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RESEARCH REPORT

SPACE POWER: MILITARY IMPERATIVES
IN AUSTRALIA'S ENVIRONMENT

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SPACE POWER: MILITARY IMPERATIVES
IN AUSTRALIA'S ENVIRONMENT

by

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A DEFENCE ANALYTICAL STUDY SUBMITTED TO THE FACULTY
IN
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REQUIREMENT

Advisor: Colonel Eric Sundberg

MAXWELL AIR FORCE BASE, ALABAMA

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EXECUTIVE SUMMARY

TITLE: Space Power: Military Imperatives in Australia's Environment

AUTHOR: Kenneth J. Drover

The theme of this paper is to examine why the military use of space power is ideally suited to Australia's geopolitical environment and show how the Australian Defence Force can use space assets to effectively increase the utility of existing terrestrial based forces.

Australia has been slow to accept the military use of space and its untapped potential, indeed, the issue of space was not even addressed in the 1987 Defence White Paper.

Space, as the newest dimension of military warfare must overcome political, economic, and organizational prejudices before acceptance as a unique military dimension with its own unique policy, doctrine and strategy. Space can provide a very positive contribution to defence throughout the range of credible contingencies. Thus, to ensure Australia is provided with the best defence capability within budgetary constraints, the ADF must recognize the importance of the dimension of space. Accordingly, the future challenge for the ADF is to formulate a viable military space policy and doctrine that provides a vision for the future employment, organization and integration of space assets into the ADF in order to provide the optimum defence structure for Australia's continued security.

BIOGRAPHICAL SKETCH

Wing Commander Kenneth J. Drover joined the Royal Australian Air Force as a cadet at the RAAF Academy in January 1969. Since graduation as an electronics engineer in 1972 he has worked in a variety of communications and avionics appointments in the Melbourne area. In 1977 he attended the Advanced Maintenance Engineers Course in the UK. Since then he has specialized in avionics engineering with tours as a project engineer in Support Command, Senior Engineering Officer at 492 Maintenance Squadron and Deputy Director of Avionics Engineering in Department of Defence (Air Force Office). He is a graduate of the RAAF Staff College 1986, and of the Air War College, Class of 1989. He holds a BSc from Melbourne University, a BE from Caulfield Institute of Technology and an MBA from Troy State University.

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SPACE POWER: MILITARY IMPERATIVES
IN AUSTRALIA'S ENVIRONMENT

CHAPTER I

INTRODUCTION

"The modern concept of a theatre of military operations may include the entire territory of a belligerent or coalition, whole continents, large bodies of water, and extensive regions of the atmosphere, including space."

Soviet Marshal V.D. Sokolovskiiy ¹

PRECEDENCE: FLASH

TO: COMMANDER JOINT FORCES AUSTRALIA (CJFA)

FROM: SATELLITE COMMANDER (SATCOMAUST)

"LAST PASS OF ANZACSAT1 SHOWS KAMARIAN NAVAL BATTLE GROUP HEADING ONE-NINE-ZERO, LATITUDE 14 DEGREES SOUTH AND LONGITUDE 112 DEGREES EAST. MAJOR AIR ACTIVITY ALSO ON ALL KAMARIAN AIRFIELDS. IF CURRENT HEADING MAINTAINED, EXPECT INCURSION INTO AUSTRALIAN WATERS WITHIN 12 HOURS."

ANZACSAT1 was one of four Australian/New Zealand surveillance satellites that had been placed in low earth orbit to provide electronic intelligence and high resolution optical and infrared surveillance of Australia and New Zealand's area of military interest. Because of increasing tension between Australia and Kamaria, the satellites

sensors had been concentrated on the Kamarian region and had provided early warning of their military buildup, naval concentrations (especially of naval landing craft), unusually high exercise activity and a tenfold increase in military communications traffic.

The early warning had allowed time for Australian Defence Force (ADF) assets to be positioned on the West Coast of Australia to counter the threat. Airborne Early Warning and Control (AEW&C) aircraft and P3C Orions were stationed at Learmonth, FA-18 fighters and B707 tankers flew from Derby, F-111 strike and photo reconnaissance aircraft from Pearce, and Rapier surface to air missiles guarded the main airfields in the West. Royal Australian Navy frigates (FFGs), destroyers (DDGs) and submarines had moved to patrol off the north-west cape, and Army forces had moved into key points along the north-west coast. An unlikely scenario? Yes, but only in the sense that Kamaria is a mythical country. A similar threat is still feasible. An unlikely use of space assets? Yes, but only because to date, the Australian Defence Force has not pursued a policy of taking military advantage of the use of space. Whether the unique advantages offered by space are utilized by defence planners depends on the timely development of a viable space policy by the Australian Defence Force.

Focus of the Paper

This paper focuses on the use of the medium of space ² by the Australian Defence Force within the parameters of Australia's current defence posture and unique operating environment. Space is a medium that paradoxically holds unlimited potential for both warfighting and peacekeeping. Historically, space has been the domain of the superpowers. However, more and more nations are employing space as part of their national defence policy or are involved commercially in space. To date just over 24 nations possess spacecraft and seven countries³ have demonstrated space launch capabilities. More than 2100 companies are involved in commercial space activities and there are more than 109 member nations in the International Telecommunications Satellite Organization.⁴ Thus a prime question that must be addressed by defence planners is what can the use of space provide for Australia's defence and should the ADF also become actively involved and exert a regional influence in the military use of space in its area of immediate interest.

The civilian sector in Australia has committed itself to space research and applications in order to, "assist in different areas of space science and technology, and in the selection of spectral bands that would be employed in future satellites so as to optimize their utilization in the Australian environment." ⁵ Despite a government commitment

to the civilian applications of space, there is no adequate strategic guidance for military space involvement. The recent Dibb Report and Defence White Paper both provided comprehensive strategic guidance for the defence of Australia. Both papers critically examined the use of land, sea and air power for the defence of Australia and a coherent policy of defence in depth was developed and approved by the government. However, space as the fourth and potentially crucial medium for defence and deterrence was not addressed. Such an omission could be crucial to the long term stability and security of Australia and its interests in the region.

Aim

The aim of this paper is to provide the rationale and a framework for the development of an Australian Defence Force policy and doctrine on the future military use of space.

Layout of the Paper

Chapter II of this paper will address how the use of space by the Australian Defence Force could provide a crucial edge in the region. The chapter will analyse Australia's unique strategic problems stemming from its geography and demography in the context of current defence policy. The chapter will develop the thesis that space power has the potential to be used effectively in Australia's

unique strategic situation and is an option defence planners should not overlook.

Chapter III will trace the evolution of the use of space and show that it is a unique military dimension that potentially holds great military advantage if properly utilized. The chapter will describe how space assets can be particularly effective, if not essential as a means of enhancing the effectiveness of terrestrial forces.

Chapter IV will examine the contextual relationship between using space for military purpose and Australian foreign policy on space. My thesis in this chapter is that defence planners need to consider all the benefits that can accrue from using the new dimension of space for military purposes and if these benefits clash with government policy then the issue needs urgent resolution. The chapter will show how space can be used in a range of credible contingencies and examine how this would impact on ADF force structure.

Chapter V will focus on the direction that should be taken for the development of space policy and doctrine. Broad guidelines and essential questions for the development of Australian space policy and doctrine are addressed in this chapter. Unfortunately, the treatment of this topic will of necessity be broad brushed and lack some detail due to time constraints and lack of ready access to source

material. However, a coherent space policy and doctrinal framework is developed that will easily accommodate future expansion.

CHAPTER II

AUSTRALIA'S STRATEGIC SITUATION

Australia faces no presently identifiable major military threat, except for the remote possibility of global war.

Defence White Paper 1987 ¹

Evolution of Australia's Defence Strategy

Historically, Australia's national security policy has relied overwhelmingly on the concept of forward defence,² resulting in a force structure oriented towards providing expeditionary forces around the world, and operating as part of a much larger allied force. The genesis of forward defence can be considered to stem from World War I when Australia's military history was forged on foreign soils; in the campaign for Gallipoli and in the trenches of the Western Front. World War II saw Australians fighting on foreign soil again in Europe, North Africa, Asia and the Pacific. Recent examples of the forward defence thinking are many; there was Australia's contribution to the Korean War, the Malayan Emergency, commitments to various SEATO plans, commitment of a battalion of soldiers and a battery of artillery to Borneo during the Indonesian Confrontation, and the provision of a brigade of 4,500 soldiers to Vietnam from 1965 to 1971.³

However, 1971 effectively saw the end of forward defence as a viable policy and there was a gradual shift toward a more self-reliant posture. To a large extent this was forced upon Australia by external events from our two closest allies, Great Britain and the United States. The events that provided the catalyst for change were: the withdrawal of British forces east of the Suez Canal; the appearance of Soviet ships in the Indian Ocean; the thawing of the West's relations with China; the 1969 announcement by President Nixon of the Guam Doctrine;⁴ and the withdrawal of US ground forces from South-East Asia.⁵

Defence Policy Today

Australia's current Defence policy is set out in the policy information paper, The Defence of Australia 1987, (the White Paper). The paper clearly sets out the guidelines for Australia's defence. The policy is heavily based on defence self-reliance, but still within a framework of alliances and regional commitments requiring a coherent strategy and enhanced capability. Chapter 1, paragraph 1-1 of the White Paper states:

This Government's policy of defence self-reliance gives priority to the ability to defend ourselves with our own resources. Australia must have the military capability to prevent an enemy from attacking us successfully in our sea and air approaches, gaining a foothold on our territory, or extracting political concessions from us through the use of military force. These are uniquely Australian interests and Australia

must have the independent military capability to defend them. *

Australia believes the policy of self-reliance can best be achieved through a strategy of defence in depth. The concept of defence in depth requires that the Australian Defence Force maintain the optimum mix of forces operating synergistically to provide the capability to defeat any credible levels of threat in Australia's area of direct military interest.⁷ Of fundamental importance to this strategy is control of the air and sea gap that separates the island continent of Australia from all other nations.

Australia's Unique Strategic Problems

Although the White Paper clearly outlined Australia's defence policy, the massive problems of fulfilling this task must be put into the context of considering Australia's vast area to be defended, small defence force, limited infrastructure, and low population. Australia is an island continent with an area of 7.62 million square kilometers (about the same area as mainland USA) and a population of 16.2 million. This makes Australia one of the most sparsely populated nations in the world, yet her area of direct military interest includes Australia, its territories and proximate ocean areas, Indonesia, Papua New Guinea and other nearby countries of the South-West Pacific. An area that stretches over 7,000 kilometers east-west and over 5,000

kilometers north-south, or about 10 per cent of the earth's surface.⁸ (See Appendix 1 for a map of the region). This area is characterized by vast tracts of empty oceans to the east, south and west. To the north, the only corridors to Australia would be through the Indonesian archipelago and its extension through New Guinea - an area containing over 175 million people and only a quarter of Australia's land mass. To the north-east, access to Australia is via the sparsely populated areas of the Bismark archipelago, Solomon Islands, New Hebrides or New Caledonia.

Thus Australia's unique features of remoteness, vastness and low population density set it apart from other island nations of the world. In his book, The Tyranny of Distance, Geoffrey Blainey argues that three features of Australia's physical environment have as great an influence today as they had for the first settlers in 1788, viz. crushing isolation, vast internal distances and almost uniformly inhospitable climate and terrain.⁹ These enduring physical features of Australia have had a major impact in formulating strategic policies and defence force structure. However, these features are a two-edged sword in that they can be both a benefit and a disadvantage. As a benefit, they force any potential enemy to project power over long ocean and air approaches, (providing strategic warning time) and then operate in a hostile climate and terrain. Such an operation would be extremely hazardous, especially against a

well armed and alerted maritime and air force, which has the capability to control the air and sea gap that separates Australia from any aggressor. On the negative side, the disadvantages of distance are that it increases demands on the area's infrastructure and dictates the parameters needed for military equipment. Distance also makes Australia very vulnerable to any disruption in trade. International trade, on which Australia depends, must be conducted over vast distances and through easily controlled strategic chokepoints; such as the Maldives Channel, Lombok and Wetar Straits and the Molucca passage in Indonesia, and the many narrow waterways of Melanesia and Micronesia.¹⁰

To defend against attacks in her region of direct military interest, Australia has a small but technically advanced defence force of about 70,500 regular servicemen and servicewomen; comprising 32,000 Army, 22,800 Air Force and 15,700 Navy, plus a force of 27,000 reservists.¹¹ The annual defence budget has averaged between 2.6 and 2.9 per cent of gross domestic product since 1980 (GDP for 1985 was AUS\$ 207.1 billion). This translates to between 9.2 to 9.9 per cent of the annual budget for the same period.¹² The problem then becomes manifestly clear; ranged against a vast area, Australia's small population and limited economy are ill-equipped to match the full military requirements in the region. In any credible contingency other than low level conflict, the ADF would most likely be confronted by a

numerically superior force. Thus, as Air Marshal Newham has stated, "The size of our area of interest and our probable numerical disadvantage imply that technology must substitute for size in our force structure." ¹³ This concept has been accepted by the government in the White Paper where it states; "...the ability to apply advanced technology effectively provides the only real solution to many aspects of defending our vast continent and our interests in surrounding maritime areas." ¹⁴

The Threat to Security

As a counter to the strategic and demographic problems, Australia currently faces a relatively benign threat environment. The White Paper states that no nation in the Australian region currently poses a threat; although this could change at some future time. Because of Australia's enduring national features of remoteness and vastness, the only countries that have the military capabilities to threaten and sustain an invasion on Australian soil are the USA and Russia.¹⁵ Neither contingency is credible; the USA is Australia's closest ally and the Soviet Union has nothing to gain by invading Australia. On the other hand, the same features can work against Australia. Given the vast area to be covered by Australian defence forces, a small enemy force harassing or invading one of Australia's outlying territories or interdicting sea lanes and disrupting trade

would require disproportionate effort and commitment of resources by Australia. For example, according to a study published by the Australian Defence Association, both the Cocos and Christmas Islands off Western Australia are "highly vulnerable to attack," and could present Australia with a "Falklands type war before the end of the 1990's." ¹⁴ Thus the ADF must be structured to ensure a balance between the use of limited resources of men and materiel, against an array of credible contingencies; from threats that develop in the short term and require a rapid response, to higher level threats that take longer to develop but require the capability to expand to effectively counter the potential for higher levels of conflict.

The government White Paper identified three levels of credible threat scenarios applicable to Australia, short of global war; low level conflict, escalated low level conflict and more substantial conflict.¹⁵ Low level conflict includes; "The use of military force to harass remote settlements and other target in northern Australia, off-shore territories and resource assets, and shipping in proximate areas, ... to force political concessions over some disputed issue." ¹⁶ Escalated low level conflict would be similar to low level conflict, but harassment and raids would be at a higher frequency and intensity. Enemy units would be prepared to directly confront Australian forces. "The limits of escalated low level conflict would be set by

the capabilities that could practically be brought to bear against Australia's interests."¹⁹ Finally, more substantial conflict is the euphemism for invasion and subjugation of Australia.²⁰ These threat scenarios are discussed in more detail in Chapter IV.

Need for Force Multipliers

Given the fiscal and manpower constraints in Australia, and the diverse, but generally low threat environment, the force structure of the ADF must be tailored to achieve the maximum efficiency for operations over the large area of interest. A major factor in achieving the maximum utility from the limited ADF resources is to make the use of force multipliers that will disproportionately increase the returns for the effort expended. Lord Trenchard may not have understood the term force multiplier, but he was espousing the same concept when he said: "to expand the effectiveness of man and machine without increasing the numbers of either; in that way lies economy." ²¹

The limited size of the ADF makes the employment of force multipliers an essential requirement to provide a capability that ensures adequate force projection while simultaneously restricting attrition losses. Indeed the restriction of attrition losses is one of the major benefits that accrue from the employment of force multipliers, as

attrition losses would be unacceptable for a small highly skilled force such as the ADF.

Force multipliers can run the full gamut from low cost low technology options, such as better manpower distribution or improved training; to high cost high technology options such as "brilliant" weapons systems that have an almost certain one round kill probability. However, what is often forgotten by the detractors of high cost high technology options is that their overall cost effectiveness is much greater than most low cost weapons systems in a conventional conflict. For example, one Harpoon anti-ship missile costs over one million dollars, but when one or two harpoons can almost certainly sink or cripple an enemy warship worth over 100 million dollars, without the launch platform which may be worth 50 million dollars, ever coming within the defensive perimeter of the target to face attrition losses, then the cost effectiveness of the system becomes obvious. Thus the use of force multipliers must be an important facet of ADF strategy. Examples of force multipliers being purchased by the ADF include: improved communication, command and control facilities; air-to-air refuelling pods for Boeing 707 tankers; precision guided munitions (PGMs) for the FA-18 and F-111C; over-the-horizon radar (Jindalee); and airborne early warning and control (AEW&C) aircraft.

However, one important ~~force~~ force multiplier that the 1987 Defence White Paper does not mention is space assets, other than to give an implicit acknowledgement that space assets will sometimes be used as a medium of communication and/or navigation. Such an omission could be crucial for future defence strategy.

Space as a Force Multiplier

Because of Australia's vast area, the use of space as a force multiplier holds many advantages. For example one geostationary satellite can provide continuous surveillance for all Australia's region of primary military interest, or several low earth orbit satellites with 90 minute revisit times could provide detailed electronic, optical, and infrared intelligence and tactical targeting data. In fact, space assets probably provide the only cost effective method of monitoring Australia's 35 million square kilometres of primary military interest. Space as a force multiplier is well recognized by the US Space Command. Indeed their Space Systems Handbook for Staff Planners and Operators begins with words;

Using space systems, whether for communications, reconnaissance, surveillance, environmental monitoring, tactical warning or position or navigation, provides a potential force multiplier for tactical, operational and strategic forces throughout the spectrum of conflict. Space based sensors serve as an integral part of the early warning and attack assessment structure;... 22

The way that space systems could be used to advantage in the defence of Australia will be the subject of following chapters. However, the evolution of space as a dimension for military operations has been the focus of much debate over how, when, where and why employ space systems. Fundamental issues that will need to be addressed by the ADF are questions such as: how and when to employ space assets; should control of space forces be divided into parts and apportioned to each individual Service, or should space forces constitute a separate Service that can be integrated into the combined arms team? Furthermore, because space systems are so technology dependant and relatively new, their continued evolution tends to outstrip the doctrine that should be guiding their development and use. Chapter III will examine the evolution of space, why employment ambiguities have sometimes surrounded its use, and detail unique capabilities that space can provide to the art and science of war.

CHAPTER III

SPACE: THE FOURTH MILITARY DIMENSION

Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after changes occur.

Giulio Douhet¹

The Birth of the Space Age

To understand the impact of space on military philosophy, it is important to see how the use of space evolved and grasp the enormity of the technological explosion associated with the space race and the revolutionary impact on strategic thinking. As early as 1934, the German army recognized the military potential of space when it funded the development of a rocket to deliver a one ton payload over 200 miles,² but it took the events of World War II to provide the impetus for Germany to develop the V-2 rocket. The first successful launch of the V-2 occurred on 3 October 1942 from Peenemuende, on the Baltic coast of Germany. On that day the V-2 Project Director, Major General Walter Dornberger, issued these prophetic words:

"... To land, sea and air may now be added the infinite empty space as an area of future intercontinental traffic, thereby acquiring political importance. So long as the war lasts, our most urgent task can only be the rapid perfection of the rocket as a weapon. The development of possibilities we cannot yet envisage will be a peacetime task..."³

Although the launch of the V-2 heralded the first military use of space, the real birth of the space age came when man put an artificial satellite into orbit around the earth. This occurred on 4 October 1957 when the Russians launched Sputnik 1. Sputnik 1 gathered upper atmosphere density and temperature information with rudimentary instrumentation sealed in an aluminium sphere weighing 184 pounds and measuring 22.8 inches in diameter. The orbit of Sputnik 1 gave credibility to the earlier dreams and predictions of men, like the famous science fiction writer of the mid nineteenth century, Jules Verne; the Russian philosopher Konstantin Tsiolkovsky (1900s) who conceived rocket propulsion theory; the American inventor Robert Goddard (1920s) who built the first liquid propellant rocket; or even to some Chinese technician who manufactured the first rocket around 1200 AD. The launch of Sputnik 1 marked the first part of Tsiolkovsky's prophesy, "Mankind...will timidly penetrate beyond the limits of the atmosphere." * The door to outer space, and all the potential associated with this medium had been opened.

Most Americans were stunned and shocked by the realization that the Russians had taken the first giant stride off the planet. Until then, the US believed they were world space technology leaders. The launch of Sputnik destroyed that belief. US preconceptions were further shattered on 3 November 1957 when the Russians sent a live

dog into orbit on board the 1,120 pound satellite Sputnik II, and on 15 May 1958 when they successfully launched a well equipped flying laboratory weighing 2,925 pounds on Sputnik III.³

The US response after the launch of Sputnik II was for the President to order the Army to put a satellite into orbit as soon as possible. The Army team led by Doctor Von Braun, of German V-2 rocket fame, successfully placed the US satellite Explorer I into orbit on 31 January 1958. The 18 pound satellite Explorer I was responsible for many scientific advances, including the discovery of the enormous radiation belts around the Earth named after the professor who designed the Explorer's payload, James Van Allen.⁴ In addition, despite earlier failures, a US Navy team successfully launched the Vanguard satellite into orbit on 17 March 1958. The Space race between the two superpowers was well and truly on, a race that still continues today.

Traditional Warfighting Dimensions

Before the space age, there were three accepted dimensions to warfare: land, sea and air. The special physical characteristics of each of these environments greatly influenced the development of doctrines, strategies and tactics of the military forces operating in these dimensions. Airpower is the most recent of these three military dimensions to warfare, but its universal acceptance

has only been cemented during the middle of this century. Earlier this century there was a great debate on whether airpower was anything more than a marginally useful adjunct to land and sea forces. For example, on 7 August 1913, the US Assistant Secretary for War, Henry S. Breckenridge said:

"Military aviation is merely an added means of communications, observation, and reconnaissance which ought to be coordinated with and subordinate to the general service of information and not erected into an independent and uncoordinated service." 7

Today, nobody would seriously argue that airpower is not a unique military dimension. The impact of airpower on the application of land and naval power as well as the impact of airpower in itself has been well illustrated since World War I. Acceptance of airpower came slowly, and it took the unflagging efforts of airpower champions such as Billy Mitchell (1879-1936), Giulio Douhet (1869-1930), Alexander de Seversky (1894-1974) and Lord Trenchard (RAF Chief of the Air Staff, 1919-1929), plus the lessons of two world wars and several smaller wars to overcome the narrow and short-sighted vision of many military "experts".

Emergence of Space Power

Space power, as the newest dimension of military warfare faces many of the same problems that an emergent air power faced in its formative years. While there is no shortage of space theorists and experts, much of space strategy is driven more by technology and its rapid changes

rather than practical examples. In short, no war has yet been fought in space, so space power like air power in its earlier years, has yet to find an unchallenged niche in military thinking or strategic theory. There is no universal agreement or accepted conventional wisdom on the many ways to employ space assets; for example, whether to use them in cooperation with surface and air forces or whether to use them independently.⁸ Consequently proponents of space power have trouble convincing the traditionalists on the utility of using space in lieu of traditional tried and true methods. Not only has space power suffered because of the difficulty in gauging its utility compared to traditional forces, but it also competes in a three way struggle for survival among existing Services who wish to control space assets. As an example of the difficulty faced in coming to terms with space doctrine, in 1958 General Thomas D. White, then USAF Chief of Staff, introduced the term aerospace as a means of conveying his belief that air and space were inseparable entities. He said:

"The aerospace is an operationally indivisible medium consisting of the total expanse beyond the earth's surface. The Air Force comprise a family of operating systems-organizations, ballistic missiles, and space vehicle systems. These are fundamental aerospace forces of the nation." ⁹

Today the term aerospace is a familiar and well accepted term used by military and civil authorities alike. Yet the very existence of the term continues to muddy the

waters on the fundamental difference between air and space. Air and space are not the same. The physical characteristics of space are as least as distinct from air as the air is from land or sea, and these distinctions as much as anything else drive the conclusion that space is not just a continuation of the air warfare environment but a separate military dimension.¹⁰ Parochial thinking from all traditional military services must give way to a more enlightened approach to ensure space power can make the maximum contribution to national security. This can best be done in the same way that air, land and naval forces make their optimum contribution to national security - as separate specialist Services. For space power, a similar logic prevails, a separate service is necessary because space is a unique military dimension requiring unique strategy, doctrine and tactical application.

What Makes Space Unique

Three factors separate space from any other dimension of war; the environment, operating characteristics of space systems and capabilities of space forces. The space environment is characterized by global coverage, vast distances, orbital flight, weightlessness, free access, and no legal or physical boundaries.¹¹ Space systems are characterized by their endurance, range, exceptionally high speed, requirement to work in a vacuum, difficulty of

reconfiguration once in orbit, pervasiveness and technical sophistication.¹² This combination of unique environmental and operational characteristics of space systems result in capabilities that cannot be duplicated by other forces. Such capabilities include: free access to overfly any terrestrial location; instant linkage or connectivity between diverse locations due to their global coverage; ability to be deployed to high global vantage points; relative security because of their distance from earth, orbital velocities and high cost to attack; and their ability to collect, process and relay large volumes of data faster and more efficiently than any other system.¹³

Each of today's space faring nations have developed or are developing their own space philosophies. In particular, the US and Soviet space programs show very different philosophies to the use of space, a manifestation that probably reflects the fundamental differences in their political and social systems.

US Space Philosophy

American planners have generally viewed space as "a sanctuary unsullied by military interactions" ¹⁴ and as offering a medium for communication and transportation. The current US space policy is detailed in National Security Decision Directive 42 (NSDD-42), publicly announced by President Reagan on 4 July 1982. In short:

NSDD-42 reaffirms a national commitment to the exploration and use of space in support of the national well-being... strengthening US security, maintaining US space leadership, obtaining economic and scientific benefits through space exploration, expanding the investment and involvement of the US private sector in civil space and space related activities, promoting international cooperative activities in the national interest, and cooperating with other nations in maintaining the freedom of space for activities that enhance the security and welfare of the entire human race. ¹⁵

Soviet Space Philosophy

The Soviets on the other hand view space as a fundamental strategic operating medium, providing unparalleled opportunities and fulcrums for applying national power to achieve permanent advantage.¹⁶ From 1979 to 1983, the Soviets spent an average of 1.5 per cent of their GNP in support of space activities. The US on the other hand averaged only 0.35 per cent over the same period.¹⁷ Today the Soviets have nearly 150 active or reserve satellites in orbit. Of these, 70 per cent have a purely military function and another 25 per cent have a dual military/civil function. Thus 95 per cent of Soviet satellites are in the military arena.¹⁸

To put Soviet activities into perspective, in 1987 they achieved their 2,000th space mission - this was over 1,000 more than the rest of the world combined. In 1987, the Soviets reached Earth orbit 95 times with 116 payloads while the US, China, Japan and the European Space Agency together

could muster only 15 space flights.¹⁹ Clearly, the Soviets view space as geopolitical high ground and have grasped the military advantages that will accrue to the nation that can gain and maintain control over space. This is reflected in their military doctrine that holds that, "space - a fourth military environment - is critical to the success of forces in the other three environments - land, sea and air." ²⁰

Other Nation's Space Programs

After the two main superpowers, there are many other nations involved in space activities. China, France, Great Britain, Japan, Federal Republic of Germany, and India all have large indigenous space programs. In addition six European countries (France, Federal Republic of Germany, Sweden, Italy, The United Kingdom and The Netherlands) have formed the cooperative European Space Agency (ESA).

After the two superpowers, China rates as the third ranking space power.²¹ China's activities in space began in the late 1950s and was primarily aimed at building ballistic missiles for defence purposes. Their first artificial satellite, the Dong Fang Hong, was successfully launched on 24 April 1970. Since then China has a total of 21 successful launches; 18 into low earth orbit (LEO) and 3 into geosynchronous orbit.²² Their indigenous advances in space technology have long been a source of national pride

and an important aspect of the country's national defence program.

France has been mainly active in the civilian use of space, however, this emphasis is changing. The French have recently initiated three large programs to exploit the military use of space. They are the development of space reconnaissance systems (Helios) and of space telecommunications (Syracuse I) - both for use in the early 1990s, and the study and perfection of a space surveillance network.²³ Because of massive increases in defence expenditure for space, from 1995 on, French military involvement in space would, "take precedence over every other form of civil, scientific and commercial activity in space." ²⁴

India is also spending large amounts of money on a sophisticated space program. India's policy is to use the high technology associated with their space program to help solve the country's social and economic problems, and at the same time to strengthen its international position. Although India eschews the military use of space, Satish Dhawan, the former Indian head of the Department of Space said; "...any country which can place a satellite in orbit can develop an intermediate range ballistic missile." ²⁵ Thus, because of the inherent civil/military duality of many space roles and systems, India's growing space program will

acquire the option to use space for defence purposes, which would also strengthen their eminent political position in South-East Asia.

Japan also has a strong indigenous space program which has developed steadily since 1970 when they launched their first satellite, "Oshumi" into orbit. Japanese space policy is specifically oriented to only the peaceful use of space. Japan's Consultative Committee on Long Term Policy published a report in May 1987 which said:

Japan's space development must proceed solely for peaceful purposes, to build immediately the technological basis capable of executing autonomous space activities, and to extend international cooperation positively, in a manner suitable to Japan's role as an advanced country.²⁶

Clearly there is a great divergence among countries in how they approach the question of space use. Whether a nation's policies reflect the use of space for peaceful or military purposes the net effect on the hardware (satellites and space facilities) can be very similar as many civil and military applications are essentially the same. The main difference between civil and military applications is the way that the assets are used for combat rather than the technology and design of the system.

Military Space Functions

Military space functions can be considered to fall into four broad functional categories; space support, force enhancement, space control and force application. Only in the active military combat roles of space control and force application do the civil and military functions of space markedly diverge. The following diagram (Figure 1) shows the relationship between the various military space functions.

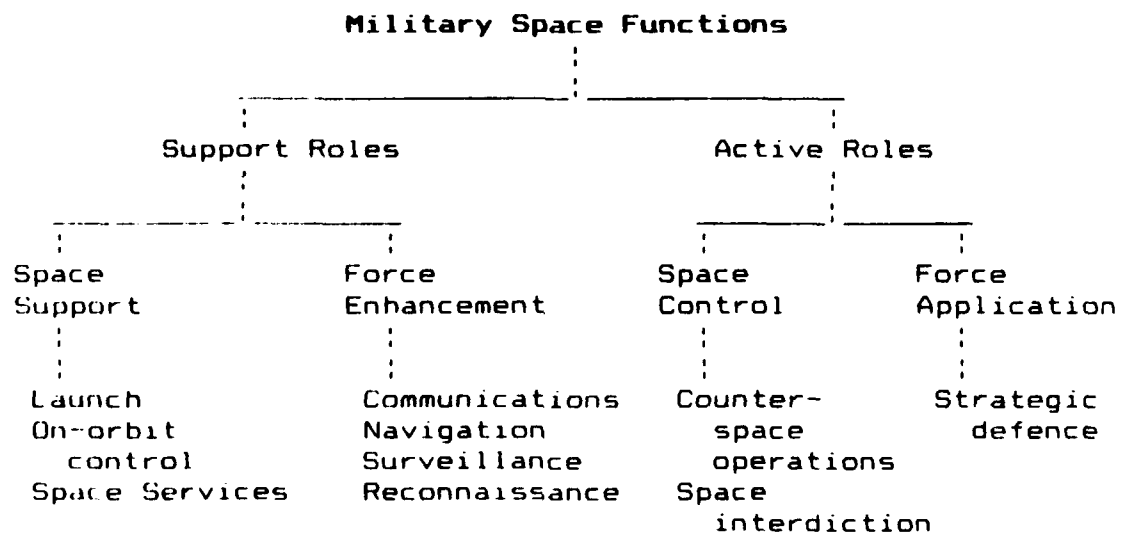


Figure 1.

Space support functions are those required to deploy and maintain military equipment and personnel in space. They include activities such as launching and deploying space vehicles, maintaining and sustaining space vehicles while on orbit, and recovering vehicles if required.²⁷ Other facets

include research and development, maintenance and repair, refuelling, satellite telemetry, tracking, and commanding networks, launch sites, and a command and control infrastructure to support space activities. Force enhancement functions are those space related support operations conducted to improve the efficiency and effectiveness of both terrestrial and space based forces.²⁸ Force enhancement includes such capabilities as communications; navigation; intelligence/surveillance; mapping, charting and geodesy; environmental sensing, reconnaissance and search and rescue.

The active combat roles of space are space control and force application. Space control functions consist of operations that ensure freedom of action in space for friendly forces while limiting or denying enemy freedom of action. This includes satellite defence and anti-satellite operations. Satellite defence requires that space systems are designed, developed and operated to ensure the survivability and endurance of their critical functions.²⁹ Force application functions consist of combat operations conducted from space.³⁰ This includes strategic defence such as ballistic missile defence.

The space combat functions of Space Control and Force Application are not serious contenders in the Australian environment. Although this policy may seem short sighted to

military planners and strategists, the situation is a product of Australia's benign geopolitical environment and limited finance. The reason for this policy and the implications for the future use of space in the Australian environment are discussed further in Chapter IV.

CHAPTER IV

SPACE POWER IN THE AUSTRALIAN ENVIRONMENT

"There are three types of companies:
those who make things happen; those who
watch things happen; and those who
wonder what happened."

Anonymous¹

History of the Australian Space Program

In the early 1950's, Australia was host to one of the world's busiest rocket ranges at Woomera, situated at latitude 31 degrees south and some 500 kilometers north-west of Adelaide. The site was jointly developed in 1947 by the British and Australian governments to launch rockets associated with several defence missile projects as well as a number of small sounding rockets. The desert launch site at Woomera allowed missiles to be launched in a north-westerly direction and tracked over 2,000 kilometers of virtually uninhabited land. During the 1960s, the European Launcher Development Organization (ELDO) conducted 10 launches from Woomera before moving operations to Kourou in French Guiana in 1970.²

The only two satellite launches from Woomera occurred in 1967 and 1971; in 1967 a US Redstone rocket launched an Australian research satellite named WRESA1 for the Weapons Research Establishment, and in 1971 a British rocket

launched the satellite Prospero. The 1970s saw a steady decline in the workload at Woomera, the low point coming with the British withdrawal from the range in 1976. Since then, Woomera has seen very little military rocket activity.

Current Space Program

The current Australian space policy in the civil sector has been heavily influenced by the Madigan Report which was published in 1985. The Report, entitled "A Space Policy for Australia," was developed by a working party from the Australian Academy of Technological Sciences. The government accepted the thrust of the Report's recommendations, particularly;

... the need to formulate a national space policy; the leading role the government has to play in helping to develop space science and technological capabilities; identification of ground sector activities and remote sensing technologies as areas of immediate potential; and the important role of international cooperation.³

An Australian Space Board within the Department of Industry, Technology and Commerce was formed to oversee the national space program. The Board aims to encourage greater involvement of Australian Industry in space research and to promote development of industries based on space technologies. In 1986-87, \$5.25 million was allocated for the following projects: feasibility studies with NASA and ESA on an orbiting satellite; work on detectors for a space telescope; and work on a ground station for a new generation

of European resource satellites.⁴ One of the beneficiaries of the new space policy was the minor resurgence of activity at Woomera with both NASA and West German sounding rockets being launched to investigate the newly discovered Supernova, 1987A.⁵

However, why was the essentially military facility at Woomera allowed to fall into disuse over the years, only to be reactivated by a civilian launch program? Why were the skills and experience gained in the technically demanding and expanding field of space launch and control allowed to deteriorate? I believe part of the answer lies in the Australian government's attitude towards the military use of space and part lies in the lack of recognition of the military dimension of space by the ADF. Each of these factors is discussed in more detail in the following paragraphs.

Government Attitude to the Military Use of Space

The Australian government has consistently called for a halt to the arms race in space. They have used political and diplomatic initiatives as well as many public statements to actively encourage the use of space only for peaceful purposes. The government's attitude towards space was clearly reflected in the votes by successive Australian delegations at the 1984 and 1985 United Nations General Assemblies supporting resolutions calling for "early

negotiations towards international agreements to prevent the extension of the arms race to space." * This is probably one reason why the use of Woomera as a proving ground for military rockets has continued to decline, as it ran counter to Australia's belief that space should be used only for peaceful purposes. On the other hand, there is a prima facie argument that the continued presence of the US space tracking facilities at Pine Gap and Nurrungar is inconsistent with this policy of limiting the arms race in space. However, the government maintains that the continuation of these facilities provides a stable deterrence as they contribute to world peace through monitoring and verifying arms control agreements.⁷

The Australian Foreign Minister, Mr Bill Hayden stated at the 1984 and subsequent Conferences on Disarmament that a strong policy on the reduction of anti-satellite and anti-ballistic missile systems should be adopted. He believes both systems pose a threat to strategic stability. The anti-satellite systems because they threaten satellites and their associated ground stations that enhance strategic stability and/or monitor arms control agreements. The anti-ballistic missile systems because if the use of such defensive systems became widespread, there is a risk that the unsettling effect on the strategic balance could greatly complicate the task of reaching agreement on reducing offensive weapons.⁸ For these reasons the Australian

Government does not support either the US Strategic Defence Initiative (SDI) or the corresponding Soviet Research program, and has declined a US offer to participate in SDI research. Thus the Australian Government is sending a strong signal to the world that it is opposed to the arms race in space.

In view of these stated policies the government is clearly against any use of space for the active military roles of space control and force application. Space control consists of counter-space operations which includes the use of anti-satellites (ASATS), satellite defence systems and space interdiction, and force application consists of strategic defence through ballistic missile defence and combat operations using space based lasers, particle beams and kinetic energy weapons.⁹ Consequently, if the Australian Defence Force is going to use the military dimension of space, it will probably be curtailed to space support roles such as force enhancement through communications, navigation, surveillance and reconnaissance. The government has already tacitly agreed to the use of space for "peaceful" military purposes by accepting the military use of satellite communications, particularly on the dedicated DEFAUSSAT,¹⁰ and use of GPS NAVSTAR for military navigation and secure position fixing. Although satellite communications and navigation have civil application, the powerful force enhancement attributes of these space

facilities makes them, in effect, a powerful military weapon in space.

Lack of ADF Commitment to Space

I believe the lack of commitment by the ADF to the military use of space assets stems from three causal factors. Firstly, there is no advocacy base for space in the ADF. There is no Space Command or a specialist space directorate in the Department of Defence as there is in the United States, nor is there a strong industrial lobby group pushing the government for the manufacture of military space assets. Secondly, there is no organizational hierarchy for space specialists in the ADF, especially at the policy making level. Consequently, while there are a few technical specialists at the lower ranks, there are no organizational or personal motivators to advance or develop policies for an overall strategy for the military use of space. Finally, there is no overt government commitment to the necessity or advantage of using space. The only mention of using space for military purposes in the White Paper is in the context that an adversary would need to use the wide area surveillance capabilities of satellites for effective interdiction of Australian trade in open ocean areas.¹¹ A fair assessment, but what about the same potential that would accrue to the ADF if they had such space assets?

This apparent ambivalence towards the use of space on the part of the government inhibits the formulation of an unambiguous military doctrine on the use of space and severely restricts the full and effective utilization of an important dimension to the defence of Australia. In the nineteenth century, Clausewitz considered that popular uprisings were a new form of warfare. On this issue he observed that, "Any nation that uses it (the new form of warfare) intelligently will, as a rule, gain some superiority over those that disdain its use. If this is so, the question only remains whether mankind at large will gain by further expansion of the element of war." ¹² The parallel with the current attempts to deal with the concept of space power is obvious. On one hand the Australian government is pursuing a desirable policy for demilitarizing space while on the other tacitly supporting the limited military use of space by the ADF. The problem with this situation is that the goal to demilitarize space is not universally supported by other nations. The reality of the situation is that space has been militarized for the past 30 years and Australia must accept that space can be used for both peaceful research purposes and for effective military purposes in the defence of Australia. Thus, in the first instance, defence planners must be allowed to consider the use of the full range of space options that effectively enhance the existing conventional forces and provide what

might be the crucial edge in any level of conflict.

Secondly, and more importantly, defence planners must incorporate the dimension of space into the overall strategy for the defence of Australia and recognize that the use of space assets can be a potent force multiplier.

Force Enhancement Capabilities from Space

ADF conventional forces can enhance their preparedness and effectiveness through the use of a range of space capabilities such as communications; navigation; intelligence/surveillance; mapping, charting and geodesy; environmental sensing, reconnaissance and search and rescue. This list of space capabilities is not all encompassing, but it does provide an indication of the range of systems that would be most suitable for Australia's remote location and in accord with current defence posture. The potential benefits and future capability that the ADF could accrue by using a range of satellites to enhance terrestrial forces will be discussed in more detail. While I will concentrate on the military applications, the reader should be aware that these systems have an inherent duality of purpose, ie. for both the military and civil applications. For example, in the civil sector there are nine commercial satellite communications systems for domestic purposes and over 500 transponders in use. There are many other global, regional and domestic satellite communications systems belonging to:

INMARSAT, ESA, ARABSAT, MOLNIA, Canada, Mexico, Brazil, Japan, PRC, India, Australia, Indonesia and France.¹³

Remote sensing satellites can also be used for a diverse range of civil applications from weather forecasting, mapping, geodetic surveying to crop, fishery, forestry and mineral forecasting.¹⁴

Communications

Satellite communication systems already provide significant support to military forces worldwide. Most of these satellites are either in geosynchronous or molniya¹⁵ orbits above the earth and provide reliable, worldwide, high capacity, secure voice and high data rate communications. The US military currently places a heavy emphasis on satellite communications systems that carry the bulk (about 70%) of the US military strategic communications traffic and a significant portion of tactical traffic.¹⁶ The Soviets, with the world's largest landmass, are also highly dependant on satellite communications systems. To bridge a country that spans half the globe, the Soviets have found satellite communications to be "three times cheaper than radio relays and they can be built ten times more quickly."¹⁷ Nearly one half of all operational Soviet satellites are devoted to communications missions.¹⁸

The ADF has also recognized the utility of satellite communications and plans to lease a transponder on the

AUSSAT B satellites due for launch in 1991 and 1992. This system will be known as DEFAUSSAT and will form part of the ADF Defence Integrated Secure Communications Network (DISCON) to augment and improve survivability of existing links between major communications centres currently using High Frequency (HF) circuits and telecommunication landlines. However, space communications should play an even greater role in Australia's defence. The basic strategy for Australia's defence places heavy emphasis on integration of army, navy and air force operations. This integration and joint services approach at both the strategic and tactical levels relies heavily on the rapid exchange of information to support timely decision making. Fundamental to this approach is an effective and well functioning command, control, communications and intelligence network. Australia's vast area of military interest and limited support infrastructure throughout the bulk of the area makes it imperative that the ADF develop the use of space communications at all levels. The importance of this development must not be played down or ignored. Significant portions of the C³I process, such as communications for coordination, surveillance and warning, can be conducted more efficiently, and often at much lower cost, from space than by any other means.¹⁷ Thus satellites can provide highly efficient command and control networks for use in the whole spectrum of military conflict.

The strategic advantage and force enhancement provided by satellite communications gives today's military commanders added advantages only dreamed of 30 years ago. For example, satellites capable of transmitting blue-green laser light can communicate with submarines at operational depths without impairing their flexibility or their positions,²⁰ thus providing a commander the capability to communicate directly at any time with all his submarine assets.

As few as four geostationary satellites can provide a commander with worldwide, instantaneous, secure communications coverage.²¹ However, a problem with current generation communications satellites is their vulnerability to electronic jamming from anyone in their extensive fields of view. But improvements in satellite antennas and radio transmitters will soon permit a shift to extremely high frequencies (EHF) which will enable communications signals to be focussed into narrow beams and switched to different locations on a prearranged schedule. Since a potential jammer must be in the beams footprint to effectively intercept or jam communications, EHF technology will significantly reduce satellites' vulnerability to electronic countermeasures.²²

Navigation

Space also provides the medium for operating worldwide navigation systems that enhance the utility of ground, sea and air forces by providing accurate positioning and navigation information; for self location, over-the-horizon targeting and, steering directions to name only a few. The most recent system available is the NAVSTAR Global Positioning System (GPS)²³ which provides a passive, all weather, jam resistant, continuous operation space based radio navigation system. The ADF is already committed to an acquisition program for GPS terminals that will provide highly accurate worldwide three dimensional position/location as well as velocity and time information.²⁴ Terminals on ships, aircraft, vehicles and in manpacks can be located with a spatial accuracy within 15 meters, velocity accuracies of 0.1 meters per second, and timing accuracies within a millionth of a second.

The capabilities provided by GPS will enhance the combat effectiveness of terrestrial forces in so many ways that many are only just beginning to be realized. In the future, the use of GPS or a similar satellite navigation systems will become so pervasive that they will form an integral part of nearly every combat scenario. Examples for the use of GPS are virtually only limited by the imagination. For example, GPS provides the navigation

capability needed to precisely fix target positions for accurate artillery and naval gunfire support,²³ and over the horizon targeting of missiles such as Harpoon. GPS could enhance the effectiveness of "smart" weapons by providing a memory of exactly where the first weapon fell and allowing other weapons to home in on the target despite adverse conditions such as haze, smoke, flying debris or airborne sand particles. The accuracy and portability of GPS terminals will allow dispersed forces to group in a precise location and at a precise time for a concentration of mass without any radio frequency (RF) emissions to betray their positions.

In a range of scenarios, the accuracy of GPS has already proved to be a powerful force multiplier by allowing: helicopters to make full instrument night landings within a few feet of a designated spot; aircraft to refuel from tankers without the need for any other aids; supplies to be parachuted to within 30-40 feet of a ground marker; an 80% increase in first hit probability of direct and indirect fire weapons; and blind bombing at night with conventional bombs to within 10-20 feet of target center.²⁴

To the Navy, the real improvement that GPS will provide is the ability for ships to determine their location at sea as well as the location of targets through differential offsetting techniques. Ships will be able to rendezvous,

manoeuvre, and navigate with a minimum of communication in all weather conditions thereby greatly enhancing warfighting potential. The Soviets will have a capability similar to GPS with their Global Navigation Satellite System, GLONASS. These capabilities will have a major impact on future naval strategies,²⁷ and indeed on strategies across the whole range of weapons systems and operating mediums.

Intelligence

Intelligence gathering or surveillance from space refers to monitoring of a particular area, activity, or frequency band. The intelligence function especially benefits from the use of space as large amounts of intelligence data collected from a wide range of sources can be transmitted quickly and accurately direct to military commanders in remote locations.²⁸ Information can, for example consist of a mixture of reports; digital imagery, SIGINT and ELINT, all provided quickly and in a package tailored to the needs of the particular commander. For example, one of the many facilities available on the current LANDSAT system is its ability to discriminate among different wavelengths which is a capability not available from other sources. Thus Australian defence planners could obtain near real time information on shoals and anchorage areas for the Navy; and vegetation, terrain, location of ground water, and lines of communication for the Army.

However, LANDSAT normally has limited near real-time capability due to processing requirements at the receive station and its 16 to 18 day earth coverage cycle due to target revisit times.²⁹

Low earth orbiting satellites make ideal platforms for collecting communications intelligence. For example, at 400 Megahertz, the US Argos satellite in a circular orbit of 800 kilometers can now detect and track to within 1.75 kilometers, a transmitter that radiates only one watt of power.³⁰ This presence of such a capability could work to advantage in two ways; either by forcing enemy commanders to adopt strict emission control procedures that might impair efficiency, or it can allow the collection of valuable intelligence data.

Surveillance

Satellite surveillance sensors fall into four broad categories: imagery or optical, infrared, multispectral and radar. In the first category, NASA has already flown a Large Format Camera with a 10 metre resolution.³¹ In clear weather and in daytime, this resolution would permit identification of frigate sized ships at sea by type. Infrared sensors, on average have three times worse resolution than imagery sensors. In clear weather and less than ideal lighting, these sensors should still be able to type and identify small surface combatants. Multispectral

sensors such as those on the French SPOT satellite with its 10 metre resolution has a similar capability to both the imagery and infrared sensors, but with the added capability of far-infrared which could corroborate identification made through other wavelengths. The use of these types of sensors would provide Australia with early warning of potential enemy force concentration, force disposition and force make-up.

Surveillance from space based radar systems also has a tremendous potential for force enhancement. Such systems could be useful to Australia by aiding air defences through augmenting existing radar coverage, by changing orbit to fill in critical gaps in existing coverage, and by providing strategic warning of enemy air and surface activity. A space based radar also has great application for civil air traffic control, surveillance of illegal fishing in territorial waters and detection of illicit drug trafficking. Technology exists for such a system, but high costs may demand that it be shared among several nations.³² The existence of space based radars would provide a potent force multiplier and play a large part in shaping future defence strategy.

Environmental Sensing

Environmental sensing from space provides meteorology, oceanography and mapping support. Accurate knowledge of the weather has always been a key to military operations, and space based weather satellites are the only means of obtaining data to accurately predict the weather more than 24 hours into the future.³³ Recent examples where the value of weather information as a force multiplier occurred in the Falklands campaign. British after action reports from this campaign emphasized strongly that wide area satellite coverage, with precise meteorological and oceanographic data and forecasts were critical to the success of military operations.³⁴ Mapping support from space can also provide vital information at all levels of military operations. Satellite systems such as LANDSAT or the French SPOT can be used to generate reliable and up to date maps and charts of regions of interest that would be denied by other methods.

The use of an oceanographic satellite would be particularly useful in the Australian environment to enhance the effectiveness of the ADF's Anti-Submarine Warfare (ASW) forces which have to operate over vast ocean areas in the region. An oceanographic satellite such as the proposed US Navy Remote Ocean Sensing System (N-ROSS) or the Soviet Ocean R series with side looking Synthetic Aperture Radar (SAR) would provide a major enhancement for existing

maritime and ASW forces. Firstly, it would allow a more effective use of ASW aircraft by detailing areas where buoy washover and high ambient noise would nullify their systems; it would provide a precise ocean map showing the surface position of ocean fronts and eddies which would allow ASW platforms to select the appropriate tactics, lay more effective sonobuoy patterns and generally waste less time searching the wrong areas; and provide information to allow submarines, ships or convoys to hide in acoustically complex waters or adverse weather.³⁵

Search and Rescue

Space can also be used for search and rescue. No longer do downed airmen or drifting lifeboats have to rely on line of sight radio signals. A constellation of three satellites, such as the combination of the Soviet COSPAS and US SARSAT, can provide almost global coverage, continuous monitoring of emergency frequencies and locate distress beacons to within one or two nautical miles.³⁶ Future collaboration with Japan, France, Canada, Brazil and other countries will expand SARSAT for global coverage and more precise position fixing.

The Australian Threat Environment

To understand how and when space assets could be used in the Australian environment, the reader must understand what type of threats that the government expects in the region. As outlined in Chapter II, Australia's stable political situation and enduring physical and demographic features create the illusion of a benign threat environment. The most credible contingencies that Australia could face are low levels of conflict that could arise in the short term. Any high intensity conflict would require long lead times, concentration of large amphibious forces and provide clear warning signs. The 1987 White Paper stated that: "No regional country now has the capability - nor the motivation - to sustain high level military operations against Australia." ³⁷ While this belief is still essentially held, several recent destabilising events in the south-west Pacific, namely two coups in Fiji, disturbances in New Caledonia and political instability in Vanuatu, have led to a re-examination of strategic defence thinking. The Australian Defence Minister, Mr Beazley has recently announced a new assessment that; "intervention of a foreign power in the south-west Pacific could not be ruled out in the next 25 years.",³⁸ and that "Australia would militarily intervene anywhere in the region if Australian citizens were in trouble." ³⁹ Mr Beazley named China, Japan, India and the Soviet Union as being the major powers with the

potential to interfere in regional affairs if they consider their interests threatened.⁴⁰

The White Paper identifies three levels of conflict, short of global war; low level conflict, escalated low level conflict and more substantial conflict. Low level conflict includes; "The use of military force to harass remote settlements and other target in northern Australia, off-shore territories and resource assets, and shipping in proximate areas, ... to force political concessions over some disputed issue." ⁴¹ Escalated low level conflict would be similar to low level conflict, but harassment and raids would be at a higher frequency and intensity. Enemy units would be prepared to directly confront Australian forces. "The limits of escalated low level conflict would be set by the capabilities that could practically be brought to bear against Australia's interests."⁴² Because of Australia's dependence on shipping for overseas trade, interference or interdiction of shipping in coastal waters or at strategic chokepoints is seen as a practical option for any adversary and could occur throughout the spectrum of conflict. Finally, more substantial conflict is the euphemism in the White Paper for the invasion and subjugation of mainland Australia,⁴³ although I believe the invasion and subjugation of Australian offshore territories or protectorates should also be included in this category. In this context the

alliance with the US is vital as it provides a measure of insurance against higher levels of conflict.

Use of Space in Various Levels of Conflict

Colin Gray has said, "The unique strategic characteristics of a particular weapon are of little interest if those characteristics are undesired for deterrent effect or for actual performance in combat."⁴⁴ In the Australian region, the presence of space assets would provide an effective deterrent; deterrence being defined as the product of capability and will.⁴⁵ Space assets would certainly be strong and credible enough to increase the capability aspect of the deterrence equation. The force multiplier effect on terrestrial forces and the presence of a surveillance and overflight capability not available in any other fighting dimension would provide the ADF with a military enhancement that would cause an aggressor to think twice before attacking Australia.

Space based assets can provide significant support to military operations throughout the whole range of possible conflict contingencies; from peacetime and times of increasing tension through to conflict involving the attempted invasion of Australia. Table 1 provides a summary, which is by no means exhaustive, but indicative of how space assets could serve the ADF in a range of credible threat conditions.⁴⁶

Table 1.

<u>Condition</u>	<u>Possible Situation</u>	<u>Potential Support from Space</u>
Peacetime	Forward deployed forces in Malaysia, Cocos Is and Papua New Guinea	Strategic warning. Communications, Navigation, Weather, Surveillance
Increased Tension or Special Ops	Potential for limited military operations	Same as peacetime plus near real-time tactical warning
Low level Conflict	Enemy forces harassing remote settlements, ship-ping and outlying territories	Global communications, Weather & Navigation tailored for theater of operations. Surveillance, Intel-ligence and Reconnaissance with C ³ Support.
Escalated Low Level Conflict	Conventional but still limited mili-tary operations. Increased air & sea harassment, frequent & intensive raids. Direct military confrontation.	Same as for low level. Increased importance of near real-time tactical warning.
More Substantial Conflict	High level military operations. Attempt by enemy to secure lines of approach & invade Australia, and/or Invasion of Australian Protector-ates/Territories.	All systems on full wartime support across all missions. Total coverage of all appro-aches to Australia.

Table 1 shows quite clearly that significant support to military operations could be provided from space based assets. The Table is not meant to imply that much of the

same support could not be achieved by other conventional means, but space provides unique advantages both at the strategic and tactical level. At the strategic level, space assets can provide large scale, if not global coverage, and detailed intelligence and surveillance over an adversary's territory that would not be available by other means. The knowledge that Australia would receive such early warning from space of enemy activity in his homeland can provide a powerful deterrent against further escalation as well as providing invaluable warning time for Australia to take political, economic, psycho-social and military counter-measures. At the tactical level, the local commander should be confident of space assets providing: global communications support; precise navigation, position fixing, and weather and timing data throughout the spectrum of conflicts; mapping information; and various degrees of surveillance, reconnaissance and intelligence data tailored to his theatre of operations.⁴⁷

Another advantage of satellite systems is the survivability of both the satellite and the ground station. Only the Soviets have a proven anti-satellite system so the only threat to Australian space sensors would occur in the unlikely event of a direct conflict with the USSR. Ground stations are also inherently survivable as they can be located well away from any potential battle area.

Force Structure Implications

The Dobb Report, which was commissioned by the Minister for Defence as a forerunner to the White Paper, states that the Australian Defence Force should be developed in a way that provides:

..the capabilities necessary to permit the ADF to fulfil its peacetime obligations, to satisfy our need for an independent military capability, and to provide a basis for expansion in the event of deterioration in our strategic circumstances.⁴⁰

Given the preceding discussion on the force multiplier effect of space systems and the advantages of using space in various levels of conflict, the capability that space provides would clearly fall under the guidelines produced by the Dobb Report, the White Paper and many other publications.⁴⁰ However, the real world intrudes. The Australian defence budget is limited to about AUS 6 billion dollars, and when the fielding of a single military satellite can cost up to AUS 600 million dollars,⁴⁰ then something has to give. (For a more detailed discussion on the costs of various space systems, see Appendix 2).

The limited defence budget and the way it is allocated would place the acquisition of any satellite systems in direct competition with terrestrial systems for scarce funds and resources. Thus the implications to force structure are that tradeoffs between some mission areas will become essential. In other words, can space assets do the same job

faster, cheaper and better, or are space assets the only way to do the job?

Consider the question of Australia's limited radar coverage in the area of military interest. What tradeoffs could be made with other surveillance systems like AEW&C and Jindalee OTHR? Could a space based radar provide better coverage at a lower cost per square mile? If space based radar provided complete coverage and improved warning times, FA-18s or F-111s could be more selectively scrambled to intercept incoming targets. Because of the improved coverage provided by space based radar, then less aircraft may be required to fly combat air patrol or reconnaissance missions. Thus, if space based radar provided more effective intercepts, then a tradeoff may involve fewer interceptors or reconnaissance aircraft and/or fewer AEW&C aircraft. The Navy would also benefit greatly from space based radar as their radar horizon would be extended from about 100 miles to a global coverage of their theatre of operations. Thus they could also make resource tradeoffs due to increased effectiveness.⁵⁴ There are many permutations in the tradeoff process and each decision should be based on a combination of national objectives and what can do the job most cost effectively in the Australian environment.

However, the decision to make tradeoffs for military space asset will be difficult in the Australian environment.

for exactly the reason I have discussed in the preceding paragraphs: namely the lack of government endorsement of the military use of space, the lack of an advocacy base for space, a lack of commitment by the military to fully utilize the medium of space, and the absence of an organizational space infrastructure at the policy level. In addition to these drawbacks, there are three other factors that make any future force structure changes and tradeoff decisions with space systems very difficult.

Firstly, space systems are fewer in number, have a higher unit cost, and are subject to different logistic concepts than terrestrial systems.⁵² On the one hand these factors mitigate against combining space forces into any one of the existing armed services, where a small but separate space force trying to compete for scarce resources against the well established tri-service infrastructure might fail to give space an equitable hearing in difficult tradeoff decisions. On the other hand, the division of space forces among the Services would also create problems as existing conventional force priorities would subsume space priorities within each service and difficult tradeoff decisions would be weighted against space systems - Catch 22. A second reason that any tradeoff decisions will be difficult is that the payoffs between space and terrestrial systems are different and hard to compare. As discussed in Chapters II and III, space systems are force multipliers and enhance the

efficiency and effectiveness of weapons systems. However, the force multiplier effect is hard to determine in any quantitative sense, yet budgeting and tradeoff decisions are, by their very nature, quantitative. Finally, tradeoffs can be hard to gauge because the decision for a space system can be all or nothing. Because of the orbital mechanics of space and the limitations of sensors and data transfer, there is a set number of satellites required for a particular job. These numbers cannot be cut back as some terrestrial systems can and still operate effectively. Thus the investment question for space assets is to do the job, or not do it at all.

The implications for force structure are clearly many and diverse. The government and the ADF must accept the existence and advantages of using the medium of space for military purposes and develop a doctrine for space employment and a coherent strategy for its military use. This must be a priority for the next decade. Not to do so will deny the civil sector from fully participating in major technological advances and deny the military sector the use of a potentially vital edge in any regional conflict.

Regional Cooperation

Force structure tradeoffs may not be enough to satisfy the initial capital investment in a military space program. The Australian government would probably need to have a cooperative program with regional allies and friends to defray some of the costs for satellites and ground stations. I believe there are four main options that are viable in Australia's current political, economic and strategic climate. These options will be discussed in what I think are their order of merit in terms of providing the ADF with an effective indigenous space capability.

The first option is to collaborate with New Zealand provided their government and military were interested and willing to use the advantages of space. New Zealand is undoubtedly Australia's closest ally in the region with largely overlapping defence interests and a shared cultural background. It is interesting to note that the 1987 New Zealand Defence White Paper also failed to address the issue of using space assets. Furthermore, New Zealand suffers from many of the same problems as Australia; a small population of about 3.5 million, a small defence budget and large ocean area in the South Pacific as their region of primary military interest. Any range of collaborative force enhancing satellites would easily cover both nations' regions of interest. Thus, although economic assistance

would be small, the enduring closeness of the two countries would ensure the optimum utilization of the benefits from an indigenous space program. Thus New Zealand should be the first option for full regional cooperation in a military space program.

A second option would be for Australia and New Zealand to pursue a tripartite space cooperation program with the US. However, the recent rift in US - New Zealand relations over the nuclear issue may preclude this type of cooperation in the short run. In that case, a bilateral arrangement with the US would still be advantageous to the ADF. Australia and the US are close allies and share many interests in Australia's region, so a common denominator for space cooperation, technology transfer and infrastructure support should be easy to find. Australia already cooperates with US Space Forces at Woomera, so that avenue could be greatly expanded to a fully cooperative military space launch and satellite development program. The use of the smaller and cheaper US LIGHTSATS launched from refurbished sites and facilities at Woomera may be an opportune way for the ADF to take the first steps in a military space program that will greatly enhance the effectiveness of existing conventional forces.

The third option would be for Australia to take the lead in forming a regional space agency similar to the

European Space Agency. For example, Australia, New Zealand, Singapore, Indonesia⁸³ and Malaysia (ANZSIM?) could be prime contenders to form such an organization. The proposed launch site at Cape York would provide a common site for all nations and could be developed into a commercially viable spaceport.⁸⁴ Initial studies indicate that a bare base could be in place at Cape York by 1993 at a cost of AUS\$1.5 billion. The base could have multiple launch pads, a multi-bay space vehicle assembly building, along with a port for handling ships up to 20,000 tons, a 3,700 metre runway, tracking facilities and administration and town facilities.⁸⁵ However, from a military viewpoint there are many drawbacks with this option. To begin, not all the nations in the region have common military interests so the use of any joint satellites or facilities may be open to dispute. Secondly, Cape York is located at the extreme northern tip of Australia so in any conflict the space launch site would be a prime target which would be difficult to defend. Nevertheless, the development of this option primarily for civil interests would provide an impetus to an indigenous Australian space program that would undoubtedly give spinoffs to the ADF through limited involvement, technology transfer, buildup of an industrial base and the military use of civil space assets in an emergency. This option could be pursued in parallel with option two and

provide an integrated space program for both the military and the civilians.

A fourth option would be a series of bilateral arrangements with various nations to cooperate in areas of expertise. For example Australia could join with Canada who are making significant progress with radar satellites, or the French with their high resolution multispectral surveillance satellites, or Japan. Indeed Australia already cooperates with Japan on several space programs such as sharing data from Japan's Marine Observation Satellite (MOS 1), and their meteorological satellite, GMS3.⁵⁴ However, this is a fragmented approach and would not solve the problem of nurturing an indigenous Australian space capability.

The Future

The government and ADF must develop a space policy that looks to the future and provides the optimum benefits for the defence of Australia. In this context, General Schriever's (USAF) observation in 1960 is a prophetic indicator to what the future should hold;

It may be said that warfare has acquired a new phase - technological war. ... Today the kind and quality of systems which a nation develops can decide the battle in advance and make the final conflict a mere formality -or- can bypass conflict altogether.⁵⁷

Using the metaphor from the quotation at the beginning of this chapter, Australia must not be one of those companies who "wonder what happened" when it comes to the military use of the dimension of space. Australia must be in the position to "make things happen", and to do this requires a cogent military space policy and doctrine. Chapter V will outline a framework for formulating an Australian space policy.

CHAPTER V

FUTURE POLICY DIRECTIONS

"Any air force which does not keep its doctrines ahead of its equipment, and its vision far into the future, can only delude the nation into a false sense of security."

General "Hap" Arnold ¹

Military Space Policy

The decade of the 1980s has proved to be a watershed for the Australian Defence Force (ADF). The commissioning of the Dobb Report and the subsequent issue of the Defence White Paper have provided clear policy guidelines for the future development of the ADF. Furthermore, the 1980s have seen the gestation of a newer, more sophisticated and better equipped force than ever before. The acquisition of the new FA-18 Hornets, P3C Orions and PC-9 aircraft; new guided missile frigates (FFGs) and destroyers (DDGs), submarines and fleet replenishment ships; the update of the Boeing B707s to provide air to air refuelling; the purchase of new ESM for the P3C; and the development of Jindalee OTHR provide dramatic testimony to the major modernization program in the ADF. However, as good as these programs may be, they are all aimed at improving the fighting capabilities of the ADF in the conventional dimensions of

land, sea and air warfare. The current defence policy is paradoxically both visionary and myopic. Visionary in that the future policies for land, sea and air developments (whether you agree with the policies or not) have never been more clearly presented, but myopic because the future for the immature, but potentially crucial dimension of space warfare, has not been addressed.

Australia is not alone in experiencing difficulty in coming to terms with a policy for the military use of space. The USA, with over 30 years of space experience remains confused on how it should think about the military uses of space, and how military space activities should affect national military policy as a whole.² In his book Military Space Policy, Colin Gray identifies five reasons why this confusion exists at the policy making level in the USA, and I believe a similar rationale can be applied to Australia's apparent inaction towards the military use of space. Firstly, the use of space adds a new dimension to the art and science of war. The majority of policy makers and defence planners who attempt to comprehend this new dimension are bound by strategic preconceptions and career experience from their current organizational culture and doctrine. Secondly, space activity has grown more in response to a technology push than to an operational pull from military users. Thus military applications tend to be reactive and stem more from what has or is being developed

rather than proactive and addressing what needs to be developed to use and command space. Thirdly, space technology is still relatively immature and there is difficulty sifting fact from science fiction in debate over future policy directions. Fourthly, space policy is too often presented from narrow single service or single user frames of reference rather than a combined national military policy level. This narrow view could be the result of service or departmental parochialism, misguided loyalties or plain ignorance. Finally, although the potential importance of space has long been recognized by policy makers, the tendency has been for minimal policy making. This is understandable in such a technology driven and uncertain environment as space, where military capabilities and the political environment can change at very short notice. The modus operandi of delaying policy decisions as long as possible until uncertainties are resolved to irreducible minima is not irresponsible, but rather a fact of life in the dynamic and uncertain space arena.³ To these factors I would add the Australian government's commitment to the reduction of the arms race in space which also inhibits the formulation of a clear policy on the military use of space. (Chapter IV discussed this aspect in detail)

Given such a scenario for confused, misguided and reluctant policy making, the ADF urgently needs the vision and leadership from senior officers to formulate a simple

overarching national military policy statement that will be endorsed by the government. The policy must recognize the fundamental importance of the military use of space in all levels of conflict and provide a flexible framework to build future doctrine and strategies that ensure the optimum defensive safeguards for Australia. In this context then, what is important in the short term is not so much a precise formulation of military strategy for the use of space, but a policy that can be readily appreciated throughout the ADF of the role that space assets might realistically achieve within the overall framework defence policy.

ADF Space Policy

Given the criteria I have developed in this paper and the difficulty of trying to formulate an all encompassing military policy for the new and challenging dimension of space, I would propose the following guidelines for ADF space policy development. The recommended policy is not meant to be prescriptive, but rather indicative of a desirable framework for future ADF space development towards the year 2000.

ADF SPACE POLICY

Principles

The military use of space can have a decisive influence in the outcome of future terrestrial conflicts. Thus the ADF is committed to integrating the use of space assets into the force

structure and to make the full use of military space capabilities to defend the sovereignty of Australia and her territories.

The military roles of space can be divided into space combat and terrestrial force enhancement. In line with government policy not to bear arms in space, the ADF is limited to the use of space for force enhancement in the short term. However, should conditions change and regional powers threaten the ADF's space assets, then the ADF must have the technological base, trained personnel and infrastructure to expand and execute the full spectrum of military space capabilities. To this end the ADF's use of space requires a strong commitment to research and development programs, and to develop a sound indigenous logistics and industrial base

Many military and civil space assets will have common applications. Because of Australia's large area of interest and limited economy, military and civil space assets should be complementary and cross supporting rather than duplicated.

Space assets must provide land, sea and air commanders at the strategic and tactical levels with responsive, flexible and accurate information to enhance mission effectiveness and success.

Basic Goals

The military dimension of space must be institutionalized within the ADF at all levels. To achieve this:

Develop ADF space doctrine to integrate space operations into the employment of land, sea and air forces. Doctrine should also address the integration of civil space assets.

Organize an ADF Space Command as a new Service to consolidate space system requirements, operations and developments, and provide a cogent and forceful advocacy base. The Command would also be responsible for planning, programming, budgeting, acquisition and support processes.

Expand space expertise throughout the ADF and foster the concept of integrating space support to improve mission success.⁴

Space Doctrine

Once a space policy that embodies Australia's national security objectives is endorsed, then a set of guiding principles to ensure that the policy is executed in the best possible way is required. These principles or maxims that guide the way military forces carry out their tasks in support of national objectives is known as doctrine. Robert Futrell defined doctrine as:

...a compilation of principles and policies applicable to a subject, which have been developed by experience or by theory, that represent the best available thought, and indicate and guide but do not bind in practice.²

The presence of a well articulated doctrine is essential for the coordinated and cohesive implementation of plans to develop and use space assets in pursuit of the national policy. The absence of a military space doctrine would provide no impetus or focus for the generation of military space requirements or for the design of an organization appropriate to plan for and operate space based systems. In other words, whereas policy provides the rationale or why the assets are needed, doctrine answers the question of how the assets will be used.

The derivation of space doctrine will not be straightforward. Space as the newest dimension of warfare has been dogged by doctrinal dilemmas since the launch of the V-2 rocket. To a large extent these difficulties

parallel the doctrinal problems that air power has struggled with over the last 75 years. Proponents of the similarity between sea power and space power, such as Colin Gray, have argued that space campaigning "is more akin to war at sea than war on land or in the air, given the featureless environment and the very small number of truly capital assets." 6 In a similar way, proponents of the similarity between air power and space power have accepted the term aerospace for both air and space forces and ascribed the same attributes of speed , range and flexibility to both. 7 (Chapter III highlights the fallacy of this argument) Finally there are those who say space has no direct analogy to any of the traditional services. 8

Space is a unique dimension of warfare and the method and characteristics of conducting space operations are unique. Consequently it would be a folly to directly apply the long standing doctrines of traditional forces to the new dimension of space warfare. However, this is not to say that much cannot be learnt from the evolution of warfare on land, sea and air. There are many parallels with other doctrines and many lessons to be learnt from their evolution, but these similarities must be applied judiciously and on a case by case basis that takes into account the unique environment of space.

As yet no war has been fought in space, so developing doctrine pertaining to space combat will be largely theoretical in nature rather than the synthesis of years of combat experience. However, experience with space assets as force multipliers is extensive and it is in this area that space doctrine can provide the greatest utility to the ADF within the constraints of government policy objectives. Space assets have been used to provide intelligence (PHOTOINT and ELINT), weather, navigation and mapping information in a wide variety of medium to low intensity conflicts; from Vietnam, the Arab-Israeli Wars, the Falklands War² to the raid by US aircraft on Libya. The experience gained in these conflicts can provide the foundation for a space doctrine applicable in the Australian environment. From a well crafted space doctrine, space organization, force structure and employments concepts should logically and easily follow. To illustrate how I believe the policy, doctrine and strategy process inter-relates, I have developed the model shown in Figure 1.

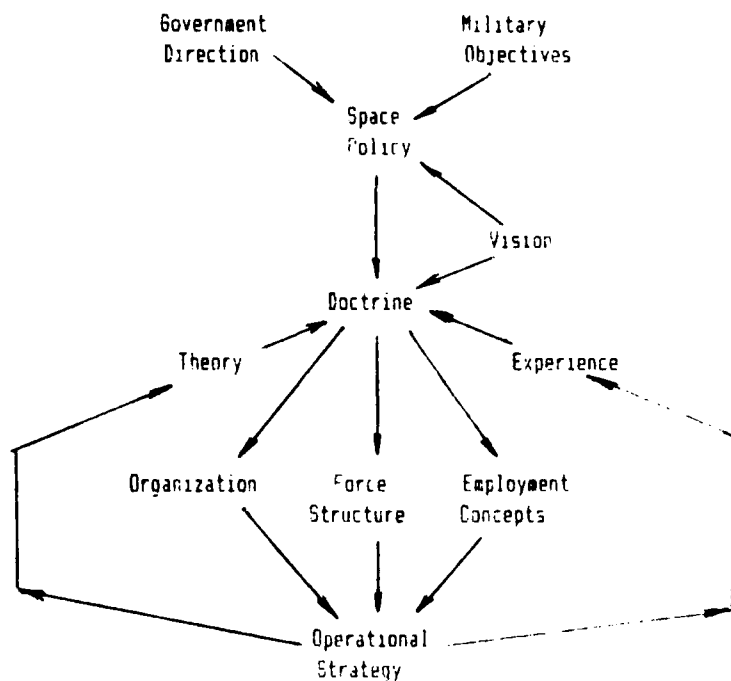


Figure 1. Inter-Relationship of the Policy, Doctrine and Strategy Processes

Writing a prescriptive ADF space doctrine is outside the scope of this paper, however, the development of any space doctrine must answer several fundamental questions. A sample listing of the more salient questions that any ADF space doctrine will be required to answer are as follows:

ADF SPACE DOCTRINE

The Military Use of Space

What are the objectives of the military use of space?

How will ADF space assets be used as a military instrument of national power?

How will space assets be used and integrated with land, sea and air forces, plus civil interfaces?

How will the ADF cope with change in the technically dynamic and relatively immature warfighting dimension of space?

What, if any overlap will be necessary with civil space assets and how will civil assets be used in times of crisis?

Employment of Space Assets

What features make the space environment unique? ie. What are the unique operational, environmental, political, legal and logistic characteristics?

What are the capabilities of Space forces and to what extent will the ADF be prepared to use them in a range of credible contingencies?

How will ADF space assets be employed? For example, will they be used for space combat or terrestrial force enhancement? How will they be used in various levels of conflict and what features will be exploited to provide maximum advantage?

If the Principles of War are the enduring, generalized and highest expression of military doctrine, then how are they applied to the employment of space assets in combat?¹⁰

What will be the specialized missions that the ADF will require of its space assets?

What coherent pattern of employment will be used for space assets to utilize their unique capabilities and provide strategic and tactical advantage for the ADF?

How will the ADF respond to an enemy using space assets (ballistic missiles or satellites) against Australia?

What is the long term goal for the military use of space? Will the goals be technology driven, or driven by visionary military requirements, or a combination of both?

Space Organization

How will ADF space forces be organized, trained and sustained?

How will space forces be organized for conflict in combined and joint operations?

How can a bureaucratic structure that can act as an advocacy base be organized? For example, should space force bureaucracy be a subset of the existing Services or should it be organized and empowered as an equal?

What infrastructure will be required in peace and times of varying tension and conflict?

What emphasis will be put on research and development?

The Challenge

The doctrine that the ADF develops for the use of space must not be so prescriptive to encumber the development or changing role of space assets. Clausewitz echoed these sentiments when he said:

...since no prescriptive formulation universal enough to deserve the name of law can be applied to the constant change and diversity of the phenomenon of war. Principles, rules, regulations, and method are, however, indispensable concepts to or for that part of the theory of war that leads to positive doctrines; for in these doctrines the truth can express itself only in such compressed forms.¹¹

Thus the major challenge facing the ADF in any foray into the space arena is to evolve and promulgate a realistic space doctrine based on: experience from other space users; judicious application of lessons learnt in the evolution of

land, sea and air doctrine; ideas on how space should be used in the Australian environment; and a vision for the future. Only through the understanding and acceptance of such a doctrine can the unique environment of space be effectively exploited by the ADF, and only by employing the full capabilities of space forces in conjunction with land, sea and air forces can the ADF obtain the maximum utility from its defence assets.

CHAPTER VI

CONCLUSION

The main question facing defence planning is how Australia should direct its spending priorities over the next decade so that force structure more demonstrably reflects our unique requirements.

Dibb Report ¹

Australian defence has moved away from an era of forward defence to a strategy of self reliance. An essential part of self reliant defence is to have a force structure that can handle peacetime tasks and credible contingencies as well as the ability to expand without major change to meet the needs of higher level conflict. The use of space represents an integral part of such a force structure. This paper has shown that Australia's unique and enduring strategic circumstances makes the use of space assets, especially as force multipliers, a compelling defence option. Given the vast area of military interest and the limited manpower and financial resources, the use of space in conjunction with other land based force multipliers is clearly the best way to ensure the maximum utility from existing terrestrial assets.

However, the use of space as an effective warfighting medium is still in its infancy and does not have the advocacy base or military champions in the ADF to offset the

inertia and traditional thinking from the proponents of existing forces. Many other nations, especially the Soviet Union have long recognized the prime importance of the military use of space. Even a cursory examination of the Soviet's defence structure, space program and doctrinal writings will indicate the importance of space to Soviet strategy. Perhaps the extreme end of this view is exemplified by a quote from a Soviet author who says:

Whoever can seize control of space - that main area of future wars - will be able to change the correlation of forces so decisively that it will be tantamount to establishing world supremacy.²

This example illustrates how important space can be to a nation's military posture and reinforces the point that Australian military planners cannot continue to overlook the importance of using the medium of space. Vice Admiral Ramsey, USN, has said:

There are hundreds of yet unthought of ways that space based systems can support the land, sea and air commander. These uses will make it possible to economize US forces by transferring some tasks to space systems, which will be on task 24 hours a day, 365 days a year, in peace, in crisis, or in war.³

By addressing the use of space in combination with terrestrial forces, the ADF can provide the optimum balance of forces to meet the range of contingencies in the Australian environment. By not addressing the issue, the ADF is abrogating a trust to the Australian people to

provide the best possible defence for the country within political and economic constraints.

The challenge for the future is for government and military leaders to urgently formulate a coherent national military space policy; a policy that recognizes the need for the military use of space, the dual role of military and civil space systems and provides a vision for the future employment, organization and integration of space assets into Australia's defence structure. The second challenge is to develop a space doctrine, as doctrine is fundamental for the proper use and development of military space assets. Doctrine lies at the very heart of warfare as it represents the integration of beliefs, experience, vision, military theory and national policy for the effective use of man and machine in war.

The lack of perceived threats or bureaucratic inertia must not be excuses for inaction by either the government or the ADF. The challenge for today is to develop space policy and doctrine for the future - for the future defence of Australia rests on the decisions taken today.

Recommendations

Australian defence is at a watershed. Significant strides have already been taken towards fulfilling a coherent strategy of self reliance as detailed in the 1987 Defence White Paper. However, further progress must be made on the issue of the military use of space. This paper has analysed the compelling reasons for the use of space and provided a framework for developing a cogent national space policy and doctrine. However, due to time and source material constraints, this paper has provided only a broad analysis of the key issues that, on balance, strongly support the extensive use of space by the ADF. Because of the long lead times associated with any space program and the importance that space holds for the future defence of Australia, the issues addressed in this paper warrant, and must receive, immediate and more detailed study.

"To have the arts of peace, but not the arts of war, is to lack courage. To have the arts of war, but not the arts of peace, is to lack wisdom." *

Hayashi Razan (1583-1657)

NOTES

CHAPTER I (Pages 1-6)

1. Gen James A. Williams. USA. "The Ambitious Soviet Space Program." Defense/85. February 1985, p. 10.
2. The three major treaties on space avoid an explicit altitude that defines the limit of space. For the purposes of this paper I will use the definition that is accepted by the major space powers in conventional and customary law as; "the lowest perigee attained by orbiting space vehicles as the present lower boundary of outer space." As a rule of thumb this translates to about 100 nautical miles. Any lower perigees cause rapid orbital decay. Space Handbook - AU-18. Maxwell AFB, Alabama, (January 1985), p. 1-4.
3. Countries that have their own space launch capabilities are; USA, USSR, China, Japan, India, France and Israel.
4. General Robert Herres, USAF. "Space Grows in Importance to the National Security." Defense/86. (Nov/Dec 1986), p. 17.
5. Quote from CSIRO Space Science and Applications - Progress Report 1986 contained in the article by; Adigun Ade Abiodun, et al. "Development of an Indigenous Capability in Remote Sensing." Space Policy. (May 1988), p. 123.

NOTES

CHAPTER 11 (Pages 7-17)

1. The Defence of Australia, 1987. A Policy Information Paper. Canberra, 1987, p. 30.
2. Cdre Alan Robertson. "The 1987 Defence White Paper, Moving from Clausewitz to Sun Tzu?" Journal of the RUSI of Australia. Canberra: September 1987, p. 6.
3. ibid.
4. In 1969, while at Guam, President Nixon issued the statement that the US would no longer intervene directly in the defence of allies unless they were confronted by a superpower and had made positive moves for their own self-defence. This policy has been continued by succeeding US governments.
5. These five factors were cited by General Sir Phillip Bennett, Chief of the Australian Defence Force, in an address titled "A Military Strategy for Australia," delivered to the USI of the ACT in Canberra, 4 December 1985. Published in Journal of the RUSI of Australia, June 1986, p. 8.
6. The Defence of Australia, 1987. A Policy Information Paper. Canberra, 1987, p. 1.
7. ibid. p. 31.
8. ibid. p. 2.
9. Deduction made by WgCdr R.N. Kelloway in his Research Paper, "Towards 2000: Directions for Australia's Military Strategy." Maxwell AFB, March 1985, p. 18.
10. ibid, pp. 19-20.
11. The Defence of Australia, 1987. op cit, pp. 90-91.
12. ibid, pp. 99-100.
13. AM J.W. Newham, AO, RAAF. "Air Power in the Defence of Australia." a speech delivered at the Conference on Air Power in the Defence of Australia, Canberra, 14-18 July 1986. Although the comment on the need to use high technology was aimed at the use of air power, it could apply equally well to the use of space power.

14. The Defence of Australia, op cit, p. 31.
15. ibid, pp. 23 and 30.
16. See newspaper article by Peter Terry. "Australia Vulnerable to Falklands-Type War." Australian, 3 January 1989, p. 2.
17. The Defence of Australia, op cit, pp. 24-27.
18. ibid, p. 24.
19. ibid, p. 25.
20. ibid, p. 26.
21. AVM R.A. Mason, CBE. "Current Airpower Developments: A European View." speech delivered at the Conference on Air Power in the Defence of Australia, Canberra, 14-18 July 1986.
22. Space Systems Handbook for Staff Planners and Operators. Prepared by the US Space Command, Center for Aerospace Analysis, 26 January 1988. p. 1.

NOTES

CHAPTER III (Pages 18-31)

1. Quoted by Maj Gen Thomas C. Brandt, in "The Military Uses of Space." Air University Review, November/December 1985, p. 51.
2. Gen Robert T. Herres. USAF. "Soviet Military Use of Space." Signal. December 1986, p. 61.
3. MajGen Thomas Brandt, USAF. "Military Uses of Space." Air University Review, (Nov-Dec 1985), pp. 43-44.
4. Quoted in a research paper by LtCol Abram Sheaffer, USAF. "Growth of United States Space Policy." Naval War College, p. 12.
5. Jerry Grey. Enterprise. New York, 1979, pp. 21-23.
6. ibid. p. 42.
7. Maj Joseph Sutter and Maj Thaddeus Shore altered this quotation by inserting the words "space systems" in lieu of "aviation" to highlight the inevitability of space warfare by looking at the evolution of currently accepted warfighting strategy in new mediums. Military Space Doctrine, The Great Frontier. USAF Academy Military Space Doctrine Symposium, April 1981.
8. The ideas I have developed here for space are the same as the rationale used by David MacIsaac on the emergence of air power in his essay, "Voices From the Central Blue: The Air Power Theorists." in Makers of Modern Strategy, from Machiavelli to the Nuclear Age, edited by Peter Paret. p. 624.
9. LtCol Charles Friedenstien, USAF. "The Uniqueness of Space Doctrine." Air University Review. November-December 1985, p. 15.
10. Col Jan Harvey. "Space: The Fourth Military Dimension." US Army War College, Carlisle Barracks, October 1986. p. 4.
11. These factors were derived from a combination of two sources: Col. Kenneth Myers and LtCol. John Tockston. "Real Tenets of Military Space Doctrine." Airpower Journal, Winter 1988, pp. 58-59., and Major L. Parker Temple III.

"How Dare They Tamper with the Sacred Functions of the Horse Cavalry." Air University Review, March-April 1986, p. 25.

12. ibid, p. 59. and ibid, p. 25. However, I have not used two factors from these sources because I disagree with them. Firstly they quote an inhospitable environment as unique to space, however, I would argue that space is no more inhospitable than working at depths of 1,000 meters for submarines or at speeds of Mach 3 plus for aircraft. Secondly they quote constrained manoeuvrability as unique to space, however, although space systems are usually limited to only a few per cent movement in horizontal or vertical planes, this can translate to several hundred miles of movement which in absolute terms is quite manoeuvrable. Further, space vehicles can rotate on their own axis or point in any required direction. I would argue that this also makes them manoeuvrable.

13. Myers. op cit, pp. 59-62.

14. Brandt. op cit, p. 45.

15. LtCol Curtiss Cochran, et al. (eds). AU-18, Space Handbook, Maxwell AFB, p. 15-7.

16. Brandt. op cit, p. 45.

17. Gen Robert Herres, USAF. "The Military's Use of Space Based Systems." Signal, (March 1986), p. 47.

18. ibid, p. 47. These figures are also corroborated by BrigGen Robert Rankine, USAF. "The Military and Space....Yesterday, Today and Tomorrow." RUSI, (June 1987), p. 8; Although Gen James A. Williams, USA. "The Ambitious Soviet Space Program." Defense/85, (February 1985), p. 10, says about 90 per cent are designed to achieve military objectives ..

19. Nicholas Johnson. The Soviet Year in Space - 1987. Colorado Springs, 1988. p. 1.

20. Williams. op cit, p. 10.

21. Bradley Hahn. "Rising Star in Space Exploration." Pacific Defence Reporter, May 1988, p. 17.

22. ibid, p. 17.

23. Jerome Paolini. "French Military Space Policy and European Cooperation." Space Policy, August 1988, p. 201.

24. ibid, p. 202.

25. Stephan von Welck. "India's Space Policy." Space Policy, November 1987, p. 333.

26. "Japan's Future in Space." edited translation of a report by Japan's Consultative Committee on Long Term Policy in, Space Policy, February 1988, p. 74.

27. Department of Defense Space Policy. Department of Defense Fact Sheet, p. 3.

28. ibid. p. 6.

29. ibid., p. 6.

30. ibid. p. 6.

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CHAPTER IV (Pages 32-63)

1. Philip Kotler. Marketing Management. 1988, p. 33.
2. Mark T. Rigby. "Launch Site Under the Southern Cross." Space World. (June 1988), p. 16.
3. See "Australian Space Program." an extract from the Science and Energy Newsletter, ACT., published in Space Policy, Vol 3, No 2, May 1987, p. 154.
4. ibid.
5. Mark Rigby. op cit, p. 16.
6. Australia and Disarmament: Steps in the Right Direction. Department of Foreign Affairs. Canberra: Australian Government Publishing Service, 1986. p. 20.
7. ibid, p. 20.
8. ibid.
9. Examples and theoretical analysis of these space force application functions can be found in Space Handbook. Air Command and Staff College Handbook, AU-18. Maxwell AFB: Air University Press, Alabama, January 1985, chapters 9 and 12.
10. DEFAUSSAT is a leased communications transponder for defence use on the next generation of AUSSAT (AUSSAT-B) satellites due for launch in 1991 and 1992.
11. The Defence of Australia, 1987. A Policy Information Paper. Canberra, March 1987, p. 28.
12. Carl von Clausewitz. On War. Edited and translated by Michael Howard and Peter Paret. Princeton: 1984, p. 479.
13. Tatsuo Yamanaka and Makato Nagatomo. "Spaceports and New Industrialized Areas in the Pacific Basin." Space Policy, November 1986, p. 345.
14. ibid, pp. 345-347.
15. Satellites in Geosynchronous (GEO) orbits remain almost stationary in near circular orbits above a chosen longitude on the equator. Orbital mechanics dictate that GEO orbits

are about 36,000 kilometres above the earth. Molniya orbits are highly elliptical (400 km by 40,000 km) orbits inclined at 63-65 degrees to the equator. At their perigee, satellites in these orbits remain high over the Soviet landmass and provide 8 hours of continuous communications linkage. As few as three satellites in Molniya orbit can provide 24 hour coverage, although 4 are normally used. The Soviets pioneered the use of Molniya orbits because antennas located in the Soviet far north cannot readily access satellites in GEO orbit without unacceptable signal attenuation.

16. Space systems Handbook for Staff Planners and Operators. Prepared by, US Space Command, Center for Aerospace Analysis. 26 January 1988. p. 9.

17. Nicholas Johnson. The Soviet Year in Space. Teledyne Brown Engineering, Colorado Springs, 1988, p. 34.

18. ibid, p. 34.

19. General Piotrowski, USAF. "C³I for Space Control." Signal, 10 June 1987, p. 23.

20. Mark Peecook. "Space: Tomorrow's Battlefield." Marine Corps Gazette, March 1987, p. 38.

21. Cdr Frederick J. Glaeser, USN. in his article "Space: A New Dimension in Naval Warfare." states that geostationary satellites provide unreliable service above 60 degrees latitude. However, this deficiency can be overcome by supplementing polar communications with low earth orbiting satellites. US Naval Institute Proceedings. May 1987, p. 125-126.

22. ibid, p. 126.

23. GPS NAVSTAR consists of 18 active satellites in orbit, any four of which will be able to give three dimensional fixes of position to accuracies within 15 metres and velocity within 0.1 metres/sec.

24. Space Systems Handbook... op cit, p. 8.

25. LtCol R.J. McNeece. "The Marine Corps and Space Activity." Marine Corps Gazette. June 1986, p. 80.

26. Mark Peecook, op cit, pp. 37-38. To me some of these claimed improvements provided by GPS seem extravagant, but I have not been able to confirm or deny them from other sources.

27. ibid, pp. 45-46.
28. McNeece, op cit, p. 79.
29. Space Systems Handbook... op cit, p. 18.
30. William Howard III. "Future Satellite Capabilities." US Naval Institute Proceedings. April 1988, p. 44.
31. A 10 metre resolution means that two point sources of equal intensity that contrast with the background in brightness can only be separately distinguished if they are 10 metres apart in a direction perpendicular to the line of sight. William Howard III, op cit, p. 44.
32. Brig Gen Robert R. Rankine. "The Military and Space... Yesterday, Today and Tomorrow." RUSI. June 1987, p. 8.
33. "Space: Force Enhancement." Seminar notes from Air War College Department of Aerospace Doctrine and Strategy, 1989, p. 10.
34. Rankine. op cit, p. 8.
35. David Honhart. "N-ROSS: A New ASW Dimension." US Naval Institute Proceedings, September 1987, pp. 112-113.
36. See McNeece. op cit, p. 80. In another article by Mark Peacock, op cit, p. 38, he states SARSAT accuracies to be only 3-12 miles. However, I assume that the poorer location fixes are from the VHF distress beacons (121.5 Megahertz) which suffer from degraded signals due to atmospheric interference. The better accuracies are from beacons operating at 406 Megahertz.
37. The Defence of Australia, op cit, p. 25.
38. See newspaper article by Randal Markey. "Major Switch in Australian Defence View." West Australian, 28 December 1988, p. 2.
39. See "Defence Forces Must be Boosted for Enhanced Pacific Role: Libs." The Canberra Times, 29 December 1988, p. 5.
40. Randal Markey. op cit, p. 2.
41. The Defence of Australia, op cit, p. 24.
42. ibid, p. 25.
43. ibid, p. 26.

44. Colin Gray. "The Ambivalence of Doctrine." Nuclear Strategy and Strategic Planning, 1984, p. 1.
45. This formula for deterrence has been stated by General Dougherty as a quote he first heard from an instructor, Colonel "Abe" Lincoln of West Point. Lincoln emphasized that this definition was a product, and if either the will or the capability were zero, then the product - deterrence - was zero. Quoted by John Correll, "How the Ducks Line Up." Air Force Magazine, June 1986, p. 73.
46. Information adapted from, Donald Latham, "Space Based Support of Military Operations." Armed Forces Journal International. November 1987, p. 43.
47. The arguments I have presented in this and the following paragraph are a synthesis of my ideas and data from several sources including: Donald Latham, op cit, pp. 43-44; and Space: Force Enhancement, AWC Seminar Guidance Notes, Maxwell AFB, 5 January 1988, pp. 5-13.
48. Paul Dibb. Review of Australia's Defence Capabilities. March 1986, p. 52.
49. Paul Dibb, ibid, pp. 52-58., and The Defence of Australia 1987, op cit, pp. 23-33., and General Sir Phillip Bennett, "A Military Strategy for Australia," RUSI, 1985, p. 13. Although none of these reports specifically mention space assets, many of the required capabilities they describe are precisely those provided by space systems.
50. "Australian Government selects Hughes for AUSSAT Follow-On." Satellite News, 20 June 1988, p. 9.
51. This example and the ideas are adapted from a similar scenario offered by General Lawrence A. Skantze in a speech entitled "Military Space: A New Era for Force Structure Decisions," delivered to the Air Force Academy Space Symposium in 1985. Printed in Vital Speeches, 15 January 1986, p. 1.
52. ibid, p. 2.
53. Indonesia already has a space capability with their communications satellite PALANBANG
54. Mark Rigby, op cit, pp. 14-15. The author states that the US, Japan, Europe, China and the Soviet Union have all expressed interest in the idea of an Australian launch site in the Cape York peninsular, particularly because of its

closeness to the equator - 11 degrees south, thus reducing the cost of putting satellites into geosynchronous orbits.

55. ibid, p. 16.

56. "Australia and Japan Conclude Space Agreement." Space Policy, November 1987, p. 349.

57. General Skantze, op cit, p. 3.

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CHAPTER V (Pages 64-75)

1. General of the USAF, H.H. Arnold, quoted in AFM 1-1, Functions and Basic Doctrine of the United States Air Force, 14 February 1979, p. 4-11.
2. Colin S. Gray. American Military Space Policy. Abt Books, 1982, p. 94.
3. ibid, pp. 94-96.
4. The ideas I have developed for this ADF Space Policy come from a combination of my own thoughts and sources throughout the bibliography. The main sources I drew upon were: An information memorandum signed by General Welch (USAF Chief of Staff) and E.C. Aldridge Jr. (Secretary of the Air Force), to all Major Commands on the subject of Air Force Space policy, 2 December 1988. Also Space Handbook, AU-18, Air University, Maxwell AFB, pp. 15-4 to 15-15. Also Colin S. Gray, op cit, pp. 96-102.
5. Robert Futrell. "The Quest for Aerospace Doctrine." in a speech to the Aerospace Studies Institute, Maxwell AFB, circa 1960., quoted in General Forces Employment, Resident Studies Syllabus, Maxwell AFB, p. 5.
6. Colin S. Gray. "Space Warfare: Principles, Weapons and Tactics." National Defense, February 1988, p. 41.
7. Col. Kenneth Myers, USAF, et al. "Real Tenets of Military Space Doctrine." Airpower Journal, Winter 1988, pp. 55 and 59.
8. Colin S. Gray. "The Need for Doctrine." National Defense, January 1988, p. 27.
9. For a good description of the use of space assets in various international conflicts see, Bhupendra Jasani and Christopher Lee. Countdown to Space War, Taylor & Francis, 1984, Chapters 3 and 4.
10. For an article detailing the application of the principles of War to Space forces, see: "A New Environmental Military Space Doctrine: For Today and Tomorrow." by Major Patrick H. Crotty, 1985., in Space, Readings from AWC Department of Aerospace Doctrine and Strategy, 1988, p. 201-208.

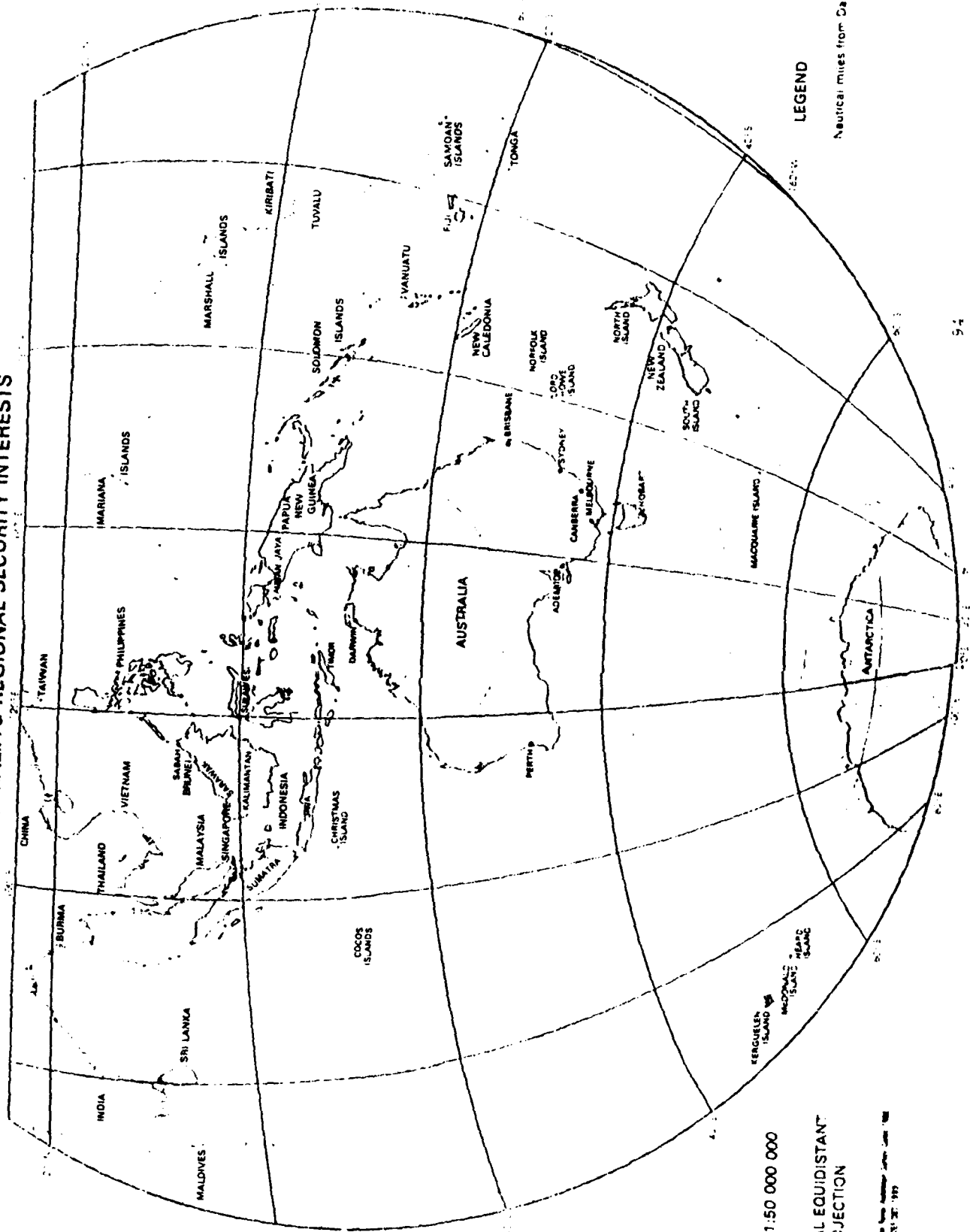
11. Carl von Clausewitz. On War. Edited and translated by Michael Howard and Peter Paret. Princeton University Press, 1984, p. 152.

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CHAPTER VI (Pages 76-79)

1. Paul Dibb. "Review of Australia's Defence Capabilities." March 1986, p. 176.
2. G. Sibiriyakov and A. Khabarov, quoted by VAdm William E. Ramsey, USN in "Space Support to Military Forces." Signal, June 1987, p. 34.
3. ibid, p. 39.
4. Attributed to Hayashi Razan (1583-1657), a Neo-Confucian scholar, in Sun Tzu, The Art of War, translated by Samuel B. Griffith, Oxford University Press, 1971, p. 174.

AUSTRALIA'S REGIONAL SECURITY INTERESTS



SCALE 1:50 000 000

AZIMUTHAL EQUIDISTANT
PROJECTION

LEGEND

Nautical miles from Darwin

APPENDIX 2

SPACE COSTS

Space Budgets

Countries throughout the world are spending more and more on space systems as the advantages of space are utilized. The civil space budgets for the 11 leading space powers are shown in Table 1 below.¹

1987 Civil Space Budget

\$US billion

USSR.....	14.4
USA.....	9.0
China.....	2.9
ESA.....	1.5
France*.....	0.86
Japan.....	0.82
W. Germany*.....	0.48
Italy*.....	0.46
UK*.....	0.42
Canada*.....	0.35
India.....	0.07

* Includes contributions to the European Space Agency (ESA).

Table 1.

These figures do not include the military budgets for USSR and USA. If these were included then the figures for these two countries would be approximately doubled.²

1. "1987 Civil Space Budgets." Aviation Week & Space Technology, Vol 129, No 10, 5 September 1988, p. 55.

Costs of Space Systems

Costs of space systems fall into four broad categories: satellite costs, launch costs, ground station costs and maintenance costs. Because of the advanced technology required and the huge fuel bill, the cost of a spaced based system can range from high to astronomical. However, despite high unit costs, when space costs are amortized over their life of type, then they are cheaper than trying to provide the same capability with a conventional system.

For example many countries have invested heavily in telecommunications satellites because they provide long haul communications without the need for large and expensive terrestrial infrastructures. The estimated worldwide (excluding USSR) investment in commercial telecommunications satellites is shown in Table 2 below.³

Investment in Commercial Telecommunications Satellites

	\$US Million
USA	3190
INTELSAT	1201
Europe	504
Japan	212
Latin America	166
Asia	163
Australia (AUSSAT)	114
INMARSAT	110
Canada	78
ESA	59
EUTELSAT	50
Arab States (ARABSAT)	45

Table 2.

2. Andre Lebeau. "The Astronaut and the Robot." Space Policy, Vol 3, No 3, August 1987, p. 208.

3. ibid. p. 210.

Australia plans to spend more on telecommunications satellites and the government has recently announced the purchase of two new Hughes body stabilized satellites to be placed in orbit in 1991 and 1992 to replace the current AUSSAT 1 and 2 satellites. The contract is worth up to US\$645 million,⁴ however, substantial savings could be made if the US government permits the use of the Chinese Long March boosters for the satellites.

For satellite costs, the Earth Observation Satellite Company (EOSAT) conducted a feasibility study on sensors for the new Mediasat that could be employed on a Landsat platform for newsgathering. The cost of a sensor with a 10 meter resolution and weighing 45 kilograms would be about US\$5 million. A sensor with a resolution of 5 meters would cost between US\$60 million and US\$80 million and weigh about 225 kilograms.⁵ EOSAT plans to have a package that would provide the 5 meter resolution and process the images within a few hours on board Landsat 7 in 1994.

France is planning a photographic reconnaissance satellite program based on development of the Helios military reconnaissance spacecraft. This program is

4. "Australian Government selects Hughes for AUSSAT Follow-On." Satellite News, 20 June 1988, p. 9.

5. Bhupendra Jasani and Christer Larsson. "Security Implications of Remote Sensing." Space Policy. February 1988, p. 48.

expected to cost US\$550 - 700 million for a system comprising four satellites, ground receiving stations and quick image processing facilities.⁶ Launch of these satellites which are expected to have a resolution of one meter are planned for 1992. Spain and Italy have recently also agreed to join this program.

US costs for various satellite programs include: Global Positioning System (GPS) of 28 satellites for just over US\$1 billion, which works out at about \$40 million per satellite; and commercial C-Band and Ku-Band communications satellites, with five to ten year on-orbit designs, sophisticated multiple redundancy systems and weighing about 2,500 to 3,000 pounds for about \$25 million each. Another example, the Defence Meteorological Satellite Program (DMSP) whose satellites weigh 1,792 pounds and contain multiple sensors, on-board recorders and real-time downlinks to worldwide users cost about \$85 million each. The latest version of DMSP will weigh 2,300 pounds and can be launched using a refurbished Titan II for a total cost of about \$120 million per satellite on orbit.⁷

6. ibid. p. 48.

7. Donald Latham. op cit, pp. 42-43.

GLOSSARY

ABM	Anti-Ballistic Missile
ADF	Australian Defence Force
AEW&C	Airborne Early Warning and Control
AFB	Air Force Base
AFM	Air Force Manual
ARABSAT	Telecommunications satellite financed by the Arab states
ASAT	Anti-Satellite
ASW	Anti Submarine Warfare
AUSSAT	Australian Telecommunications Satellite
AVM	Air Vice Marshal
AWC	Air War College
CAP	Combat Air Patrol
CBE	Commander of the British Empire
COMINT	Communications Intelligence
C ³	Command, Control and Communications
DISCON	Defence Integrated Secure Communications Network
DDG	Guided Missile Destroyer
DEFAUSSAT	A leased transponder on the Australian Telecommunications Satellite B (AUSSAT-B) for ADF use
DSAT	Defensive Satellites
ECM	Electronic Countermeasures
ELDO	European Launcher Development Organization
ELINT	Electronic Intelligence

EOSAT	Electronic Intelligence Ocean Reconnaissance Satellite
ESA	European Space Agency
ESM	Electronic Support Measures
FA-18	Hornet; Australian version of US Navy F-18s, a short range tactical fighter/bomber
F-111C	Australian variant of F-111, Long Range All Weather Bomber used against land and maritime targets. Affectionately known as the "pig" or "aardvark"
FFG	Guided Missile Frigate
GDP	Gross Domestic Product
Geostationary	Circular orbit about 33,000 kilometers above the earth's surface in the plane of the equator. An object in this orbit rotates at the same rate as the planet and therefore appears to be stationary with regard to any point on the earth's surface. It is a particular type of geosynchronous orbit.
GLONASS	Global Navigation Satellite System
GPS	Global Positioning System
Harpoon	Sea skimming anti-ship missile
HUMINT	Human Intelligence
Jindalee	Nomenclature for Australian developed Over the Horizon Radar
LANDSAT	Previously called Earth Resources Technology Satellite
<u>Madigan Report</u>	<u>A Space Policy for Australia.</u> Prepared by the Australian Academy of Technological Sciences
Molniya	Molniya orbits (from Russian meaning Lightning) are highly elliptical (400 km by 4000 km) orbits inclined at 63-65 degrees to the equator.
MOS-3	Marine Observation Satellite (Japan)

NASA	National Aeronautics and Space Administration
NAVSTAR	Navigation Satellite Timing and Ranging
NSDD	National Security Decision Directive
OTHR	Over the Horizon Radar
PGM	Precision Guided Munition
PHOTOINT	Photographic Intelligence
PRC	Peoples Republic of China
P3C	Orion; long range maritime patrol aircraft and anti-submarine warfare aircraft with an offensive capability
RAAF	Royal Australian Air Force
RUSI	Royal United Services Institute
SAMRO	Satellite Militaire de Reconnaissance Optique
SARSAT	Search and Rescue Satellite
SDI	Strategic Defence Initiative
SEATO	South East Asia Treaty Organization
SIGINT	Signals Intelligence
SPOT	Systeme Probatoire d'Observation de la Terre
USSR	Union of Soviet Socialist's Republic
<u>White Paper</u>	<u>The Defence of Australia, 1987.</u> A Policy Information Paper. Australian Government Publishing Service, March 1987.
WRESAT	Weapons Research Establishment Satellite

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