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# AUSTRALIA'S PLACE IN SPACE

## TOWARD A NATIONAL SPACE POLICY

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# PREFACE

This report has been prepared as an aide memoire for politicians, policy makers, commentators and citizens with an interest is space matters.

Space is not a 'top of mind' issue for many people, although it fundamentally affects the lives of all of us. The space environment is physically and politically fragile and Australians must have assured and secure access to space if the economy is to thrive, if the society is to become more resilient and if the nation is to contribute to global affairs as a respected middle power.

To achieve these goals an Australian national space policy must promote the establishment of political, industrial, commercial and educational constituencies for space, which together can fulfil national self reliance objectives. The policy will need to be pragmatic and provide clear direction for a middle power which is determined to take its proper place within the international space community.

We have tried to keep the language simple, to avoid jargon and unnecessary acronyms and to suggest what the national space policy must embrace, if it is to succeed, in plain English.

We hope that the suggestions we make help Ministers and their officials to craft a credible national space policy for Australia. We also hope that this report will serve as a readily accessible reference which promotes broader community understanding of and support for space.

*Brett Biddington*

*Roy Sach*

# EXECUTIVE SUMMARY

Australia is embarking on a journey to develop, for the first time, a national space policy. This activity is not occurring in a vacuum or from a clean slate. Many policies and activities in this country make reference to space activities and are reliant on assured and secure access to space-based systems – notably for timing and navigation, communications and remote sensing data.

"Why now?" and "Why at all?" are two important questions which this report addresses as it goes about its prime purpose of suggesting what might or might not be included in a national space policy and how those points might be addressed in the policy.

This report also considers some principles which the policy drafters might consider as they set about their work. A diverse group of Australian stakeholders in and outside of government as well as Australia's allies and neighbours will need to be convinced about the intent of the policy, as well as its implementation path, for it to succeed.

## "WHY NOW?" AND "WHY AT ALL?"

Australia has a chequered history in national space activity, knowledge of which is assumed in this report. In essence, Australia has permitted metropolitan powers, the United Kingdom (UK) and then the United States (US), access to Australian sovereign territory to conduct experiments, develop new capabilities and support the conduct of routine operations in space. In exchange, Australia has gained strategic and operational benefit. Its enduring strategic interests have been looked after, by default, by a prevailing metropolitan power, notably by the US, since the 1960s. Australia's operational interests in space, notably access to all types of earth observation data, have been provided, mostly at little or no cost, through a series of bilateral and multilateral data sharing, processing and dissemination agreements.

Political and military leaders, policy makers and other opinion makers increasingly understand and accept that domestic and regional economies, and indeed the global economy as a whole, are fundamentally dependent on assured and secure access to space-based services. If these services were to be denied or severely disrupted global economic and social life would suffer dislocation and some sectors may even grind to a halt

Compelling, quantitative data to support these assertions does not exist and perhaps could only be obtained if access to these services were removed. Only then would the true nature and extent of dependence on space-based services become apparent. There are numerous anecdotes about the rapid and significant negative impacts on specific activities, usually confined in time and location, when access to space-based services has been lost. However, comprehensive quantitative data which might guide the development of evidence-based policy remains to be gathered.

As all countries on Earth have become more reliant on space-based services to support many aspects of social economic and cultural life as well as for national security purposes, Australia has come to understand, looking into the future, that its best interests may be served only by adopting a more active and self-reliant stance. This does not mean stepping away from the US alliance; on the contrary, it may strengthen the relationship because Australia would join the international tables of space diplomacy as an informed and credible voice generally supportive of the US.

Space-based services – timing and navigation, satellite communications and remote sensing data – are so deeply and pervasively embedded into the economic and social systems of the world that it makes sense to think of them as global critical infrastructure demanding similar levels of protection to national critical infrastructure. Only national governments, acting in concert, have the capacity to protect the space environment itself, which is fragile and easily damaged, as

well as the satellites in the environment from which humankind derives such benefit.

From a national perspective, Australia would do well to consider all space-based services as 'virtual' components of national critical infrastructure deserving similar levels of attention from the perspective of business continuity, risk mitigation, disaster response and recovery, which is allocated to terrestrial utilities – water, sewerage, power, communications and transport.

In the national security domain Australia regularly participates in war-gaming activities in the US which are designed to allow military leaders to understand the extent of dependence of their equipment and operations on space-based services. Although the results of these activities are classified, available public comment suggests that the forces of the US and its allies rapidly lose their ability to move and to fight effectively if denied access to space-based services. They become simultaneously highly vulnerable to attack and less capable of bringing decisive military effect to bear against the adversary.

If these extreme consequences were experienced as a result of simulated space denial activities, they would seem to expose vulnerabilities which no responsible government can afford to ignore, notably with regard to military forces deployed on operations. Assured access to space-based services is a crucial component of capability which supports the men and women of the Australian Defence Force who are deployed to Afghanistan and elsewhere in the world.

In the Australian context, how should this nation proceed? What should it do to ensure that access to space-based services is guaranteed to a high level of certainty over time? These are the question faced by Australia today and precisely the questions a national space policy must address.

In December 2008 the Prime Minister released Australia's first ever national security statement.[1] There is no direct reference to space in this document. Assured and secure access to space-based services is simply assumed or taken for granted, for example, the monitoring and verification of arms control treaties which are mentioned as essential to Australia's national security. The national security statement proposes an 'all hazards' approach to national security, which takes account of a range of non-conventional threats of global dimension, including climate change and population movements. The statement also discusses and develops the concept of resilience through the identification and protection of critical national infrastructure. Space-based services must be considered as part of this infrastructure and deserves such protection as can reasonably be provided.

The Defence White Paper, released in April 2009, is unequivocal in recognising space as an essential enabling element of Australia's defence and broader national security capability.[2] Five key points from the White Paper are:

- assured and secure access to space is essential for a highly networked force to be able to operate effectively;
- Australia is seeking to become more self-reliant, especially in remote sensing and will seek to acquire a Synthetic Aperture Radar (SAR) satellite within the next decade;
- Australia should place priority on Space Situational Awareness (SSA);
- Defence is committed to developing a cadre of space experts; and

[1] Rudd, The Hon. Kevin, MP., Prime Minister of Australia, *The First National Security Statement to the Australian Parliamen*t, 4 December 2008.

[2] Australian Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030. Defence White Paper 2009*, Australian Government, Canberra, 2009.

- hedging investments may need to be developed in the event of space weaponisation – something which Australia is keen to see the world avoid.

## COUNTING THE COST

Policy, without resources is at best aspirational and at worst a waste of effort This report does not advocate that Australia should have or needs to develop an independent 'soup to nuts' space capability with associated industry support. The argument is about achieving necessary and sufficient international *credibility*, through necessary and sufficient *collaboration* (nationally and internationally) by developing necessary and sufficient national *capacity*; a "3Cs" approach.

The approach is intensely pragmatic and seeks to strengthen a component of national capability and capacity which presently is weak.

Investment in three areas is proposed:

- the acquisition of a 'space segment' – a satellite or satellites to put additional 'skin in the game',
- investment in Space Situational Awareness (SSA), and
- investment in an enduring national space research and technology program.

Money for the first and the importance of the second, without resource commitment, has been foreshadowed in the Defence White Paper. A modest initial commitment to the third has also been made through the establishment of the Australian Space Research Program to which $40 million was allocated in the 2009 Budget.[3] An immediate aim must be to ensure that the $40 million is well-spent in order to allow Government the confidence to invest in follow-on phases,

[3] Department of Innovation, Industry, Science and Research, Australian Space Research Program: Discussion Paper, June 2009.

creating, in effect, and enduring space program which meets essential national needs.

Long term determination and commitment by government to strengthening Australia's place in space is considered essential. One indicator, but only one, is the level of investment that government is prepared to make or facilitate. Numerous companies, researchers and expatriate Australians who work in the space sector outside Australia, are watching developments with considerable interest, primarily seeking to understand whether there may be a future from them in Australia or whether, as has occurred in the past, government interest will wane.

The basis for a space industry appropriate to Australia's needs already exists in niche areas of the electronics sector of the economy. Appropriately nurtured, this sector has the potential to grow significantly over the next decade to include an export component. Such growth should assist Australia to become more self-reliant in areas already identified by Government as being of strategic importance, including electronic warfare, secure communications and systems engineering. Complementary industry opportunities have also been presented by the Government's recent substantial investments in radio and optical astronomy.

The quantum of new money required, especially when spread over a period of 10-20 years, is likely to be modest because at best, the capabilities will remain niche. However, this sector, on the basis of overseas experience, offers high value and high direct and indirect returns.

## GOVERNANCE

The most important and immediate need is for leadership and a sense of coherence for a disparate set of companies, researchers, operational staff and policy makers all with vital interests in space which are not capable of being realised due to fragmentation and a lack of a sense of common purpose. The international community is also looking for a single place

in Government where it can go for advice and comment about Australia's intentions with regard to space.

Considerable progress with regard to governance has been made in 2009. There is now an Australian Government website, www.space.gov.au, which is intended to serve as an initial entry point for anybody seeking information about space in Australia. More substantially, a Space Policy Unit (SPU) has been created in the Department of Innovation, Industry, Science and Research (DIISR). The SPU has many tasks which need to be tackled simultaneously. Two of the most daunting are:

- to establish and administer the Australian Space Research Program; and
- to draft a national space policy to be ready for consideration by Government in mid 2010.

A third initiative is the establishment of a Space Industry Innovation Council (SIIC). This Council comprises representatives from industry, government and academe and has been charged with building the political constituency for space in Australia and promoting growth in the sector.

These are positive first steps. The next steps, moving from establishment to growth, may well be the most difficult to negotiate. There remains a body of opinion that Australia should move quickly to establish a space agency and that to do so would solve most of the outstanding problems with regards to Australia's future involvement in space. The authors of this report do not accept this argument opting instead for a gradualist approach to governance which provides first and foremost policy clarity and certainty.

At some point a satellite design and operations authority might be necessary and appropriate. How, when and where this might be established will not be possible to determine until key investors and other stakeholders are known.

## IMPLICATIONS FOR NATIONAL SPACE POLICY

A national space policy needs to consider how to treat these and related matters as well as questions of international collaboration and capacity building in Australian industry, research and educational institutions. This report makes two sets of recommendations; the first proposes a set of general principles which might guide or frame the policy development process and the second relates to matters which the policy might specifically address.

## RECOMMENDATIONS

### *Broad Recommendations*

- Any revised National Security Statement must include reference to space security as a necessary element. Space-based communications, timing and navigation and earth observation services are a vital, if not essential, 'virtual' component of Australia's national infrastructure. It behoves the nation to take all reasonable steps to ensure that access to these services is assured and secure over time and that Australia has a sufficiently independent and self-reliant voice to be counted on its own merit and not merely as a close ally of the United States.
- The proposed national space policy, to be, to the extent possible, 'future-proofed'. A course needs to be set in principle which permits future Governments considerable latitude in how and when to respond to specific developments, threats and opportunities without violating essential elements of the policy.
- The proposed national space policy be developed in broad consultation with the Australian community as well as with key international actors including major and emerging space-faring nations (the United States, Russia, China, Japan, India, Europe, Canada, Israel and Brazil) and major international organisations including the United Nations (especially the

Committee on the Peaceful Uses of Outer Space (COPUOS)), the European Space Agency (ESA), the International Telecommunications Union (ITU) and relevant public and private policy institutes with space credentials.

## *Supporting Recommendations*

The recommendations in this report are divided into three groups, identified by the three words 'must, 'should' and 'might'. Only recommendations beginning with the words 'must' and 'should' are provided in the Executive Summary. Those starting with 'might' are at the end of their relevant chapters. Also, some of the recommendations below have been combined for the sake of brevity.

The proposed national space policy:

- Must be firmly set in the context of Australia's national security overall, taking account of:
  - The advantages and constraints conferred by Australia's strategic geography,
  - Australia's alliance relationship with the United States,
  - Australia's determination to use creative middle power diplomacy to further its national interests in bilateral and multi-lateral forums, and
  - Australia's aim to become more self-reliant in remote sensing and generally more competent in space matters.
- Should emphasise Australia's determination to take all reasonable steps as a reputable middle power to keep space a 'global commons' at the disposal of all of mankind for peaceful purposes, with the corollary that Australia will take all reasonable steps to ensure that weapons are not placed in space.
- Should acknowledge that space is a fragile environment which is easily disturbed and that any

such disturbance may have direct and far-reaching consequences for Australia and all other nations.

- Should acknowledge that assured and secure access to space is only capable of being realised with any measure of certainty if a holistic approach is taken to space security which addresses the ground, electro-magnetic spectrum, cyber and physical domains.
- Should emphasise Australia's determination to abide by international law as it applies to the regulation of space. Australia will take positive steps to strengthen the regulatory regime and associated cooperative and confidence building measures which govern human activity in space to avoid misunderstanding, miscalculation and precipitate action which may be harmful to the interests of all space-faring nations and mankind more generally.
- Should acknowledge that the satellites on which Australia depends are considered to be components of the critical national infrastructure and that they will be afforded protection legally, diplomatically and technologically.
- Should place a high value on global partnerships and collaborative activities beyond Australia's relationship with the US and, to this end foreshadow that resources will be allocated to strengthening existing relationships with space-faring nations and creating new relationships as and where appropriate.
- Should acknowledge the requirement for close executive coordination of Australia's space equities, activities and possible future investments, closer than has occurred in the past. It should acknowledge steps already taken to strengthen coordination without making any commitment about a space agency, or any similar body, until more evidence has been obtained and evaluated.
- Should carefully distinguish between Australia's strategic and operational interests in space yet

demonstrate how necessary and sufficient investment in the latter positively impacts on the former by developing national capacity, competence and confidence in space-related activities.

- Should note, in the context of Australia's strategic geography, that this country is uniquely placed to host instruments, such as SSA sensors, the data from which could be used to build confidence amongst space faring nations by reducing uncertainty and ambiguity about the behaviour of particular spacecraft and other space objects.
- Should note that many space assets have dual military and civil or commercial applications, and note also that such arrangements help to spread financial and operational risk amongst a range of users whilst maintaining the higher levels of security required by the defence force and the national security community.
- Should note that technologies are being developed which are quickly lowering the barrier of entry into satellite design, manufacture and operation. This may offer opportunities for Australian companies to take advantage of these developments.
- Should recognise that an effective national space policy cannot be confined to consideration of space assets alone; supporting ground infrastructure needs also to be considered through a rigorous whole-of-system approach. In particular, balanced investments are needed across the system for data classification, interpretation, overlay, analysis, storage, dissemination and retrieval, all with maximum reliability and minimum delay. Only then is the system likely to provide optimal return on investment.
- Should note that for Australia to benefit optimally from data derived from satellites, strong data management policies backed with appropriate levels of investment in ground infrastructure will be essential.

- Should indicate possible areas for industry development and pure and applied research which advance Australia's overall strategic aim to guarantee assured and secure access to space whilst also meeting operational objectives which support specified national and community needs.
- Should note the potential for Australian industry, building on current strengths, skills and experience, to lead in the development of SSA technologies for national benefit and possibly also for export.
- Should note the potential for industry to play a more prominent role, in principle, in the exploitation, processing and dissemination of data derived from remote sensing satellites to support the requirements of public and private users.
- Should recognise the importance of, in the absence of a strong industrial base, the space research and education community in Australia as a source of expertise, including 'smart buyer' and policy advice, and as a conduit to many space agencies and organisations in other countries.
- Should acknowledge the importance of a comprehensive communications strategy to inform national and international constituencies of the steps being taken by Australia to strengthen its role in space.

These recommendations indicate the complexity of the task and point to the extent of collaboration, nationally and internationally that will be needed for the policy to be viewed as a credible basis to define, protect and strengthen its legitimate interests in space.

This report is not intended to be the last word on the subject. Readers who wish to discuss and debate aspects are encouraged to do so by preparing either a short commentary or a longer article for the Kokoda Foundation's professional journal, *Security Challenges.* For details on how this can be done, please visit:

http://www.kokodafoundation.org/journal/New%20Site/author.html

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# ABOUT THE AUTHORS

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Brett is a consultant who is well-informed about space matters. From 2002-2009 he was employed by Cisco Systems, where he worked in a small team which had been challenged by the company to transform global space communications by placing internetworking technologies in space. In parallel, he provided a focal point for the Australian space community including the national security, space science, astronomy and education sectors. Before joining Cisco, he served for 23 years in the Royal Australian Air Force occupying a range of intelligence, security and capability development appointments. He retired as a Group Captain.

Brett serves on a number of boards and committees relevant to Australia's interests in space. These include:

- Australian Space Industry Chamber of Commerce (Chair)
- Australian Space Industry Innovation Council
- Australia Telescope Steering Committee
- Australian Space Research Institute
- Giant Magellan Telescope Project Oversight Committee
- Antarctic Astronomy Advisory Committee
- Advisory Board of the Institute for Telecommunications Research at the University of South Australia

## ROY SACH

Roy served for 40 years in the Royal Australian Air Force and Department of Defence. He filled several space-related positions including Director of Defence Space. He lectured both in Australia and overseas and led an Australian team participating in US Space Command's space war games. He also served on the advisory board of the Institute for Telecommunications Research. Roy completed Harvard University's Senior Executive Fellowship program and has worked in the Executive Office of the US President (President Clinton). On 'retirement' his distinguished contribution was acknowledged jointly by the NASA Administrator and Under Secretary of the US Air Force.

# CONTENTS

# AUSTRALIA'S PLACE IN SPACE: TOWARD A NATIONAL SPACE POLICY

## Introduction

History may record 2009 as having been a tipping point in Australia's involvement in space. A number of events and forces, many quite modest and even seemingly disconnected, have combined, leading the Commonwealth Government to re-think Australia's place and role in space.

Perhaps the decisive factor has been the leadership shown by the Prime Minister, Kevin Rudd. Unlike other areas in which Prime Ministerial leadership has been exercised, which have been marked by fanfare and publicity, progress in the space policy domain has occurred away from public gaze. Relevant officials from several departments have worked together and with a small number of well-informed members of industry and the research and education sectors to lay the foundation from which Australia can begin to think again about its role in space.

The Prime Minister has invited Senator the Hon Kim Carr, Minister for Innovation, Industry, Science and Research, to have his department prepare a national space policy for consideration by Cabinet in the latter part of 2010. This was an ambitious timescale for a complex undertaking.

In January 2010 Minister Carr announced the membership of the Space Industry Innovation Council (SIIC) which has been established to provide an independent and informed line of advice to Government on the development and implementation of Australia's space policy and future space activities. In his speech the Minister made clear that his principal aim was to establish what he called a 'political constituency' for space, at the heart of which was a small, highly skilled workforce. He also spoke about the 'wonder' of

space and its importance in inspiring future generations to undertake studies in the sciences, engineering and mathematics.[1]

The purpose of this report is to make some suggestions, from an independent perspective, on what an Australian space policy might or might not contain and to discuss some areas, which may be contentious and in need of careful development and explanation, notably in those parts of the policy dealing with national security. A second related purpose is to expose and explain a series of concepts about space governance with which few Australians are familiar in order to aid public conversation and discussion as the policy is developed. The final aim is to show why secure and assured access to space is a matter of concern for all Australians and a value which we should take care to protect and promote.

## WRITING NEW POLICY

Writing new policy is complicated. There is rarely such a thing as a clean sheet or an uncharted area. In the case of space the landscape is a tangle of interests, arrangements, investments, organisations and baggage, the latter often arising from disappointment and failure. Policy makers also need to wade through a sea of assertion and opinion which has been an enduring characteristic of discussion about Australia's place in space over many years. Such evidence as exists is in disconnected pockets and is not linked to broader trends in policy development, the national economy and society more generally.

The new policy must provide a sense of direction, commitment and purpose and also provide incentive or reason for existing vested interests to not merely lend support but, ideally, to become advocates of the proposed new direction as enunciated in policy.

[1] Remarks by Senator the Hon Kim Carr, Minister for Innovation, Industry, Science and Research, when announcing the membership of the Space Industry Innovation Council (SIIC), at the University of South Australia, Mawson Lakes, 20 January 2010.

## *Space Policy: Some Differentiators*

A successful space policy must operate at several, not always mutually compatible, levels. For the purposes of this study, space is defined as the physical environment which extends from the outer reaches of the Earth's atmosphere to the edge of the solar system. Particular emphasis is given to the space environment which is relatively close to Earth, including the moon and the closer planets.

Beyond the solar system lies the near and far universe which can be observed by astronomers but lies beyond direct human influence except through radio and similar signals which have been generated on Earth and are travelling away from Earth at the speed of light and growing increasingly faint in proportion to the square of the distance travelled.

Space is a physical environment which is subject to gravitational effects, weather (mainly electromagnetic and cosmic radiation mostly generated by the Sun), and contains many naturally occurring objects such as asteroids. For all intents and purposes space is a vacuum and it does not support life as known on Earth.

Space is also a political and legal environment. A significant body of international law has been created to regulate human activities in space. Not all of these activities in space have worked to reinforce the statements of principle contained in several treaties and other international instruments. Indeed, some recent events have lacked restraint and seem to have been designed to provoke reactions from others. This may be an indication that the treaty regime which has served well since the 1960s, may now be under considerable and increasing stress; stress which may be very difficult to reverse unless there is swift and decisive action by the international community.

Space is a physical environment with an existence independent of human activity, and the interaction between natural phenomena and human activity needs to be regulated

just as happens with the sea, land and air environments on Earth.

## *Policy, Strategy and Operations*

This report does not seek to debate terms such as 'policy', 'strategy' and 'operations'; that task is left to public policy educators. However, the first two terms, 'policy' and 'strategy', are often used interchangeably. In the minds of the authors of this report they are distinguishable. In this report, 'policy' is used to refer to a written, Cabinet-endorsed document which outlines Government intent with respect to a discrete area of activity and requires priorities to be set and resources to be allocated in order for the intent to be realised. A national space policy, in this context, must account for and be generally consistent with other policies which are in place and also have resources allocated to them for implementation.

Not all policies are equal either absolutely or over time. Their relative importance or priority, particularly when resources are allocated for implementation, is determined by 'strategy'.

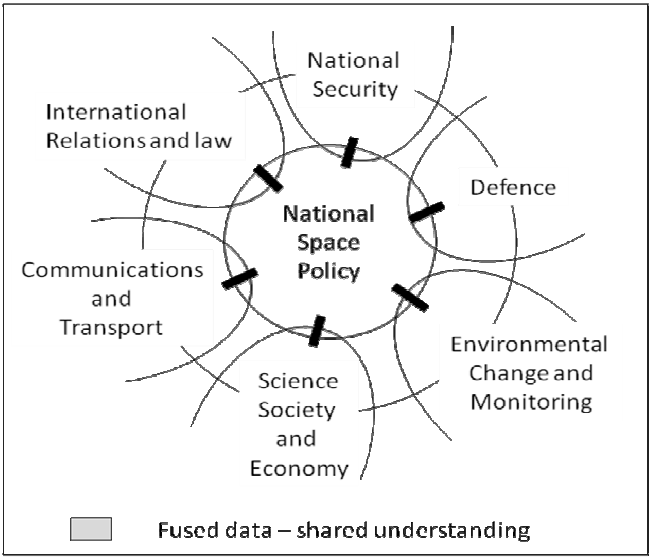
Simply put, 'strategy' links ends and means. This can apply at any level of activity however, for the purposes of this report, the concept is reserved for the higher level linkages Government seeks to make to preserve and advance Australia's enduring national and sovereign interests over time.

'Operations' describes routine activities which are conducted from the resources allocated to implement policies. Operations, undertaken in accordance with polices, achieve outcomes which may advance the ends identified in strategy. They may also have unintended consequences which also need to be identified and monitored.

These distinctions are important in the development of an Australian space policy because of the links that policy must forge with a range strategic imperatives, whilst also achieving operationally desirable and useful outcomes.

Figure 1 is a schematic representation showing how a new space policy, which fills an identified policy gap, will need to be melded with existing policies in numerous areas. The aim is to achieve an integrated and consistent policy fabric by which Government can pursue its strategic interests. There will also be a need to develop a shared understanding of the space environment—concepts, technology and terminology—in order to ensure synchronised decision-making and investment across a range of diverse policy areas.

**Figure 1. Relating New Policy to Old**




## STRUCTURE OF THE REPORT

The report has eight sections. The first identifies the enduring strategic drivers of Australia's national strategy as it affects and is affected by space. This section also outlines the changes which have occurred since the Kokoda Foundation published its previous report on space in 2008 (Kokoda Report Number 7, *Skin in the Game: Realising Australia's National Interests in Space to 2025*) and describes the intent of the

Government, notably with regard to the preparation of a national space policy.

The second section describes the space environment from a security perspective and demonstrates the domains which need to be secured as an integrated whole.

The third and fourth sections are concerned mainly with space as an element of national strategy. The third outlines recent changes to the international environment and discusses the implications of these changes for Australia. These changes represent threats and opportunities and also present choices which may need to be reflected in the emerging space policy. The fourth is concerned specifically with Space Situational Awareness (SSA). SSA is a capability which Australia is well-placed to develop for national and international benefit. The location of SSA capabilities in Australia could offer strategic and operational advantages not available to any other nation on Earth. There are clear implications for space and other linked policies.

The fifth and sixth sections focus mainly on operational level matters. They deal with how space investments that Australia might make for strategic reasons might be put to best effect in the national interest by supporting a range of existing programs, as well as providing data to support new initiatives. The fifth section deals with a set of questions involving dual use technologies, notably in remote sensing.

Section six addresses questions of managing data derived from space, including how this data might be assessed, stored, shared and integrated with data from other sources. What, if anything, might the national space policy usefully say about space-based sensors and ground-based applications?

Section seven considers the implications for industry together with the research and academic communities of a national space policy.

Section eight draws the strands of the report together and concludes that a national space policy is a vital first step in this long ignored area of activity.

## CONDUCT OF THE STUDY

Most of the original material for this study was gained from four closed workshops held in Canberra and Sydney during October and November 2009. Additional material was gained by one of the authors during visits to Canada and the United States (US) in August and September 2009. Interviews, mostly off the record, were conducted with numerous Government officials and others involved in Australia's space endeavours. Finally, a range of hard-copy and soft-copy sources were consulted and, where used, have been acknowledged using a conventional referencing scheme.

# Background and Context

## BACKGROUND

In the past five years there has been persistent discussion about Australia's role in space in and beyond Government. The international environment has also changed considerably, and there is evidence that the pace of change may be accelerating.

Towards the end of 2008, there was an important, even critical development. The Prime Minister took a personal interest and instructed his Department to conduct a review of Australia's approach to and involvement in space. A series of workshops was held and the review findings were provided to the Prime Minister ahead of the May 2009 budget.

The Global Financial Crisis (GFC) and the election of Barak Obama as the 44th President of the United States represented major changes to the international landscape. The Rudd Government acted swiftly to cushion the Australian economy from the GFC and also established a new basis from which Australian strategic policy might develop

On 4 December 2008, the Prime Minister released a statement on Australia's national security in a speech to Parliament. This speech called out the enduring importance of the US alliance, and made clear the Government's determination to lift Australia's international standing through 'creative middle power diplomacy'. The statement took an 'all hazards' approach to national security and identified a raft of new and emerging threats including climate change, global warming, land degradation and the risk of cyber attack, all of which may cause serious harm to national infrastructure and the national economy. The overall aim of the various initiatives announced by the Prime Minister was to make Australia a

more resilient nation, capable of meeting and dealing with these threats.[2]

Space *per se*, seems not to have been an explicit consideration in the Government's deliberations. There is no direct reference to space at all in the National Security Statement. However, assured and secure access to space-based utilities is implicit in the document for the achievement of a number of specified national security objective including treaty verification, the measurement and monitoring of climate change and to achieve broader economic and security objectives.

The authors of this report have not been able to determine whether reference to space was omitted from the National Security Statement after due deliberation, because it did not loom as a topic worthy of mention, or because those who drafted the statement were not sure what the statement should say about space.

## DEPENDENCE

Australia's dependence on space is well-recognised by Government.

> The Australian Government has identified the increasing use of space systems both for civilian purposes and military, with these systems becoming essential for everyday services like television broadcasting, weather forecasting and banking. Due to Australia's growing dependence on space systems, the Australian Government is looking to develop a clear understanding of its interests and objectives in space; its existing and emerging opportunities; areas of leverage and competitive advantage; and how best to prepare to meet future challenges effectively.[3]

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[2] Rudd, The Hon. Kevin, MP., Prime Minister of Australia, *The First National Security Statement to the Australian Parliament*, 4 December 2008.

[3] Department of Innovation, Industry, Science and Research, Space Policy Unit, Manufacturing Division, Request for Tender: Australia's Domestic Space Capabilities, Canberra, 2009, p. 4. Although this is a departmental

Unfortunately this understanding is not shared by the broader public which largely takes for granted its dependence on space-based services, especially the timing signals from global positioning satellites on which all elements of national infrastructure and many routine functions and processes have substantial, increasing and, in some cases, complete dependence. The space community has been notoriously bad at explaining the role that satellites play in the daily lives of Australians.

In the national security domain Australia regularly participates in war-gaming activities in the US which are designed to allow military leaders to understand the extent of dependence of their equipment and operations on space-based services. Although the results of these activities are classified such public comment that is available suggests that the forces of the US and its allies rapidly lose their ability to move and to fight effectively if denied access to space-based services. They become simultaneously highly vulnerable to attack and less capable of bringing decisive military effect to bear against the adversary.

If these extreme consequences have been experienced as a result of simulated space denial activities, they would seem to expose vulnerabilities which no responsible government can afford to ignore, notably with regard to military forces deployed on operations. Assured access to space-based services is a crucial component of capability which supports the men and women of the Australian Defence Force who are deployed to Afghanistan and elsewhere in the world.

What now needs to be determined is what Australia should do that is reasonable, affordable and credible to ensure that the space environment remains sufficiently safe, stable and regulated to serve Australia's enduring national interests. The focus of this report is to discuss this issue, explore options and consequences and make recommendations about the

level formulation, Minister Carr has strongly echoed these sentiments in public including in his speech announcing the membership of the SIIC in Adelaide on 20 Jan 2010.

structure and content of the Australian space policy in order that the policy is consistent with other policies and initiatives and is given every chance to succeed.

At a level below national strategy, space, space science and astronomy received emphasis in a series of other reviews and reports in 2008 and 2009. These included:

The Review of Australia's national innovation system (Cutler review) which identified astronomy and space science as one of six areas which warranted targeted investment in research and development in the coming decade.[4]

An enquiry into space activities in Australia was conducted by the Economic Committee of the Senate which resulted in the November 2008 report *Lost in Space? Setting a new direction for Australia's space science and industry sector*.[5] The recommendations of the Senate committee report are at Annex A. The Government formally responded to the recommendations of the Senate inquiry in December 2009, and in broad terms, accepted the findings of the Senate Committee report.[6]

The Defence White Paper released in April 2009 makes plain the importance to the ADF and Australia's national security more generally, of having assured and secure access to space. The White Paper states that Australia will seek to acquire a remote sensing satellite, points to the importance of SSA and announces that Defence will develop a cadre of space specialists.[7] Collectively, this represents a major shift in

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4 Cutler, T., *Venturous Australia - building strength in innovation: Report on the Review of the National Innovation System*, Department of Innovation, Industry, Science and Research, Canberra, 2008.

5 The Senate Standing Committee on Economics, *Lost in Space? Setting a new direction for Australia's space science and industry sector*, Commonwealth of Australia, Canberra, 2008.

6 Australian Government, *Response to the Senate Inquiry into the current state of Australia's Space Science and Industry Sector*, Canberra, November 2009, http://www.innovation.gov.au/Industry/Space/Pages/SpaceResponse.aspx.

7 Australian Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030. Defence White Paper 2009*, Australian Government, Canberra, 2009, pp. 82 and 85.

emphasis by the national security community, led by Defence, towards acknowledging the importance to Australia of assured and secure access to space.[8]

Each of the documents listed is substantial and they contributed to the logical and evidentiary basis on which the Department of Innovation, Industry, Science and Research (DIISR) proceeded to construct a New Policy Proposal (NPP) for renewed direct investment by Government in national space capabilities. The outcome of the NPP was reflected in the May 2009 Budget. In excess of $168 million was allocated to space science and astronomy, including:

- $8.6 million to establish a space policy unit within DIISR, and
- $40 million over four years to establish an Australian Space Research Program (ASRP).

Later in 2009, two further reports were released, the second as a draft.

- *An Australian Strategic Plan for Earth Observations from Space*.[9]
- *Building a National Presence in Space: The First Decadal Plan for Australian Space Science*.[10]

These plans were produced too late to influence the NPP. Both documents have been subject to extensive consultation, collaboration and iteration within the remote sensing and space science communities. Both have Learned Academy

[8] For more detail on the treatment of space in the White Paper see, Biddington, B, 'Remote-sensing essential for security', *Defence Supplement, Weekend Australian*, 24 Oct 2009, p. 12.

[9] Australian Academy of Science (AAS) and the Australian Academy of Technological Sciences and Engineering (ATSE), *An Australian Strategic Plan for Earth Observations from Space*, AAS/ATSE, Canberra, July 2009.

[10] The Steering Committee First Decadal Plan for Australian Space Science and the National Committee for Space Science, Australian Academy of Science, Draft of the Final Release, *Building a National Presence in Space: First Decadal Plan for Australian Space Science*, Canberra, 2009. Final report is scheduled for formal release some time in 2010.

endorsement and may be expected to influence science policy development and resource allocation in the future.

## THE PAST

Australia has a chequered history in space. By and large, the nation's strategic interests, to the extent that they have been discussed or defined at all, have been met through alliance relationships and obligations. The Woomera test range was established in the early days of the Cold War specifically to support the United Kingdom's nuclear program. Warheads and delivery mechanisms (sub-orbital rockets) were developed and tested. Australia contributed the real estate and little else.

As the strategic relevance of the US increased and that of the United Kingdom (UK) waned, Australia permitted the US to locate several satellite ground stations critical to the security of that nation on Australian soil. One, at Nurrungar, near Woomera township, supported satellites in the US Defense Surveillance Program (DSP) and continuously scanned the Asia Pacific region for signs of ballistic missile launches.[11] Another facility, at Pine Gap near Alice Springs, supported and continues to support US intelligence-gathering satellites. These ground stations and their supported satellites have played a vital role in arms control treaty verification over many years.

In effect, Australia hooked its strategic interests in space to powerful allies, initially the UK and then the US. Australia contributed the real estate and enacted a quite draconian security regime to deter the inquisitive. To preserve, and be seen to preserve, sovereign control over these activities the doctrine of "full knowledge and concurrence" was developed and implemented.

This allowed Australian officials comprehensive insight into the activities being conducted on Australian soil in order that

[11] Richelson, J. *America's Space Sentinels: DSP Satellites and National Security*, University of Kansas Press, USA, 1999, pp. 54-55 and ff.

the Australian Government could be assured that none of these activities violated Australian domestic law, compromised the nation's international obligations or represented unknown and unwanted threats to Australia's territorial integrity and international reputation.

The big issues, in short, were left to London and later to Washington.

Despite this history, long term determination and commitment by government to strengthening Australia's place in space is considered essential. One indicator, but only one, is the level of investment that government is prepared to make or to facilitate. Numerous companies, researchers and expatriate Australians who work in the space sector outside Australia, are watching developments with considerable interest, primarily seeking to understand whether there may be a future for them in Australia or whether, as has occurred in the past, government interest will wane.

The authors of this report judge that in 2009, the national business case for space was made – something that has not happened in the past. This was a 'tipping point'. The question is no longer whether to become involved but how and to what extent. The enduring drivers now need to be critically examined and re-evaluated in the light of the space ambitions of important regional neighbours in the broader context of international affairs and the rapid evolution of technology.

## ENDURING DRIVERS

The enduring drivers of Australia's approach to space sum to five points.

### *Strategic Geography*

The Australian continent is roughly equidistant between Europe and the Americas. Except for the major population centres around the Australian coast, the continent is remarkably radio quiet. Australia is well-served by undersea cables and satellite communications. This combination of

attributes makes Australia a unique vantage point for satellite ground stations which support security, civil and commercial activities, radio telescopes and other sensors which require large apertures and radio quietness to achieve optimal performance.

## *US Alliance*

The US Alliance is the bedrock of Australian national security policy and Australia has largely viewed its involvement in space as a sub-set of the alliance relationship. Australia has used its strategic geography to advantage as a tangible contribution to the alliance by allowing sensitive US satellite ground stations to be located on Australian sovereign territory. In international space policy matters, Australia has been largely content to support US positions, perhaps seeing space diplomacy as fundamentally non-core Australian business.

There are clear signs that Australia is now seeking to tread a more self-reliant path, within the context of the advantages and constraints which the US alliance confers.

## *Good International Citizen*

Australia is a signatory to the key treaties and other international instruments which govern human activities in space. From being a founding and active member of the Committee on the Peaceful Uses of Outer Space (COPUOS), which is based in Vienna, the Australian chair is now more often than not empty and the Australian voice at this table, muted. Surprisingly, Australia is one of only a handful of nations to have signed and ratified the Moon Treaty which aims to protect the resources of the moon from being exploited except in the interests of all mankind. Just what prompted this action in the late 1970s and early 1980s remains a mystery to the authors of this report.

## *Cost*

There is an enduring view in government, which is shared more widely, that access to space is expensive. Certainly, to build and sustain an end-to-end industry which would make Australia substantially self-reliant in space would take a massive investment. However such a commitment is neither warranted nor advocated. In broad terms there are three main components to the cost of launching a satellite: the launch, launch insurance and the satellite itself. Small satellites typically operate for three to five years whereas the design life of larger craft is longer – typically eight years – while satellites in geosynchronous orbit (some 36 000 km from Earth) remain operating for up to 15 years and sometimes longer. Some satellites exceed their design lives by at least a factor of two, which is a tribute to the care taken in their design, manufacture, testing and operation.

Launch costs remain the principal barrier to unfettered access to space by all newcomers. The cost of getting a sandwich to the International Space Station has been estimated to be in the order of $10,000. As smaller satellites become more capable, launch costs as a proportion of the overall capital cost of next generation satellite systems may be expected to reduce. Operationally useful earth observation satellites can now be designed, built and launched for between $20 million and $50 million depending on the complexity of the payload and the orbit required.

By far the greater cost is in operating satellites over their lifetime – paying for staff, ground stations and data processing, storage and dissemination infrastructure which is necessary for the data to be of use. This is an area ripe for investment in Australia. Data received at an Australian Government owned and operated ground station in Alice Springs, for example, is still forwarded to Canberra on discs via air cargo despite the fact that high speed communications links run past the facility.

## Access to Radio Spectrum

Radio spectrum is a finite resource and the radio frequencies which are optimal for satellite communications are also sought by terrestrial operators. Considerable care is taken to ensure that these transmissions do not interfere with each other. All satellites need access to spectrum. Command signals need to be sent from Earth to tell satellites what to do. Satellites need to transmit to Earth information about their performance; they also need to transmit timing signals, digital images and other data from their sensors. The 'payload' communications data carried by communications satellites can include telephone conversations, emails, television broadcasts and data streams which control or coordinate all manner of government, business and private activities on Earth.

The International Telecommunications Union (ITU) regulates the issue of spectrum licenses to all satellite operators. The process is slow and cumbersome and has not prevented occasional instances of interference or potential interference.

In Australia, the Australian Communications and Media Authority (ACMA) is responsible for allocating radio spectrum and represents Australia's national interests at the ITU. In Australia 25% of all spectrum licenses are held by the Department of Defence. Some of these allocations are under considerable pressure from commercial interests seeking access to spectrum which is currently reserved for national security purposes.

Developments in technology are promoting more efficient use of spectrum; however, there is considerable competition in some particular bands. ACMA is in a difficult position. It has a legislative responsibility to consider the national interest when allocating spectrum. It also has commercial pressures and incentives to release spectrum for wider use. It is in a poacher and gamekeeper situation which may not be in the best interests of anybody going forward.

## SPACE SEGMENT

This section briefly discusses current, proposed and possible Australian investments in satellites. The reason for the phrase "space segment" is to make the point that satellites are only one element within a larger system, all parts of which must work for the benefit of the satellite to be realised.

### *Communications*

According to the DIISR website there are presently four operational communications satellites in orbit around the Earth which have Australian registration for the purposes of liability and international accountability. They are the Optus C1, D1, D2 and D3 satellites. All are owned by the Singtel Corporation based in Singapore however they are 'flown' from a control centre in Sydney.

The Australian Department of Defence is paying for another satellite to be added to the US Wideband Global System (WGS) constellation. This satellite, which is due to launch in 2013, will strengthen the overall constellation and provide Australia access to satellite communications bandwidth across the entire constellation. Defence already has access to the first WGS satellite. Defence has also announced that it plans to enter a long term arrangement with INTELSAT to purchase access to further communications bandwidth on a satellite due for launch in 2012.

In this model, the launch and technical risks are met by others. Some transfer of technology, skills and experience occurs but is limited and does not amount to or create a critical mass from the point of view of industry development and sustainability.

Putting national security aside, the Australian Government anticipates that communications satellites will play an essential part in delivering wide-band communications to remote and other disadvantaged users as part of the National Broadband Network (NBN). In January 2010 the National Broadband Network Co. (NBNCo) issued a Request for

Capability Statement (RCS) regarding the supply of a satellite network and services. The purpose of the RCS is to elicit from industry options for the delivery of broadband services to those users across Australia for whom access to broadband via optical fibre and wireless links is not feasible.[12] Just how these services will be delivered remains to be seen. But a constellation of two satellites is envisaged as an essential minimum capability in space.

## *Navigation and Timing*

There is no suggestion that Australia should seek to develop or invest in an independent or complementary space-based alternative to the US Global Positioning System (GPS). The system is, for all intents and purposes, ubiquitous and touches many facets of daily life directly and immediately (such as in car or mobile phone navigation systems), as well as less obviously (such as in banking, mechanised agriculture, mining, power transmission and the regulation of water flows). GPS is effectively provided to the world by the United States as a free good and the US has made clear that it intends to maintain and strengthen the GPS constellation indefinitely.

GPS satellites operate in Medium Earth Orbits (MEO). This is a less cluttered environment than closer to Earth where the majority of satellites, especially earth observation satellites, operate in Low Earth Orbits (LEO). MEO provides considerable inherent protection against collision with orbital space debris but is a much harsher environment from the point of view of cosmic radiation.

Some nations are developing their own timing and navigation systems. Towards the end of the Cold War, Russia developed its Global Navigation Satellite System (GLONASS). Europe is persisting with the development of the Galileo system. China and India have announced plans to develop independent capabilities and other nations, including Japan

[12] NBNCo Ltd., Request for Capability Statement regarding the supply of a Satellite Network and Services, January, 2010.

are exploring the possibility of developing complementary systems to GPS. Australia, as a consequence of its strategic geography, has the potential to benefit from access to all of these systems and has an opportunity not available to other nations to develop technologies which permit these diverse systems to operate as a virtual but integrated whole.

### *Remote Sensing*

The implications of Defence acquiring a Synthetic Aperture Radar (SAR) satellite are discussed more fully in the fourth section of this report. Suffice to say in this context, Australia, for the moment, is dependent on data from satellites owned and operated by others.

## GOVERNANCE: THE QUESTION OF A SPACE AGENCY

Since the demise of the Australian Space Office in the mid 1990s, there has been a continuous murmur from Australian space industry advocates, the space science community and space enthusiasts that Australia needs a space agency of some sort. Some critics point to the fact that Australia is the only OECD country not to have a space agency. The formation of an agency is seen by some as a panacea for all of Australia's space ills. The authors of this report do not support this view.

There is no question that Australia needs to strengthen coordination mechanisms associated with space activities. This point was recognised by the Senate Inquiry and the recommendations (reproduced at Annex A in this report) foreshadow the need for an agency as some future point. However, a dedicated agency comes with attendant risks.[13]

Almost all of the world's major space agencies are beset with difficulties which can be reduced to two basic points; mission clarity, and funding. The former is a reflection of the multi-disciplinary, multi-organisational and multi-purpose nature of human involvement in space. The latter is

[13] Senate Inquiry, *Lost in Space?,* 2008.

considered to be a reflection of the small size of the global space sector relative to other industry segments.

Space activities overall do not create and sustain large numbers of jobs. However, some local economies, such as the Huntsville region of Alabama and the Orlando region in Florida in the United States, are heavily dependent on space industry jobs and could be expected to suffer considerably if the US Government reduced its investment in space or sought to adopt new approaches to space. The imminent demise of the space shuttle program is expected to lead to the loss of 7000 jobs in and around the Kennedy Space Centre in Florida.[14]

Some of the major questions about the future uses of space, nationally and internationally, include:

- The national security uses of space.
- Robotic exploration of the solar system.
- The future of human space flight - most immediately, the future of the International Space Station but looking ahead, the return of humans to the moon and then human voyages to the planets, notably Mars.
- Earth-based versus space-based astronomy.

How priorities are set between these sometimes competing objectives, notably in the US but also in Europe, Japan, India and China, may be expected to have direct and indirect impact on space activities in Australia in three ways.

- Collaborative research opportunities which derive from presently hosted facilities such as NASA's Deep Space Tracking Station at Tidbinbilla and the European Space Agency's deep space mission support facility at New Norcia in Western Australia may be expected to change.

[14] Block, R and Matthews, MK, *Obama aims to ax moon mission*, Orlando Sentinel, 27 January, 2010.

- There may be opportunities to host new ground stations to support the activities of new entrants to space and to support recovery operations as well.
- There may be opportunities to participate in collaborative space missions with other nations in ways not possible in the past.

## *Australian Government Stakeholders in Space*

The principal Commonwealth Departments with direct responsibilities for and interests in aspects of Australian space engagement include:

- Agriculture, Fisheries and Forestry
- Attorney General's
- Broadband, Communications and the Digital Economy
- Customs and Border Protection
- Defence
- Environment, Heritage and the Arts
- Foreign Affairs and Trade
- Infrastructure, Transport, Regional Development and Local Government
- Innovation, Industry, Science and Research
- Resources Energy and Tourism

There are a number of agencies and statutory authorities which have substantial operational and research interests somewhat distinct from the policy responsibilities of the departments through which they are administered. These include:

- Australian Research Council
- Bureau of Meteorology
- Commonwealth Scientific and Industrial Research Organisation
- Defence Imagery and Geospatial Organisation
- Geoscience Australia

- Ionospheric Prediction Service[15]

The length of this list is an indicator of the many operational users of space-based services each of whom has some responsibility for policy and strategy but none of whom have sufficient motivation, authority or budget to exercise strong executive leadership.

Until the latter part of 2009 the only dedicated mechanism for achieving space policy coordination across the Commonwealth was the Australian Government Space Forum (AGSF). The AGSF is chaired by DIISR, and meets twice a year at the official level. It has no executive responsibilities.

The Senate Inquiry[16] recommended that Australia should move progressively towards establishing a space agency and progress has been made.

- A Space Policy Unit has been established within DIISR
- A dedicated website, www.space.gov.au, has been set up
- A Space Industry Innovation Council has been established.

Unambiguously there is now a first and central point of contact in the Australian Government for space matters. This is the Space Policy Unit in DIISR and one of its tasks is to involve relevant Ministers and their departments in the resolution of questions which have whole-of-government and whole-of-nation implications for Australian space policy and space activities. This is a major step forward.

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[15] Most, but not all, of the agencies listed are members of the Australian Government Space Forum. There are also some notable missing stakeholders including the Department of the Prime Minister and Cabinet, the Department of Climate Change and the Customs and Border Protection Service. See http://www.innovation.gov.au/Industry/Space/Pages/SpaceForumMembers.aspx, for further details.

[16] Senate Inquiry, *Lost in Space?*, 2008. See especially, Recommendations 4 and 5 (reproduced at Annex A of this report).

One advantage of this approach, vis-a-vis an agency model, is that the policy unit, within the larger departmental structure is shielded somewhat from future, and anticipated government efficiency measures which tend to be applied indiscriminately to large and small organisations alike. A large department is better able to absorb a 5% or 10% cut in funds than a small agency. The Finance Minister has made plain that he and the current Government has no stomach for small, specialist agencies. In his view they can lead to inefficiencies in the machinery of government which he is seeking to avoid.

> The indiscriminate creation of new bodies, or the failure to adapt old bodies as their circumstances change, increases the risk of having inappropriate governance structures. . . . When determining the appropriate governance structure for a new function or activity, I have asked my colleagues to consider, in the first instance, whether it can be accommodated within an existing body. While forming a new body may be attractive from many perspectives, including signalling a new presence to citizens and other stakeholders, consideration should always be given to the alternatives. Incorporating a new function within a department is almost always the preferred option because of the difficulties a small body faces in meeting its own needs.[17]

In December 2009 the UK Government announced that it was moving to create a space agency to replace the British National Space Council, which has lacked authority and a budget. Presently the UK Government spends about £270 million annually (AUD 480 million) on space, mostly via its membership of the European Space Agency. A number of key UK departments have agreed to contribute personnel and funds to the revised organisation in order to strengthen coordination of British space activities, and to provide a platform from which to improve industry performance. The UK

[17] Tanner, The Hon. Lindsay, MP., Minister for Finance and Deregulation, Speech to Australian Institute of Company Directors Public Sector Governance Conference, Canberra, 14 October 2009.

space industry sector contributes in the order of £6.7 billion (AUD 11.6 billion) a year to the UK economy and is considered to be at the forefront of innovation in that country.[18]

The UK experience is likely to provide relevant pointers which may be adapted and adopted to guide developments in Australia.

## IMPLICATIONS FOR A NATIONAL SPACE POLICY

This section has ranged widely over domestic matters which a national space policy may need to comprehend. The following recommendations are made.

### *Principal Recommendation*

The principal recommendation of this report relates to the document that should sit above the national space policy to provide context and a sense of relative priority. This recommendation is:

> That any revised National Security Statement must include reference to space security as a necessary element. Space-based communications, timing and navigation and earth observation services are a vital, if not essential, 'virtual' component of Australia's national infrastructure. It behoves the nation to take all reasonable steps to ensure that access to these services is assured and secure over time and that Australia has a sufficiently independent and self-reliant voice to be counted on its own merit and not merely as a close ally of the United States.

### *Supporting Recommendations*

The proposed national space policy:

[18] UK Department for Business Innovation and Skill, News Release, Science Minister Announces New Executive Agency for UK Space and Satellite Industry, 10 Dec 2009, London, http://www.financeminister.gov.au/speeches/2009/sp_20091014.html.

- Must acknowledge the enduring drivers of Australia's approach to space, notably the advantages and limitations conferred by strategic geography, alliance and broader international obligations.
- Should carefully distinguish between Australia's strategic and operational interests in space yet demonstrate how necessary and sufficient investment in the latter positively impacts on the former by developing national capacity, competence and confidence in space-related activities.
- Should acknowledge the requirement for close executive coordination of Australia's space equities and activities, closer than has occurred in the past; it should acknowledge steps already taken to strengthen coordination without making any commitment about a space agency, or any similar body, until considerably more evidence has been obtained and evaluated.
- Should enunciate principles for governance and oversight of Australia's current and proposed space investments but leave open the question of structure and possible funding sources; these and related matters may belong better in a parallel document-- an investment strategy-- which states how the policy will be implemented.
- Might acknowledge the importance of leadership as an essential element to the creation of a sense of coherence between companies, researchers, operational staff and policy makers all with vital interests in space which have not being properly realised in the past due to fragmentation and the lack of common purpose.

# Securing Space

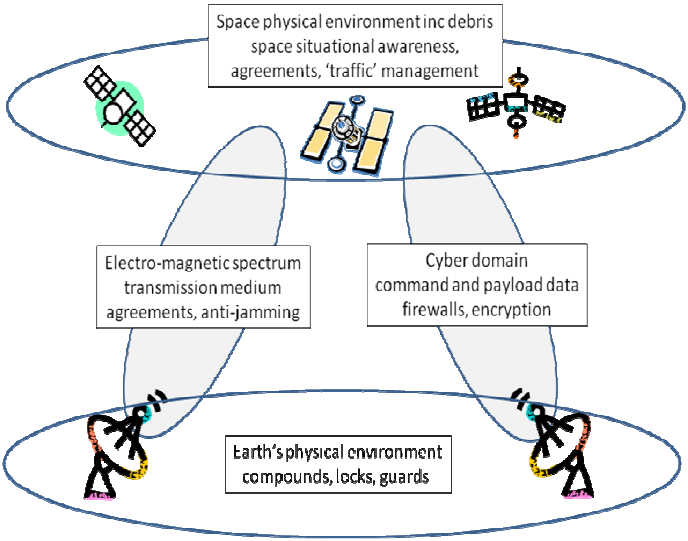
## DEFINING THE PROBLEM

Space is a hostile and fragile place. In addition to the political domain, a sustainable and comprehensive space security regime must address four environmental domains as well:

- The Ground Domain: Earth stations, control and processing facilities and the work force;
- The Electronic Domain: that part of the electro-magnetic spectrum which is used for communications between satellites and Earth stations and, increasingly, between satellites, this is the medium through which data passes;
- The Cyber Domain: the information and data which passes via the medium of the electromagnetic spectrum to and from spacecraft; and
- The Physical Domain of space.

Assured and secure access to space cannot be achieved unless each of these domains is adequately protected in its own right and unless the interactions between the domains are also understood, leading to a comprehensive approach across the entire system. Trade-offs must be made and investments balanced on the basis of evidence-based risk and threat assessments.

**Figure 2. Domains of Space Security**




The purpose of security of any sort is to protect:

- People from being subverted,
- Information from being stolen or interfered with, and
- Property from being damaged or destroyed.

To this end considerable efforts are taken by Governments and private entities to protect their people, their information and their property. These general principles apply to space systems as they do for any other system. However, their application in the space environment is different.

The following section outlines the challenges involved in securing satellite systems from a technical perspective. The overwhelming point is that this is basically impossible to achieve. There are numerous single points of failure and no amount of technology will prevent a determined adversary from intruding and causing damage at some point in the system.

## ASSURED AND SECURE ACCESS TO SPACE

There are near and longer term threats to space security. All need to be identified, assessed and treated appropriately. Mitigation measures taken quickly tend to be reactive and can be difficult to undo at a later time. Longer term measures may be more robust and enduring but come at the risk of not being ready in time to counter a particular emerging threat. Intelligence, counter intelligence and security intelligence all have important roles to play in helping decision makers to determine the balance of short and long term security risk and the appropriate mix of response options.

### *The Ground Domain*

The ground domain is the most familiar and tangible from a security perspective. Intruder detection systems, fences, locks, checks, procedures and guards can provide layered systems to protect physical assets, such as satellite ground stations, the information they contain or regulate the people who design, build and operate such systems.

People can be, and are, subjected to suitability and character testing which aims to minimise the likelihood that they will act inappropriately when occupying a position of trust. The 'insider' threat remains the most serious and potentially damaging of all threats to satellite systems.

None of these systems are fool-proof as shown by the regular failures of airport security and other similar systems.

### *The Electro-Magnetic Spectrum Domain*

The electro-magnetic spectrum domain refers to the medium through which communications occur between Earth and satellites. Most communications between Earth and satellites occur in a familiar set of radio frequencies; however, systems which use much higher frequencies are also now being developed. Radio communications may suffer from Radio Frequency Interference (RFI). Mostly this is transitory and unintended, either being caused by natural phenomena

such as solar flares or by malfunctioning equipment. Interference is readily detected and the questions become immediately ones of source and intent. Was the interference unintentional or intentional? If unintentional what is the source of interference and what can be done to overcome the problem? If intentional, who was responsible, why did they do it, and is retaliatory action warranted?

Interference may be subtle, making attribution of cause and intent extremely hard to determine. Crude measures also exist, such as the detonation of an electro-magnetic pulse weapon which may prevent many satellites (friend, foe and neutrals alike) from functioning properly. To date, such measures have not been used and there is no evidence, in the public domain at least, to suggest that any nation has any formed intent to take such drastic measures.

### *The Cyber Domain*

The cyber domain refers to the content of commands and other data transmitted between Earth and satellites. By definition any hacking attack against any satellite system is a deliberate act; however, the identity and the intent of the hacker may not be immediately apparent and this would need to be determined before retaliatory action could be contemplated.

Whereas electronic attacks target the transmission medium, cyber attacks target the information being carried on the medium. Firewalls and other network security techniques and encryption are examples of measures that may be taken to deter and foil would be hackers from gaining access to and interfering with these data streams.

Satellite operators go to considerable lengths to protect their satellites from electronic and cyber attack.

### *The Physical Domain of Space*

Space is a fragile environment which is readily disturbed. Any compromise to the environment potentially affects the

safe operation of all satellites, irrespective of their launch state and the operator.

Space debris is of increasing concern. Today in the order of 800 operational satellites are in orbit around Earth. These are accompanied by tens of thousands of pieces of space debris and by millions of smaller objects as well. The impact of even small objects, such as a fleck of paint, hitting a large object can cause significant even catastrophic damage.[19]

Space-faring nations have agreed to a number of measures which are designed to reduce the proliferation of debris in future. However, in recent years, the deliberate destruction of two satellite and a collision between two others has added considerably to the amount of debris in the Low Earth Orbit domain. [20] Arguably the political fall-out from these events has been a greater consequence than the physical, serving as a wake-up call to the international community to rethink the regulatory regime for space to consider the increasingly cluttered physical, electronic and political environment.

## *Balancing the Risks*

Of these four security domains, the first three are reasonably well understood, as are the measures needed to mitigate the security risks they present. The integrity of the physical domain of space is now emerging as perhaps the most serious challenge being faced by space-faring nations and the users of services from space alike.

## *Mitigating Space Dependencies*

There are some mitigating technical options available to nations acting on their own account but these are not

[19] Christiansen EL, Hyde, JL, Bernhard, B, 'Space Shuttle debris and meteoroid impacts', *Advances in Space Research*, 34, 2004, pp. 1097–1103.

[20] See p. 28 for some detail of these events.

comprehensive, they come at considerable cost and they can limit interoperability. Examples of such measures include:

- The use of High Altitude Long Endurance (HALE), unmanned aerial vehicles (UAV) for surveillance and reconnaissance tasks and also for communications relay – noting the fundamental limitation that these vehicles need authorisation to overfly foreign territory;
- The use of networked satellites to reduce single points of failure in communications in space;
- The use of high frequency (HF) radio communications to cover long distances, noting that the amount of data capable of being transmitted by the HF radio medium is considerably less than that which can be transmitted by modern satellites; and
- Deliberate policies to avoid undue dependence on GPS and related systems for navigation and timing.

The capacity for nations acting alone to secure the physical environment of space is limited and the environment is readily disturbed to the detriment of all users. The keys to a secure space environment rest in tireless and well-informed diplomacy, necessary and sufficient transparency, confidence building measures, and agreed 'rules of the road' which govern the conduct of space operations and which are agreed, and followed by space-faring nations.

## IMPLICATIONS FOR A NATIONAL SPACE POLICY

The proposed national space policy:

- Should acknowledge that space is a fragile environment which is easily disturbed and that any such disturbance may be expected to have direct and far-reaching consequences for Australia as well as for all other nations.
- Should acknowledge that assured and secure access to space is only capable of being realised with any measure of certainty if a holistic approach is taken to

space security which addresses the ground, electro-magnetic spectrum, cyber and physical domains.

- Should acknowledge that the satellites on which Australia depends are considered to be components of the critical national infrastructure and that they will be afforded such protection as Australia can muster diplomatically and technologically.

# International Developments

The international political environment is increasingly complicated and vexed. Important parts of the space environment itself are under stress from human activity.

There are several key themes to the political discussion: US space policy, proliferation in the number of space-faring nations and the relationship between space diplomacy and the diplomacy of nuclear disarmament, and the abolition of other weapons of mass destruction (WMD).

## US SPACE POLICY

The space policy of President George W Bush's Administration was cast in the language of dominance and unilateral action. The US reserved the right to destroy any piece of infrastructure in space and on the ground, irrespective of location, if that system was seen to be supporting activities considered to be inimical to its vital interests. Many other nations, including traditional allies of the US, found the rhetoric and the implied reality to be belligerent, offensive and disrespectful of their own capabilities and ambitions.

Many nations and commentators judged the US policy of dominance to be technically unachievable so hubris, rather than rational calculation, seemed to be a driving force. The policy flew in the face of the Outer Space Treaty which asserts that outer space is a 'global commons' to be used for peaceful purposes for the benefit of mankind. It was a unilateral declaration of intent which asserted a right to independence of action without the requirement to consider the consequences for others.

There is no question that of all nations the US has by far the largest investment in space for all purposes – military, civil and commercial. There is also no doubt that the US is most dependent on space-based services which pervade all sectors of national life. This is both a strength and a vulnerability. The

US military, like none other, is capable of unparalleled global reach, in no small measure because of its reliance on space-based services. The vulnerability is inherent in the fragility of the space environment and the difficulty of providing conventional forms of protection to space assets (satellites). They cannot be locked away or guarded by traditional means.

The Bush policy was based on the assumption that technical means could be developed to counter any and all activities, in or through space, which the US determined were directly or indirectly inimical to its vital interests. Ballistic Missile Defence (BMD) was perhaps the touchstone program. Phrases such as "offensive counter space" entered the lexicon indicating that military forces had begun to apply their conventional approach to convention warfighting – thrust and counter-thrust, offence and defence - to the theatre of space. The likelihood of technology being able to defend with complete assurance against any attack within or from space is not simply remote but approaches defiance of the basic laws of physics.[21]

From the perspective of crafting an Australian national space policy, the following principles would seem to stand out:

- the policy must consider Australia's interests and obligations to alliance relationships, notably with the US; and
- the policy must take account of Australia's multinational treaty and related commitments.

President Obama's Administration has launched a review of US space policy in the context of a more wide ranging set of strategic posture reviews. Informal indications are that the space policy of the Obama Administration is likely to be less bellicose in language and place considerably more emphasis on international cooperation and collaboration as the only realistic and affordable path by which the US will be capable of adequately securing its vital interests in space. Whether such

[21] Johnson-Freese, J., *Heavenly Ambitions: America's Quest to Dominate Space*, University of Pennsylvania Press, Philadelphia, 2009, p. x.

a policy will be endorsed and funded by Congress remains to be seen.

A question for Australia is whether Australia might seek to influence the space policy debate in Washington. If Australia were to become involved, what should be the extent of this involvement and at what direct and indirect cost? Australia would also need to determine how to judge the effectiveness of such intervention which, almost invariably, would have bi-lateral and multi-lateral dimensions.

Bringing this conversation down a level, what might an Australian space policy say about US policy?

Such considerations will occur within a politically charged and rapidly changing environment. Mention has been made already of the Chinese ASAT test in early 2007 and of the destruction by the US of a crippled intelligence satellite in 2008. More recent developments include:

- The collision early in 2009 between a defunct Russian spacecraft and an operational Iridium communications satellite.
- Various missile launches by North Korea and Iran in the latter part of 2009 which raised widespread international concerns as to the capability of these regimes to launch weapons of mass destruction (WMD). In the absence of clear understanding about the intent of these regimes, emphasis is placed on trying to understand the nature of their capability.

These are substantial developments since Kokoda Report Number 7, *Skin in the Game: Realising Australia's National Interests in Space to 2025*, was published in mid-2008.

Australia needs to quickly strengthen its credentials and capability in space in order to contribute more effectively and to the fullest possible extent in international debates and discussions which aim to provide all nations with assured and secure access to space.

## SPACE WEAPONISATION AND MISSILE DEFENCE

The world's major space powers, the US, Russia and more recently China and India, have all allocated resources to developing an array of technologies which could be used to attack and even destroy space objects, including satellites, ballistic missiles and their warheads. Some of these systems, such as the kinetic interceptor being developed by the US, have no purpose other than as weapons. Others are more ambiguous.

How is it possible to know if a collision in space was accidental or intended? How is it possible to know if the jamming of a satellite communications system or the 'dazzling' of a satellite sensor is accidental or deliberate? There are no easy ways of finding answers to such questions. A useful first step is to understand the environment – where space objects are, what they do and why they are where they are.

Australian strategic policy is unambiguous in its commitment to nuclear non-proliferation and, by extension, to preventing strategic weapons from being placed in space.

The Labor Party's policy, which provides the aspirational direction of the Government's policy is clear:

> **Ballistic missile defence**
>
> Labor considers that the proliferation of weapons of mass destruction and ballistic missile delivery systems is one of the most serious international security issues confronting the world today. Labor considers effective efforts to combat these developments require sustained multilateral, diplomatic and defence cooperation and action.
>
> Labor is concerned that as a unilateral response to the problem of ballistic missile proliferation, national missile defence is disproportionate, technically questionable, costly and likely to be counter-productive. It also has the potential to undermine non-proliferation and derail world progress towards nuclear disarmament. Labor also notes that national missile defence would impact on the security

situation in the Asia-Pacific region, and that this could have serious consequences for Australia's strategic circumstances and national security.[22]

Successive Australian Governments, Liberal and Labor, have approached the concept of ballistic missile defence with considerable caution and Australian involvement, to date, in missile defence activities has been confined basically to limited contacts between relevant US agencies and the Defence Science and Technology Organisation (DSTO). These contacts have permitted Australia to understand some of the core technologies involved in missile defence and to assess the implications for Australia's enduring national security interests. The 2009 Defence White Paper proposed a series of 'hedging investments' in a number of new capability areas including, "...space capability assurance against counter-space threats, ballistic missile defence and counter-WMD capabilities (the latter in the event that a rogue state or non-state actor acquires WMD capability that is likely to threaten Australia)".[23]

Missile defence, as a concept, is one of the 'elephants in the room' in the developing and increasingly multi-faceted relationship between the United States and China. Each nation is suspicious of the intent and capabilities of the other in space. At some point, unless carefully managed by the leadership of both countries, this could represent a security challenge of considerable magnitude to the region and to global society more generally.

A further regional complication has arisen with the announcement by the head of the Indian Defence Research and Development Organisation (DRDO) in January 2010 that India is developing "lasers and an exoatmospheric kill vehicle

[22] Australian Labor Party, 'National Platform and Constitution', Chapter 10 paras. 126-127, 2009.

[23] Defence White Paper 2009, para. 8.28, p. 62.

that could be combined to produce a weapon to destroy enemy satellites in orbit."[24]

Australia has vital interests in maintaining very sound relationships with the United States, China and India. Australia may be called upon to exercise all of its creative diplomatic skills to do what it can to ensure that the interests of especially the US and China are mediated such that competition between these two nations does not lead to a debilitating and potentially de-stabilising arms race and possibly to direct conflict.

## *Looking Ahead*

George Friedman in his 2009 book, *The Next 100 Years: A Forecast for the 21st Century*, makes a series of predictions about the importance of space to world affairs in the current century. The two themes from his book which are relevant in this context are:

- US global supremacy today is a function of sea control based on surveillance from space; and
- By 2050 US pre-eminence in space will be enshrined in international law and the US will maintain manned command and control centres (he calls them "Battlestars") in geostationary orbits.[25]

Friedman is the first to admit that the further into the century he looks, the less accurate his predictions will be and many may well disagree with those predictions, dismissing them as far-fetched and fantastic. However, the certainty is that human use of space and the geo-politics of space almost certainly are going to change profoundly and these changes are likely to affect the lives of all on the planet.

[24] V.K. Saraswat, Director-General of the Defence Research and Development Organisation of India to the 97th Indian Science Congress in Thiruvananthapuram, 3 Jan 2010. Reported by Peter B. de Selding, Paris

[25] Friedman, G., The Next 100 Years: A Forecast for the 21st Century, p 180-183, 2009

The loose governance arrangements which successive Australian governments have applied to space provide neither a necessary nor sufficient basis from which Australian interests can be defined or articulated internationally and, if necessary, defended.

## SPACE: A GLOBAL COMMONS

The international treaty regime which has regulated human activities in space since the early 1960s is based on the principle that space is the common heritage of all mankind. Article 1 of the Outer Space Treaty states:

> The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.[26]

More than 40 years have passed since the Outer Space Treaty entered into force in 1967. Much has happened in that time and the aspirational words of the Treaty have been given remarkable effect. Although few nations actually launch and operate satellites, the people of all nations on earth, from the richest to the poorest, benefit from the work horse space applications – timing and navigation signals which are provided as a free good by the US to any would be user, satellite communications and the data from remote sensing satellites.

Space has become a global commons and there is no technological solution capable of guaranteeing that it will stay this way. No nation, not even the United States, possesses the capacity to impose its will on every other space-faring nation by force if necessary without placing in jeopardy the environment it sets out to preserve.

[26] United Nations, "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies" (the Outer Space Treaty), entered into force 10 October 1967

The regulatory regime of the Cold War is struggling to cope with the politics of 21st century space. The US/Russian duopoly of the 1960s has given way to a more complex system of 20 or so nations which design, build, operate and launch satellites.[27] The handful of satellites in the 1960s, has now grown to hundreds, each seeking to be secure in its orbit and each seeking to have access to the radio spectrum bandwidth necessary for the conduct of its mission.

There are clear signs that the US, China, Russia, India and possibly Israel and Japan as well are all investing in technologies designed not only to protect their own satellites but also with the potential to attack the satellites of others. This is an expensive and risky business and the opportunity exists for Australian policy to demonstrate leadership backed by national capabilities which can remove much of the doubt and ambiguity which presently surrounds the space environment in order to deter inappropriate behaviour, and to encourage transparency and the cooperation necessary to ensure that space remains accessible to all on an enduring basis.

## IMPLICATIONS FOR A NATIONAL SPACE POLICY

The proposed national space policy:

- Must be firmly set in the context of Australia's national security overall, taking account of:
  - Australia's alliance relationship with the United States,
  - Australia's determination to use creative middle power diplomacy to further its national interests in bilateral and multi-lateral forums, and
  - Australia's aim to become more self-reliant in remote sensing and generally more competent in space matters.

[27] The list includes: Brazil, Canada, China, Japan, France, Germany, India, Israel, Italy, South Korea, Russia, Ukraine, UK, USA. Some other nations need also to be taken into account, notably, Iran, North Korea and Pakistan

- Should emphasise Australia's determination to take all reasonable steps as a reputable middle power to keep space a 'global commons' at the disposal of all of mankind for peaceful purposes with the corollary that Australia will take all reasonable steps to ensure that weapons are not placed in space.
- Should emphasise Australia's determination to abide by international treaty and customary law as it applies to the regulation of space. Australia will take positive steps to strengthen the regulatory regime and associated cooperative and confidence building measures which govern human activity in space to avoid misunderstanding, miscalculation and rash action which may be harmful to the interests of all space-faring nations and mankind more generally.
- Should state that no nation has, or is ever likely to possess, the technical means to dominate space; that is, to deny access to any other nation or to prevent the space activities of any other nation with complete certainty. This recognises that assured and secure access to space can be achieved only through cooperative and collaborative means.
- Should place high value on global partnerships and collaborative activities beyond Australia's relationship with the US and, to this end, foreshadows that resources will be allocated to strengthening existing relationships with space-faring nations and to creating new relationships as and where appropriate.

## Space Situational Awareness

Space Situational Awareness (SSA) is a clumsy phrase the meaning and implications of which are not readily apparent. Put plainly SSA is about knowing where satellites and other objects, including space debris, are in space. SSA is also about knowing something of the purpose and operational profiles of satellites. Satellites in Low Earth Orbits typically circle the Earth every 90-100 minutes at a speed of around 20 000 km/hr. As already noted, collisions between even the smallest objects at these sorts of speeds can be catastrophic. A key task for SSA systems is to allow satellite operators to de-conflict orbits in order to minimise the risk of collisions.

One positive attribute of objects which orbit the Earth is that their orbits are mostly stable and predictable. Over time, the orbits decay and the objects re-enter the Earth's atmosphere where most burn up. Some larger objects, or parts of them, survive re-entry and reach the Earth's surface.

The United States, France and Russia have developed SSA systems which can monitor thousands of space objects as they orbit the Earth. These include operational and defunct satellites and space debris. The operators of these systems look for what the Americans call 'conjunctions'. Conjunctions occur when two or more space objects are predicted to pass close to each other and possibly collide. Not only can collisions cause catastrophic damage to a working satellite, they also create more debris and the prospect, of more conjunctions and collisions.

Although vast, some regions in space, especially those parts used by the world's satellites, are increasingly crowded. Numerous countries have developed launch capabilities and even more are operating satellites in their national interest. Most operational satellites are either in Low Earth Orbits (LEO) or in Geo-Synchronous Orbits (GEO). In addition there are in orbit tens of thousands of pieces of space debris down to the size of a small coin and possibly millions of even smaller

objects such as flecks of paint. Nature adds to this collection with meteorites and micro-meteorites as well as the occasional large object.

Satellites in LEO mostly carry cameras and other sensors which are used to observe all manner of phenomena on Earth, including rainfall, soil moisture, vegetation types and crop growth. Reconnaissance satellites and human space missions, including the International Space Station (ISS) also operate in LEO.

LEO satellites, together with vast quantities of space debris, operate in orbital planes which cross the polar regions on each orbit. This means that LEO space above the poles is increasingly congested.

GEO satellites occupy orbital 'slots' about 36,000km above the Equator and orbit the Earth at a speed coincident with the speed of rotation of the Earth. This means that satellites in GEO appear to be stationary relative to the Earth. GEO is largely the preserve of communications satellites, both commercially and government owned. Also in GEO are various types of earth-observation satellites which stare, more or less continuously, at the region of the Earth which is below them. The orbital slots are increasingly scarce and their use is closely monitored by the International Telecommunications Union (ITU).[28]

Radio interference is a constant concern for operators of all satellites but, especially those in GEO. Signals beamed between the Earth and particular satellites, unless carefully managed and monitored, can interfere with transmissions to and from other satellites, notably those in adjacent positions or 'slots'.

In the past three years, three events have served to focus the attention of policy makers on the fragility of the space

[28] For the sake of completeness, GPS timing and navigation satellites occupy Medium Earth Orbits (MEO) in physically uncluttered regions of space.

environment and especially on the LEO environment in which most satellites operate.

**Chinese ASAT Test**. In January 2007, China conducted an anti-satellite (ASAT) test in which an old satellite, Feng Yun 1-C, was destroyed with a rocket fired from a launch site in China. The impact in a particularly crowded part of low earth space created a debris field of at least 35 000 separate objects larger than one centimetre. There is much about the Chinese test which remains unclear, including the level of authorisation for the test to proceed, the timing of the test and the adequacy of the risk assessment – notably the size of the debris field likely to be created and the degree of international political fall-out which followed. The debris field has directly impacted the space operations of numerous satellite operators.[29]

**US Destruction of a Crippled Intelligence Satellite.** In February 2008, the US destroyed an intelligence satellite (designated US 193) which had failed to achieve its intended orbit some time previously. This was, for all intents and purposes, an ASAT test. The official reason given by the US for this action was to prevent potentially highly toxic satellite propellant from returning to Earth. The US took pains, through careful selection of the intercept geometry, to ensure that many of the objects in the debris cloud created by the impact would quickly fall towards Earth. The impact of the residual debris field for ongoing space operations seems to have been minimal.

**Russian/US Collision.** On 11 February 2009, a defunct Russian satellite collided with a functioning US Iridium communications satellite over northern Siberia. The satellites were both in highly-inclined orbits (meaning that they crossed the polar regions on each orbit). One satellite seems to have driven into the side of the other. Two debris fields were created by this collision – one along the orbital path of the

[29] Johnson-Freese, J., *Heavenly Ambitions: America's Quest to Dominate Space*, University of Pennsylvania Press, Philadelphia, 2009, p 9ff.

Russian satellite the other along the path of the American satellite. Given the vastness of space, the odds of such an event occurring at all are extremely low although the consequences can be severe. The event has therefore raised an alarm in the international community that some parts of space need to be more carefully monitored to reduce the likelihood of similar future events occurring.

Adding to these concerns are questions arising from developments in technology. Large satellites are now being launched with their own onboard surveillance cameras which scan the immediate vicinity of the satellite for signs of debris or other objects which could become a hazard. The technology exists to build and launch small satellites which can be placed in orbit close to large satellites. The small satellites might perform benign environmental monitoring tasks. Equally they might carry an electro-magnetic or a kinetic charge which may be detonated at a time of crisis to cripple the large satellite. In effect, they can perform as space-based weapons.

Ground-based lasers can be used to 'dazzle' space-based instruments and to oblate the surface of objects in orbit, thus altering their orbital characteristics and potentially their operational utility. Less dramatically, the data communications on which all satellites depend for their links to Earth can be quite easily interfered with or jammed, either intentionally or unintentionally.

This is not the stuff of fiction. The capabilities exist today to cause such events to occur, and indeed they have occurred. In some instances, whether such an event was an accident or deliberate has been impossible to determine. Herein lies the rub. What can the world do to reasonably prevent accidents in space and deter hostile acts in space?

## CURRENT SSA CAPABILITIES

Both the Soviet Union and the US developed SSA systems during the Cold War. Both systems have struggled to attract new and persistent investment in the intervening years. There

is evidence that this is changing and renewed attention is being paid to SSA as the world's dependence on space-based services is better understood by governments. China, India, Japan and Europe (the latter through EU mechanisms), have all indicated intent to develop some degree of SSA capability aimed initially at reducing the vulnerability of their national systems. France has already done so.

The United Nations maintains a register of objects launched into space. Launching States notify the orbits and other details of satellites and this data can be reviewed to determine if proposed orbits might lead to collisions. These arrangements have major limitations, however. Not all launches are notified. Satellites do not remain precisely in their assigned orbits, either because operators have deliberately modified the orbits or because the satellites have begun an inevitable process of re-entry into the atmosphere. Space debris can be orbiting in almost any direction.

The SSA system operated by the United States, although by no means comprehensive, is the most capable in operation. Much of the data is made freely available on-line, although not to the same level of detail as is available at the classified level to the US and allied security communities. A critical weakness of the US system is the lack of ground-based SSA sensors anywhere in the southern hemisphere. This gives rise to two main concerns; launches from Asia and data quality.

### *Launches from Asia*

Space launches from Iran, China, North and South Korea and Japan into typical highly-inclined LEO orbits are conducted in a southerly direction. The actual launch almost certainly will be detected by US satellites with powerful infra-red sensors which can detect the hot exhaust plume of the launch vehicle against the colder background of the Earth, the atmosphere and near space. However, the US has no reliable means of detecting the payload until it has crossed Antarctica and is ascending northwards across the Atlantic. In the intervening 40 minute period, especially if one vehicle has

launched several satellites, they can have been placed into discrete orbits to achieve quite different operational objectives.

At present the task of finding, categorising and cataloguing these objects is time-consuming and can lead to ambiguity and uncertainty.

### *Data Quality*

The location of any space object which has been catalogued by the US is given in terms of a three-dimensional ellipse. A region in space and time along the predicted path of the object is noted with a probability that the object will be somewhere inside the defined volume at the time given. Where ellipses intersect, a conjunction is formed. Satellite operators and others then have to decide what, if anything, to do about the potential collision. The more precisely an object's orbit is measured and the more often it is observed, the finer the tolerances and the smaller the defined volumes in which the object will be located.

Precision comes with data and the current situation, where some objects can proceed unmonitored for long periods, is not conducive to creating high levels of confidence in the data itself or in its relevance and utility.

## SSA IN AUSTRALIA

### *Strategic Geography.*

Australia's strategic geography lends itself exceptionally well to hosting SSA sensors. The United States has already initiated discussion with Australia about locating SSA radars on Australian soil and there is a high likelihood this will occur. The question for policy makers, and for a national space policy is, under what terms?

The United States has a deep vested interest of its own in strengthening its SSA network in the southern hemisphere and this could tempt Australian policy makers to leave the US to bear the brunt of the investment, with Australia being content

to provide the real estate. This would be to forego an enormous strategic and a significant industry development opportunity.

## *Engagement Models*

Three models for Australian involvement in SSA are advanced:

- US ownership and control of the radars with some degree of Australian participation and data access – an arrangement similar to the model which has applied to Joint Facilities such as Nurrungar in the past and which applies to Pine Gap today.
- Shared ownership and control with Australia contributing to the development and installation costs as well as to the ongoing costs of operations.
- Full Australian ownership and control with data being provided to the US, and potentially to others, at Australia's discretion. This option would, by necessity, involve innovative Australian industry. It would allow the Australian Government to determine the extent to which it might or might not wish to be involved in the ballistic missile defence of the US through SSA being used a cueing mechanism for responsive strike (SSA data cannot be used to guide an intercept vehicle into an approaching missile).

With regard to the first and second models, over time another option might emerge whereby Australia could progressively accept more responsibility for operating SSA sensors on Australian soil as other components of capability, notably qualified staff, are trained. As these people gather the experience, not simply to operate the systems but also to advise policy makers and politicians of the implications of particular events or predicted events in space, the SSA system would be expected to become a source of intelligence and advice of importance to government.

The easiest and least expensive option is the first. The most expensive and potentially most nationally advantageous is the third. A way of realising the third option incrementally has been described.

## FULL KNOWLEDGE AND CONCURRENCE

When Pine Gap and Nurrungar were first established they were essentially stand-alone facilities with thin communications links providing processed information to various headquarters and other agencies in the USA and also in Australia. Australian officials were integrated into the operations of both facilities. They had deep operational knowledge and could assure the Australian Government that the facilities were only being used for the purposes agreed in the formal arrangements under which facilities were established.

The advent of the internet and networking technologies more generally has wrought major changes. Nurrungar closed in 1999 because the Defense Support Program (DSP), of which it was part, no longer needed a manned ground station in Australia. Today, two remotely operated satellite terminals located on land at Pine Gap pass tasking and collect data from the relevant DSP and follow-on satellites and forward that data directly to a processing centre in the continental United States. Pine Gap remains a major manned facility, although developments in networking technology in the past decade would now permit some of the intelligence gathering, treaty monitoring and verification functions once performed on site to be controlled remotely from the US

Australian personnel remain intimately involved in operations at Pine Gap today. However, the exercise of full knowledge and concurrence of an integrated global system of which Pine Gap is but one element requires a very different approach to that which has been applied in the past. A number of Australian military and civilian Defence officials are now integrated into major headquarters and agencies in the United States itself. They have deep system insight and

understanding although they may not see how every piece of information collected through the Australian-based facility is used.

The concept of full knowledge and concurrence has been an exceptionally important assertion of Australian sovereignty for more than 40 years. However, against the backdrop of rapid technological change the concept, as originally developed, has become little more than a convenient fiction. The opportunity exists to review the concept in the context of the space policy development process to the benefit of the Australian/US alliance relationship and potentially to inform Australia's response to future requests from other nations seeking to locate ground stations on Australian soil.

### *Sharing Intelligence and Sharing Knowledge about Capability*

An adjunct discussion, entirely relevant in the SSA context, concerns the type of information to be shared and the depth or level considered necessary by the Australian Government to protect and advance vital national interests.

To generalise, nations are far more willing to share intelligence about a third party than to share knowledge about classified technologies which provide a capability edge. As Australia's alliance relationship with the US had matured the US has indicated a willingness to share an array of advanced technologies with Australia. Perhaps the most obvious evidence for this is the Joint Strike Fighter project which can only succeed if there is substantial technology transfer from the US to Australia and other participating nations.

Such technology transfers can be impeded by the US International Traffic in Arms Regulations, the ITAR. These regulations are administered by the US State Department and Congress takes a close interest in their application and implementation. Presently, all US manufactured satellite components are subject to the ITAR and the regulations have

been interpreted so narrowly as to cause considerable harm to the US space industry over the past decade.

To underscore this point, the President of the US National Defense Industrial Association wrote the following in a recent editorial.

> U.S. industry depends upon exports for its financial health and to maintain proficiency. Some areas of the industrial base, especially the space industry, are suffering. Regulations in this sector are so restrictive that U.S industry is losing business to overseas competitors. One now routinely sees advertisements of "ITAR-Free" products in the space sector. This reflects the unreasonable restrictions the space industrial sector suffers.[30]

From the perspective of Australia's space ambitions, ITAR is a two-edged sword. There is no question that Australia has the opportunity to develop ITAR-Free technologies and products which can be sold globally, including into the US. However, alliance sensitivities may lead to self-limiting behaviour by Australia to ensure that some technologies are not marketed or sold widely. Australian companies seeking to collaborate with US companies in technology development programs need to be aware of the difficulties that ITAR can present unless carefully and continuously managed.

Irrespective of how Australia decides to proceed with the implementation of SSA capabilities, questions about full knowledge and concurrence and technology transfer should be anticipated. SSA offers Australia in the 21st century an opportunity not dissimilar to that offered by Over the Horizon Radar (OTHR) technology in the latter part of the 20th century. Indeed, SSA would potentially provide a lot more because the data from SSA sensors has global relevance and impact whereas that from the Jindalee OTHR system is regionally bounded and of limited relevance, even to regional

[30] Farell, LP Jr, 'President's Perspective', *National Defense*, November 2009, p. 5.

neighbours, unless integrated into a sophisticated all source surveillance fusion system.

## INDUSTRY INVOLVEMENT

Australia's investment in the Jindalee system has encouraged the development of enduring high technology capabilities in Australian industry. These include some of the core technologies needed for 'space fence' radars, including phased array sensors, low noise amplifiers and digital signal processors. Australia has developing strengths in systems and software engineering, both being essential for the successful implementation of a 'space fence' radar program.

These technologies are also directly relevant to radio astronomy and to Electronic Warfare (EW). Australia is seeking to host the Square Kilometre Array (SKA) radio telescope, a mega-science instrument which will span the continent, and to that end has committed well in excess of $100 million to build the Australian SKA Pathfinder (ASKAP) telescope which is due to be commissioned in 2012.

EW has been identified by Defence as one area where a high degree of self-reliance in terms of industrial capacity is considered essential. How this manifests through the proposed Priority Industry Capability (PIC) program remains to be seen. One imperative would seem to be to grow the overall industrial base for EW and adjacent technology areas. Indigenous investment in 'space fence' is compelling in this regard.

There are synergies between OTHR, radio astronomy, microwave phased array radars, EW and SSA that warrant careful attention from the perspective of capacity building in industry.

## THE STRATEGIC AND OPERATIONAL BENEFITS OF SSA

### *Strategic Benefit*

As already noted the Australian economy is increasingly dependent on assured and secure access to space-based services. A credible national SSA capability, closely integrated to that of the US, would not only be a major national commitment to the Australia/US alliance, but would also allow Australia to participate from a well-informed basis in the international efforts which are being taken to strengthen space security.

The argument for Australian investment in SSA extends beyond Defence into the broadest national security domain including into most sectors of the economy and society. Sensibly, Defence should lead in the development, acquisition and operation of any SSA capability located in Australia, given its background and relevant experience. In formulating the Australian space policy an opportunity exists to consider the national, indeed international, significance and benefit of investing in SSA.

There have been suggestions that some senior leaders in the ADF may not be strongly committed to SSA largely on the basis that any Australian investment in such capabilities could lead to a reduction in the amount of money available to purchase new equipment for the ADF itself. By implication the suggestion is that the future operational effectiveness of the ADF might be compromised. Ultimately, this is a question for Government to resolve.

New money may be required to kick start this major strategic investment in Australia's security and one of the questions to be answered is the extent of the investment that government is prepared to make in SSA as a 'hedging investment'.

SSA does not readily fit into the organisational structure or culture of any of the Armed Services. The Royal Australian Air Force (RAAF) has taken the lead and is the designated

capability manager for space within Defence. However, finding staff to design, build and operate a SSA system under present guidance, may well come at the direct expense of the staffing levels and sustainability of some other capability.

In this regard, the Defence Reform Program (DRP) may offer some hope. If it succeeds in eliminating some of the endemic inefficiencies in Defence the DRP may release resources for SSA and for other capabilities as well.

### *Operational Benefit*

Many ADF activities and those of the Australian national security community more generally are often conducted without consideration being given to the possibility that they are being observed from space. Counter-surveillance in this country is undeveloped and under-valued as an important protective security discipline.

This comment may be broadened to apply to economic activity. Rates of mineral extraction, crop growth and yields, and the health of fisheries are examples of the sorts of information which competitors may derive about conditions in Australia from earth-observation satellites. SSA data would alert officials to the presence of space systems which may be gathering intelligence about these activities.

## IMPLICATIONS FOR A NATIONAL SPACE POLICY

The proposed national space policy:

- Should note, in the context of Australia's strategic geography, that this country is uniquely placed to host instruments such as SSA radars. The data from SSA could be used to build confidence amongst space faring nations by reducing uncertainty and ambiguity about the behaviour of particular spacecraft and other space objects.
- Should note the potential for Australian industry, building on current strengths, skills and experience, to

lead in the development of SSA technologies for national purposes and possibly also for export.

- Might note the essentially strategic and long term nature of investing in SSA and the implications for Australia's diplomacy and international standing and the US alliance.
- Might take the opportunity to review and possibly reformulate the doctrine of 'full knowledge and concurrence' to account for technological changes which severely limit the intent of the phrase being realised in practice.

# Dual Use Technologies

Space professionals commonly distinguish those who launch and use satellites for national security purposes from those who use satellites for civil and commercial purposes. Increasingly, satellite operators and investors are seeking to share cost and risk – leading to the concept of 'dual use' satellites and associated launch and ground systems.

The phrase 'dual use' has different meanings in different contexts. The most important concern from the perspective of an Australian space policy is how the term is applied to remote sensing satellite systems designed for both national security and civil or commercial applications. Broader meanings and contexts are discussed first.

## *Space Launch*

Most space launch facilities are owned and operated by governments. By their very nature, launch systems, including the facilities, launch vehicles and command and control, are 'dual use' because they are used to launch government and commercial payloads. Launch manifests and schedules need to be synchronised to meet the interests of all operators seeking to launch satellites. Australia has no organic launch capacity of its own and has expressed no intent or desire to develop or acquire such a capability. Future launches of satellites designed specifically to meet Australian needs may be expected to be provided largely on the basis of best value for money and could be provided by companies based in India, Russia, Japan, China and France, amongst others.

## *Communications Satellites*

The only space service which has become commercially viable is satellite communications. Typically companies recover the investment cost of a new communications satellite within five years of launch and reap dividends for the remainder of the life of the satellite. Some governments

operate their own communications satellites which are often hardened, more so than their commercial counterparts, against physical and especially electronic attack. Hardened satellites are not able to handle the growing amounts of data demanded by users, especially imagery and video, and governments now routinely purchase access to commercial satellites as well. In excess of 80% of all US Department of Defense communications traffic to and from the Middle East theatres of operations is carried by commercial satellites.

Australia makes heavy use of commercial communications satellites for national security purposes. The Department of Defence operates a shared payload on the Optus C1D satellite and it routinely leases additional bandwidth from commercial providers. The Australian Government, as already noted, is also investing directly into the US Government's Wideband Global System (WGS) and has announced plans to purchase dedicated bandwidth on a future INTELSAT satellite. These arrangements make operational and commercial good sense and point to a sophisticated understanding of the advantages of 'dual use' spacecraft.

### *Timing and Navigation*

The US Global Positioning System (GPS) is the world's primary Global Navigation Satellite Systems (GNSS). Russia and France operate partial systems and Europe, China, India and Japan have all announced their intention to invest in systems of their own over which they can exert some sort of sovereign control.

Although GPS was developed initially by the US Department of Defence to support American forces, the signal quickly became embedded in myriad civil and commercial applications which now impact, albeit transparently, on many aspects of daily life. American and allied forces, through specialised GPS receivers, can gain greater accuracy than can non-military users. However, the US Government realised many years ago that the global economic dependencies on GPS were so great that the signal would not be turned off or

severely degraded, even in times of conflict. To do so would cause more harm than good to US, allied, and other interests across the world.

Timing and navigation satellites are quintessentially 'dual use' systems. Australia, uniquely, is placed to benefit from all of these systems if it is prepared to develop robust integrative technologies which allow the separate systems to work as a virtual whole.

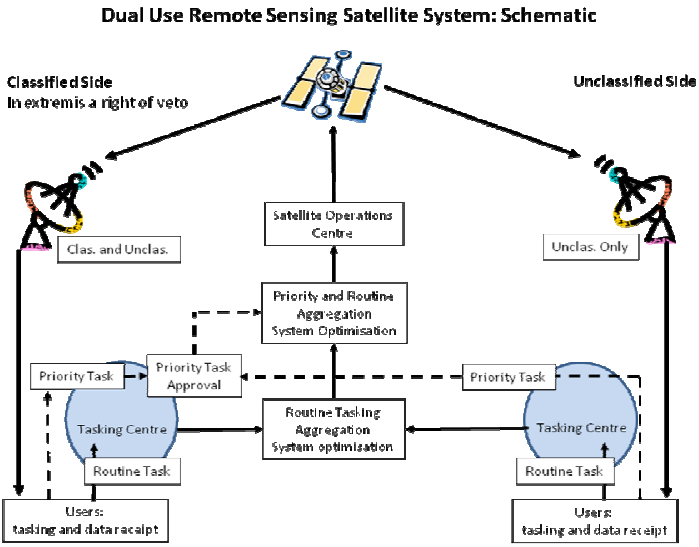
## REMOTE SENSING

The phrase 'dual use' has particular relevance in the remote sensing domain where the security requirements of the national security and defence communities can butt against the needs of other users in numerous ways. The most obvious is that national security requirements often dictate that data be collected over foreign territory, whereas the focus of most civil agencies is on the sovereign territory and territorial waters. Quite important trade-offs need to be made including in:

- satellite system design, including sensor and orbit selection;
- the tasking method to ensure that the integrity of classified tasking is not compromised;
- ways in which tasking contention are resolved and priority tasking, irrespective of source, is managed; and
- data delivery from the satellite to ensure that classified data is not made available unwittingly to those with no need to know.

The Italian Space Agency is leading development of the Cosmo-Skymed SAR satellite system which is an operational, dual use system. Figure 3 below outlines, in general terms, how tasking, contention, priority and data integrity issues have been resolved.

**Figure 3. Dual Use Remote Sensing Satellite System**




The SAR satellite proposed for Australia in the Defence White Paper may well be a 'dual use' system. Many trade-offs will need to be made. Three of the more important are:

- **Orbit Selection.** Almost certainly, the national security community will argue for the satellite to be in a LEO, possibly around the Equator, in order to regularly image Australia's northern approaches which are cloud-covered for much of the time – thus the attraction of a SAR satellite which can 'see' through cloud. The Civil community may well prefer a highly inclined orbit in order to obtain imagery on a regular, but not time-critical, basis of the Australian continent and adjacent waters, including those to the east, south and west of the continent. One satellite is incapable of meeting both of these objectives which points to the need for a suite of satellites, in time, with complimentary sensors and orbits.

- **Sensor Selection.** The radio frequency band(s) selected for a SAR sensor determines what it can 'see'. The national security community may well argue for the SAR satellite to operate in frequencies which allow ships and boats to be detected in Australia's maritime approaches and Exclusive Economic Zone whereas civilian users may argue for frequencies which better characterise land use, crop growth, soil characteristics, water flows, etc.
- **Tasking, Contention and Data Delivery.** Agreement across government will need to be obtained about the rules and policies to be applied if more than one agency seeks access to the satellite at the same time but for different and incompatible tasks. How these questions are resolved may be expected to influence technical aspects of the system design as well as decisions about the cost of the overall system, system governance, sources and shares of investment and operational level funding, and the way in which the operating authority is organised and staffed.

The actual organisational mechanism by which these and other potential sources of disagreement are resolved is yet to be developed. In the absence of an executive agent or agency for space, it may come down simply to a question of who is paying. Perhaps the most important point to make is that the satellite proposed by Defence is an operational satellite first and foremost. Its primary mission is to support identified users with identified requirements. It may support experimentation and research but as a secondary task.

## BUILDING DUAL USE CAPABILITY

When developing new capabilities Defence considers eight Fundamental Inputs to Capability (FIC). These are:

- Personnel
- Organisation
- Collective Training

- Major Systems
- Supplies
- Facilities
- Support
- Command and Management.[31]

Any new capability proposed for Defence must consider the investment required across each of the FIC. It is not simply a matter of purchasing a piece of equipment.

This is certainly the case with the proposed SAR satellite which is perhaps the most sophisticated and complex class of remote sensing technology yet developed. There is an enormous amount of preparatory work to be done. Appropriately qualified people need to be recruited or trained. New organisations may need to be created and existing organisations modified. Information systems will need to be designed which can accept, store and process the data from the proposed satellite and fuse that data with relevant information from other sources. Quite possibly a small number of precursor or pathfinder systems may need to be built and flown as experimental payloads to test and prove concepts.

Numerous opportunities for government departments and agencies beyond Defence, and for industry as well, are foreseen in these preparatory phases. The Defence SAR satellite project offers the possibility of becoming the cornerstone project of an emergent national space program.

## *Funding Dual Use Satellite Systems*

Almost certainly, the Australian Government, through Defence, will fund the SAR satellite envisaged in the 2009 White Paper. The satellite, as noted above, is only part of the total capability. Others departments and agencies may need to make their own arrangements in order to receive and process data from the satellite and to issue tasking requests.

[31] Australian Department of Defence, *Defence Capability Development Manual 2006*, Australian Government, Canberra, 2006, pp. 4-5.

Looking further ahead, follow-on satellites will need to be contemplated and eventually funded to ensure that the skills and innovation base developed for the Defence SAR project does not dissipate through want of follow-on work.

Two important issues come to the fore: the role of private investors, and the role of data use agencies such as the Bureau of Meteorology, Geoscience Australia as well as State and Territory level users including first responder agencies including police and fire authorities.

**Private Investment.** The Senate Committee report recommendations (Annex A) emphasised the importance of industry involvement in the future development of Australian space capability. Conversations with senior bankers indicate that the major Australian lending institutions have little appetite to invest in space activities because they have no experience in assessing the risk. These institutions are more than comfortable investing in "mortgages and mines" – markets they understand. They do not have the same confidence when being asked to lend in areas where technical risks are difficult to quantify and the returns on investment are less certain. Satellites present a further risk simply because of the remote environment in which they operate and the hazardous nature of space launches. This is an environment about which Australian banks have little knowledge or interest, notwithstanding the importance of the GPS timing signal to myriad financial transactions which occur around the clock.

**User Agencies as Satellite Investors.** Data user agencies, such as BoM, GA and emergency services organisations have no abiding need or interest to own and operate their own satellites or other sensors for that matter. Their prime concern is to gain access to data that is timely, accurate and relevant, at minimum cost so that they may perform their core missions efficiently and effectively.

Numerous satellite manufacturers and operators have come to Australia in the past decade to sell satellites to agencies whose principal interest is data. Fire authorities, for

example, have no interest in owning satellites which serve no useful purpose in terms of fire detection and monitoring in the Australian environment for nine of the 12 months of each year. This point seems to be missed or is deliberately overlooked. The net result is frustration all around. The satellite operators do not make sales (and so far seem to struggle with the concept that they might be trying to sell the wrong product) and the potential users want the data, but not the operating overhead. The market, so far, has not worked.

## Related Developments and Possible Alternative Technologies

The unique attribute of satellites, especially earth observation satellites, is that they may pass across foreign territory unimpeded. President Eisenhower, from the beginning of the 'space age' advocated an 'open skies' policy in space and this eventuated. No nation has seriously challenged the proposition that satellites should fly unfettered in their orbits around the Earth. To do so would be to defy the laws of physics. At times nations attempt to conceal activities from the view of satellites for national interest reasons and they take appropriate counter-measures to prevent them from being readily observed from space.

Australia, as already noted, has little current capacity to determine when other nations may be observing activities in this country or the activities of Australians overseas, such as deployed forces in Afghanistan, from space for their own purposes. As the number of nations operating remote sensing satellites increases and includes competitors, trading partners and potential adversaries, Australia will be well-advised to begin to take the discipline of counter surveillance seriously.

From an operational perspective, increased resilience and self-reliance in space may be achieved by numerous means, including the development though legal agreements of virtual constellations, more careful and systematic data re-use, increased dependence on aircraft, especially High Altitude Long Endurance (HALE) Unmanned Aerial Vehicles (UAV)

and responsive space. Each of these means is designed to remove single points of failure and to provide flexibility and redundancy.

**Virtual Constellations.** One possible way of meeting the needs of disparate users of geo-spatial information is to create, through binding agreements and contracts with a number of satellite operators, a virtual constellation of satellites by purchasing tasking and data rights over selected areas at selected times. This approach removes the investment costs and risks associated with satellite ownership and operation. There are disadvantages; some flexibility may well be lost, the use being made of satellites in the virtual constellation is apparent to satellite owners and operators and the service might only be available at a premium price.

**Data Re-Use.** For some applications, images or data sets that have been collected in the past are adequate for particular uses. A current image is not always needed; however, it is often easier to order a new image than to find an older one in storage and retrieval systems which have been neglected and not kept current in terms of the storage media in use and the actual data archive structures. Other applications seek to compare data, which has been gathered over decades, longitudinally. This is not possible unless the whereabouts of early data is known and the means of retrieval exist.

**Use of UAVs.** HALE UAVs, such as Global Hawk, display some similarities to satellites. They are persistent and can operate with a high degree of autonomy. Several manufacturers of large UAVs have made unsuccessful attempts to sell these aircraft and their associated support systems to Australia. Whilst this is not a lost cause, a more productive approach might be to sell managed services both in support of seasonal events such as the summer bushfire season and also for specific tasks. The cost of such services are likely to more closely match the budgets of the user agencies and they are absolved the management, maintenance and associated overheads.

**Responsive Space.** Elements of the US Department of Defence have argued for some years for the need for the US to be able to launch satellites, at very short notice, essentially on demand, to support the specific operational needs of in-theatre commanders. With existing technologies, the concept makes little sense unless satellites and launch vehicles are held in a 'warm' mode in order that they may be launched quickly. This is expensive and, in the Australian context, impractical. In 2003, the Australian Department of Defence commissioned a study to look at the practicality and costs associated with Australia acquiring a "cheap, flexible space asset, launched on demand". The study found that such a capability was neither cheap nor practical.[32]

However, space research organisations are known to be taking renewed and systematic interest in small satellites including those which may operate in networked swarms. These would be produced to far less rigorous technical standards than have applied to satellites in the past and would be designed deliberately for specific missions. Australian industry is more than capable of participating in the global supply chains leading to the manufacture of such systems should their operational feasibility be established.

## IMPLICATIONS FOR A NATIONAL SPACE POLICY

The proposed national space policy:

- Should note that many space assets have dual military and civil or commercial applications and that such arrangements help to spread financial and operational risk amongst a range of users whilst maintaining the higher levels of security required by the defence force and the national security community.
- Should note that technologies are being developed which are quickly lowering the barrier of entry into satellite design, manufacture and operation. This may

[32] Auspace Ltd., Tactical Satellites Study, Final Report, Issue 2, 14 August 2003, p. 8.

offer opportunities for Australian industries which are well-sized to take advantage of these developments.

- Might note that the creation of a national space capability involves considerably more than simply acquiring, launching and operating satellites; there is an entire support infrastructure to be developed and sustained.

# The Data Deluge

This section seeks to explain the main issues associated with the management of remote sensing data derived from satellites and discusses associated policy implications.

In 2008/2009 the Commonwealth took deliberate steps to broaden the meaning of national security by embracing an 'all-hazards' approach. High on the list of areas to be improved across all elements of the national security community was the collection, processing, management and dissemination of timely, relevant and accurate information, to those in the field as well as to military commanders, senior officials, politicians, the media and the wider community.

Much relevant information comes from satellites, a great deal under international agreements and some under commercial arrangements. The most simple, least expensive and least risky part of the process in the Australian context, is obtaining the data in the first place. Basically an agreement is formed, or a contract signed, with the satellite owners or operator(s), a ground station is established and a means of recording and storing the data, once it arrives at the ground station, is acquired.

To be of value, the data needs to be analysed in its own right, used to populate models and be compared and correlated with data from other sources. Also, it needs to be disseminated to users in time for them to be able to use the information in decision-making. The process sounds simple but can become quickly complicated and difficult.

## *Standards*

Geo-spatial analysts regularly seek to compare, sometimes with extreme precision, data sets of the same place on Earth. In order to know what has been observed they need to understand how this has been done as well. Sometimes the data might have been derived from different

systems and sometimes it may have been derived from the same system at different times and from different aspects. In order to account for the inherent variations in the data collection process, analysts need access to numerous parameters including:

- the technical specifications of the collection system, known as the 'camera model' and how well the system is functioning against those specifications at any given time;
- the behaviour of the atmosphere above the point(s) to be imaged; and
- the precise coordinates of the point(s) of interest.

A key variable in all remote sensing systems is the resolution of the sensor. Some sensors, such as those on intelligence gathering satellites, seek to obtain very high fidelity data, which can be represented as images, of quite small areas of Earth. Other sensors operate at much lower resolutions because they seek to gather data about broad activities and events such as soil moisture content and crop growth.

The amount of water vapour or other particulate matter in the atmosphere can have a marked effect on the accuracy of measurements taken from space of points on Earth. The atmosphere is dynamic and its composition in any given place can vary markedly, sometimes from hour to hour, often from day to day and certainly from season to season.

The Earth is not a perfect sphere; centrifugal forces created by the Earth's rotation about its axis cause the Earth to bulge at the Equator. Complex formulae are needed to describe, in mathematical terms, the Earth's shape and different models have been developed for different applications. If analysts are to be sure that they are comparing data from precisely the same place on Earth, they need to know which elevation model of the Earth has been used by the satellite operator.

These and other parameters need to be expressed in data structures and computer languages that allow for ready translation and comparison of one data set with another. Early systems used bespoke or proprietorial coding systems which sometimes make comparison of disparate data sets difficult especially in longitudinal studies and research.

More recently, there has been a move to 'standards-based' and 'open architecture' approaches. These aim to integrate hardware and software from numerous commercial vendors into systems which are tailored to meet the specific needs of a given customer yet remain flexible and rapidly adaptable to cope with changing customer requirements and to allow for new technology insertion

Technical constraints, however, are only one part of the problem. Substantial legal, organisational and business impediments exist as well.

### *Data Ownership, Use, Modification and Re-Use*

Government agencies in Australia are provided, under international agreements, with enormous amounts of data collected from various types of satellites for 'public good' applications including weather and climate modelling and prediction, support to mining and primary production and for intelligence purposes. The quid pro quo for Australian access to such data is that it is stored appropriately and that the results of analysis are readily available to relevant international users and researchers as necessary.

Data which is purchased from foreign governments (usually via the trading entities of those governments) and commercial vendors often comes with quite restrictive licensing conditions affecting the use, modification and re-use of the data. These conditions have lead to situations where the same data has been purchased more than once not only by the same government in Australia, but by the same department. That such situations can arise is a reflection of the fragmented approach to the acquisition, stewardship and

use of geo-spatial data, within governments and their agencies in Australia. It also points to opportunistic behaviour by some vendors. Examples such as this have been cited by senior officials as evidence of the overall immaturity of the Australian geo-spatial industry.

A theme which emerged from the workshops used to gather information for this report was that well-informed officials consider the remote sensing industry in Australia to be generally unsophisticated, under-developed and ripe for change. The authors formed the view that governments would welcome the opportunity to contract out larger volumes of work, including more complex work, to industry. However, governments are not convinced that industry has the overall capabilities to meet their needs at acceptable levels of technical and business risk. If this assessment is accurate, there would seem to be some point in trying to understand in more detail what is wrong so that the problems can be solved to the benefit of governments and industry.

## THE DATA DELUGE

Early in 2009 the Australian Space Industry Chamber of Commerce (ASICC) encouraged the Government to consider upgrading the national satellite data processing infrastructure in the context of the economic stimulus package. Although the proposal was not progressed formally, provision was made in the 2009 Budget for some significant improvements, notably in supercomputing.[33] These developments notwithstanding, the current infrastructure is struggling to cope with the data that is available, let alone that which is soon to become available. Some examples of the new missions follow.

**Soil Moisture and Ocean Salinity (SMOS).** SMOS is a European satellite which provides unique datasets on soil moisture of importance in meteorology, extreme weather

[33] One of the author's of this report (Biddington), is Chair of ASICC. He signed the letter on behalf of the organisation.

prediction, hydrology and water resources (European Space Agency).

**Advanced Land Observing Satellite 2 (ALOS-2).** ALOS-2 is a Japanese satellite planned to provide a radar dataset that can be used to measure the contribution of Australia's forests to the national carbon account – required in support of Australia's global climate policy engagement.

**Global Precipitation Measurement Mission (GPM)**. GPM is a constellation of satellites being developed by the US, Japan, France, India and Brazil which is planned to provide three-hourly, high accuracy maps of rainfall Australia-wide – a radical new capability unmatched in coverage by existing ground rain radars.

**Global Monitoring for Environment and Security (GMES).** Of special interest is the planned operation from 2011 of several series of satellite missions co-funded by the European Space Agency and the European Commission – known as the Sentinels. These missions will form the foundations of many new application services, known as GMES. These services have the potential to be of significant value to Australian society including, for example, the GMES Flood and Fire Risk Operational Information Services. Other initial GMES services include:

- Services for the marine environment which focus on marine safety and transport, oil spill monitoring, water quality, weather forecasting and the polar environment.
- Services for the land environment which focus on water management, agriculture and food security, land-use change, forest monitoring, soil quality, urban planning and natural protection services.
- Atmospheric services which focus on air quality, ultraviolet radiation forecasting, and climate change studies.

- Security services which provide support for peace-keeping efforts, maritime surveillance and border control.

These services are likely to offer direct operational benefit to Australia and are also likely to help officials and Ministers formulate policies and approaches with respect to key climate change and environmental issues internationally.

Operational meteorology and climate services in Europe and the US assimilate data from a much larger number of existing satellite data sources than is the case in Australia – with corresponding improvements in capability and accuracy. Australia has the practical and political capability to access these same sources providing the data systems (downlink, storage, processing, fusion, and dissemination) are adequate for the task and there are sufficient people to do the work.

Through its connections to the Japanese Aerospace Exploration Agency (JAXA) and to the Asia Pacific Regional Space Activities Forum (APRSAF), Australia has access to the Sentinel Asia (no relation to the ESA satellites also called Sentinels) disaster response system. This and similar data channels which are accessible under the International Disaster Charter (of ESA, France and others) may assist Australia to better mitigate the impacts of natural disasters and aid response, recovery and reconstruction efforts.[34]

## *Some National Security Considerations*

The data deluge is not confined to civil applications. The same trend is apparent in the national security and defence domains where there is increasing emphasis being given to such concepts as 'multi-sensor fusion'. The idea is that data from numerous types of sensors can be automatically correlated and presented in ways that patterns and activities which would not have been apparent from any single sensor are revealed to intelligence and operations staff in ways that

[34] The authors acknowledge the assistance of Mr Stephen Ward, Symbios Communications, in the compilation of this section of the report.

allow responses to be planned with considerably more certainty as to the outcomes than might have been the case previously. The Distributed Common Ground System (DCGS), in use in the US Army, is one example of a multi-sensor fusion system. The aim of systems such as DCGS is to ensure that every piece of useful information that can be gained from any piece of collected data is extracted and made available to users in ways which enhance their understanding of their environment, their adversary and their own force dispositions and options. Such knowledge is called 'situational awareness' by the military.

Implicit in the paragraph above is recognition of the importance of computing systems which can automatically link pieces of information together, typically using time and location tags to relate one piece of information with the next. Such tags are routinely provided by GPS and other space-based systems.

## IMPLICATIONS FOR A NATIONAL SPACE POLICY

The proposed national space policy:

- Should recognise that an effective national space policy cannot be confined to consideration of space assets alone; supporting ground infrastructure also needs also to be considered through a rigorous whole-of-system approach. In particular, balanced investments are needed across the system for data classification, interpretation, overlay, analysis, storage, dissemination and retrieval all with maximum reliability and minimum delay. Only then is the system likely to provide optimal return on investment.
- Should note that for Australia to benefit optimally from data derived from satellites, strong data management policies backed with appropriate levels of investment in ground infrastructure will be essential.
- Should note the potential for industry to play a more prominent role, in principle, in the exploitation,

processing and dissemination of data derived from remote sensing satellites to support the requirements of public and private users.

- Might note that the effective and efficient domestic use of space assets demands extensive consultation and networking to ensure that data and services are available to all levels of government and, potentially, to industry as well under arrangements to be determined.

# Relationships, Research, Industry and Education

The prime currency of governments is jobs. As Australia's role in space strengthens and becomes more evident questions about the economic benefit and specifically the number of jobs created as a result of investment in space activity is likely to be a frequently asked question.

This section is focused on Australia's industrial capacity related to space. It also considers relevant activities in research and education.

## DEFINING THE SPACE INDUSTRY

Since the 1950s there has been well-intentioned debate about the need for an Australian space industry. Proponents have asserted that Australia needed to be substantially self-reliant in launch, satellite manufacture and satellite operations for reasons of industry potential, national security and national pride. However, the global economy, through global supply chains, has become increasingly integrated. Also, across the board, there is a substantial oversupply of launch vehicles and launch capacity. This situation seems unlikely to change in the foreseeable future.

In a similar vein there is minimal justification for committing public funding to support human space flight beyond assistance with supporting ground infrastructure and such other help as is required by the relevant treaties. There is no substantive Australian technological base on which to build the supporting technology is incredibly expensive and robotic systems are increasingly capable of performing functions in space which formerly required direct human involvement. Human space flight is said to inspire and enthral and this may be so. However, the costs are exorbitant and, from the perspective of a middle power, difficult if not impossible to justify.

Singly or together these realities should have terminated the debate surrounding national launch capabilities as envisaged even 10 years ago. Some proponents nevertheless cling to that dream.

The question of satellite and sensor design and construction in Australia is more complex with particular regard to space qualified sensors for operational Earth observation and space science applications.

Such is the dependency of Australia and other nations on space-based services, notably the GPS timing signal, the question of where a 21st century space industry might begin and end in Australia is increasingly difficult to determine. Figure 4 (below) outlines the problem.

**Figure 4. Defining the Australian Space Industry**

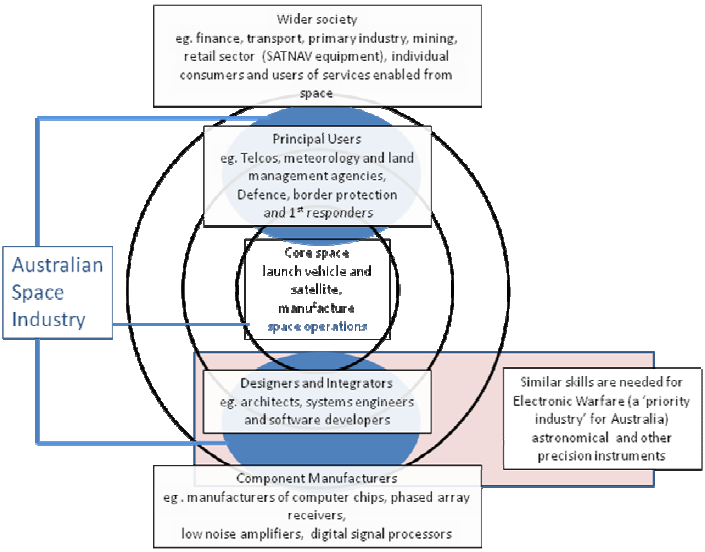



Figure 4 indicates that the Australian space industry sector comprises four basic segments.

- The first segment comprises a small number of people who occupy 'core space' positions, mainly as staff who task and 'fly' satellites. The number of people involved in these activities is not expected to grow significantly in the next decade.
- The second and third segments comprise a larger number of people who are integrators and manufacturers. These individuals work for companies (many small and medium enterprises) and organisations which provide niche products and services mainly for the domestic market, but, with some notable exceptions, which export into the global market. More is said of this group below.
- The fourth segment is classified as principal users, comprises, for example, employees of the BOM, GA and Defence whose daily work includes tasking satellites and interpreting the data received for numerous purposes including weather prediction and intelligence analysis. This group is important in helping to set requirements for future satellite systems and, therefore, has direct influence on the core.

Beyond the four identified segments of the space industry is the wider society, which makes routine use of space-based services with little or no appreciation of its dependence on space. This includes organisations needing to sequence large numbers of transactions such as banks, communications companies and stock exchanges. The authors of this report consider that these functions, although dependent on space-based services, ultimately have little or no interest or influence in how these services are funded, engineered, organised and delivered. These functions and the people who perform them lie outside the space industry per se.

For the purposes of this report, it doesn't much matter if any one category is included or not. In aggregate the number in Australia is small, perhaps not more that 5 000 people overall, most of whom are in the principal user sector identified in Figure 4 above. This situation is not likely to alter

significantly in the short term. However viewed, the Australian space sector, from the perspective of jobs, is very small. By way of comparison, the UK space industry employs 68 000 people.[35]

Although the space workforce may be small, its impact is high. Overseas experience suggests that the space sector workforce generates a multiplier of between three and five jobs for each one in the sector. This estimate is similar to figures for other high technology sectors of the economy, and reinforces the argument for policies which encourage investment in these sectors.

Space research in the UK attracts in excess of 2% of total Research and Development fund in contrast to the 0.2% in Australia. This is a paltry sum which must change if Australia's national interests in space are to be realised. In this regard, the Australian Space Research Program (ASRP) is a welcome first step.

In summary, the Australian space industry is organised around two loci – a principal user group and a design and integration group (the darker ellipses in Figure 4). In many countries, core knowledge of the space environment and the design and engineering constraints imposed by that environment reside largely in industry. In Australia this is not the case and much of this level of expertise resides in the space science and research community. This points to the need for this group to be specifically nurtured in the context of developing necessary and sufficient space-related industry in Australia.

Employment is a primary economic indicator for several reasons including that it commonly translates at least approximately into measures of productivity and national wealth. As Australia's role in space strengthens and becomes more evident, questions about the economic benefits are likely to be asked, specifically the number of jobs created as a result

[35] UK Department for Business Innovation and Skill, News Release December 2009.

of investment in space activity.. Compelling answers will be the key to the success of the 'political constituency' which Minister Carr says he is determined to construct for the space sector.

Is a farmer who ploughs or fertilises a paddock using a GPS controlled tractor to be counted as a member of the space sector? Probably not. However, the efficiency and profitability of his farm may have a fundamental, and possibly unrecognised, dependence on assured and secure access to the GPS signal. If the signal became inaccessible the farmer could still plough or fertilise his paddock but less efficiently and effectively. His per unit cost overheads may be expected to increase and, in time, his crop yields may fall.

Is a person who sells in-car navigation systems in an electronics store to be counted as a member of the space sector? Without access to the GPS timing signal these products would simply not exist. Possibly, the salesperson would sell other goods instead, but in the retail sector there are likely to remain a number of positions, in aggregate, which are solely reliant on the availability of these products. Another factor to consider is that these jobs may have displaced some others; for example, those occupied by people associated with the production and sale of paper street directories and maps.

Several of Australia's largest mining companies are investing heavily in robotic mines, seeking eventually to minimise the number of people engaged in drilling, loading, carting, grading, etc. GPS, once again, is a core enabling technology with no ready or immediate substitutes on the horizon. As is commonly the case this development will lead to people being taken out of ore production and transportation processes and placed into positions requiring higher levels of analysis, synthesis and, ultimately, judgement.[36]

The current generation of mobile phones not only deliver GPS-dependent content such as maps and directions but the

[36] For example, see Ben Woodhead, 'Mining bonanza drives resource boom', *The Australian*, February 12, 2008.

phones themselves are dependent on the GPS timing signal. These sorts of devices have created new ways of working for millions of workers from financial advisers to plumbers. The workers move from job to job, reducing office and workshop overheads.

In systems terms, these 'value chains' are more tightly coupled than they were in the past. The capacity of the overall system to absorb and then quickly recover from the impact of major disruptions or shocks caused by reduced access to timing signals from space is likely to be diminished which may in turn diminish the overall resilience of the economy.

Assured and secure access to space-based utilities is the key enabler for these new methods of work and the consequent new social, economic and political behaviours as well. The essential enabling role of satellites is not well-appreciated in the community and is essentially taken for granted.

The rate of adoption and ubiquity of numerous applications indicates just how reliable space systems are. From Australia's national economic security standpoint the overall impact of this reliance or dependence must be understood by governments together with corresponding vulnerabilities.

## WHY DEVELOP A SPACE INDUSTRY SECTOR?

If not to create jobs in any significant number, the immediate question becomes why should Australia invest in the space sector? Three closely linked reasons are proposed.

- Critical Infrastructure Protection
- Self Reliance and Adjacencies
- International Credibility and Influence

### *Critical Infrastructure Protection*

The fabric of Australian society and the economy is dependent on assured and secure access to space-based services. They form a ubiquitous, if virtual, component of the

national critical infrastructure deserving similar levels of protection as are afforded to the nation's water, energy, transport and information infrastructure. Satellites cannot be guarded by conventional means but a necessary and sufficient investment is needed to understand the physical environment of space in order to comprehend and, where possible and appropriate, mitigate the risks posed by high levels of space reliance.

It is difficult to exaggerate this point. The implications for Australia of space denial or disruption would be profound and long-lasting. Moreover, disruption could be achieved regionally, for example in the centre of a major city, with relatively low technology and inexpensive, readily available equipment controlled by semi-skilled operators. With improved encryption of some space signals the danger is diminishing but it will remain significant into the foreseeable future.

## *Self-reliance and Adjacencies*

In a world of global supply chains, ideas of complete national reliance, certainly for a middle power, simply make no sense. The question is more one of degree and speaks possibly more to the skills within the workforce and the research and educational sectors than it does to the existence of factories and specialist manufacturing facilities. The Defence White Paper makes clear that one compelling reason for Australia to acquire a space-based SAR capability is to become more self reliant in remote sensing for national security purposes. Elsewhere in the White Paper there is discussion of some technology areas in which Australia seeks to maintain a higher than the norm level of self-reliance which translates to sustainable industry capability. EW is one such domain singled out as warranting PIC status.

The industry capabilities and skills which exist in Australia and which are encapsulated in the rectangle towards the bottom of Figure 4 include:

- Digital signal processing which are essential in systems such as the Jindalee Over the Horizon Radar Network (JORN) and in radio telescopes such as those operated by the CSIRO.
- Phased array receivers, which are used in the JORN, in shipborne systems and in next generation radio telescopes such as the Australian Square Kilometre Array Pathfinder (ASKAP).
- Low noise amplifiers, receivers on a chip and radiation hardened and low noise chips, such as have been developed by LaTrobe University and Sapphicon in Sydney for radio astronomy and potential EW applications as well.
- Systems engineering and other integrative skills such as those being carefully developed by the Defence Advanced Systems Institute (DASI) in South Australia.
- Adaptive optics and laser technologies which have applications in astronomy, communications and EW.
- Robotics and autonomous vehicle operations which have application in planetary exploration with direct application to a range of human activities on Earth including robotic mining and agriculture and adaptive processes which require a capacity to anticipate and not merely to respond to the sensed environment. Increased use of robotic systems by the ADF promises to reduce battlefield casualties, especially in high intensity conflict.

This list is not exhaustive but is sufficiently detailed to indicate that selected niche capabilities, relevant to a emerging space industry and which strengthen national security and resilience already exist in Australia. Presently they are applied largely to military and ground-based scientific endeavours but they could move, and some already are, into adjacent space markets without undue difficulty. In broadening their markets, the sector could be expected to attract more business and to become more robust and self-sustaining thereby meeting the self-reliance objective identified in the

Defence White Paper and delivering broader benefit to the economy and the nation.

The export potential of some of these technologies, in principle, is considerable. A limiting factor may be their sensitivity from a national security perspective, which may restrict the markets into which they can be sold. The good news is that many of these technologies will be shared with the US and contribute to the overall strength of the Australian/US alliance. This has been the case with OTHR technology and may well extend, in future, to phased array sensors, for example, which have been developed in Australia and which have SSA applications.

## INTERNATIONAL CREDIBILITY AND INFLUENCE

The second section of this report discussed Australia's aim to become more active and visible in space diplomacy. Any credible contribution to these processes which support assured and secure access to space requires Australia to have discernable investment and commitment.

Credibility and influence must be grounded in national capacity. The question becomes one of how much industry and space research capability is enough to be taken seriously. Australia's most important and enduring attribute has been its strategic geography. This, although still relevant to some space-related activities, is no longer sufficient to guarantee a hearing or an effective voice. At a minimum, Australia needs to demonstrate that it can express its requirements for space-based services competently, convert those requirements to physical or virtual systems, and operate them in the nation's best interests. Fortunately there have been some encouraging signs.

Announced investments by Government in the US Wideband Global System (WGS) and in a forthcoming Intelsat communications satellite indicate a high level of sophistication in Australia's approach to space. However, such investments can be interpreted as Australia being content to occupy a

supplicant role in space to the United States. This may have been the case in the past, although recent announcements in the Defence White Paper, the establishment of the SPU and the initiation of the ASRP point to a more active approach which will be sustained into the indefinite future as a matter of national necessity.

The Senate Inquiry report[37] encouraged the Government to strengthen Australia's existing ties with a number of space agencies and also to consider developing new ones. The Government, in its formal response to the Senate report, accepted this recommendation.[38] Strong institutional research relationships will be important to add bulk and diversity that could otherwise be somewhat limited or constrained by the size and niche nature of the Australian space industry sector.

One significant challenge for Australia will be to determine when, where and in what to invest with a number of space agencies around the world, including NASA, ESA, JAXA, ISRO, CSA and others. Almost certainly, there will not be sufficient resources to invest in substantial collaborations with all of these agencies. Investment, therefore, will need to be closely aligned with Australia's strategic, operational and research interests in space, as expressed through the national space policy.

## CONTRACTING POLICY

A significant impediment to innovation in Australia across all technology sectors is the preference of governments for firm, fixed price contracts. Although the rhetoric is correct – risk should be borne by the party best equipped to accept it – the reality is often much different. Small and large firms working in technology development areas often find

[37] Senate Inquiry, *Lost in Space?,* 2008.

[38] Department of Innovation, Industry, Science and Research, Government *Response to the Senate Inquiry into the current state of Australia's Space Science and Industry Sector*, http://www.innovation.gov.au/Industry/Space/Documents/GovernmentResponsetoSenateinquiryintoSpace.pdf

themselves being required to shoulder a disproportionate share of the risk. One method of improving this situation would be for the Government to instigate cost plus contracts for projects that are inherently developmental in nature. By definition they can be expected to present technical challenges which might be foreseen but cannot be quantified at the outset as well as other challenges which simply cannot be foreseen during the tender and pricing phase of the project.

## RESEARCH AND EDUCATION

### *Research*

Space science research covers a multitude of interests and disciplines including remote sensing of Earth from space, exploration of the planets and other celestial bodies, solar science and space weather. Over the past four years space scientists have developed a sense of community previously not apparent and have produced the two plans noted previously:

- *The Decadal Plan for Space Science*; and
- *An Australian Strategic Plan for Earth Observations from Space*.

Both documents have highlighted the fragility of the space science community, taken as a whole. They also reinforce the recommendation of the Cutler review into the national innovation system that space science is an area deserving of specific attention for new science investment. The ASRP, in part, is a response to this recommendation.

A major objective of the ASRP is to encourage some of these small and separate groups to begin working together in Australia to obtain critical mass and also to forge partnerships with international collaborators. A number of Australian researchers already have excellent relationships with foreign space research organisations and institutes. Australian companies which most closely align with and support space activities deal in technologies with applications in domains and

markets other than space. In consequence, the research community has a relatively more prominent role to play in developing and maintaining a more complete spectrum of links with the global space community than might be the case with other nations.

This points to the need for the ASRP to become an enduring program and part of the foundation which underpins Australia's future space engagement.

### *Space Education*

If Australia's vital interests in space are to be protected and advanced over time, a sustained and sustainable workforce will be essential. Many will need science, engineering and technical qualifications. There is evidence, based largely on anecdote and small samples, which suggests that a significant number of young Australians aspire to work in the space industry. Some are deterred because they see that the employment opportunities in Australia are exceptionally limited.

One estimate is, of those who complete relevant tertiary studies, one third move overseas to work in the mainstream space industry, one third remain in Australia and manage to find positions which are space-related and the remaining third leave the area altogether.

Australia, consistent with the experience of other Western countries, is struggling to attract sufficient students into mathematics, science and engineering at the senior secondary school and tertiary levels. Space is said to inspire students to both enter the science stream at secondary school and to persevere with these subjects at the tertiary level. There is considerable anecdotal material to support this claim but no known quantitative evidence gained through longitudinal studies.

The gathering of firm evidence would seem important to understanding the emphasis to be placed on space as a magnet attracting students to study science as well as a guide

to resourcing space education. However, if this seed investment is not to be wasted such initiatives will have to be tied to realistic assessments of relevant employment opportunities.

## COMMUNICATING INTENTIONS

Nearly all space assets and their terrestrial applications can be employed in support of civil as well as military roles. They are critical components of national infrastructure. Almost any initiative undertaken will have both international as well as domestic ramifications. Accordingly, our intentions regarding space industry and related domestic activities, even if the decision finally is to do little or nothing, will send omni-directional signals. Australia will need to manage the communication process with care, clarity and sensitivity; affected audiences include:

- politicians and senior public officials;
- foreign governments, notably in Australia's case the United States, China, Russia, Japan and India;
- the educational and research communities;
- relevant industry sectors and key industry associations; and
- the wider Australian electorate.

While there are core themes that can be expected to remain constant for all audiences, emphasis and nuance will and should vary. Some of the core themes will be difficult to convey, especially to wider audiences because the impact of space on the daily lives of citizens is essentially transparent; at least not until access to space-based services is lost and the effects become apparent to individuals.

A national investment in space is not likely to create a huge number of new jobs or employment opportunities for young Australians. The more abstract aim of Australia taking all reasonable steps, consistent with its ranking as a middle power, to ensure that access to space-based services remains

assured and secure, is much more difficult to convey. The concept of community 'resilience' may provide a useful point from which to begin.

## IMPLICATIONS FOR A NATIONAL SPACE POLICY

This section has ranged widely over industry and other national capability matters which a national space policy may need to comprehend. The following recommendations are made. Perhaps unconventionally, the first two, in the interests of clarity, state what will not be done at least in the short term.

The national space policy:

- Should indicate possible areas for industry development and pure and applied research which advance Australia's overall strategic aim to ensure assured and secure access to space, whilst also meeting operational objectives which support specified national and community needs.
- Should recognise the importance, in the absence of a strong industrial base, of the space research and education community in Australia as a source of expertise, including 'smart buyer' and policy advice, and as a conduit to many space agencies and organisations in other countries.
- Should acknowledge the importance of a comprehensive communications strategy to inform national and international constituencies of the steps being taken by Australia to strengthen its role in space.
- Should acknowledge that the principal justifications for government to encourage and facilitate the growth of an Australian space sector includes:
    - The need to comprehend and, where possible and appropriate, mitigate the risks posed by high levels of space reliance in Australia.
    - The need to maintain and possibly expand some existing arrangements to achieve self-

reliance in practicable space-related technologies.
  - The attainment of a position of international credibility and influence in space-related matters with credibility being grounded on existing and proposed national capacity.
  - The need to recognise the significance of Australian space-related research, noting the need for effective domestic coordination and international collaboration.
  - The need to recognise and comprehend the professional and intellectual demands of realistic Australian space engagement and to relate these to Australia's educational arrangements.
  - The need to provide some level of confidence to potential investors in space activities.
- Might make clear, perhaps in contextual remarks, that Australia does not anticipate investing in activities associated with human space flight – beyond existing treaty and communications support obligations. In effect, this is an area of scientific and engineering endeavour which Australia envisages leaving to others. The policy might leave open the question of participation in robotic exploration of the moon, the planets and other space objects because of existing niche capabilities and the relevance of this research to Earth-bound activities such as robotic mining.
- Might note, perhaps in contextual remarks that launch activities using conventional means, are not anticipated nor envisaged as an objective of the policy. Legislation already exists to permit and support any proposed commercial launch activity, the success or otherwise of which would be determined by the strength of the business case. Looking ahead 20 to30 years, the policy might note, however, that Australia's geography may afford a unique global advantage in

developing and supporting new space launch and recovery technologies.

- Might acknowledge that increased Australian involvement in space is not expected to generate large-scale employment opportunities. However, those that will be created are likely to be of high value with a high multiplier effect.

# Policy – The Vital First Step

Writing policy rarely occurs in a vacuum. Invariably there are precedents, commitments and stakeholders with some preceding interest in at least part of the topic for which the new policy is proposed. There is no clean sheet. This is certainly the case with the proposed Australian Space Policy.

A space policy for Australia is an important national initiative. The success of the policy – its content, acceptance (nationally and internationally) and implementation – will require wide consultation and the careful setting and management of expectations. An important component will be an informed public debate. This report is offered as a contribution to the process.

The broad themes of the argument which have been developed in the preceding section are summarised below. The themes explain why the policy is being written and provide pointers to the content.

- Australia has vital dependencies on space-based services – timing and navigation, communications and remote sensing – for economic, social and national security purposes. Assured and secure access to space is, therefore, an important value, worth understanding and protecting into the future.
- The satellites which provide these space-based services form 'virtual' elements of Australia's critical infrastructure and Government would do well to take reasonable measures to protect the operating environment of space so that satellites in that environment may operate safely and unfettered from interference.
- The operating environment in which satellites operate is fragile and quite easily damaged to the detriment of all nations. Space debris, especially in LEO, is a

growing problem and the risk of collisions between satellite, debris and other space objects is increasing.

- Space is a 'global commons' in which the concept of sovereignty, as applied on Earth, has reduced relevance. Technology alone is incapable of guaranteeing any nation assured and secure access to space. International diplomacy and agreements to limit behaviour will be essential and enduring elements of any regime which aims to secure space for the use of mankind into the future.
- Australia is seeking to become relatively more active and influential in world affairs as a middle-power occupying a landmass of considerable strategic significance. The nation has under-performed in space diplomacy over many years and has placed itself in an unnecessarily vulnerable position as a result.

The proposed national space policy, in effect, must outline a process by which Australia will develop the confidence and capacity to address the issues which emerge from the themes. Three basic elements or tasks have been identified

- To strengthen the nation's international credentials in space by quickly acquiring and operating a small number of spacecraft for national purposes. This makes a statement about 'skin in the game' and also about determination to be relatively more self-reliant in this element of human endeavour than has been the case to date.
- To use the natural advantage of Australia's strategic geography to its best advantage in protecting and preserving the fragile environment of space. SSA sensors, located on Australian soil, especially if the data is capable of being shared widely amongst space-faring nations, will add substantially to the transparency of future space operations and serve as a confidence-building measure of benefit to all space-faring and space dependent nations.

- To build a sustainable educational, research and industrial base which can:
    - support components of a satellite industry in Australia (noting that global supply chains dictate that not all elements of that industry need to reside in the country);
    - build on current strengths to design, build operate and possibly export advanced SSA technologies; and
    - convince any outside observer that Australia is taking its obligations, in regard to space, seriously in both its national interests and in terms of its broader international obligations as well.

Australia is ready for this challenge which must be taken up if national, allied and broader international interests are to be protected and advanced. The proposed Australian space policy is a vital first step.

# ANNEX A

## THE SENATE STANDING COMMITTEE ON ECONOMICS

## LOST IN SPACE? SETTING A NEW DIRECTION FOR AUSTRALIA'S SPACE SCIENCE AND INDUSTRY SECTOR

## RECOMMENDATIONS

### *Recommendation 1*

The committee recommends as a first step that the Government give the existing unit within the Department of Innovation, Industry, Science and Research more resources to enable the establishment of an Australian government Space Information Website. This would provide information on government programmes and contacts, and links to Australian companies working in the space industry as well as Australian universities offering courses in space science and space engineering.

### *Recommendation 2*

The committee notes that Australia is the only OECD country without a national space agency and, as a consequence is missing out on opportunities to engage in this important area of innovation and technology. The committee also notes the comments by the Chief Scientist and the conclusion of the Cutler Report in relation to the importance of the space industry for innovation within Australia. The committee recommends that immediate steps are taken to coordinate our space activities and reduce our over reliance on other countries in the area of space technology.

### *Recommendation 3*

The committee notes the wealth of expert, well informed evidence received by the committee. Despite some deviations,

the overwhelming majority of witnesses strongly supported the formation of a government unit to coordinate Australian space activities, including those in the private sector. The committee supports this conclusion and notes that there must be a proper balance between industry and government involvement.

### *Recommendation 4*

The committee notes the various models of space agency within the OECD and emerging economies and supports Australia having a space agency. The committee recommends initially establishing a Space Industry Advisory Council comprising industry representatives, government agencies, defence, and academics. The committee recommends that the advisory Council be chaired by the Minister for Innovation Industry Science and Research or his representative.

### *Recommendation 5*

As a precursor to the establishment of the space agency the Advisory Council would:

- Conduct an audit of Australia's current space activities within six months of the establishment of the Council;
- Analyse the strengths, weaknesses, opportunities and threats to Australia's emerging space industry;
- Focus on the key "workhorse" space applications of Earth observation, satellite communications and navigation as the most practical and beneficial initial priorities;
- Systematically evaluate the medium/long-term priorities for a space agency including the national benefit of defence related activities, Earth observation, environmental, land management, exploration, national disaster prevention and management, treaty monitoring, e-commerce and telemedicine;
- Examine the benefits to Australia of improved international collaboration including membership of the international space groups;

- Develop a draft strategic plan for the establishment of a space agency and the most appropriate form of that agency, including public/private funding, budget and staffing priorities; and
- Identify critical performance areas such as research, technological development, development of the skill base, effective partnerships, delivery of new services, and financial management.

### *Recommendation 6*

The committee recommends that any Australian Space Agency reassess the case for Australia becoming more closely linked to an international space agency.

# List of Abbreviations

| | |
|---|---|
| ACMA | Australian Communications and Media Authority |
| ADF | Australian Defence Force |
| AGSF | Australian Government Space Forum |
| ASAT | Anti-SATellite |
| ASKAP | Australian SKA Pathfinder |
| ASRP | Australian Space Research Program |
| APRSAF | Asia Pacific Regional Space Agencies Forum |
| BMD | Ballistic Missile Defence |
| BoM | Bureau of Meteorology |
| CSA | Canadian Space Agency |
| COPUOS[UN] | Committee On the Peaceful Uses of Outer Space |
| DASI | Defence Advanced System Institute |
| DCGS | Distributed Common Ground System |
| DIISR | Department of Innovation, Industry, Science and Research |
| DRDO | [India] Defence Research and Development Organisation |
| DRP | Defence Reform Program |
| DSP | [US] Defense Support Program |
| DSTO | Defence Science and Technology Organisation |
| ESA | European Space Agency |
| EW | Electronic Warfare |
| FIC | Fundamental Inputs to Capability |
| GA | Geoscience Australia |
| GEO | Geostationary Orbit |
| GFC | Global Financial Crisis |
| GLONASS | [Russian] Global Navigation Support System |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| HALE | High Altitude Long Endurance [UAV] |
| ISRO | Indian Space Research Organisation |
| ITAR | International Traffic in Arms Regulations |
| ITU | International Telecommunications Union |

| | |
|---|---|
| JAXA | Japanese Aerospace Exploration Agency |
| JORN | Jindalee O[TH] Radar Network |
| LEO | Low Earth Orbit |
| MEO | Medium Earth Orbit |
| NASA | [US] National Aeronautics and Space Administration |
| NBN | National Broadband Network |
| NPP | New Policy Proposal |
| OTHR | Over the Horizon Radar |
| PIC | Priority Industry Capability |
| RCS | Request for Capability Statement |
| RFI | Radio Frequency Interference |
| SAR | Synthetic Aperture Radar |
| SIIC | Space Industry Innovation Council |
| SKA | Square Kilometre Array |
| SPU | Space Policy Unit |
| SSA | Space Situational Awareness |
| UAV | Unmanned Aerial Vehicle |
| WGS | Wideband Global System |
| WMD | Weapons of mass Destruction |

# About the Kokoda Foundation

## Purpose

The Kokoda Foundation has been established as an independent, not-for-profit think tank to research, and foster innovative thinking on, Australia's future security challenges. The foundation's priorities are:

- To conduct quality research on security issues commissioned by public and private sector organisations.
- To foster innovative thinking on Australia's future security challenges.
- To publish quality papers (*The Kokoda Papers*) on issues relevant to Australia's security challenges.
- To develop Security Challenges as the leading refereed journal in the field.
- To encourage and, where appropriate, mentor a new generation of advanced strategic thinkers.
- Encourage research contributions by current and retired senior officials, business people and others with relevant expertise.

## Membership

The Kokoda Foundation offers corporate, full and student memberships to those with an interest in Australia's future security challenges. Membership provides first-release access to the *Kokoda Papers* and the refereed journal, *Security Challenges*, and invitations to Foundation events. Membership applications can be obtained by calling +61 2 6295 1555, and downloaded from:

http://www.kokodafoundation.org/Joinindividual.html