

Securing space: Australia's urgent security policy challenge for the 21st century¹

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Introduction

In 1963, there was one geosynchronous satellite in space, being used to examine the feasibility of establishing a worldwide communications network. Today, there are over 800, controlled by dozens of public and private operators in more than 50 countries,² all contributing to the estimated US\$123bn worth of satellite industry annual revenues.³

Australia, along with most developed nations, is becoming increasingly dependent on a range of space-based systems, a dependence which has evolved on the assumption that space is a secure domain. In reality, space is an incredibly fragile and insecure environment. The US, Russia and China all have the demonstrated capability to destroy space vehicles using ground-launched anti-satellite missiles (ASATs).⁴ Also, in February 2009, the first major collision between satellites occurred when a Russian communications satellite accidentally collided with a US-owned satellite, causing a debris cloud of over 1800 trackable fragments, which joined the 14,000 or so satellites, discarded rocket parts, and detectable debris and space matter already littering space.⁵

While there has been very little effort in Australia to ensure that its space interests are secure, many other nations have acknowledged this vulnerability and are now investigating options to secure space.⁶ This is a very complex challenge. There is no global consensus regarding how to secure space, with various nations considering options such as treaties, codes of conduct and even weaponising space. This paper proposes a national-level policy to establish a foundation for securing Australia's future space activities.

'Space security' defined

James Clay Moltz defines space security as 'the ability to place and operate assets outside the Earth's atmosphere without external interference, damage or destruction'.⁷ During the Cold War, when the US and Soviet Union were the only significant players in the space domain, a series of agreements and treaties were initiated that formed what is often referred to as 'the rules of the road' for space activities.⁸ As these nations developed their individual capabilities, they also developed a realisation that there were substantial mutual benefits in a stable and secure space environment.⁹

Even though these rules have become less relevant over the past decade, partially as a result of reduced Russian influence and an increase in new players, space has remained a relatively secure domain. While there is no doubt the US will remain the most advanced and influential space nation for the foreseeable future—in terms of assets in space, technological status and overall investment¹⁰—there is some significant risk that the overall security of space is changing as newcomers with different national interests and technical abilities develop rudimentary space capabilities, without necessarily the same 'rules of the road' to govern their activities and behaviour.

On 11 January 2007, China destroyed one of its inactive weather satellites using a conventional ballistic missile modified to perform an ASAT function. This was China's first successful ASAT space engagement. It left a dangerous debris cloud of more than 35,000 individual particles, large enough to cause damage to other space assets, much of which NASA expects to remain in space for at least two decades—and 10 per cent of it for up to 100 years.¹¹ Russia and the US had conducted similar ASAT events in the past¹² but, due to the mutual concern to keep space clear of debris, both countries showed restraint when it came to conducting counter-space tests and operations.¹³

There is growing international concern that the unrestrained development and transfer of ASAT technology, primarily from China, could see ASATs being developed in the Middle East, specifically in Iran, and in Pakistan.¹⁴ This may prompt nations such as India and Israel to initiate their own space warfare programs.¹⁵ It is likely also that over the next decade or so, several other nations may develop the capability to undertake rudimentary kinetic space warfare.¹⁶

Australia's space dependency

Australia, like most first-world nations, has become increasingly dependent on space to support a range of national functions. This is particularly evident in the defence domain, where over 50 per cent of the projects listed in the Defence Capability Plan (DCP) in the period to 2016 rely on space.¹⁷ Increasingly, the ADF's weapons systems, communications, intelligence and situational awareness tools are dependent on space-based systems.

Australia's dependence on space is not limited to Defence. Space-based technology 'underpins transport, precision agriculture, mining, precise timing for telecommunications [and] e-commerce'.¹⁸ The routine use of space is set to increase rapidly over the next decade as more and more national functions become critically reliant on space, with little or no provision for effective terrestrial redundancy for the space-based function. As Australia's dependence on

space increases, the consequences of losing the freedom to operate in the space domain will increase commensurately.

Moreover, while first-world nations are more reliant on space than emerging nations, the dependency gap is likely to increase over the next decade as first-world nations accelerate their use of space.¹⁹ Emerging nations are becoming mindful of the strategic consequences of such dependency. Attacking an advanced nation's space-based functions may present an attractive asymmetric war fighting option for nations with relatively low space dependency.²⁰

So, while Australia's dependency on space continues to increase, the development and spread of ASAT and other offensive space technology is also increasing,²¹ as is the potential for accidents resulting from congestion and increased debris in space. The longstanding secure space environment is rapidly becoming insecure as new players enter the space domain. Hence, assuring the security of space represents a key security challenge for Australia and, indeed, for the world over the next decade.

Australia's space security policy history

In 2005, Senator Grant Chapman (Liberal, SA) convened an informal expert group known as the Space Policy Advisory Group, which prepared a report later forwarded to the Prime Minister. The report noted that Australia had:

[N]o effective whole-of-government mechanism for addressing the wide-ranging implications for our national security of the fast-moving developments in space-related strategic policy, international relations or technology—issues which most other comparable economies have long since taken up as a matter of national priority.²²

The report concluded with two key 'essential and urgent objectives'. Firstly, that the Australian government develop and promulgate a broad and far-sighted whole-of-government space policy and, secondly, that a 10-year action plan to address Australia's space shortcomings be

developed.²³ Little has changed as a result of that report. Australia remains devoid of a national space policy, its space dependency continues to increase, and Australia still has no mechanism for addressing space security.

In 2008, the Senate's Standing Committee on Economics conducted an inquiry into Australia's space sector. Its November 2008 report, titled 'Lost in space', sought to examine Australia's role in the global space environment. It concluded with six recommendations, largely relating to the establishment of a national space organisation, deriving from the Space Policy Unit (SPU) within the Department of Industry, Innovation Science and Research.²⁴ While this suggests a degree of commitment to the development of a national space policy, there is no specific remit for this unit to address space security.

There was also no mention of space or space security in the first National Security Statement (NSS), delivered by then Prime Minister Rudd to the Australian Parliament on 4 December 2008,²⁵ although many of its objectives cannot be met without assured access to space.²⁶ The subsequent 2009 Defence White Paper made several references to space and specific reference to 'mission assurance'.²⁷ In this context, the White Paper acknowledges that Australia relies heavily on networked space-based systems and that technologies are emerging that could threaten this reliance.²⁸ To some extent, perhaps not surprisingly given the history of space in Australia, the White Paper infers that Defence has a leading role in space security.

Indeed, Australia's vast and isolated real estate has provided a strategically attractive, southern hemisphere location for many military space programs. In 1971, a ground station supporting the US Air Force's Defence Support Program satellites began operations at Nurrungar, near Woomera.²⁹ The Joint Defence Facility at Pine Gap began its intelligence collection operations near Alice Springs in June 1970 and has been operating there since. The interaction of operational, technical, scientific and policy staff at these installations has served Australia well, enabling it to gain expertise without the

substantial investment in infrastructure that would normally be required.³⁰

More recently, Australia has committed \$927m towards the US Wide-Band Global Satellite (WGS) system, which is 'the largest single direct investment that Australia has made in space to date'.³¹ The system will provide the backbone of ADF communications until about 2025. More broadly, the Government announced in its 2009 budget the allocation of \$8.6m for the development of the SPU in the Department of Industry, Innovation Science and Research to provide whole-of-government advice on space and industry development. The complementary Australian Space Research Program, with funding of \$40m, will similarly support space research, innovation and skills development in areas of 'national significance'.³²

Australia's key space policy influences

There are several key influences that will drive the development of a space security policy for Australia. The various approaches that Australia's allies and partners have to pursuing space security—and the nature of Australia's relationships with these partners—is obviously critical. Australia's space security policy will also be shaped by domestic influences. Indeed, domestic influences—such as supporting organisational structures and economic, industry and educational considerations—will specifically shape policy implementation and typically be more discretionary than international considerations.

International considerations

United States

The Australia/US alliance must be considered in the development of Australia's space security policy. It is inconceivable that Australia could have a space security policy that would either lead Australia in a separate direction to the US or, worst case, be directly counter to US policy. To do so and then expect to remain so closely connected to the US space program would be

folly. The Defence White paper is clear in this regard, noting that 'our alliance with the US is our most important defence relationship. Without access to US capabilities, the ADF simply could not be the advanced force it is today'.³³

US space policy has not changed fundamentally since it was first developed during the Eisenhower Administration in 1955.³⁴ At the macro-level, there have been two important constants and two important variables. The first constant is that US space exploitation—while having several other motivating factors (notably national pride and economics)—has primarily been about ensuring US national security. The second is that the US has always reserved the right to use force to protect its space capability.³⁵ The first variable has been the degree to which various Administrations have cooperated with other major space powers in mutual space pursuits. The second is that policy approaches have fluctuated between treaties, 'rules of the road' and specific weapons programs, driven by contemporary party, domestic and global considerations, and by key personalities within successive Administrations.³⁶

In 2002, the Bush Administration withdrew from the 1972 Anti-Ballistic Missile (ABM) Treaty and signalled its intention to deploy missiles to defend the US from missile attack, while also funding a series of space-based weapons projects, all of which put the US at odds with the rest of the space-faring world.³⁷ While the debate on whether to weaponise space is still active in the US, the Obama Administration has shown an inclination to be more cooperative with others.³⁸ There are also several think tanks, academics and some senior US officials espousing the value of a 'code of conduct' to govern space activities, likely reflecting the realisation that attaining 'space dominance' (a term coined under the Bush Administration), would be enormously expensive and most likely unachievable and unsustainable.³⁹

A final consideration is 'technological edge'. The US is the only nation that can conduct a 'robust' degree of global space surveillance. It is the only nation that knows the location and activity of

most space vehicles and a considerable amount of space 'junk'.⁴⁰ And, while the global space surveillance coverage of other nations is likely to increase, the US will remain the leader for the foreseeable future. For all intents and purposes, that makes the US the 'traffic controller' of space and the logical key contributor to and leader of the global space surveillance effort.⁴¹

China

China is the major space power of the Asia-Pacific region⁴² and, although technically decades behind the US,⁴³ is increasingly becoming a competitor with the US in many space areas. China has long called for space to be free of weapons. At the Conference on Disarmament in Geneva in 2002, China (along with Russia) argued for space arms control and a new 'Outer Space Treaty', to include a ban on the stationing of weapons in space and the use, or threat of use, of force against space objects (although its ASAT test in 2007 arguably undermined this position).⁴⁴

Australia's space security policy should recognise the importance of China as a rising space power. The different approaches to space security by China and the US, coupled with the underlying lack of trust between the two, creates a tension in Australian policy development. But it also creates an opportunity for Australia to use its bilateral ties with both to seek common ground in space security, which would make an important international contribution to space security.

The Asia-Pacific region⁴⁵

The creation of the Asia Pacific Multilateral Cooperation in Space Technology and Applications (AP-MCSTA), since evolved to the Asia-Pacific Space Cooperation Organisation (APSCO), which came into being when a memorandum-of-understanding was signed between China, Pakistan and Thailand in 1992, signalled China's desire to be identified as the major regional space power. Japan has coordinated a separate regional forum, known as the Asia-Pacific Regional Space Agency Forum (APRSAF) since 1993. Neither has declared a policy approach to space security and, given their

respective charters, neither is likely to in the near future.⁴⁶

APSCO was formed to bring together the substantial resources of the Asia-Pacific nations in pursuit of 'peaceful development of outer space among Asian-Pacific countries'.⁴⁷ With seven inaugural members, including China, Thailand and Pakistan, and invitations to the 'space technology powerhouses [of] Japan, Russia, Australia and the US',⁴⁸ China had high hopes the forum would become a significant contributor to space technology development and cooperation in the region. Of interest is how wide the definition of Asia-Pacific has been cast, as the forum now includes Peru, Iran, Pakistan and Turkey, as well as Indonesia.

APRSAF was formed to 'enhance the development of each country's space program and to exchange views towards future cooperation in space activities'.⁴⁹ The group has 27 participants, including the US, China, India, Japan, Australia and Indonesia, and includes a series of regional and international organisations, including ASEAN and the European Union (EU). The group tends to focus on the use of space as a vehicle for socio-economic development and differentiates itself from APSCO by both its membership and objectives, and its means of cooperation. Essentially, APSCO is seen as an organisation that promotes technology transfer, while APRSAF supports a series of specific projects, including education.⁵⁰

There are several impediments to space security cooperation in the Asia-Pacific region, notably longstanding historic mistrust and strategic competition between a number of regional states. That said, if the region could agree to a space security approach, it would become a very powerful international voice. And this is not unrealistic, as the region has shown itself to be pragmatic over recent years, putting practical resolution of several key issues ahead of historic mistrust. An example is the recent agreement in principle for an East Asian free trade area, demonstrating that the major regional powers can come together where there is collective self-interest.⁵¹

This presents an opportunity for Australia to play a leadership role in the development of space security policy in the Asia-Pacific region, where Australia's leading export partners are China, Japan and South Korea.

Australia's middle-power diplomacy

Australia has a long history of shaping and influencing opinion on particular global issues. The Chemical and Biological Weapons Conventions and the protection of the Antarctic under the Antarctic Treaty are two good examples. Both suggest Australia could play a similar role in global space security issues. Indeed, as a close ally of the US, a key trading partner and increasingly a friend to China, an important member of the Asia-Pacific region and a respected 'middle power' in global diplomacy, Australia is ideally positioned to take an active role in progressing space security policy.

The European Union

The primary motivation in examining the EU's approach to space security is the maturity of its current policy and its leadership in calling for a rules-based code of conduct for space security. In 2008, the EU adopted a 'Code of Conduct for Outer Space Activities',⁵² taking the opportunity to play a leading role in global strategic affairs—immediately after the Chinese ASAT incident—when space security was high on the international security agenda. The EU code is less restraining than the treaty proposed by China and Russia at the Conference for Disarmament in 2002 (and again in 2008), as it is not legally binding and relies on voluntary adherence.⁵³ An extract is as follows:

The purpose of the present code is to enhance the safety, security and predictability of outer space activities for all, recognising that a comprehensive approach to safety and security in outer space should be guided by the following principles:

- (i) freedom of access to space for all for peaceful purposes,

- (ii) preservation of the security and integrity of space objects in orbit, and
- (iii) due consideration for the legitimate defence interests of states.⁵⁴

There are several examples where similar codes have been successful, including the 1972 Code of Conduct in the High Seas.⁵⁵ Over the years, Australia has shown a willingness to participate actively in the development and honouring of such codes, as well as some latent interest in a 'rules-based' international community.⁵⁶ In the space domain, a code of conduct would begin the process of providing behavioural regulation in space. This may or may not lead to more formal arrangements, such as treaties. But it would codify global behavioural expectations.

Domestic considerations

The argument for a 'National Space Agency'

Australia has a decentralised approach to space, with multiple entities in the Department of Defence, the Department of Industry, Innovation, Science and Research, CSIRO, the Australian Communications and Media Authority, the Bureau of Meteorology, the Department of Climate Change and several other government departments. These tend to develop their own policy within their own 'stovepipes', with very few national-level or cross-portfolio investments. This is both inefficient and confusing for other nations and organisations trying to reach into the Australian space community. As a result, Australia is missing opportunities to engage in the global space security debate and to expand its space enterprise.

Of the six recommendations in the 'Lost in space' report, five were focused on the need to establish a national space agency.⁵⁷ The arguments revolve around efficiency, developing and maintaining a cohesive national approach to space development, and providing an informed and appropriate government-level point-of-contact for external space contacts. The Canadian Space Agency is referred to in the report because Canada is 'arguably the most similar country to

Australia'.⁵⁸ It was established in 1989 and now includes a number of facilities, 575 permanent staff and some 100 rotating positions for students.⁵⁹ It is very active in global space activities and has well-established relationships with most of the world's significant space agencies.⁶⁰

This paper agrees that Australia needs a national space agency. Under the current Australian government departmental organisation, the obvious department to provide the necessary whole-of-government vision and perspective is the Department of Prime Minister and Cabinet (PM&C). Within PM&C, there is an existing high-level National Security Adviser, with a growing span of influence over whole-of-government security issues.

This would appear to be a logical place initially to establish a body that could grow into an Australian Space Agency (ASA). The level of statutory authority, control, staffing and budgeting would need to be subject to detailed study, as would the practicalities of relocating the existing space entities from their current departments into the ASA.

Economic considerations

Investment in space security should be seen as an essential and sensible national security cost, much like maintaining maritime or air surveillance capabilities, or maintaining alliances and regional relationships. While it is relatively easy to identify costs associated with developing space security capabilities, it can be difficult to quantify potential savings, that is, how do we cost 'security'? If space security policy has the desired effect, there would be no hostile incidents in space, which would obviously be of significant economic and national security benefit.

The Canadian Space Agency is funded at approximately CA\$375m per year.⁶¹ Apart from the security outcomes that would be expected with such a level of investment, investment in space security can also return a measurable economic benefit to industry. For example, by the year 2000, '[Canadian] exports in space

technologies had become greater than government budgets each year for supporting space activities'.⁶²

Development of an Australian space industry

Australia's space industry is characterised by a series of highly-specialised companies producing technology, components and applications that generally support other nations' space activities.⁶³ These 'niche' capabilities are well-respected around the world but, in reality, even as a combined grouping they employ very few people and do not represent a significant industry sector in Australia. It is difficult to make an argument that supports Australia trying to build a space industry to compete with the established overseas producers, launchers or operators of satellites. This would require substantial Government seed investment and, in reality, it is unlikely that Australia would be able to create and then sustain a serious competitive market.

What Australian industry can do better is identify global opportunities and priorities as a sector, and focus its investment on these opportunities. With the aid of its space agency, Canadian industry has done just that and has been very successful.⁶⁴ To do similar, Australian industry needs a clear understanding of what Australia's priorities—and, perhaps more importantly, its realistic opportunities—are for space and a roadmap that identifies where Australia is likely to invest in the coming years. If space security is to be a national priority for Australia, then Australian industry should be encouraged to become involved in programs that support Australia's space security endeavours. Australian industry needs some degree of certainty before it invests in space. The development of policy should provide that certainty.

National space education

Australia has a pressing need to educate a future space workforce. Such a workforce would need to include operators, technicians, engineers, scientists and, importantly, policy makers. Australia has historically been able to train

operators, technical and scientific staff to work at sites in Woomera, Pine Gap and the various defence and scientific sites around Australia and in the US.

However, even though training and education opportunities still exist, there are little perceived career opportunities in the space industry in Australia. As a result, it is difficult to attract new students and retain graduates in Australia, particularly outside the defence area.⁶⁵ Australia needs to attract engineers, technicians and scientists into key space technology areas, such as signal processing, space-focused physics, systems engineering, and network design and management. One of the benefits of introducing an ASA is the opportunity it would provide to focus on building both a sustainable national education effort and industry opportunities that would offer interesting and rewarding employment for space graduates.

Apart from professional space training, Australian executives, managers and public officials—and the general public for that matter—are largely unaware of the dependence Australia has on space. Again, the formation of an ASA would enable a targeted and coordinated education program to be initiated across all domains and disciplines within the Australian community.

An Australian space security policy proposal

Australia must decide what it seeks to secure with regards to space, before it develops policy and implementation strategies. The following vision statement is proposed for Australia's space security policy:

Australia's space security policy seeks to ensure that Australia has assured and secure access to space-based services, irrespective of the owner or provider of those services, which support all forms of national endeavour and which operate in space free from the threat of interference, damage or destruction.⁶⁶

The vision statement is simple yet comprehensive and would be suitable for the next iteration of the National Security Statement. In implementing

that vision, it is suggested Australia should pursue its space security policy through three key strategies:

- **Strategy 1.** By increasing its investment over the short to medium term in the development of space surveillance infrastructure, technical and operational expertise, and information sharing with the US, Australia would raise its profile and contribution to the international development of a space security framework.
- **Strategy 2.** By engaging diplomatically with the US, China, the EU and our Asia-Pacific partners, Australia would investigate the applicability of a code of conduct for space activities for the Asia-Pacific region.
- **Strategy 3.** By the creation of the Australian Space Agency, Australia's would advance its interests in space, in particular in space security, and provide a single centre of space expertise in Australia, linking investment and existing programs with the national space security policy and the broader national strategic agenda.

Conclusion

Australia is increasingly dependent on space-based systems for its economic, security, environmental, cultural and social interests, and yet the space environment is becoming increasingly vulnerable. While many nations are publicly debating and championing various space security options, Australia has no space security policy and to date has shown little interest in the global debate. This should change if Australia is serious about securing its space-based national endeavours.

Australia's space policy must be developed within the US alliance framework. It must also recognise China's strategic space aspirations and, crucially, the importance of the relationship between China and the US in future space security. It should also be cognisant of the dynamics of the Asia-Pacific region and the increasing interest in that region of space and space security.

The space security policy proposed in this paper is developed around the broad approach of championing a code of conduct in the Asia-Pacific region and bringing together the US and China in space security policy. It provides investment, predominantly in the space surveillance area, and seeks ultimately to bring together Australia's national space endeavours under a single policy and a single statutory authority—the Australian Space Agency.

Air Commodore Chris Westwood joined the RAAF in 1982 and, following air defence controller training, was posted to various operational and instructional posts. His executive posts include CO 1RSU (1994), CO 3CRU (2001-03) and OC 41WG (2004-08). His staff appointments include Operations Manager AEW&C acquisition project (Project Wedgetail) 1997-2001.

He has participated in a number of homeland defence operations, including providing security for the Melbourne Commonwealth Games. During 2007/08, he deployed three times to Afghanistan, heading air worthiness accreditation teams. He commenced as Director General Joint Capability Coordination in January 2010. He has a Graduate Diploma in Management Studies, a Masters of Arts (strategic studies) and an MBA. In 1997, he published 'The future is not what it used to be', as part of a Chief of Air Force fellowship.

Notes

- ¹ This article was published in Issue No. 183 of the *Australian Defence Force Journal* in 2010.
- ² Joan Johnson-Freese, *Heavenly ambitions—America's quest to dominate space*, University of Pennsylvania Press: Philadelphia, 2009, pp. 1-3.
- ³ Richard H. Buenneky, 'Protection of critical infrastructure', presentation to the UN Institute of Disarmament Research Conference on 'Space security 2009: moving towards a safer space environment', Geneva, Switzerland, 16 June 2009.
- ⁴ Johnson-Freese, *Heavenly ambitions*, p. 16.
- ⁵ *Space Daily*, 'Satellite collision not to delay China's space programme', *Space Daily* [website], 14 February 2009, available at <http://www.spacedaily.com/reports/Satellite_Collision_Not_To_Delay_China_Space_Program_999.html> accessed 13 March 2017.
- ⁶ This is evidenced by global moves to introduce codes of conducts, treaties and similar. See Laurence Nardon, 'Space security: Europe takes the lead', *Institut Francais des Relations Internationales*, Paris, 2009, and Jessica West, 'Reaching out – new approaches to security in space', *The Ploughshares Monitor*, Spring 2009, pp. 6-8.
- ⁷ James Clay Moltz, *The politics of space security – strategic restraint and the pursuit of national interests*, Stanford Security Studies: California, 2008, p. 11.
- ⁸ These are described in Johnson-Freese, *Heavenly ambitions*, pp. 37-9.
- ⁹ Brett Biddington, *Skin in the game: realising Australia's national interests in space to 2025*, Kokoda Foundation: Canberra, 2008, p. 47.
- ¹⁰ Johnson-Freese, *Heavenly ambitions*, pp. 1-7.
- ¹¹ Johnson-Freese, *Heavenly ambitions*, pp. 10-1.
- ¹² David Steele, 'The weaponisation of space: next arms race?', Centre for Defence and Strategic Studies, Australian Defence College: Canberra, 2007, p. 6.
- ¹³ Johnson-Freese, *Heavenly ambitions*, p. 39.
- ¹⁴ Desmond Ball, 'Assessing China's ASAT program', Austral Special Report 07-14S, RMIT University: Melbourne, 14 June 2007, pp. 6-7.
- ¹⁵ Ball, 'Assessing China's ASAT program', pp. 1-3.
- ¹⁶ T. Allard, 'Battle lines in the final frontier', *Sydney Morning Herald*, 25 April 2008, p. 31 as referenced in 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, p.19. In addition to ASATs, which currently target specific space vehicles, non-specific attacks by crude weapons have the potential to deny orbits in space for a very long time by creating chain reactions of debris clouds.
- ¹⁷ Department of Defence, 'Submission to Senate Standing Committee on Economics Inquiry into "the Current State of Australia's Space Science and Industry"', Department of Defence: Canberra, 2008, p. 2.
- ¹⁸ Graeme Hooper as quoted in 'Lost in space', p. 13.
- ¹⁹ A good example of this can be found in the Defence Capability Plan. More and more equipment is being introduced into service with the ADF that is dependent on space capabilities.
- ²⁰ Wade L. Huntley, 'Smaller state perspective on the future of space governance,' *Astropolitics*, Vol. 5, No. 3, September 2007, p. 253; and Ball, 'Assessing China's ASAT program', p. 6.
- ²¹ There are several other methods of attacking in space, including lasers and RF weapons. Discussion of these is beyond the scope of this paper but are well covered in several references, including Ball, 'Assessing China's ASAT program', pp. 2-3.
- ²² Senator Grant Chapman, *Space: a priority for Australia*, Commonwealth of Australia: Canberra, 2005, p. 1.
- ²³ Chapman, *Space*, p. 3.
- ²⁴ Senate Standing Committee on Economics, 'Lost in space', p. 67.
- ²⁵ Kevin Rudd, 'The First National Security Statement to the Australian Parliament', 4 December 2008, available at <<https://monash.rl.talis.com/items/29DB370C-B118-102B-5B8A-491ADBCEDDFB.html>> accessed 13 March 2017.
- ²⁶ ABC Radio National, 'Future tense – the space boffins have a plan', *ABC* [website], 12 November 2009, p. 3, available at <<http://www.abc.net.au/rn/futuretense/>> accessed 19 November 2009.
- ²⁷ Australian Government, *Defending Australia in the Asia Pacific century: Force 2030*, Commonwealth of Australia: Canberra, 2009, p. 85.
- ²⁸ Australian Government, *Defending Australia in the Asia Pacific century*, p. 85.
- ²⁹ Helen Buchanan and Katrina Edwards (eds.), *Woomera: the first fifty years – 1947-1997*, Woomera Board: Woomera, 1997, p. 18.
- ³⁰ Biddington, *Skin in the game*, p. 6.
- ³¹ Defence submission to 'Lost in space', pp. 1-2.

- ³² Department of Industry, Innovation, Science and Research website, available at <http://www.innovation.gov.au/Section/AboutDIISR/FactSheets/Pages/SuperScienceSpaceandAstronomyFactSheet.aspx> accessed 2 November 2009.
- ³³ Australian Government, *Defending Australia in the Asia Pacific century*, p. 93.
- ³⁴ For coverage of US space policy history, see Moltz, *The politics of space security*.
- ³⁵ Johnson-Freese, *Heavenly ambitions*, pp. 1-3.
- ³⁶ Moltz, *The politics of space security*, pp. 86-301.
- ³⁷ James Clay Moltz, 'The past, present, and future of space security', *Brown Journal of World Affairs*, 2007, Vol. 14, No. 1. p. 191.
- ³⁸ During his election campaign, President Obama suggested a code of conduct for space activities: see 'Presidential candidates respond to seven key national security questions', Council for a Liveable World, 16 August 2007, as cited in Nardon, 'Space security', p. 9.
- ³⁹ Johnson-Freese, *Heavenly ambitions*, pp. 32-3 and Moltz, 'The past, present and future of space security', p. 193.
- ⁴⁰ Johnson-Freese, *Heavenly ambitions*, p. 10.
- ⁴¹ Since this article was written, the US has issued a revised National Space Policy that includes a change of focus in the US position, particularly around developing international 'rules of the road' (especially from an arms control perspective, but also regarding debris mitigation), the commitment by the US to maintaining a leadership position in all respects (rules, technology, industry etc) and its emphasis on international cooperation: see www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf accessed 10 September 2010.
- ⁴² China has achieved much in the space domain over the past decade. China has a comprehensive space infrastructure that includes a space research, development and manufacturing base; a ground support segment; various launch vehicles and satellites; an inhabited space program; and a commercial space industry. See Ashley J. Tellis, 'China's space capabilities and their impact on US national security', Congressional Testimony before the US-China Economic and Security Review Commission 'China's Proliferation Practices and the Development of its Cyber and Space Warfare Capabilities', 20 May 2008, *Carnegie Endowment for International Peace* [website], available at <http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=20139&prog=zch> accessed 15 November 2009; and Gregory Kulacki, 'A space race with China', *Harvard Asia Pacific Review*, Vol. 9, No. 2, Spring 2008, pp 12-5.
- ⁴³ Moltz, *The politics of space security*, p. 276.
- ⁴⁴ Moltz, *The politics of space security*, pp. 273-5.
- ⁴⁵ The politics of space in the Asia-Pacific region is a significant area of study and this paper cannot cover the dynamics that are currently being played out. See Jo-Anne M. Gilbert, 'Space is not a vacuum: Australia's future in the new frontier', Griffith Asia Institute's submission to Senate enquiry, 2008, available at http://www.aph.gov.au/senate/committee/economics_ctte/space_08/submissions/sub59.pdf accessed 12 November 2009; and Erik R. Quam and James Clay Moltz, 'Asian approaches to space security', *Monterey Institute of International Studies* [website], 10 May 2007, available at <http://cns.miis.edu/stories/070510.htm> accessed 12 November 2009.
- ⁴⁶ See APRSAF website at <http://www.aprsaf.org/text/about.html> accessed 10 November 2009 and APSCO website at <http://www.suparco.gov.pk/pages/apSCO.asp> accessed 16 November 2009.
- ⁴⁷ Chinese Vice Premier Zhang Dejiang in a letter to APSCO marking the formal establishment of the group, as reported in *People's Daily On-line*, 'Asia-Pacific Space Cooperation Organisation starts Operations', 17 December 2008, available at <http://english.peopledaily.com.cn/90001/90776/90883/6554845.html> accessed 12 November 2009.
- ⁴⁸ *China Daily*, 'New space body welcomes all', *China Daily* [website], December 2008, available at http://www.chinadaily.com.cn/world/2008-12/17/content_7311933.htm accessed 12 November 2009.
- ⁴⁹ See APRSAF website.
- ⁵⁰ Peter Brown, 'Japan's next chapter in space begins', *Asia Times On-Line* [website], 9 September 2009, p. 2, available at <http://www.atimes.com/atimes/Japan/KI09Dh02.html> accessed 12 November 2009.
- ⁵¹ See <http://www.thetrumpet.com/index.php?q=6677.5148.0.0> accessed 16 November 2009.
- ⁵² The Council of the European Union, 'Draft code of conduct for outer space activities', Brussels, 17 December 2008, available at http://www.stimson.org/space/pdf/EU_Code_of_Conduct.pdf accessed 1 Nov 2009.
- ⁵³ Nardon, 'Space security', pp. 11-2.
- ⁵⁴ The Council of the European Union, 'Draft code of conduct for outer space activities', pp. 4-5.
- ⁵⁵ Nardon, 'Space security', pp 10-2.

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- ⁵⁶ Australian Government, *Defending Australia in the Asia Pacific century*, pp. 43-4.
- ⁵⁷ Senate Standing Committee on Economics, 'Lost in space', pp. 66-7.
- ⁵⁸ Senate Standing Committee on Economics, 'Lost in space', p. 68.
- ⁵⁹ See
<http://en.wikipedia.org/wiki/Canadian_Space_Agency
> accessed 13 November 2009.
- ⁶⁰ Huntley, 'Smaller state perspective on the future of space governance', pp. 245-52.
- ⁶¹ See
<http://en.wikipedia.org/wiki/Canadian_Space_Agency
> accessed 13 November 2009.
- ⁶² Canadian Space Agency, 'State of the Canadian space sector 2000', as cited in Huntley, 'Smaller state perspective on the future of space governance', p. 250.
- ⁶³ ABC Radio National, 'Future tense – the space boffins have a plan'.
- ⁶⁴ Huntley, 'Smaller state perspective on the future of space governance', p. 250.
- ⁶⁵ Biddington, *Skin in the game*, p. 61.
- ⁶⁶ This statement uses some elements of the definition of space security contained in Moltz, *The politics of space security*, p. 11 and some from Biddington, *Skin in the game*, p. iii.