advanced military.[36] Indeed it is in space that China believes that the US 'weak points' or its Achilles heel lie. A key tenet of Mao, who is still widely regarded in the PLA as a strategist, is to identify and attack where the enemy is most vulnerable, particularly in the rear and flanks, which are seen as the most vulnerable and vital.[37] It is clear to PLA strategists that space is the new rear, particularly given US reliance on space based information systems, and that these systems are vulnerable to attack, as a *Liberation Army Daily* article shows:

'If an anti-satellite weapon destroys a space system in a future war, the destruction will have dealt a blow to the side that owns and uses the space system, stripped it of space supremacy, and weakened its supremacy in conducting information warfare, and even its supremacy in the war at large. Anti-satellite weapons that can be developed

at low cost and that can strike at the enemy's enormously expensive yet vulnerable space system will become an important option for the majority of medium-sized and small countries with fragile space technology.'[38]

The strategic logic of China developing systems to counter US conventional superiority is clear as one Chinese military scholar has described:

'An effective active defense against a formidable power in space may require China to have an asymmetric capability against the powerful United States. Some have wondered whether a defensive policy applied to space suggests that China's possession of a robust reconnaissance, tracking, and monitoring space system would be sufficient for China to prevent an attack in space and would be in line with China's 'doctrinal' position of 'defensive' capabilities. An effective active defense strategy would include the development of these systems but would also include anti-satellite capabilities and space attack weapon systems if necessary. In essence, China will follow the same principles for space militarization and space weapons as it did with nuclear weapons. That is, it will develop anti-satellite and space weapons capable of effectively taking out an enemy's space system, in order to constitute a reliable and credible defense strategy.' [39]

Whilst much of the current Chinese writing remains aspirational, it is clear that the military applications of space form an integral component of doctrinal thought and provide an indication as to where China is heading, both in current developmental terms and in the future. What is in itself staggering is the speed in which these developments are occurring. China has gone from having no geo-stationary satellites in 1984, and little doctrinal thought regarding space, to advanced space systems, including manned space flight and anti-satellite weapons and the significant integration of space operational theory into current doctrine in only 25 years. The implications of these programmes could be significant for those nations who have come to rely on space for military operations as McDonald notes:

'China is possibly seeking a full space war-fighting capability and not just a finite deterrence posture. However, PLA writings make clear what Chinese diplomacy does not: the PLA envisions conflict in space and is preparing for it.'[40]

China's Space Programmes

In his 2002 NDU book *On Space Operations* Colonel Jia Jumming recommended a two phased approach for China's space programmes: '*For our country, in phase one, 2000-2015, we must develop space for combat support. In phase two, 2015 to 2030 then develop limited space deterrence and "assassins mace" space weapons."*[41] The ASAT test has demonstrated that China already possess at least one 'assassins mace' weapon, but direct assent weapons form only one element of the larger spectrum of offensive capabilities aimed at vitiating American dominance in space.[42] In addition the latest Annual Threat Assessment of the US Senate Select Committee on Intelligence, released in Feb 2009, noted that counter-command, control, and sensor systems, to include communications satellite jammers and anti-satellite weapons are among Beijing's highest military priorities. The assessment asserted that China

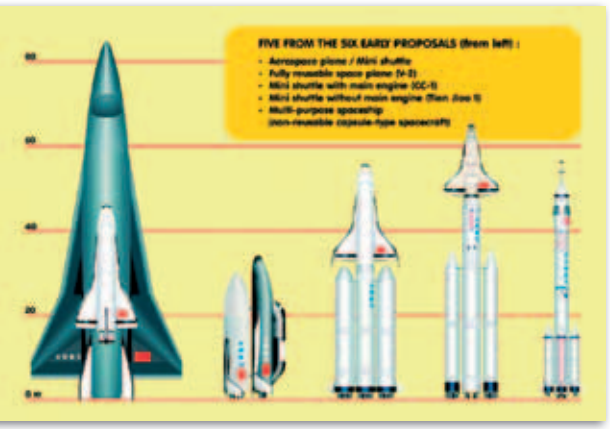
continues to pursue a long-term program to develop a capability to disrupt and damage critical foreign space systems.[43]

Written evidence of these programmes has existed for some time. In *Space Warfare*, published in 2001, desirable systems and technology that could be used for military operations in space were described in four categories:

Model of the proposed Chinese space shuttle.

Platforms

- Aerospace plane
  (e.g. space shuttle)

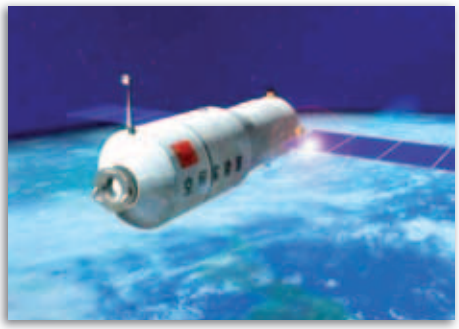


Aerospace plane/Mini shuttle designated as H-2, it was proposed by Institute 601 of the Ministry of Aeronautics. Its first launch targeted around 2015.

- Space plane

The Shenzhou 5 Space Capsule reentry module.

- Space craft
  (e.g. Shenzhou space capsule)
- Spacecraft carrier
  (able to dock other spacecraft for resupply, refuel and repair)
- Space station
  (for scientific experiments or weapons use but not designed for docking or maintenance)



China has unveiled a mockup of the planned Space Laboratory, a man-tender mini space station. It is believed that the first launch will be before 2010.

Support Technology

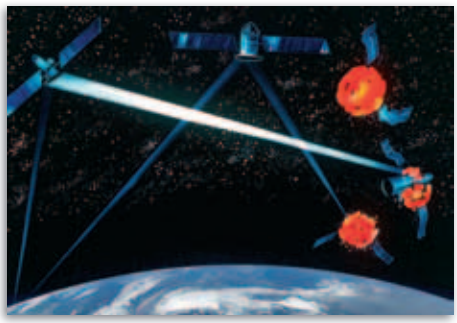
- Communication, Navigation, Reconnaissance, Early Warning and Meteorological satellites

Safeguard Technology

- Launch and recovery vehicles.

Transportation equipment

Counter-Space and Space Defence Technologies



An artist's concept of a USAF ground/space-based hybrid laser weapon.

- Anti-satellite satellites
- Directed energy weapons including lasers and microwave weapons

An artist's concept of a USAF Space Laser Satellite Defense System.

- Kinetic energy weapons

Chinese ASAT Kinetic Energy Weapon test.

- Missiles

Anti-Sat weapon.

(nuclear and non-nuclear)

- Orbital bombs
- Manipulation

Computer Network hacking/attacks.

- Computer Network Attack
- Passive Measures (including denial deception and concealment)
- Electronic Attack
- Ground based operations (e.g. special forces operations)[44]

Despite appearing far-fetched, China already possesses some of these capabilities and is in the process of acquiring more, all of which are of utility for military operations. Indeed since 2001 when *Space Warfare* was published China has made staggering progress in space and it is the scale

of China's long-term space ambitions that is of concern to others. The manned Shenzhou programme has already seen the first Chinese spacewalk in 2008, and aims to have three capsules join to form a space laboratory in 2010. The goal is to replace this with a full-scale space station by around 2020 and follow that with a manned lunar landing by 2024, and a manned mission to Mars by 2050.[45] The PLA is heavily involved in these programmes, which are occurring whilst US space programmes, including a proposed mission to Mars, are being curtailed and the space shuttle limps towards retirement in 2010 with the proposed replacement still under development.

Satellites

In tandem with its successful manned space programme, China has launched an impressive satellite program, with a clear objective to advance its capabilities in satellite technology particularly in regard to production, launch capacity and infrastructure. This ambitious plan is primarily driven by the attraction of gaining a larger share of the current annual $100 billion global commercial satellite market, which is set to grow to $150 billion by 2010.[46] However, although primarily intended to facilitate national economic growth, many of China's new satellites do contain important dual use capabilities that support PLA requirements including:

i. The ability to find enemy forces
ii. The ability to coordinate one's own forces, which may be multi-service
iii. The ability to locate and move one's own forces to within reach of the enemy
iv. The ability to undertake precision, long range strikes against the enemy, assess the results, and either sustain those attacks or move on to new targets[47]

Liftoff of Beidou-2 (COMPASS-G2) navigation satellite on 15th April 2009.

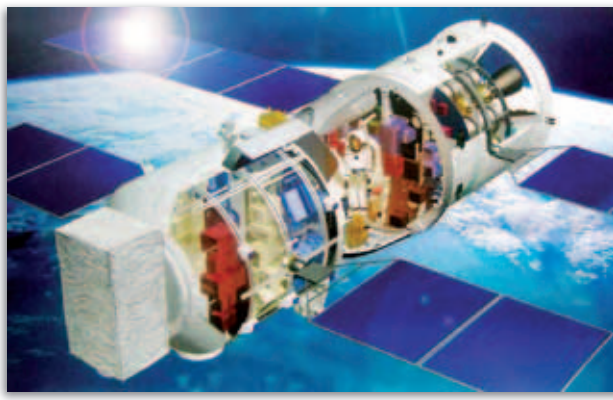
As a result, China is estimated to be developing numerous types of satellites that include imagery reconnaissance, electronic intelligence and signals intelligence reconnaissance satellites; small and micro-sized satellites for imagery, navigation and communication roles; and anti-satellite satellites.[48] It is assessed that China may have a requirement for as many as 200 military, civilian and dual use satellites in the first two decades of the Twenty-First Century.[49]

China has already launched

several generations of spy satellites including the latest Yaogan series of synthetic aperture radar satellites, offering 2m resolution, which were launched between 2006 and 2009. The introduction of a new generation of reconnaissance satellite is expected in 2010.[50]

On 15 Apr 09, China launched the second satellite in its Compass (Beidou 2) Navigation Satellite System (CNSS). This launch was the first of ten planned through to the end of 2010 alone. Initially China will provide a regional capability, but between 2015 and 2020, the constellation of thirty Medium Earth Orbit (MEO) and five Geostationary (GEO) satellites will provide a global open service with positioning accuracy of 10 meters, velocity accuracy within 0.2 meters per second and timing accuracy within 50 nanoseconds. An 'Authorized Service' will offer greater accuracy for authorised users that will primarily include the PLA.[51] Although China currently utilises the four Beidou 1 satellites as well as GLONASS and GPS, whilst investing in the EU's Galileo system, Beidou 2 will not only provide a significant improvement in capability, but also reduce reliance on foreign systems, especially GPS. This is particularly pertinent when it is considered that GPS is a primary target for China's counter-space strategy. Observing US reliance on the system, Chinese analysts have noted both its vulnerability to jamming, either the signal or at source by a space based jammer, or to destruction.[52]

US scholars have claimed that there is also ample evidence from Chinese scientific and military journals that the PRC is developing manoeuvring micro-satellites that can attach themselves to enemy satellites and destroy or jam them, or could be used to collide with and destroy enemy satellites.[53] Emerging capabilities in agile micro- and nano-satellites are most problematic from a US perspective as they can be launched quickly by mobile boosters, or covertly as secondary payloads and once in orbit are extremely difficult to detect and track.[54] These could then be used to conduct co-orbital attacks or reconnaissance on targets that may not traverse the Chinese mainland and, would provide insurance if other direct attack weapons were destroyed early in a conflict.[55] China demonstrated an embryonic capability when during the Shenzhou 7 manned mission and space-walk in 2008 Chinese scientists reported how a small satellite, carried into space by Shenzhou 7, manoeuvred into orbit around the spacecraft successfully taking photographs for a number of days.[56]



Shenzhou spacecraft cutaway.

Chinese analysts have also highlighted the importance of both active and passive defensive measures for their own satellites. Passive defence measures include hardening,

encryption, camouflage, stealth, and redundancy and duplication in satellite network systems and subsystems. Active defence measures include avoidance by orbital manoeuvring and countermeasures such as anti-interference and anti-jamming techniques. Micro-satellites could even be used to actively 'guard' other satellites, act as decoys, or even counter-attack.[57] Greater situational awareness through enhanced monitoring and surveillance in space is also crucial to this idea of defence in space. One of the driving forces behind China's efforts to research space debris identification and tracking is to also improve China's ability to monitor military assets.[58]

Directed Energy Weapons

China has devoted considerable resources to directed energy systems, particularly ground based high- and low-energy lasers for counter-space purposes. China's laser programme is mature and has long been recognised as world class.[59] It is believed that China has lased US satellites on a number of occasions and the Director of the US National Reconnaissance Office confirmed that a Chinese laser had illuminated a US satellite in 2006.[60] Ground based lasers are a particularly attractive counter-space weapon as they provide flexibility and allow varying levels of damage from temporarily blinding sensors to destruction.[61] Less mature programmes under development include radio frequency weapons, high power microwave weapons, electromagnetic railguns and particle beam systems.[62]

Kinetic Kill Vehicle

The 11 Jan 2007 ASAT test demonstrated

Commander of US Space Command, General C. Robert Kehler.

that China already has a direct attack capability based around a Kinetic Kill Vehicle (KKV) launched from a ballistic missile. This is particularly effective against targets in low Earth orbit, where most of the US remote-sensing, meteorological, electro-optical, infrared and radar-intelligence satellites and their relays operate.[63] As the Commander of US Space Command, General C. Robert Kehler, has observed, China is therefore able to hold low Earth orbiting systems at risk.[64] Provided a sufficiently powerful booster is available, analysts at Massachusetts Institute of Technology have concluded that this technology could be used to interdict satellites in medium Earth or geosynchronous orbit.[65] It is here where US navigation and guidance, military communications and early warning and nuclear detonation satellites currently operate. China currently has several launch vehicles and ballistic missiles that could deliver a payload to these targets.[66]

Electronic Attack

Physical attacks against any nation's space systems are likely to be both costly and in the case of the US, which has a large number of space assets and considerable redundancy, not necessarily efficient. It could also

embroil China in a war with not just the US but the wider international community. It is therefore likely that China would focus initially on electronic attack in a 'denial of service' approach. China's has considerable jamming capabilities, and targeting communication, navigation and reconnaissance satellites at source, by targeting either their command and signals or sensors, is recognised as being a key component of achieving information dominance. There has been a considerable body of analytical work in China discussing methods to counter US data-links particularly the Joint Tactical Information Distribution System (JTIDS), primarily by space based jamming.[67]

It is likely that Computer Network Operations (CNO) against all elements of US space systems would accompany any electronic attack.[68] PLA theorists have coined the term 'integrated network electronic warfare' to describe the use of electronic warfare, computer network operations and kinetic strikes to disrupt battlefield network information systems that support an adversary's warfighting and power projection capabilities.[69] Many of these information systems are based in space.

One of the simplest counter-space methods available to China and one that would be fully in keeping with its 'Active Defence' doctrine and Anti-Access and Joint Anti-Air Raid strategies and indeed 'integrated network electronic warfare' would be conventional physical attacks against ground based space related facilities, especially those based in the Pacific. China has a rapidly expanding ballistic and cruise missile inventory at its disposal that could be effectively employed on these operations.

It is clear therefore that China can already field and continues to develop significant capabilities that can counter the space based capabilities upon which US and other forces rely, but the implications are wider than that:

'…the Chinese space programme, or Project 921 as it is fondly known to the PLA, has far more significant implications beyond simply propaganda value and national prestige for the People's Republic, and has long-reaching consequences for the global space industry and international security.'[70]

An awareness of these implications is of fundamental importance for Western military planners.

The Implications of China's Race for Space

'Intentional interference with space-based intelligence, surveillance, reconnaissance, navigation and communication satellites, while not routine, now occurs with some regularity. America's ever increasing appetite for space-based technical solutions for global positioning, communications, and weather among others, if not properly managed could become our Sword of Damocles – we must not become trapped in this vulnerable position. Space is now a contested domain where, without adjustments to our strategy, we may not be able to count on unfettered access to space-based systems should others persist in their course of developing counter-space weapons.'[71]
General James Cartwright, Commander US Strategic Command, 2007.

The implications of China's space strategy are profound and wide reaching. Whilst the topic is hotly

debated in military circles in the US the effects are felt across the globe, with many militaries now relying on space as an enabler of core capabilities. The images of the Chinese flag being waved 340 km above the globe were interpreted, with unease, by regional rivals as a further indication of the growth of Chinese power.[72] Events such as this and the ASAT test have threatened not just a reaction in the US but a wider space race, particularly as it remains unclear whether China's offensive counter-space capabilities are for deterrence or as useable weapons of war.[73]

A New Space Race?

India, one of China's primary regional rivals, has watched with concern as China has expanded its space capabilities. India's army chief of staff has stated that "the Chinese space program is expanding at an exponentially rapid pace in both offensive and defensive content," and another Indian general has observed that "with time we will get sucked into a military race to protect our space assets and inevitably there will be a military contest in space."[74] A former Indian Air Force Air Chief Marshall recently advocated the formation of a joint "aerospace command" for India to use the missile, satellite and communications capabilities of the Indian armed forces effectively.[75] Interestingly whilst India views China as a factor, it is not the only factor in its pursuit of space. As Gopal Raj the author of *Reach for the Stars: The Evolution of India's Rocket Programme* observed:

'The Chinese programme is predicated on an idea that you need to have independent access to space. India sees the same logic – we need the option to use space on our own terms.'[76]

Other regional rivals, including Japan, hold these views. Both Japan and India have ambitious lunar programmes whilst Japan is developing and already fields a basic ballistic missile defence, which is of considerable unease to China. Beijing is also concerned about Japan's development of remote sensing satellites, fearing that in the future they can be turned to military use.[77] South Korea is not far behind India and Japan, whilst Malaysia, Singapore and Taiwan also have impressive satellite capabilities.[78]

Vladimir Popovkin, Russian General, Commander of RF Space Forces.

In perhaps the most direct response to the Chinese ASAT test and the subsequent US shoot down of a malfunctioning satellite in Feb 2008, the Russian Deputy Defence Minister Vladimir Popovkin announced to the press, on 5 Mar 2009, that Russia was also developing anti-satellite weapons:

'We can't sit and watch others do it. I can only say similar works are done in Russia too.'[79]

Some have argued that the US shoot down of their own malfunctioning satellite was in fact a deliberate message aimed at China and not to prevent toxic fuel entering the

atmosphere as officially claimed.[80] It is clear that it is the dynamic between China and the US in space that will determine the nature of the future operating environment. Although the US is not necessarily entering a race with China (it currently has massive superiority in space) it is beginning to understand the nature of the threat and is taking steps to mitigate and counter it. It has been argued that they have little choice:

'China's military space doctrine and intentions are far from clear and urgently require further analysis and understanding, leaving the United States with no choice but to hedge prudently against this uncertainty.'[81]

The US military has long understood the importance of space as it has relied on the militarisation of space for it's conventional superiority for some time. As these new threats become clear it is gradually changing focus, as General C. Robert Kehler, Commander US Space Command, has noted:

'The Air Force is shifting its space mindset to one of operating in a contested environment with an increased emphasis on space protection.'[82]

Whilst space has been militarised for some time, most countries, including China, are keen to prevent it becoming weaponised. However, as discussed above, many in China and elsewhere believe that weaponisation of space is inevitable and that attempts to control the use of space are doomed to failure, especially as they perceive US intransigence over new regulations. This bears comparison to 1907 when Hague conventions were implemented in an attempt to limit air power, in much the way that conventions on the military use of space are introduced (and similarly disregarded) today.[83]

Space Debris

One obvious implication of China's ASAT test is space debris. NASA has catalogued and monitored over 1736 objects of trackable size (greater than 10cm) from the explosion and estimates there may be over 35,000 shards greater than 1cm that are now in varying orbits.[84] This single event increased space debris by ten percent in one incident and poses a significant threat in low earth orbits. On 14 May

A fish-eye view shows space shuttle Atlantis lifting off from NASA's Kennedy Space Center in Florida.

09, NASA announced that the space shuttle Atlantis had been narrowly missed by a piece of debris from the Chinese ASAT test.[85]

Implications for the UK

'Our reliance on space is increasing (for example: precision navigation and timing, communications and surveillance) and could be a critical vulnerability unless we understand the weaknesses of space and exploit its strengths. We must ensure that threats to our space capability are identified, understood and either neutralized or mitigated.... The UK's

RAF Reaper.

data exploitation and missile warning capabilities cement our close links with US space-based capabilities; this linkage should not be underestimated.' [86]

Whilst some of the implications of China's space strategy, such as debris, will affect all countries with space assets, the UK is in a unique situation and could be affected more than most. Close ties with US space-based capabilities and concurrent operations around the globe have the potential to mean that the UK's ability to conduct military operations could be impacted by any future China-US conflict. The most obvious example would be the denial of GPS, upon which the UK's armed forces are increasingly reliant, but other areas could be equally significant. Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) systems such as the RAF's Reaper, which is controlled by satellite link from the US,[87] could be impacted as well as space based collection assets vital for shared intelligence. Communication systems could also be affected, as China would have to target myriad commercial satellites that are utilised by the US for its military communications. The crossover is clear and it has to be recognised that what is a threat to the US is, to a lesser extent, a potential threat to the UK. Given the critical nature of space for current and future operations, understanding this potential threat is of fundamental importance.

Collision incident between a US EP-3 reconnaissance aircraft and a Chinese fighter in 2001.

One of the key questions then becomes whether a conflict between the US and China utilising counter-space weapons is a credible scenario. China's military modernization goals remain focused on a possible Taiwan conflict and the prevention of US involvement, through either deterrent or anti-access strategies.

As described above, counter-space systems could play a key role in these strategies. The standoff with Taiwan in 1996, when President Clinton sent US carrier groups to the area, remains at the forefront of many Chinese strategists' thoughts. China is also particularly vexed over defending its national sovereignty and territorial and economic rights. As incidents such the collision between the US EP-3 reconnaissance aircraft and a Chinese fighter in 2001 and the recent naval stand-off have shown, China is particularly concerned about US activities in its Exclusive Economic Zone. Recent legal articles in China that equate reconnaissance with battlefield preparation put these incidents into perspective.[88] Chinese commentators are extending this thinking into considerations about space reconnaissance[89], which is considerably at odds with US space strategy:

'The United States considers space systems to have the right to pass through and peacefully operate in space without interference, not unlike that of transit through international waters. Consistent with this principle, the United States views purposeful interference with its space systems as an infringement on its rights, and furthermore considers space capabilities, including the ground and space segments and supporting links, as vital to its national interests. Recent events, make it clear others may not share these values. Platforms costing billions of dollars to replace and the lives of astronauts from many nations are now at risk from debris left by China's recent ill-advised anti-satellite test.' [90]

There are countering arguments over whether China is acquiring counter-space capabilities primarily as a deterrent. However, danger lies in comparing the deterrence regime during the Cold War and that between China and the US today. During the Cold War both the US and the USSR were superpowers and both relied upon space.[91] At present China is in a transitionary phase towards becoming a superpower, and does not yet rely on space to the same degree as the US. Therefore using counter-space weapons would make strategic sense to mitigate US conventional advantages, especially in the near future. There is also evidence that there may be greater willingness to use space deterrence capabilities compared to traditional deterrence because of the perceived lower risks.[92]

The issues outlined above mean that although conflict between China and the US is remote it is a possibility. This may become more of a reality in the future, as the peaceful rise of China may not last forever. As noted in the DCDC Global Strategic Trends, once China has established itself as a major world power, possibly as early as 2025, it may feel less constrained in its behaviour, thereby presenting greater challenges to the international system.[93] Nowhere may this be more evident than in space. By which time China expects to have both a manned space station and landed a man on the moon.

DCDC Global Strategic Trends noted that:

'Given current multi-lateral agreements and technical factors, the effective weaponization of space is unlikely before 2020. However, nations will seek to inhibit the use of space by opponents through a combination of electromagnetic manipulation, hard-kill from ground-based sensor and weapon systems, the targeting of supporting ground-based infrastructure and a range of improvised measures. At its most extreme, the weaponization of space may eventually include the development of space-based strike weapons capable of attacking ground-based and other space targets; for example solid metal projectiles travelling at orbital velocities, so-called 'rods from the gods'. However, this will remain extremely unlikely without the prospect of sustained and extreme deterioration in international relationships and will be technically difficult to achieve before 2020.'[94]

This document was published in 2006 prior to China's ASAT test which confirmed the intention, of China at least, to inhibit the use of space. Many military scholars in the US, China and elsewhere believe that conflict in space is inevitable. The UK needs to ensure that it remains fully conversant with this threat as it widens. Although space is recognised as a key operating environment in British Defence Doctrine[95], the UK is in danger of lagging behind as other countries, such as China and India, develop Space or Aerospace commands and sophisticated space programmes and doctrine. The USAF has already stated that it is "now transitioning from an air force into an air and space force, on an evolutionary path to a space and air force." The importance of space will continue to grow as other countries, particularly those at a distinct conventional disadvantage, will realise that strategic necessity dictates that counter-space weapons are a viable option. With even a rudimentary space programme then counter-space weapons, even if simple in nature, are a future possibility for nations such as Iran and North Korea.

The US is aware of this threat and taking active steps both to understand the implications and how to mitigate and indeed counter it. For them the threat is very real:

'The implications of these new counterspace developments for peacetime and crisis stability, as well as the conduct of warfare, are profound. The sudden major loss of satellite function would quickly throw U.S. military capabilities back twenty years or more and substantially damage the U.S. and world economies. While backup systems could partially compensate for this loss, U.S. military forces would be significantly weakened.' [96]

Given the seriousness of the consequences, the UK and the RAF, as the primary repository of aerospace expertise, cannot afford to ignore the issue.

Notes

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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.

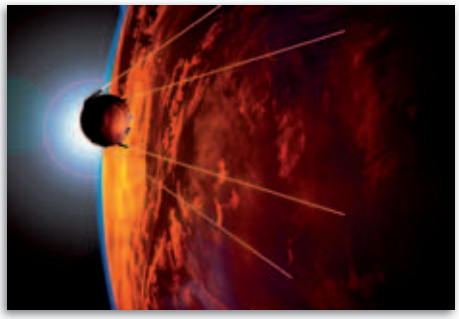
Zeigler assumes (correctly) that military capability serves the ends of policy, and therefore that capability should be assessed against policy utility and not just theoretical possibilities. He explains that there are two theoretical underpinnings to Sanctuary viewpoints; those that are direct counters 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

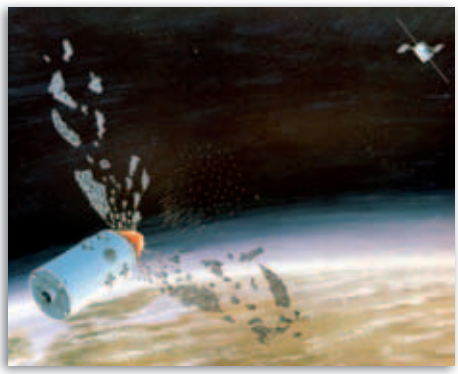
The Theatre model, after its initial dalliance with military manned systems and exotic basing options, has proven a useful basis for development of space policy, though as with all the other schools of thought, not quite in the way its originators expected. Partly this is because there has never been 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.

Counterspace Operations and the Evolution of US Military Space Doctrine

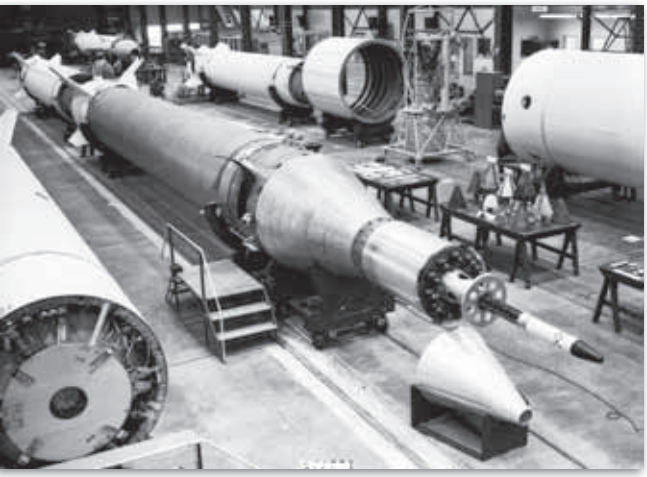
By Prof Michael Sheehan

Since the advent of military space technology in the late 1950's, the United States has gradually developed doctrine to govern their use in relation to wider military and strategic objectives, consistent with US national security policy. Given the unprecedented nature of the space environment and of technological evolution, space doctrine development has been a sporadic and problematic process, undertaken in a political context complicated by debates over the 'weaponization' of space.

US doctrine has evolved from a 'space sanctuary' position in the 1950's to 'counterspace operations' by 2004. It was not until 1982 that the first specific space doctrine document was published, but AFM 1-6 noted the key issues that would dominate all subsequent policy – the need to protect US capabilities from space-based threats, to prevent space being a sanctuary for aggression against the US, and the need to exploit space to enhance US military capability.

Introduction

The United States has been debating the desirability of placing weapons in space since the dawn of the space age. From the 1950's onwards there has always existed a tension between logics driven purely by military considerations, and those reflecting a Clausewitzian concern for the *political* purpose of military forces. The political leaderships' unwillingness to meet the uniformed military's wish to weaponize space has always been predicated on a belief that in the overall calculation of strategic priorities, the United States had more to lose than to gain from space weaponization.

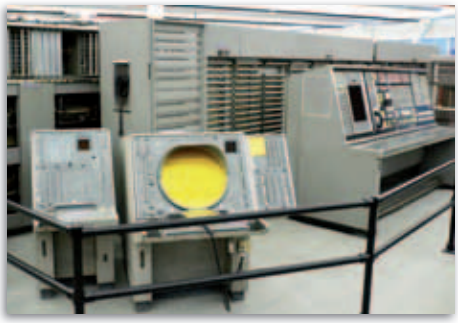


Jupiter-C Missile No. 27 assembly at the Army Ballistic Missile Agency (ABMA), Redstone Arsenal, in Huntsville, Alabama, January 31, 1958.

From the outset, the US reluctance to weaponize space was less a moral commitment to the preservation of space as a sanctuary, than a pragmatic reflection of the belief that there was no compelling *strategic* reason for such weaponry to be developed in the face of competing demands for military resources that were more urgently

needed to meet US requirements to maintain deterrence in particular and American war-fighting capabilities more generally.

During the subsequent years of the Cold War a number of factors emerged that helped to discourage American leaders from pursuing the weaponization, as distinct from the militarization of space. Militarisation was a reality soon after the initial launches as both Superpowers moved to deploy a range of satellites for such purposes as reconnaissance, ballistic missile early-warning, communications, navigation, weapons targeting, meteorology and geodesy.



IBMs SAGE is a large semi-automated air defense system from the Cold War era, deployed in 1958, obsolete by 1960.

Many of these roles were centrally related to the maintenance of nuclear deterrence and the United States was reluctant to initiate or encourage a weaponization of space which might

threaten the Superpower strategic stability achieved by the late 1960's. An attack on the satellites of the other Superpower might well be interpreted as a precursor to the launch of a first-strike, and escalation would be all the harder to halt as the communication and reconnaissance assets represented by the satellites were lost. Because of its perceived importance to strategic stability, space became effectively a 'sanctuary' as far as the deployment of weaponry was concerned.

Official portrait of General Oris Johnson (USAF).

However, as US reliance on military space developed during the 1960's, this 'space sanctuary' assumption began to be questioned within the USAF. In 1968 General Oris Johnson noted the momentum behind the Soviet military space programme and suggested that 'the necessity for effective space defense weapons is both obvious and urgent'[1]. Studies carried out by the Ford administration as early as 1976 suggested that the United States was becoming increasingly dependent on satellites for various functions and that little provision had been made for satellite survival in wartime.[2]

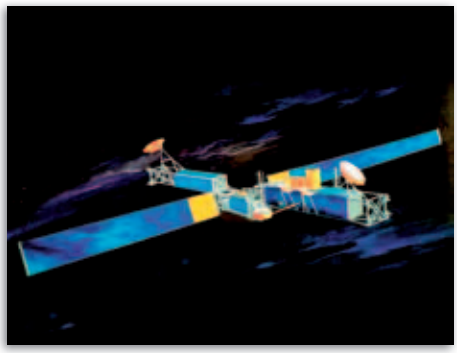
During the 1980's, the United States pursued weapons development programmes in both the anti-satellite and ballistic missile defence realms. The ASAT, a Miniature Homing Vehicle launched from an F-15 aircraft, never went into operational deployment, while the Strategic Defence Initiative remained a research and development programme, with only limited testing, and again, no deployment. However, while President Reagan's initiative took the political community by surprise, it was in line with the revised USAF doctrine which had come out the previous year, evidence that the relationship between doctrinal evolution and White House policy should be taken seriously.

With the passing of the Cold War it was natural that the United States would eventually re-evaluate the utility of its Cold War policies in the light of the new strategic environment. The demise of the Soviet Union meant that America no longer had to fear the reactive response of a credible rival should it desire to deploy weapons in space.

A Soviet Tu-95 Bear-D strategic bomber aircraft.

Nor did the Cold War concerns about the effect such a move might have on strategic stability carry the same weight as they once had. The

treaty regime has also become less constraining.



Milstar a global military communications system was launched on 7 February 1994 aboard a Titan IV expendable launch vehicle.

Historically, much of the opposition to the deployment of space weaponry derived from concerns about the effect of such a development on the arms control treaty regime that had emerged to reinforce the stability of strategic nuclear deterrence. The vast majority of the arms control treaties signed between 1971 and 1991 relied upon satellites as the primary 'national technical means' for verification of treaty compliance by the other parties. Non-interference with these systems was therefore written into the treaty terms, implicitly providing the peacetime protection of international law for each sides military satellite systems.

Most crucial of the arms control treaties was the ABM Treaty of 1972. This agreement underpinned the strategic reduction treaties that followed, and its terms banned the testing and deployment of weaponry capable of performing the ballistic missile defence role, a technology that strongly overlapped with anti-satellite weaponry. Any system with an exo-atmospheric missile defence capability would be a highly effective anti-satellite system. With the withdrawal of the United States from the treaty, this factor is no longer relevant as a restraining factor on space weaponization. The only treaty that specifically forbids such weaponization is now the Outer Space Treaty of 1967, which relates specifically and solely to weapons of mass destruction. There is no international treaty obligation for the United States to refrain from deploying conventionally armed weaponry in space, only a residual commitment not to target satellites crucial to the monitoring of compliance with arms control agreements.

A wide range of elements would need to be in place if the United States were to proceed to deploy space weaponry in an attempt to achieve space control, but three 'stand out as especially critical: sound doctrine, viable technology and political will'.[3] Such debate as there has been on this subject tends to focus on the difficulties or otherwise of acquiring the technology, but it is the doctrinal and political criteria that are the most crucial, and ultimately determining factors. History furnishes a long record of the tendency of the countries of the West to embrace new forms of technology which promise to provide military advantages over their rivals, and this tendency has been highly instrumental in making possible the domination of 'the West over the Rest' that has characterised the past three centuries.[4] There is no reason to believe that the United States would deploy weapon systems simply because the technology existed. Such weapons would need to address a genuinely perceived threat and to

be appropriate within prevailing doctrine for them to be desirable.

Side view of the Capital Building, Washington DC.

The very fact that there is currently no credible military rival to the United States means that Washington is not driven by an urgent strategic need to accelerate space weaponization. Nor, despite the vigour of the ballistic missile defence programme, is appropriate technology ripening at a rate that would force an administration's hand. To focus on the gestation of technology alone is therefore a misleading way of attempting to predict whether US space weaponization is imminent or likely. A better guide is the evolution of US military doctrine as it pertains to the use of space. The most powerful 'driver' favouring such weaponization is in fact the evolving *doctrine* of the United States armed forces.

Doctrinal Evolution during the Cold War

In parallel with the evolution of political attitudes towards military space, there has been a crucial evolution of USAF and Pentagon military space doctrine. Doctrine lies at the very heart of modern warfare for the advanced industrial states. 'It represents the central beliefs for waging war in order to achieve victory…it is the building material for strategy. It is fundamental to sound judgement'.[5] According to the US Air Force, doctrine represents the central beliefs of the armed forces about the best way to wage war[6] , and reflects 'an analysis of the current mission, its history, the threat, the evolving state of technology, and the underlying military concepts of operations'.[7] Doctrine is the structured thinking about military operations that guides the training, equipping and employment of military forces.

Aerial view of The Pentagon.

Different levels of doctrine can be distinguished. Drew makes a useful distinction between fundamental, environmental and organisational doctrine.[8] The former refers to fundamental principles of war, applicable in all operating mediums. Environmental doctrine in contrast, refers specifically to a particular medium, such as the sea or space, and is significantly shaped by the physical characteristics of that particular medium. Organisational doctrine defines how a branch of the

armed forces believes war should best be conducted in its own medium. Significantly, organisational doctrine is highly technology dependent, 'and is often tempered by local political constraints'[9], both prominent features in the contemporary American debate over space weapons.

Doctrine is normally largely based on previous wartime experience, and the absence of such experience contributed to the long delay in the development of a genuine military space doctrine for the armed forces of the United States, given that 'while space operations have been conducted since the late 1950's, no hostilities have ever occurred in space'.[10] In the absence of such experience, space doctrine had to be derived from theory.

The first two US doctrine documents with relevance to military space made no mention of it, other than to include it as an *environment* within the overall definition of 'aerospace'.[11] It was not until 1971 that the USAF first outlined the 'Role of the Air Force in Space' in its revised version of AFM 1-1, the basic doctrine of the US Air Force. American space forces were now defined as having two national responsibilities, to 'promote space as a place devoted to peaceful purposes', and to 'insure no other nation gains a strategic military advantage through exploitation of space'.[12] These roles appeared unchanged in the 1975 version of AFM 1-1. In 1979 however, the doctrine was significantly revised and the new version notably expanded the treatment of space operations listing three responsibilities; to protect American use of space, to enhance the performance of land, sea and air forces, and to protect the United States from threats in and from space.[13]

The first *specific* space doctrine document appeared in 1982. Air Force Manual (AFM) 1-6 identified three roles for space power, these being to strengthen the security of the United States, to maintain American space leadership, and to maintain space as an environment where nations could enhance the security and welfare of mankind.[14] The wording reflected the continuing American division between a desire to preserve space as a non-weaponized sanctuary, and a recognition of its longer-term potential as a theatre of military operations. It reaffirmed the subservience of military doctrine to political control, emphasising the constraints imposed by US national law, international law and national policy.[15]

The military objectives of US space forces were described as being to maintain America's freedom to use space, to increase the readiness, effectiveness and survivability of US forces, to protect US resources from threats operating in or through space, to prevent space from being used as a sanctuary for aggressive systems by adversaries, and to exploit space to conduct operations to further military objectives.[16] The 1982 doctrine also described two existing and three potential missions. The former consisted of force enhancement and space support. These are roles that became routine over the subsequent two decades, the use of satellites to increase the effectiveness of terrestrial forces, for example by more accurate surveillance, and the acquisition of an array of capabilities able to

sustain the American military use of space. The potential missions were space based weapons for deterrence, space-to-ground weapons, and space control and superiority.[17] This document, which appeared a year before President Reagan's famous 'Star War's' speech, called for the development of space-based weapons capable not only of contributing to a ballistic missile defence system, but also of carrying out direct attacks against military targets on the Earth's surface with space-based weaponry. AFM 1-6 was updated in 1984 and 1992, but there were no significant changes to the objectives established in the 1982 version.

During the 1970's and 1980's the United States military saw space as an environment which supported defence capability and policy at the *strategic* level. Satellites played a crucial role in the maintenance of strategic stability and deterrence, and they were force-multipliers of terrestrial capabilities in terms of broad surveillance and long-range communications. US doctrine reflected this thinking, and calls for programmes to enhance satellite survivability related to these strategic roles. In the post-Cold War period however, the survivability issue became increasingly important as satellites began to play a direct role in terrestrial warfighting.

US Doctrinal Evolution in the Post-Cold War Period

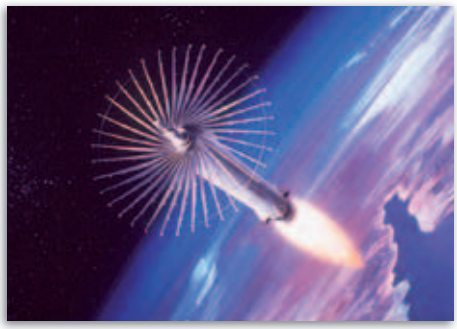
During the 1990's, the United States armed forces increasingly looked to the significance of space as the 'new high ground'. In 1996 Air Force Chief of Staff Ronald Fogleman released a new list of 'core competencies' required of the USAF, of which the first was 'air and space superiority'.[18] This objective was repeated in the updated version of AFM-1-1, the USAF's first significant effort to produce a space doctrine, which called for the Air Force to gain and maintain dominance of space.[19]

F-117 Nighthawk used the the Iraq War, 1991.

Doctrine in the 1990's did not place significant emphasis on counter space operations.[20] AFDD-1, *Air Force Basic Doctrine*, defined counterspace operations as 'those kinetic and non-kinetic operations conducted to attain and maintain a desired degree of space superiority by the destruction, degradation or disruption of enemy space capability'. AFDD-1 stated that 'to ensure that our forces maintain the ability to operate without being seen, heard or interfered with from space, it is essential to gain and maintain space superiority'.[21] In

Bombing of Zastava factory, post-strike bomb damage assessment, Kosovo.

1991, during the First Iraq War, the US had demonstrated a major asymmetric advantage with its space capabilities, but conflicts in the 1990's did not see attempts by adversaries to counter these capabilities, other than a fairly effective effort by Yugoslavia to use camouflage to negate the effectiveness of NATO reconnaissance capabilities during the Kosovo War. Nevertheless, Air Force planners argued that the US needed to be able to accomplish three key missions, space surveillance, space negation and space protection,[22] and that the US should proceed with the development of the technology to achieve these goals including the acquisition of ASAT systems, space mines, uplink and downlink jammers, and space decoys.



Concept of an Anti-Satellite (ASAT) Weapon.

The US Air Force and Joint Staffs codified operational level space operations doctrine through Joint Publication 3-14, *Joint Doctrine for Space Operations*, (1992), and Air Force Doctrine Document 2-2,*Space Operations*, (1998). JP 3-14, which deals with joint operations doctrine, concentrates on global space forces, though there is some treatment of theatre operations. AFDD-2 deals with the command and control of space forces, both at the global and theatre levels, and the planning and implementation of space operations, again at both global and theatre levels.

The USAF now seems to have moved fully away from the 'space sanctuary' concept to a position consonant with a 'high ground' posture.[23] Certainly the terminology is prominent in key documents, such as AFDD 2-2, which declares that, 'space-based forces hold the ultimate high ground, offering the potential for permanent presence over any part of the globe'.[24] In addition US Space Command's *Long Range Plan* anticipated a future where, by 2020 any ballistic or cruise missiles could be targeted, but in addition, the same space weapons could target high-value terrestrial targets'.[25] This reflected the view that had been present in USAF doctrine since the 1982 publication of AFM-16. During the 1990's, the US military space doctrine evolved from an environmental to an organisational doctrine, and like all such doctrine, it was technology-dependent, but also sensitive to national political constraints.

The growing debate over the utility of military space systems during the 1990's led Congress to pass legislation included in the Defense Authorisation Bill for fiscal year 2000, which established a special Space Commission to evaluate the need for reform of US military space organisation and capabilities.[26] Donald Rumsfeld chaired the commission until he was nominated by President George W.Bush to serve as Secretary of Defense as the commission was finalising its report. As Secretary of Defense, Rumsfeld was able to ensure that many of the commission's recommendations

were implemented. As a result a single military service, the USAF, became the Department of Defense's executive agent for space, with the Under Secretary for the Air Force assuming direct responsibility for all national security space, including the National Reconnaissance

Official portrait of U.S. President George W. Bush.

Office.[27] In March 2001, a Space Policy Coordinating Committee was established under the National Security Council.

The Commission reaffirmed the traditional American commitment to the peaceful uses of space declaring its 'conviction that the US has an urgent interest in promoting and protecting the peaceful use of space'.[28] Nevertheless, it also called for the development of physically destructive anti-satellite capabilities and the development of 'live firing ranges' in space to test these systems on a regular basis.[29]

The UN Headquarters in New York.

The Report recommended a general ignoring of alleged legal impediments to the use of weapons in space. It did this by asserting that the US and most other nations interpret 'peaceful' to mean 'non-aggressive', and that non-aggressive incorporates the legitimate right of self-defence, including 'anticipatory' self-defence under the UN Charter and Article III of the Outer Space Treaty. In addition it noted that 'there is no blanket prohibition in international law on placing or using weapons in space, applying force from space to earth or conducting military operations in and through space'.[30]

Current Space Doctrine

The merger of US Space Command and US Strategic Command in October 2002 to form the new USSTRATCOM meant a requirement for updating of the space doctrine, a process encouraged also by experience derived from operations in Afghanistan and Iraq. The merger meant that the new joint space support teams would integrate all STRATCOM missions, including space, global strike, global ISR, information operations and missile

defence.[31] USSTRATCOM carries out its functions through four primary missions, space support, force enhancement, force application and space control. Space support refers to the operations needed to enable space capability to be exercised, for example space launch and satellite operations. Force enhancement embraces the force multiplier effects to terrestrial forces that have become

2nd Battalion, 503rd Infantry Regiment (Airborne), during Operation Destined Strike, Afghanistan.

familiar over the past thirty years, such as intelligence gathering, early warning, communications, navigation and weather forecasting. In these functions the armed forces are supplemented by capabilities from civil, commercial and national space systems. Force application involves applying force either from or through space. Spaces forces can target land, sea and air forces. They can do this either by acting as the 'gun sights' for terrestrial weapon systems, or by directly attacking terrestrial forces with space to ground weapons, as AFM 1-6 called for as early as 1982. The ability to carry out all these functions generates *space control*, defined as 'combat, combat support, and combat service support operations to ensure freedom of action in space for the United States and its allies and, when directed, deny an adversary freedom of action in space'.[32]

The operations in Afghanistan and Iraq showed that the existing space operations doctrine provided inadequate detail regarding the coordination and integration of space forces supporting theatre operations. In addition, Iraq's attempts to jam US global positioning system signals in 2003, showed that US adversaries had understood the importance ofUS military space capabilities and were beginning to develop capabilities to counter and disrupt them.[33] Even though the Iraqi efforts were not successful, and were defeated by GPS guided munitions, the experience reinforced the perceived requirement to develop a doctrine relating to counter-space operations. Work on such a document was already underway at the time of the 2003 Iraq War.

In August 2004 the United States Air Force published AFDD 2-2.1, *Counterspace Operations*, the first doctrinal document on this critical subject. USAF Chief of Staff General Jumper noted that USAF doctrine was, 'evolving to reflect technical and operational innovations'.[34] The rationale for the doctrine is succinctly presented at the outset, as following from the same military logic as the requirement for air superiority, to gain control of the skies at the outset of a campaign and deny them to the enemy.

AFDD 2-2.1 declares firmly that 'space superiority provides freedom *to* attack as well as freedom *from* attack'.[35] Counterspace embraces both

offensive and defensive operations, both of which are dependent upon effective space situation awareness, (SSA). Defensive counterspace operations preserve the US ability to exploit space for military purposes and include passive satellite defences, such as the use of camouflage, concealment, deception, dispersal and the hardening of systems. Offensive counterspace operations are those designed to deny an adversary, the ability to use space to support their military operations. The methods employed to do this may be permanent or reversible and embrace the 'five Ds' – deception, disruption, denial, degradation and destruction. The more dependent an adversary is on space capabilities, the more vulnerable they are to counterspace operations. Offensive counterspace operations may target the ground or space segment, or the links between them. Ground segment may include both ground stations and launch facilities. The methods used to achieve these objectives depend on the target and may range from laser weapons to special operations forces.

NORAD Command Center, Cheyenne Mountain, Colorado, circa 2005. (USAF)

US counterspace operations, like all other US military operations, reflects an effects-based methodology, to allow the choice of the tactics most appropriate to achieving the objectives. Among other things this requires careful planning to ensure that objectives at every level, tactical, operational and strategic are taken fully into consideration when

SM-3 missile just after launch to destroy the NRO-L 21 satellite.

planning counterspace operations, AFDD 2-2.1 makes the important points that neither adversary use of space nor counterspace operations by an opponent necessarily requires that the enemy be a space-faring nation themselves. US space capabilities can be attacked at the ground segment as well as the data links, and the space segment can be attacked by weapons fired from the earth. Similarly adversaries can purchase space services and products such as imagery and communications from third parties.

Non-space ASAT options

Proponents of the acquisition of ASAT capabilities by the US argue that

ASAT weapons are essential if the US is to dominate the space environment, because they are essential to the protection and negation roles.[37] However, it is important to remember that an anti-satellite system does not need to be space-based, or to necessarily involve the physical destruction of the satellite. Jamming, spoofing and control seizure can be done from the ground, and terrestrial elements of the satellite system, such as ground control, can be attacked by conventional terrestrial methods. Critics of space-based ASAT systems, such as DeBlois et al, after a detailed survey of possible technologies, argue that 'space weapons are generally not good at protecting satellites capabilities', and suggest that protection would be better served by reducing satellite vulnerability to signal interference and focussing on conventional terrestrial and political counterspace options.[38]

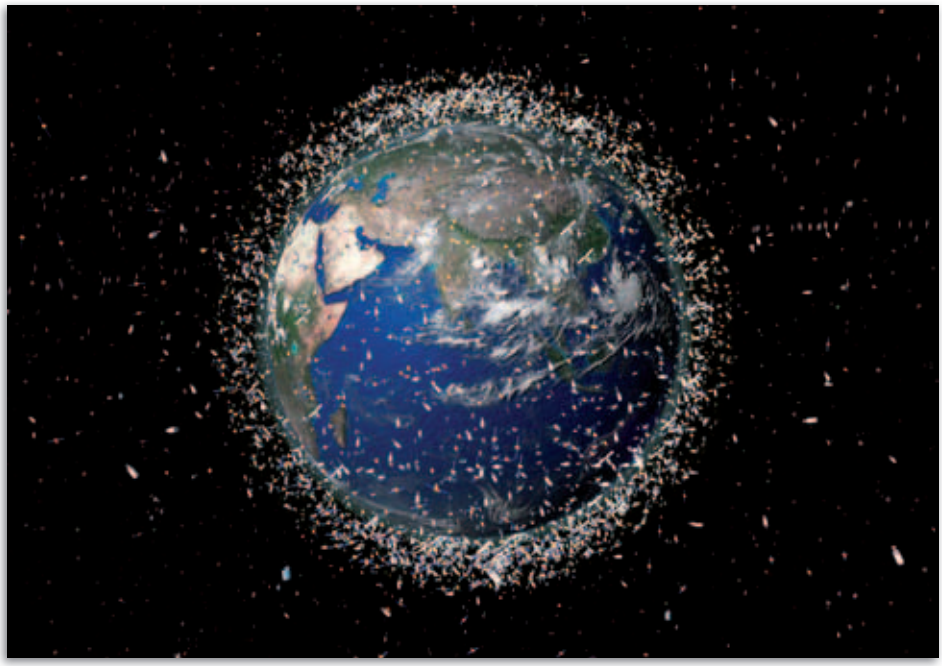
The objective of US space control is essentially information dominance in wartime. In order to achieve this it is the information flow that is critical and not necessarily the information systems themselves. Current US space control thinking tends to focus on physical assets, rather than on capabilities.[39] In reality however it is information dominance rather than asset destruction which is needed. Space control is about dominating the space lines of communication, and for this the requirement is simply to impact effectively upon one of the segments of the space system or the links between them.

In 1999 Deputy Secretary of Defence John Hamre testified before Congress that DoD views on space control emphasised the temporary denial of space to an enemy, rather than the destruction of space systems.[40] Since

Official portrait of John J. Hamre, a former Deputy Defense Secretary under President Clinton.

space is a global commons, return of full access to space for all nations as soon as possible must be part of the 'exit strategy' for space operations in wartime.[41] This requires the US to possess the full spectrum of military options for counterspace operations, (lethal to non-lethal) and a doctrine that produces desired effects with minimum impact on the commons. The 2001 Space Commission report re-emphasised this, noting that while the US reserves the right to destroy either ground sites or satellites if necessary, the preferred approach is to use methods that are 'temporary and reversible in their nature'.[42]

Offensive counterspace, aimed at denying the enemy the use of space in wartime, can be carried out in three ways. First, targeting the enemy's terrestrial space segment, their launch infrastructure, satellite command and control systems and satellite communication nodes.[43] These capabilities are already possessed by the United States. The second approach would be to target the communications segment between the satellite and its associated ground equipment. The United States currently has the capability to successfully jam the ground segment, but has no capacity to interfere with



A image from European Space Agency of satellites in orbit around the Earth.

the space segment.[44] The third approach would be to launch a direct physical attack against the satellite itself.[45] The United States does not currently have the capacity to carry out such attacks, except by using nuclear warheads, which is against a number of treaties to which the US is a party and which would create damaging debris and EMP effects in the satellite orbit and upper atmosphere, or by using residual ASAT systems, such as the Space Shuttle, which are not optimised for such a role.

AFDD-1 states that the United States must achieve and maintain space superiority, but at no point does it suggest that space weapons are required to do so.[46] There are a variety of alternative ways to achieve the same end, including 'implementing an international agreement to shut off a satellites downlink, terminating imagery sales, destroying ground sites, destroying or disrupting system software programs, spoofing or jamming link signals, damaging or disrupting satellite subsystems, and disabling or destroying the satellite'.[47] The use of ASAT weapons is the least attractive option. In an earlier technological era, ASAT weapons appeared to be the only reliable way to achieve control of space, but in the contemporary information dominated society, a

Concept of a Defense Support Program satellite.

much wider array of techniques is available.[48] Even if physical destruction of a satellite system was seen as necessary, the US could attack the ground segment or space segment using weapons launched from the Earth's surface at a fraction of the cost and difficulty that would be involved in weaponizing space.[49]

The Political Context

The United States continues to maintain a dualistic posture on space policy. US Undersecretary of the Air Force, Peter Teets, argued that the United States had come to

Portrait of U.S. Undersecretary of the Air Force, Peter Teets.

take its unrestricted access to and exploitation of space for granted. But in doing so, it had become reliant on a capability whose continuation could no longer be simply assumed, but required the acquisition of survivable launcher and satellite assets. Even while supporting the peaceful use of space by all countries, 'prudence demands that we ensure the use of space for us, our allies and coalition partners, while denying that use to adversaries'.[50]

While there may be clear military rationales in favour of the weaponization of space by the United States, it is a decision that would have considerable political implications. It is also true that to date there have always existed powerful domestic cultural and political obstacles in the United States to such a development. Since 1964, USAF doctrine has consistently recognised that national objectives and policies are a fundamental constraint on doctrine, but that such policies are evolutionary over time, as are the potential threats and developments in military technology.[51]

US National Space Policy states that the United States is committed to the exploration and use of outer space 'by all nations for peaceful purposes and for the benefit of all humanity'.[52] The

Views of the extravehicular activity using a nitrogen -propelled hand-controlled manned maneuvering unit (MMU) during STS 41-B taken 11 February 1984.

policy does allow for the use of space for the purpose of national defence and security, but nevertheless, the weaponization of space would seem to run counter to a very long-standing national policy.

It is also notable that the US armed forces are aware of the need to respect the concept of space as a 'global commons', so that if 'the United States impedes on the

commons, establishing superiority for the duration of a conflict, part of the exit strategy for that conflict must be the return of space to a commons allowing all nations full access'.[53] Current US military space doctrine is careful to emphasise the political implications of military operations in space and the need to be sensitive to legal issues. USDD 2-1.1, *Counterspace Operations*, insists that 'in all cases, a judge advocate should be involved when considering specific counterspace operations to ensure compliance with domestic and international law and applicable rules of engagement'.[54]

Leonid Brezhnev and Gerald Ford are signing joint communiqué on the SALT I treaty effectively established parity in nuclear weapons between the two superpowers circa 1970.

Space begins where laws change. Where international law replaces domestic laws of national sovereignty and where the laws of orbital mechanics take over from the laws of aerodynamics. International law would clearly mitigate against a move to weaponization. However, the lack of response by the international community to the growing threat to space as a sanctuary suggests that the United States would not significantly alienate itself from the international community if it crossed the threshold to the weaponization of space. There has been no reaction to the doctrinal evolution over the past decade, and the ultimately submissive reaction to the US withdrawal from the ABM treaty is suggestive.

Certainly the United States has shown a consistent reluctance to support efforts to develop a more constraining arms control regime for space, and has argued at the UN Conference on Disarmament that it sees the current international space regime as entirely satisfactory and in no need of renegotiation.[55] This position is likely to be maintained as long as there is no viable challenger to US dominance of military space.

The United States could, at some cost, place weapons in space. That it has not yet done so is because such a step would be in conflict with long-established national space policy. The existing US national space policy is the main barrier to the weaponization of space, and is 'a remnant of space policies developed during the Cold war'.[56] The non-weaponization of space is due to an American self-denying ordinance, not primarily to commitments imposed by international law. As General Estes, Commander in Chief of US Space Command said in 1997, 'we… support whatever decisions our elected leadership may arrive at with regard to space control and the weapons systems required'.[57] Nevertheless, it has been growing increasingly clear over the past two decades, that the USAF has a doctrinal commitment to the weaponization of space and in carrying out its duties has lobbied the political leadership to accept what it sees as the logic reflected in the doctrine, and pursue the development of technology that would allow the doctrine to be fully implemented. The current policy is designed to allow the

United States to gradually acquire the capability to implement the doctrine once US military space hegemony is seriously challenged by other states. Until such a development appears imminent there is no requirement for the US to cross its self-imposed threshold.

Crucial to the emergence of space weaponization would be the abandonment of the idea that space constitutes a strategic sanctuary. As Gray and Sheldon put it, 'in order for space power to reach its full potential however, space must be recognised as a geographical environment for conflict that is, in a strategic sense, no different from the land, sea, air and the electromagnetic spectrum, (EMS).[58]

The final political disavowal of the 'space as sanctuary' concept has not yet occurred. Such a move would be a crucial threshold decision.[59] However, while it has not yet happened, US military doctrine is pushing strongly in that direction. Where the traditional political perspective remains crucial is that while the USAF/DOD arguments for satellite vulnerability, counterspace capability and wartime space control are compelling, their logic does not necessarily prove that *weaponization* is the answer, given that alternative strategies exist for addressing these issues. In the longer term, the outcome of this debate is critical, not just for the United States, but for all the world's leading industrial states.

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Historic Book Review

John Boyd and Air Power Theory

Reviewed by Air Cdre Neville Parton

It could be argued that this book review is the odd-man out in the series, as it could not, by definition, actually relate to a book produced by John Boyd, as he was famous (or infamous) for never committing his thoughts to paper. However, it is almost impossible to conceive of a series examining the way in which thinking about air power has developed over the last ninety years or so that does not include Boyd and his theories related to air power. Furthermore, recent research shows that whilst he did indeed seem to prefer oral briefings, he also produced a number of papers which do provide significant insights into his beliefs regarding air power and air warfare. This review is therefore based upon three books about Boyd and his ideas, together with a number of short articles and papers that he did write.[1] As with the other reviews in this series, it seeks to put into context both the individual and his theories, and in this particular case to explain why it was that John Boyd was so reluctant to expose his thoughts in a formal publication, together with an assessment of whether this helped or hindered his cause. Perhaps more importantly, it should interest all those who want to understand how original thought in a military context is generated, as Boyd's story is, at times, almost too incredible to be believed.

So let us begin by considering the man behind the theories. John Boyd was an incredibly gifted fighter pilot, air tactician and military strategist, as well as a hugely patriotic individual.

Col John Boyd in his days as a Korean War Fighter pilot.

John Boyd was a bombastic loud-mouth with a bullying personality, deeply anti-authoritarian in nature, prone to gross over-exaggeration, and cared little for other than that which he held to be true. Both of these statements are undeniably accurate, and perhaps an estimate of the true nature of Boyd can be determined from the fact that a single person could generate such widely differing perceptions. He was, without doubt, a larger-than-life personality, and it is likely that any psychologist would have a field-day relating his personality traits to his early upbringing.

Born in Erie, Pennsylvania in 1927, his family situation was relatively comfortable until his father died

when John was three years old, leaving a family of five children to be raised during the Great Depression. Boyd's mother was focussed on keeping up appearances, but had a number of issues besides the lack of income to deal with, including a daughter who developed polio, and a son (John's elder brother) who developed schizophrenia and died as a consequence, all of which resulted in her encouraging the children to keep their family affairs extremely private. At High School, Boyd was quite athletic, although at best an indifferent scholar, and he became a keen swimmer and lifeguard in his spare time but with no clear view on what he wanted to do later on in life – other than succeed. The Second World War perhaps provided a fortuitous intervention, in that John then left to join the US Army Air Corps as a gun-turret mechanic, having been rejected as a pilot due to a lack of aptitude. The end of the war meant that he became part of the US occupation forces in Japan, but employed in a range of 'filler' posts, which lasted until he was discharged in 1947. It was during this period that the first of the John Boyd 'stories' emerged which starts to give an indication of some of his particular personality traits. Without going into overmuch detail, this involved Boyd and a number of fellow privates dismantling wooden hangars during a bitter winter in Japan to provide them with fuel, as they had no proper accommodation and no heating. When discovered and threatened with court-martial, Boyd was able to overturn the charges by pointing to fundamental derelictions of duty amongst the officers in charge.[2] Fundamentally, Boyd loved to portray himself as the underdog who was able to overcome the system by force of personality and always being in the right.[3] Following his return to civilian life, Boyd then took advantage of the provision for education within the GI Bill, and attended the University of Iowa to read for a degree in economics.

T-6 Texan circa 1950.

Boyd's interest in the Air Force had obviously not been dampened by his early experience, and he joined the Reserve Officers Training Course (ROTC) whilst at Iowa, although he maintained at the time that he did so only for the extra income it afforded him. After graduation in 1951 he immediately joined the USAF full-time, and during his basic flying training on the T-6 some of the attributes that would be associated with him throughout his later life could be discerned – in particular a willingness to operate outside the rules. Of course this could be another example of exaggeration, but the evidence suggests that he often operated aircraft outside the cleared envelope from the very beginning of his flying career, regarding this as fundamental to the role of being a good fighter pilot – which even then was what he was determined to be. He excelled throughout his flight

training, on the T-6, then the F-80, and finally the F-86, where he was considered competent enough to be posted direct to a combat unit during the Korean War.

F-86 Sabres in Korea.

So it was that in early 1953, Boyd was posted to the 51st Fighter Interceptor Wing in Korea. Here though, as in the Second World War, he had arrived effectively too late for the active part of the conflict, flying 22 combat sorties but with nothing to his name other than being credited with damaging a MiG-15. It might have been very different, but for a theatre rule that element leaders were the 'shooters' in this conflict, and it required 30

Russian mechanics working on a MIG-15 during the Korean War, 1952.

missions before an individual would be made an element leader – and the ceasefire was signed before he reached that magic number. After hostilities had ceased, the F-86 squadrons began practicing air combat, and Boyd's prowess resulted in his being appointed as a flight commander and tactics instructor for his squadron. The latter led to colleagues asking him to put down his ideas in diagrams, and he began to teach combat tactics in classes: the assessment of his performance and abilities that resulted led, almost inevitably, to a posting to the Fighter Weapons School (FWS) at Nellis AFB, where he was to serve for six years, and during which time the 'myths' would begin to grow taller.

Nellis Air Force Base part of Air Combat Command (ACC).

It was during this period that he gained the sobriquet of '40-second Boyd' or 'Pope John', relating to his role as an instructor at FWS, where he had a standing bet for all comers: the challenger would begin on Boyd's tail, and within forty seconds Boyd would be on the challenger's tail – the loser to pay out forty dollars. In six years he never lost the bet.[4] It was towards the end of his time at Nellis, however, that he first produced a serious piece of work, with the assistance of Vernon Spradling, the FWS's lynchpin, and a dictaphone. Written in his own

time and based upon his work as an instructor and detailed analysis of contemporary aircraft and weapons, Boyd's Aerial Attack Study quickly became the official USAF tactics manual for fighter aircraft, and resulted in the personal award of a Legion of Merit. John Boyd was not content with the manual though, as he felt that there was something missing – and his next assignment would provide the breakthrough that he was seeking.

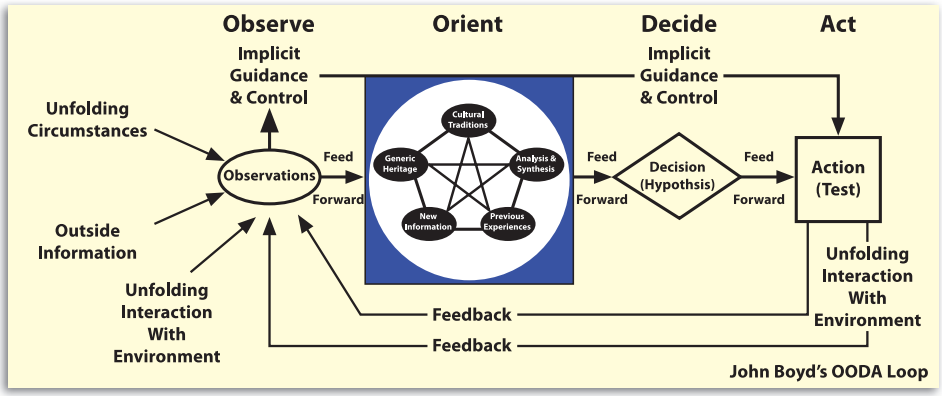
Indeed the next two years would prove to be perhaps the most formative in Boyd's life. Whilst not many can claim to have had fundamental insights into the nature of warfare as a result of attending engineering classes as an undergraduate, that is exactly what happened to Boyd during his time at Georgia Technical University from 1960 to 1962, and would lead to his first major piece of original work. His 'Damascus Road' moment came whilst trying to understand the concept of entropy in thermodynamics, and eventually led to his 'Energy-Manoeuvrability Theory' (E-M theory), for which he and his co-author, Tom Christie, would receive the U.S. Air Force Scientific Achievement Award for 1964. Without getting too much into detail, E-M theory provided a way in which the combat performance of aircraft could be compared in a meaningful way, and allowed far more detailed specification of what was required from an aircraft in terms of performance.[5] This single piece of work – and the insights into aircraft performance that Boyd drew from it – would dominate his life over the remaining 11 years of his career. The years that followed, until Boyd's retirement from the USAF in 1975, saw him engaged in constant combat with bureaucracy over the need to develop a 'proper' fighter aircraft for the USAF, which began with the F-X programme that would eventually result in both the F-15 and F-16. Space does not permit a detailed exposition of Boyd's part in this development, nor of his period in command of a task force at Nakhon Phanom AFB in Vietnam (complete with further Boyd myths), but it would be impossible to underestimate the role that Boyd played in the development of the F-16 in particular, and of the Military Reform Movement in general.[6]

Two USAF F-15s head on.

However, it was in the years that followed his resignation from the Air Force that Boyd's ideas on warfare at a more general level really began to take shape. This was largely as a result of Boyd continuing his own education but in ever more disparate areas; he told his friends that what

he was working on was an attempt to produce work which would "… link Godel's Proof, Heisenberg's Uncertainty principle and the second law of thermodynamics."[7] The end result was *Destruction and Creation*, one of the few genuine papers that Boyd ever produced - although it was never formally published.[8] *Destruction and Creation* would be subject to revision to the end of John Boyd's life, and was concerned with the way in which creativity occurred in the human mind - and how this could result in confusion and disorder if there was a mismatch between a concept or idea and observed reality.[9] This basic thought would underpin his next piece of work, which was applying the insights from *Destruction and Creation* to an operational issue, resulting in the *Patterns of Conflict* briefing – and the OODA Loop. Boyd's life would now be consumed by the need to perfect the concepts contained within *Patterns of Conflict*, and to make others understand – and use – the insights that they provided. This was the path which led to the infamous and ever-lengthening briefing sessions, with constant revisions to the content.[10] The final evolution, which attempted to sum up all of his work, was entitled *A Discourse on Winning and Losing*, and involved 14 hours worth of briefings delivered over a 2-day period.

The most detailed analysis of Boyd's theories is provided in Osinga's book on *Science, Strategy and War*, where most of the content is related to analysing the core arguments in Boyd's work, and considering their origins.[11] Even a cursory examination quickly reveals that the schematic OODA-loop is a gross over-simplification of Boyd's ideas, which contained a great deal more insight, and provide much more food for thought, than is perhaps generally understood. Certainly simply getting inside an enemy's OODA loop is not what John Boyd had intended people to take away from his ideas - and perhaps why he insisted on only explaining the concepts in person, through the highly interactive medium of a briefing. Although *A Discourse on Winning and Losing* was never fully written up, enough remains to be able to understand that Boyd was more interested in how people and organisations learn and adapt, and how vitally important – in fact fundamental - the element



Full diagram originally drawn by John Boyd for his briefings on military and fighter pilot strategy.

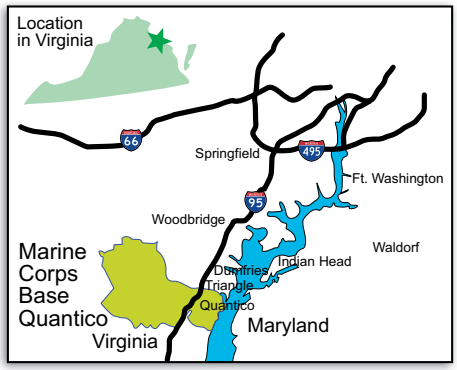
of *orientation* was. Furthermore, the issue of tempo was relative not absolute, and thus it was the speed of *correct* decision making that was important, with the aim of consciously generating mismatches between the events that an enemy observes or anticipates, and those that he must react to. Drawing heavily on military strategists from Sun-Tzu to Liddell-Hart, and rejecting much of Clausewitz along the way, Boyd was a firm believer in using the manoeuvrist approach to create those mismatches and uncertainty, and many of his ideas certainly appear in current thinking on 4th generation warfare (4GW).[12]

We do still need to address the question posed at the start of this article though, regarding the effect on Boyd's ideas of never having properly committed them to paper. Boyd has been described as perhaps the first post-modern strategist, and has left a "… sophisticated, multi-layered and multidimensional legacy and a new set of terms and concepts to study conflict that is useful, if at places abstract, biased, cryptic and difficult to fathom."[13] Would it have been any different if he had produced well-laid out, academically respectable papers? Having read widely about Boyd, it is difficult to avoid reaching the conclusion that if he had been the kind of person who had produced lengthy written papers, he would not have been the person who came up with the concepts that he did, nor had the energy and drive to force them to be taken seriously by the establishment.

The most difficult question posed by John Boyd though from the perspective of any air force, and one which will be returned to later on in this series when Warden's *Air Campaign* is examined, is what do military bureaucracies do when faced with mavericks? Boyd was, without doubt, a highly complex character, with many distinctive traits – some impressive, whilst others were less desirable. A deep thinker, but often 'anti-intellectual'; hugely gregarious – but also intensely private; someone who inspired many and made converts ('acolytes') of a few – although he also made a significant number of enemies; and was someone who held grudges for a long time. And whilst he could be absolutely correct in his analysis, he would often deliberately refuse to see the wider picture, preferring to concentrate on reducing all struggles to black and white issues. Yet without his insight and keen analytical ability, both the USAF and the broader military community would have been denied not only techniques to allow fighter aircraft designs to be better optimised but also remarkable new ways of thinking about the very nature of conflict. Indeed, it is hard to think of an officer who has made so many original contributions to any armed service, but despite this, within the USAF Boyd was more vilified than praised – a direct reflection on the way that he operated.

Perhaps the most accurate way of summing up the way in which Boyd was regarded by his own Service is to consider how he was initially remembered, which was solely by the naming of a small building at Nellis Air Force Base (AFB), used by the crews acting as aggressors in the Red Flag exercises.[14] By way of contrast, in the US Marine Corps Research Center at Quantico there

was (and still is) a large display case containing Boyd's flight suit, medals and logbooks, and his papers are all contained within the Marine Corps library.[15] In fact, there were more



Location of US Marine Corps Base, Quantico.

representatives at John Boyd's funeral service from the other branches of the armed force than there were from the USAF.[16] However, it is worth noting that Boyd's reputation has been considerably reassessed during the last two years, to the point where the Secretary of Defense, Robert M. Gates, praised Boyd during a speech in 2008 at Maxwell AFB as an individual whose commitment and integrity should be emulated by those aspiring to truly serve their nation.[17]

Official portrait of Secretary of Defense, Robert M. Gates.

Given that this edition of Air Power Review is majoring on the 'space' theme, you could be forgiven for asking what relevance an individual like Boyd, who had such clear contempt for the US astronaut corps for instance, has to the subject.[18] However Boyd demonstrated, throughout his life, the ability to take information, deconstruct it, and synthesize it in new ways – and the results were dramatic, had tremendous impact, and are still with us today. If we are to succeed in making the most of the opportunities that space has to offer, we either need more Boyd-like characters, or the ability to use his insights into critical thinking to make sure that we have all genuinely understood the advantages that operating in this environment can bring. Moreover his identification of manoeuvre warfare as being the optimal paradigm for warfare also provides a test, in that air forces, being largely technology-driven and technology-dependent, have an innate leaning towards a Jominian approach, with its focus on force and kill ratios, centralized control, detailed planning and a 'scientific' approach to warfare. In an era when the dominant form for enemies is in the shape of terrorist or guerrilla organisations, who are sustained by a very different understanding of warfare, the need to understand the manoeuvrist approach is clear. Boyd's personal story should act as both a reassurance and challenge to all those of us who believe in air and space power. A reassurance in that anybody can, if they really believe in what they are doing, make a difference – and that difference can be out of all proportion to an individual's actual place within an organisation. A challenge that we all need to ask ourselves is do we have the innate honesty and integrity to stand up to the system if we believe that we are in the right?

Note

There are a significant number of books that have been written both about Boyd, and his theories. Indeed, the number of publications that seek to apply the ideas contained within the OODA-loop theory seems to go on growing, particularly within the genre of military-theory related books for business, on which the English-speaking business world seems to thrive. However, for anyone wanting to get an understanding of John Boyd as an individual then either of the books by Grant Hammond or Robert Coram are sufficient – and both are a good read – albeit it should be noted that both are also written by Boyd supporters! For anyone wanting a greater understanding of the ideas underpinning Boyd's theories, the academic analysis provided in Frans Osinga's publication is excellent – albeit not quite so accessible. The remaining two, detailed below, can be taken as representing the genres of applying Boyd's ideas more widely to the fields of strategy and business respectively.

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Notes

[1]With the exception of a short paper on energy management produced in 1961.

[2]One biographer relays this as gospel, whilst another notes that it was 'difficult to believe'. All those who mention it do so in the context of his perennial belief in making a principled stand.

[3]If all the stories relayed by biographers are to be believed, John Boyd was also responsible for the desegregation of Las Vegas, identifying a fundamental design flaw in the F100 when he threw one away whilst aggressively manoeuvring it, and stopping the careers of a number of generals. His nickname in later years was 'hoser', from his penchant for describing having defeated individuals within the Pentagon, all at rank levels superior to his own, as having been 'hosed' – from the use of the term to indicate having succeeded in filling an enemy aircraft with machine-gun or cannon fire.

[4]Robert Coram, Boyd : *The Fighter Pilot who Changed the Art of War* (Boston: Little, Brown and Company, 2002), pp.87 - 89.

[5]The basic equation in E-M theory is $P_s = [T-D/W]V$, where P_s = specific energy rate, T = thrust, D = drag, W = weight and V = velocity – this gives a method of analysing how much excess energy a platform possesses – which can then be used to determine how much performance in terms of acceleration, or the ability to climb or turn, an aircraft has at any point in its flight envelope.

[6]See Coram, *Boyd : The Fighter Pilot who Changed the Art of War*, ch, 22 and 23.

[7]Ibid., p 321.

[8]Athough a version can be found

online at **http://www.goalsys.com/books/documents/DESTRUCTION_AND_CREATION.pdf**

[9]Boyd's aim was to provide some independent scientific or logical proofs to back up his ideas, although what he actually provides are examples of scientific theories which can be used as metaphors for better understanding the nature of human systems. See Grant T. Hammond, *The Mind of War : John Boyd and American Security* (Washington: Smithsonian Institution Press, 2001), ch. 8.

[10]The different versions were referred to by a major heading (Warp I, Warp II etc. – after the Star Trek series) and a minor heading (Wicker 1, Wicker 2 etc). So there were a range of variants between Warp I and Warp XII – after which he simply referred to it as *Patterns of Conflict*. Coram, *Boyd : The Fighter Pilot who Changed the Art of War*, p 328.

[11]Frans P.B. Osinga, *Science, Strategy and War : The strategic theory of John Boyd* (London: Routledge, 2007).

[12]Ibid., ch. 7.

[13]Ibid., p. 255.

[14]Albeit there was an indirect remembrance at Maxwell AFB, where the small circular road outside the doctrine centre had been formally named as 'The OODA Loop.'

[15]The US Marine Corps contacted John Boyd's family within 48 hours of his death in 1997, offering to provide a home for his papers.

[16]Hammond, *The Mind of War : John Boyd and American Security*, p 203.

[17]See transcript at **http://www.defenselink.mil/transcripts/transcript.aspx?transcriptid=4214**

[18]Because they weren't fighter pilots!

Book Review

Astropolitik: Classical Geopolitics in the Space Age

By Everett C Dolman

Reviewed by Gp Capt Ian Shields

The Royal Navy practiced sea power long before Alfred Thayer Mahan wrote in 1890 telling the world what they had been doing. So it is with space power, at least up to a point... Space power implies a function parallel to sea control in space control. But in order to seize and exercise space control, first a polity needs to understand space as an environment for war, in essence no different from the land, the sea, the air or cyberspace.

USAF Air University at Maxwell AFB, Alabama.

Thus writes Professor Colin S Gray in his introduction to Everett Dolman's 2002 *Astropolitik*, capturing the spirit of this excellent volume. The reason for reviewing the book again, 7 years after its initial publication, is two-fold. First, there are still very few writers on space from a strategic, even operational, viewpoint; Dolman's work remains all but unique. Second, how does his book hold up to critical scrutiny approaching a decade after it was first conceived?

Before considering the book itself in order to try to answer my question above, who is Dolman, and what did *he* hope to achieve by writing this book? Everett C Dolman lectures at the USAF Air University at Maxwell AFB, Alabama. He is regarded, universally and justifiably, as one of the foremost thinkers on space in the West and has influenced a generation of USAF space practitioners. It is also worth highlighting two further points straight away. First, Dolman is something of an arch-realist, and this colours his views and judgements. Not necessarily a bad thing, but it

Dr. Wernher von Braun became Director of the NASA Marshall Space Flight Center on July 1, 1960.

is worth being aware of this when reading his book. Second, he wrote this book around a decade after the end of the Cold War. He had seen the spurring of the "space race" as an extension of both national pride and the Cold War (a variation of the proxy wars around the core region of Eurasia that so characterised the years 1945 – 1989) and had then seen the optimism of the post-Cold War years fade.

Apollo-Soyuz Test Project Apollo Mission insignia showing the docking of American and Soviet spacecraft in Earth orbit, 1975.

Dolman set himself five targets in writing this book. First, he wanted to prove that many of the classical geopolitical theories are compatible with evolving theories on space. Second, he postulated that these theories, already exploited for sea and air power, would prove to be equally applicable to space. Third, he suggested that the unique characteristics of space would demand specific tactics if space was to fully exploited. Next, he wished to prove that the concept of space as a power base, as we would understand it from a classical, military viewpoint, was, with some minor modification, valid. Finally, he pleaded that if we wish to exploit space, particularly as military strategists, we needed a thorough understanding of the astromechanical and physical demarcation of space itself. I believe that Dolman achieved all these aims handsomely, and in doing so added markedly to an understanding of space when he wrote this treatise. So how did he go about this?

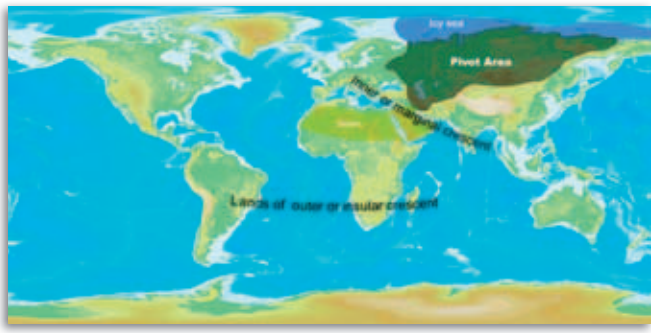
This is not a long book, only some 180 pages of text, split into 7 short chapters. It is not, it must be admitted, an easy read but nevertheless well worth the effort. The introductory chapter is, perhaps, the weakest of the book and those without a good foundation in International Relations theory, or a sympathy with the realist viewpoint, could afford to skip it. The chapter is almost a charter for Dolman's views on power balance and the meaning of strategy, and although it signposts what is to follow it can legitimately be ignored or skipped over. The same could not be said for the remainder of the book. Chapter 2 is the true foundation of the book: titled 'From Geopolitics to Astropolitics' Dolman traces the rise of the notion of geopolitics and then extrapolates into astropolitics in an entirely logical manner. Starting with Parker's definition of geopolitics as:"the study of states as spatial phenomena, with a view towards understanding the geographical bases of power" (p. 13), he draws on the writings of, among others, Sir Halford Mackinder and the German school of *realpolitik*, to define astropolitics as:" the study of the relationship between outer space terrain and technology, and the development of political and military policy and strategy" and then (deliberately more negatively) astropolitiks as: "a determinist political theory that manipulates the relationship between

state power and outer-space control for the purpose of extending the

Portrait of Sir Halford John Mackinder.

dominance of a single state over the whole of the earth" (p. 15). From this solid foundation, Dolman takes a canter through history to underline the credence of his definitions by considering how geographical influences have influenced social and political development, a process he describes as geodeterminism. From here, he postulates that there are direct parallels between geodeterminist theories and astropolitics, an extension afforded by technological advances. Dolman rightly acknowledges that geodeterminist theories of state power were largely discredited after the end of the Second World War, but that technological advances are constantly challenging this position and he remains convinced, and bases his theories of astropolitics on geopolitical thought.

If Chapter 2 is heavy going, Chapter 3 is, in contrast, one of the clearest and best-written explanations I have yet come across on orbits and orbital mechanics. But the great strength of this Chapter, indeed of the entire book, is that Dolman does not stop at a description of the physics, but then combines these physical laws and attributes with a real understanding of power politics by showing why they are important. He maps space, in a way similar to Mackinder's mapping of the earth, into regions of importance and influence, he draws on Mahan's work to identify key astropolitical positions in space (such as the Lagrange Libration Points) and combines geopolitical and geostrategic thought in a challenging and entirely convincing way to demonstrate the value of his thesis of Astropolitik.



Situation of the pivot area established in the Theory of the Heartland developed by Halford John Mackinder.

Having set the scene, Dolman's next three chapters build his case further. He starts by examining what we mean by space domination, and highlights the historic anomaly that led to the US being (at least at the time of his writing) the undisputed master of space due to the Cold War legacy and American technological dominance. In Chapter 5 he explores how the governance of space has been shaped and asks what are the implications. In this he is less than convinced of the value of the 1967 Outer Space Treaty, arguing that it has hindered space exploration by controlling space exploitation (one of the occasions on which I disagree with Dolman's views). The penultimate Chapter draws these various threads together into an examination of power, policy

and their applications, concluding that a benign hegemon in space (by which he means the United States) could and should dominate that sphere thereby increasing peace and prosperity. Whether you agree with his arguments or not, they are well and powerfully made. The final Chapter, concludes the book with a somewhat gloomy assessment of where space might have been heading (remarkably prescient in all respects other than his assumption of continued US dominance) at the time of writing.

And this was the great strength of this book when first published: the examination of space as a realm that, just as the sea and the air before, demanded a politico-military understanding if we are to lever the maximum benefit from it. Only by combining an understanding of space, strategy and politics, as Dolman did, into a single theory can the importance of space be truly appreciated. At the time he did strategic military thinkers a great service by highlighting space as a distinct realm, and not merely a continuation of the air environment, demanding its own understanding and applications. He meets, as I hope my review has demonstrated, his own five targets and produces a compelling narrative.

The acid test, though, is whether it has enduring relevance? At a fundamental level, space has little altered since Dolman's book was first published, and although he would have been aghast at the decline in the pre-eminent American position in space when he was writing, the US still enjoys such a degree of dominance as to support much of his thinking. However, does his theory survive as we move from a uni-polar to a multi-polar era of contested space? I believe that the answer has to be a resounding yes: Dolman's fundamental points that we must understand the space domain in order to lever its advantages, that space has remarkable parallels to the air and maritime environments and that we can therefore exploit its advantages, and that, above all, space is another arena of political conflict all hold good. This is not the easiest book you will ever read, but if you have a serious interest in the growing part that space has to play for we professional military exponents, it is one that you should read.

Backdropped by a blue and white part of Earth, the International Space Station is seen from the Space Shuttle Discovery as the two spacecraft begin their separation at 6.42am (CDT) on 11 June, 2008.

Book Review

Wolfram Von Richthofen: Master of the German Air War

By James S. Corum

Reviewed by Gp Capt Al Byford

In popular consciousness, the name von Richthofen automatically evokes the First World War's most famous air ace. However, in terms of historical significance - and particularly in the evolution of air power - the 'Red Baron' is totally overshadowed by his relatively unknown cousin, Wolfram. Wolfram von Richthofen was a competent and pragmatic air leader who commanded at formation level in at least seven major air campaigns before and during the Second World War, ranging from the Spanish Civil War, through the Polish campaign and the Battles of France and Britain, then onto the Balkans, Russia - including Stalingrad - culminating at field marshal rank as the Axis air commander in the Italian campaign before being struck down by a brain tumour, leading to his premature death as the war ended in 1945. Though clearly a character of considerable historical significance, it may be asked why today's air power practitioners should be interested in von Richthofen. The answer is that while there are many elements of his story that have contemporary interest, his key role in the development of effective air-land integration - an issue of real current concern - provides an obvious focus of interest. Von Richthofen was the *Luftwaffe's* ground-attack commander *par excellence* and the techniques and principles of air-land cooperation he established are still worthy of analysis today. He helped put the theoretical concept of the operational air war into practice and played a key part in enabling the German army and *Luftwaffe* to work together in what we would now recognise as the Joint Campaign, concentrating overwhelming air and land combat power together at the *schwerpunkt* – the point of decision – to impose shock and paralysis, delivering the operational and strategic success of the early, *blitzkrieg* years. An analysis

Manfred von Richthofen, more commonly known as The Red Baron, was a German World War I fighter pilot.

Wolfram von Richthofen Cdr, Condor Legion Uniform, 1939.

Panzer IV tanks entering France May 1940.

of von Richthofen's life in detail should, therefore, significantly expand our collective understanding of the historical development of air power, while also providing enduring lessons of real contemporary relevance for current operations.

James Corum previously taught at the USAF's School of Advanced Airpower Studies and his works have included *The Luftwaffe: Creating the Operational Air War, 1918-1940* and *The Roots of Blitzkrieg*. His extensive specialist knowledge in this area is apparent in the way he has approached this study, billed as the first full-length biography of Wolfram von Richthofen. Corum apparently

German Luftwaffe Heinkel He 111 bombers.

cultivated his contacts with von Richthofen's family to secure access to previously unpublished papers and, most significantly, his diary, and the story he tells is never less than fascinating. The author tracks von Richthofen's career as he progressed from cavalry officer to First World War fighter pilot in his cousin's old unit, JG1. He then joined the staff of the nascent *Luftwaffe's* technical office - where he played a major role in the gestation of the combat aircraft that were to fill the *Luftwaffe's* order of

German Messerschmitt 109 in Western Desert Jan 1942.

battle for much of the Second World War, such as the Heinkel He 111 and Messerschmitt Bf 109. Indeed, Corum makes the case that von Richthofen's replacement by Goering's favourite, Ernst Udet, contributed to the *Luftwaffe's* subsequent failure to bring forward a new generation of aircraft that could compete with the new and improved Allied designs that entered service later in the war, although ironically, this did pave the way for von Richthofen to move into operational command, establishing an enduring legacy as one of the greatest exponents of army–air force cooperation. The chapters on von Richthofen's contribution to the *Condor Legion* in Spain and the development of his philosophy of air-land integration will be of particular interest to current readers, although

Honour Standard of the "Legion Condor".

his experience of operational air command, at increasingly senior levels throughout the Second World War, is also never less than illuminating. Corum's style is easily readable and he always takes pains to set his central protagonist in the wider historical context; however, the emphasis on the bigger picture rather than von Richthofen himself is both a strength and a weakness. Those expecting genuine biographical insights into von Richthofen's character and motivation will be disappointed; despite the access to primary sources, there may be little here that is new to those already well-read in the 1939-1945 air war in general and the *Luftwaffe's* role in it in particular, although von Richthofen's early career - and especially the part he played as a catalyst for technical development – may be less widely known. Rather than being regarded as a traditional scholarly biography, this book is therefore better regarded as a general history of the development of German military aviation up to 1945, viewed from the particular perspective of one of its most important figures.

Despite the links the author forged with the family, this is by no means a hagiography; Corum characterises Von Richthofen as a ruthless, difficult and demanding leader, self-confident to the point of arrogance and with a loyalty to Hitler and the Nazi regime that was total, if naïve. Despite his acumen as a commander, he was directly involved in two of the *Luftwaffe's* most signal defeats, in the

87 Sqn Scramble, 1940.

Battle of Britain and at Stalingrad, and his most critical failing was common across Germany's high command; a narrowness of vision that disregarded strategy in the expectation that tactical and operational excellence would be enough by themselves, and that if sufficient battles could be won, final victory would somehow inevitably follow, regardless of the overall direction of the war. Von Manstein, one of the most acclaimed practitioners of operational art, tacitly acknowledged this when he titled his memoirs *Lost Victories*[1]. In von Richthofen's case, this shortcoming was manifest in his complacency

following the Battle of France, when in concert with his peers, he saw no reason to configure, organise and prepare the *Luftwaffe* for a long-term attritional war, and again in the Stalingrad campaign, when his focus on the tactical and operational levels blinded him to the opportunities available for the strategic use of air power, for example in attacking the Russian oil-fields, a point made more clearly in Joel Hayward's *Stopped at Stalingrad*[2] than in this work. Like the German armed forces, the US discovered in Vietnam that tactical victories do not win wars unless they are linked to a coherent overall strategy - arguably this lesson is being relearned in Afghanistan, where the heavy defeats suffered by the Taliban every time they confront NATO forces in the field have not yet been leveraged by an unambiguous strategy into campaign success.

Dornier Do 17s, France June 1940.

In sum, this biography is more useful as a general primer than for any particularly new insights it offers. But given this caveat, it does have merit, because von Richthofen was not just an important operational commander; his experiences encompassed the whole spectrum of the development of military aviation in the first half of the twentieth century, and the reader will learn as much about the evolution of air power – particularly its employment in joint operations – as he or she will about von Richthofen himself. This is by no means a perfect book – at least within the terms it sets itself - and it says too little about von Richthofen as a personality to be considered a definitive biography. But it is useful, particularly for those previously unfamiliar with the subject, in broadening understanding of how

A U.S. Air Force North American F-100D-85-NH Super Sabre aircraft (s/n 56-3415) fires a salvo of 2.75-inch rockets against an enemy position in South Vietnam in 1967.

and why the *Luftwaffe* developed in the way it did and why its operational conception of operations, delivered within the framework of a joint campaign, was initially successful but because of its strategic flaws, resulted in ultimate failure.

D Def S (RAF)

Notes

[1]Erich von Manstein, *Lost Victories* (London: Methuen), 1958.
[2]Joel S. A. Hayward, *Stopped at Stalingrad: The Luftwaffe and Hitler's Defeat in the East 1942-43* (Lawrence: University of Kansas Press), 1998.

Letters

Reviewed by Dr David Jordan

Hawker Typhoon being rearmed in France during Operation Overlord July 1944.

Sir,

Brian Armstrong's article on the lessons identified by the Royal Air Force from the Spanish Civil War (Volume 12, No 1) is a most welcome addition to the historiography of RAF doctrine during the inter-war period. Sqn Ldr Armstrong offers an interesting corrective to some of the assumptions made about the attitudes of the air force to the conflict, particularly the old canard that Sir Cyril Newall regarded air support as a 'gross misuse of resources'; as Armstrong notes, Newall in fact disputed the value of apportioning a large number of fighter aircraft in a DCA capacity directly above friendly troops. Although it cannot be denied that Newall's tenure as CAS was not marked by innovations in air support, rather than damning it outright as has been supposed, Newall would appear to have followed the Trenchardian logic that experience from the Great War demonstrated that such apportionment was largely ineffective and reduced the flexibility of the air force in its ability to provide effective support – even if that was best achieved out of the sight of those on the ground.

One further area of Sqn Ldr Armstrong's article deserves some elaboration. On pages 50-51 he notes:

"…some effort was made to identify a direct support bomber requirement to appease army sensitivities. A two seat, four machine gun turret-armed aircraft with a 1,000lb bombload was specified for direct support work but there would be no dive-bomber despite Army wishes."

This was all very well, but it is perhaps worth recalling that such an aeroplane would almost certainly have been a disaster over the battlefield in 1940. This type of aircraft would have proved easy pickings for the enemy in the absence of a favourable air situation – a direct support bomber of the sort specified would have performed just as well (or badly, depending upon how one looks at it) as the Fairey Battle over the Meuse or the Stuka over southern England. Four-gun turrets were essential on heavy bombers, but when fitted to tactical aircraft proved less than successful, as the Defiant and the Roc illustrated. The weight and bulk of the turret did little to enhance the capability of the aircraft and made it more vulnerable.

The lessons from the First World War suggested that while specialised attack aircraft were a useful asset, a fighter-bomber type which stood a chance of fighting its way out of trouble was preferable. The Sopwith Camel led the way in this regard, and the Hawker Typhoon and Republic P-47 Thunderbolt were to highlight this further in the Second World War. It is perhaps no coincidence that as the Luftwaffe lost control of the air on the Eastern Front it began replacing its specialised support aircraft (notably the Stuka) with the Fw 190 and largely relegated its dive bomber types to night operations (where their success was aided by the lack of a Soviet night fighter capability).

Yours sincerely,

David Jordan

Defence Studies Department, King's College London/JSCSC Shrivenham

Viewpoint

UK Space Policy

RAF Review

Reviewed by Dr Mark Hilborne

The recent selection of Major Timothy Peake as an astronaut by the European Space Agency has created a flurry of interest in British involvement in space. Equally however, the event has highlighted how marginal that involvement has been historically.

Timothy Peake is one of six individuals who will become Europe's new astronauts. The new astronauts were presented at a press conference held at ESA Headquarters in Paris, France, on 20 May 2009.

Major Peake will in fact be the first Briton to fly in space under the British flag. But as space becomes increasingly important, even vital, for many aspects of terrestrial life, the UK will have to take an increasing interest in space in order to stake its claim to the related commercial and technological benefits. Closely related to this is the question of security – security of the information derived from and routed through space, security of the assets involved, and possibly security of the nation from threats emanating from space.

More than the scientific or commercial aspects of space, it is this aspect of security that has perhaps received the least consideration from policy makers within the UK. At the same time, this aspect of security is also the most complicated, presenting new challenges while underlining some traditional security dilemmas. Recent events may alter the way nations approach this issue.

The challenge in determining how the UK can achieve security is in defining what is meant by that term. What is it that we seek to secure, what are the threats, and what is it we hope to achieve in space?

European Space Agency's Ariane 5.

The whole notion of security in space, let alone its definition, is subject to competing visions. However, perhaps the most comprehensive and highly regarded analysis of

the subject - the annual Space Security Index – is a useful place to start. Its' definition is 'the secure and sustainable access to and use of space, and freedom from space-based threats.'[1] Given this definition, security in space can be adversely affected by environmental factors, such as space debris, increased congestion through competition for valuable orbital slots, and from hostile military action. In order to maintain its access to space, Britain will have to decide whether it follows a path of securing this via multilateral and co-operative uses of space, or through trying to attain a level of dominance over other space actors. Interestingly, these two approaches are represented by the two main geopolitical spheres between which Britain traditionally finds itself torn – Europe and the United States. The selection of Maj Peake by the ESA may signal increased co-operation and integration with Europe, not to mention the beginning of British involvement in manned spaceflight. But this is in stark contrast to the almost total reliance that Britain has upon the US for all its military capabilities derived from space.

The reliance could bring with it some very difficult questions. US policy has been solidly resistant to engaging in any multilateral negotiations to limiting military uses of space, and has been quite forthright about allowing space to move from being militarized to becoming weaponized. US policy has clearly identified a number of roles for which space weapons would be applicable. The US 2006 National Space Policy calls for the Department of Defense to implement four main tasks in order to achieve its goals: space support, force enhancement, space control and force application missions. The latter two potentially involve space weapons - active space defences in the first, and the use of force from space against terrestrial targets in the latter.

While there might seem some specific military justification of such uses of space, from a broader security policy perspective, they create some significant problems. First and most simply, they would create the very real danger of an arms race. Other space actors are unlikely to sit idly by as one places weapons systems in this new realm. It must be questioned then whether such a move could be seen as enhancing security. Secondly, weaponisation could have an effect on existing treaties, and thus on the wider multilateral process. The Outer Space Treaty (OST), of which the UK is a signatory, requires space to be maintained for peaceful purposes. While it only mentions weapons of mass destruction, clearly there are no weapons systems that can be defined as peaceful. If the UK or the US transgresses this treaty, it would lead to questions over their commitment to other multilateral agreements, at a time when a number of those accords are currently facing substantial pressure, not least of which is the

Non-proliferation Treaty. This in turn could affect the level of legitimacy with which the nation is seen to act, so important when trying to shape and influence the international agenda, or gain backing for certain initiatives. The UK is committed to addressing security threats multilaterally through the multitude of organisations upon which it sits : the UN Security Council, NATO, the EU, and OSCE to

United Nations Security Council.

name the most important. As such it derives a great deal of influence from the current system, and to undermine that would not be in the nation's interest. The UK's policy in space needs to reflect these core tenets of the national strategy.

While UK policy and doctrine have followed the US closely, it may well be that they are in danger of falling out of step with current US thinking,

Barrack Obama speaking at Camp Lejeune, February 2009.

as President Obama has stated that the US will consider multilateral negotiations to ban weapons in space. While there are significant hurdles to overcome, both domestically and internationally, before this becomes a reality, the current Administration's early statements mark a significant change in attitude. Until this point, the US has been fundamentally opposed to negotiating any sort of treaty governing weapons in space.

This change in attitude has been mirrored by the breakthrough in the UN's Conference on Disarmament on 29 May. After 12 years of deadlock the 65-member disarmament body agreed to begin negotiations on banning the production of fissile material for nuclear weapons, with the ultimate goal of establishing a Fissile Material Cut-Off Treaty (FMCT).[2] While this is remarkable in its own right, not least because it came hot on the heels of North Korea's nuclear test that threatened the body's consensus, it has distinct relevance on the issue of space weapons. Within the Conference, a treaty on Preventing an Arms Race in Outer Space (PAROS) and the FMCT have long been held political hostage to each other, with their respective champions – China and the USA – refusing to negotiate one treaty if the other party did not negotiate the second. Thus movement on one treaty is a potential movement on both. Importantly, buried within the statement on 29 May is the news that a programme of work will include creating a working group on the prevention of an arms race in outer space. A paper tabled by Canada looking to find common ground on this issue created the momentum[4], and a last minute compromise on wording between China and the US led to the programme being adopted by consensus. While still a first step, this is a major event in terms of efforts to curb both nuclear proliferation

and an arms race in outer space. As the UK drafts its space policy, these are changes of which it has to be conscious.

While the US has rediscovered its appetite for leadership in multilateral negotiations, it has also been engaged on another, though inter-related, issue, and one that has previously received insufficient attention: that of Cyberspace. On the same day as the UN breakthrough, President Obama announced the creation of a White House office to coordinate security in cyberspace, in response to what he called "one of the most serious economic and national security challenges we face as a nation." Given the importance of space to informational infrastructures, this is clearly a subject that must be carefully considered in a future UK space policy.

Clearly then, space policy cannot be framed in isolation, and it must sit within and support wider policy considerations, both nationally and internationally, as well as those other security areas with which it is intertwined. International legal agreements as well as international legitimacy and good standing are all fundamental pillars upon which Britain's foreign policy operate.

Though it is early days, the change in the attitude in Washington may mean that the approaches to space of Britain's main strategic partners, Europe and America, may be moving closer, and this might mean that Britain is faced with policy alternatives that are less stark. It is possible that Britain will have the opportunity to play an intermediary role, a role with which it is already familiar.

European space policy emphasizes peaceful uses of space in pursuit of

Liftoff of the Ariane 5 ECA of flight V189 from Europe's Spaceport in French Guiana.

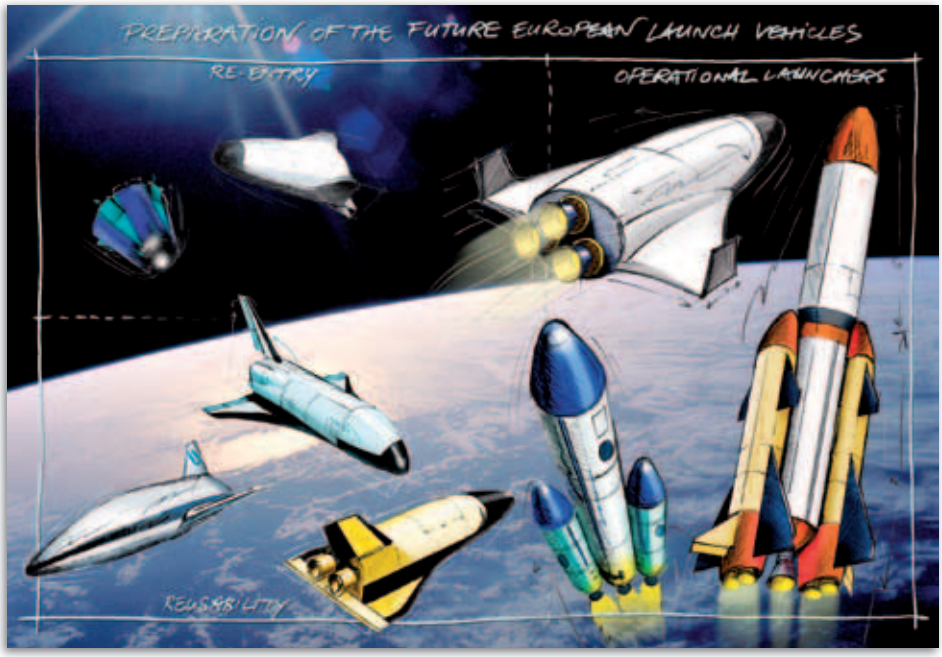
policy objectives, and co-operation in contrast to the notion of dominance that was central to US notions during the previous Administration. Also, the European organisational structure managing space has a greater emphasis on civilian activity, with access by the military where necessary. Given the overwhelming overlap of commercial and military assets, this is a realistic and cost-effective approach, utilising dual-use technology where possible. Thus the European programme as a whole may be more closely aligned with the UK's National Security Strategy and, given the potential that the UK can have a role in shaping its future, it would also benefit the nation's interests.

Of course effective policy is unlikely

to flow from ineffective organisation, and at the moment the bodies controlling UK space activities are several. Civil space activities are governed by the British National Space Council (BNSC), while military space is controlled by the Ministry of Defence as well as the Foreign and Commonwealth Office. Thus there is no single lead organisation to ensure a co-ordinated policy. In contrast, both the US and EU have a much more harmonized structure. In 2004 the US established the National Security Space Office to integrate the various requirements derived from defence, intelligence, commercial, scientific and civil sectors.

The European Union co-ordinated its structure the same year, and created the Space Council, consisting of the 27 EU member states and/or the European Space Agency states. The Council provides the opportunity for the numerous stakeholders to jointly discuss the development of a coherent overall European space programme. The UK needs to make similar moves to ensure that its own space requirements are logically integrated and clearly articulated.

A significant hurdle still exists, however, if Europe is to become a credible counterweight to the US as a strategic partner in space. Despite its steps to co-ordinate its structure, the programme's funding is complex, and its decision-making cumbersome. Furthermore, notwithstanding its competence in space, and its significant share of the market that it enjoys (50 percent for launchers and 20-30 percent for satellites), Europe is still not self-sufficient, and relies on outside expertise in some key areas. Long-term, these gaps should be overcome, for instance with the completion of Galileo global satellite



ESA's Future Launcher Preparatory Programme (FLPP) is focusing on the preparation of a Next Generation Launcher (NGL)to be operational around 2020.

navigation system. If the aspiration of space-based observation, early warning and intelligence systems are achieved, Europe may potentially attain a wide spectrum of self-sustained space activities.

Clearly there are a number of changes occurring to notions about how to best utilize and secure space, at a time when British involvement in space is at a critical juncture, and these will affect policy choices. Major Peake's selection to the ESA programme marks beginning of British involvement in manned spaceflight and should garner increased attention on British space efforts. This coincides with what appears to be the seeds of change in US attitudes on how it exploits space, and increased momentum on the subject of space security within the UN. While it is too early to place too much stock in these events, both point towards a wider consensus that co-operation in space is vital if mankind is to maintain access to it, and is to derive the maximum potential from it.

Britain will be unable to gain all its requirements from space unilaterally, thus co-operation is vital. With new players entering the domain, such as Japan, India, China and Brazil, Britain's interests will continue to be best served by orienting its policy with that of its main strategic allies. The prospects of change mentioned above mean that the conceptual differences between Britain's main strategic allies could become less, and that both will reflect wider international notions of how space should be utilized. This should simplify the framing of a space policy.

An effective policy will depend on a clear understanding of what Britain hopes to achieve in space, of how this fits into wider policy objectives. This will be facilitated by effectively harmonising its structure to co-ordinate its objectives. It is only then that its voice will be heard by the strategic partners with whom it chooses to work. But more fundamental is the integration with wider security policy. Space has often been seen as a unique, distinct activity, exclusive from other aspects of human endeavour. While a number of its characteristics certainly are unique, it is increasingly integrated with other key developments in our societies. Policy must see it as such. The assumption that space is best utilized by securing access to it, and that this is achieved by co-operation rather than confrontation, upholds many central tenets of the UK's National Security Strategy. These notions should be at the heart of the UK's future plans for space.

Notes

[1]See *Space Security Index 2008*, Waterloo, Canada, 2008, p.5 available at spacesecurity.org

[2]United Kingdom, Cabinet Office, *The National Security Strategy of the United Kingdom: Security in an Interdependent World*, London, Cabinet Office, 2006, paragraphs 4.64 and 4.71.

[3]**http://unog.ch/80256EDD006B9C2E/(httpNewsByYear_en)/92A05D4392609C48C12575C5004D6FDC?OpenDocument**

[4]Government of Canada "The Merits of Certain Draft Transparency and Confidence Building Measures and Treaty Proposals for Space Security" at **http://www.reachingcriticalwill.org/political/cd/papers09/1session/Canada-PAROS.pdf**

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