# Australia confronts a contested space domain and a rising China

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Australia is a new space power, but with a history of participation in space activities that extends back to the early days of the space age. Our involvement began in the 1960s at Woomera, South Australia, in cooperation with the European Launcher Development Organisation (ELDO), and with testing of 'Blue Streak' ballistic missile systems with the United Kingdom. At that time, we had the opportunity to emerge as one of a few active space actors alongside the U.S., France, and the Soviet Union – had we sustained our efforts in those early days.[1]

We let our focus on space, and the opportunity it presented, slip through our fingers, as ELDO pulled out of Woomera in the late 1960s, and government then pulled out of funding national space activities. The subsequent decades, until just recently, have been a series of half measures and missed opportunities. Space as a national endeavor had languished and been ignored for many years.

But the mindset of government has changed fundamentally in recent years. A review of Australia's nascent space industry sector undertaken in 2015, and published in 2018, established the framework for a fundamental shift in attitudes by government to space and was instrumental in convincing government to support the establishment of an Australian Space Agency, which was stood up in July 2018.[2] There was also growing awareness of the potential lucrative nature of commercial space, and the impact of 'Space 2.0' and 'newSpace' paradigms that have transformed global space activities.[3] The then Coalition government led by Prime Minister Malcolm Turnbull announced the formation of the Australian Space Agency at the 2017 International Astronautical Congress in Adelaide.[4] The Agency has as its mission supporting the rapid growth of Australia's national space sector, formulating space policy, engaging with international partners, regulating Australia's space activities, and supporting future space activities through STEM activities within schools and universities.[5]

At the same time, Australia's Department of Defence has been approaching space in a more ambitious manner. Historically, Australia's defence forces have been content to rely on the U.S. and other states, or commercial providers to provide a space segment – satellites and space launch capability – whilst Australia offers a 'suitable piece of real estate' for the ground segment – ground control facilities – and manages the dataflow between satellites and the ground. That traditional perspective, epitomized in the 2013 Satellite Utilisation Strategy[6], is rapidly being superseded by a more forward leaning and ambitious approach, most recently stated in the July 2020 Defence Strategic Update and reinforced in the accompanying Force Structure Plan.[7] These documents suggest that Australia is now embracing 'sovereign controlled' satellite communications and 'space-based 'geo-intelligence' capabilities', and is emphasizing assured space access and resilient multi-mission space capabilities, as well as enhanced space control against a context of a contested space domain.

That transformation in attitude – both in the civil and commercial domain, and in relation to defence space capability – is significant and represents a maturation of Australia as a re-emerging space power after decades of stagnation in policy and capability.[8]The strategic context for this step is important to consider. Australia's recognition of the importance of the space domain is occurring against a context of an increasingly dangerous and challenging security outlook, driven by growing strategic competition between a rising and assertive China that is challenging the strategic primacy of the United States. The Defence Strategic Update notes in its assessment of the strategic outlook that major powers – notably China – have become more assertive in seeking to exert influence in the Indo-Pacific, and raises the concern that some countries will pursue their strategic interests through coercive and grey zone activities, whilst accelerating military modernisation. This is placing Australia's military forces at greater risk over longer distances. A key finding of the Defence Strategic Update is that previous assumptions about a ten-year strategic warning time for a major conventional attack against Australia are no longer relevant, and the prospect of high-intensity military conflict in the Indo-Pacific is less remote than assumed previously.[9]

With this deterioration in our strategic circumstances in mind, the Coalition government of Prime Minister Scott Morrison released its 2020 Defence Strategic Update and Force Structure Plan on July 1st, 2020. In launching the update, Prime Minister Scott Morrison identified negative trends that had sharpened and accelerated insecurity in Australia's strategic outlook, noting:

> *'…we have been a favoured isle, with many natural advantages for many decades, but we have not seen the conflation of global, economic and strategic uncertainty now being experienced here in Australia in our region since the existential threat we*

*faced when the global and regional order collapsed in the 1930s and 1940s. … That period of the 1930s has been something I have been revisiting on a very regular basis, and when you connect both the economic challenges and global uncertainty, it can be very haunting. … it requires a response… we must face that reality, understanding that we have moved into a new and less benign strategic area, one in which institutions of patterns of cooperation that have benefited our prosperity and security for decades, are now under increasing – and I would suggest almost irreversible – strain.'*[10]

The 2020 Defence Strategic Update itself makes clear that Australia's region is in the midst of the most consequential strategic realignment since the Second World War, and trends including military modernization, technological disruption and the risk of state-on-state conflict are further complicating our nation's strategic circumstances.'[11]

This paper explores how Australia's approach to space as an operational warfighting domain is evolving in the light of China's growing challenge, and how China's growing military space capabilities, including its counterspace systems, will shape Australia's approach to acquiring its own space capability in coming years. It will consider how Australia intends to 'burden share in orbit' from the surface of the Earth through space domain awareness, and key partnerships such as the Combined Space Operations (CSpO) initiative, and in space through the acquisition of resilient multi-mission space capabilities for communications, intelligence, surveillance and reconnaissance, and precision navigation and timing. It will make a strong case that Australia should pursue a sovereign responsive space launch capability if it is to burden share in orbit and assure space control and space access. It will also examine how Australia will respond to China's growing counterspace capabilities, through ensuring its own space control capability.

**Australia faces a more contested space domain in a more dangerous strategic outlook**

This growing importance of the space domain must be seen against an emerging strategic and geopolitical context of growing risk and uncertainty in the Indo-Pacific region. It is China's development of counterspace capabilities that is of growing concern in ensuring Australia's access to space, and a perceived need to ensure resilient space capability.[12] Space has always been militarized, and certainly is not a sanctuary, sitting serene and untouched by terrestrial geopolitical rivalries below. Current trends suggest that the militarization of space – the use of space capabilities to support military forces on Earth – is giving way to the weaponization of space, in which space is

becoming a warfighting domain, as counterspace capabilities emerge in the armed forces of major power adversaries such as China and Russia.

The 2020 Defence Strategic Update and its accompanying Force Structure Plan elevates the profile of the space domain, in comparison to the former 2016 Defence White Paper's language, and pays particular attention to space control, including space domain awareness, as an important task.[13] It is a response to space becoming contested and congested, and with Space being a key centre of gravity for modern information-based warfare. Ensuring access to vital space support is essential to undertake joint and integrated military operations, and a key task for Australia as a new space actor is to contribute *space surveillance and space domain awareness*.

The Prime Minister in launching the 2020 Defence Strategic Update and Force Structure Plan made specific mention of the space domain. He stated:

> *"…the Government will significantly increase investment in defence space capabilities, a whole new theatre, including a network of satellites so we have an independent communications network and we're going to invest some $7 billion (AUD) in those space capabilities over the coming decade, working closely with industry and other government agencies, including the Australian Space Agency, headquartered in Adelaide where I was there to open that agency not that long ago. Working with key partners and allies, we will take advantage of Australia's unique geographical position to better contribute to collective space domain awareness and we will look to enhance the ADF's ability to counter emerging threats in the space domain and ensure our continued access to space-based intelligence and reconnaissance."*[14]

This marks a very significant step forward from the more cautious stance of previous defence white papers, and most importantly, highlights government recognition of the importance of the space domain as being equal to other operational domains, such as air, sea, and land, or cyber. It recognizes that space is contested, and yet Australia must work to ensure access to space capabilities which are crucial to the ADF's effectiveness and ability to protect Australia's territory and national security. For Australia, space is no longer an adjunct that supports traditional domains, but is an operational domain in its own right. Furthermore, the Defence Strategic Update and the Force Structure Plan makes clear that Defence recognizes the challenge posed by emerging counterspace systems – space is contested, congested and competitive – and highlights a key task for Defence going forward in ensuring space control in the face of these threats. The starting point for that task is building Space Domain Awareness.

**Space Domain Awareness as the basis for Space Control**

Space Domain Awareness is a task that Australia is well placed to support within the 'five eyes' group and beyond, through the provision of ground based facilities, such as that which is being established at Exmouth, Western Australia, and through the 2014 Combined Space Operations (CSpO) Initiative, that includes the 'five eyes' members as well as France and Germany.[15] There is also growing opportunity for Australia's expanding commercial space sector to provide new capability solutions to the space surveillance and space domain awareness mission, in a manner that will allow Australia to have a greater means to 'burden share in orbit' and support resilient multi-mission space capability. The objective must be to boost space resilience, strengthen credible deterrence in space, and reduce the threat posed by adversaries willing to exploit counterspace capability in a contested space domain as well as respond to the growing challenge of space debris. In looking forward, Australia could provide space-based space surveillance capability that would complement ground-based space surveillance. As will be argued below, such a step would be further facilitated through the establishment of sovereign space launch services in Australia's commercial space sector that would allow Australian satellites to be launched on Australian launch vehicles from Australian launch sites in a manner that is rapid, regular and responsive. A more comprehensive national space surveillance and space domain awareness capability that is both ground and space-based supports an increasingly challenging requirement for space traffic management as the space domain becomes more congested, particularly with the emergence of 'mega-constellations' in the coming decade. Australia should seize the opportunity to be a leading contributor to meeting this challenge.

Understanding the activities of other states in orbit and tracking hazardous space debris is a vital task, because for a country like Australia, the space domain is becoming far more important than in the past. Without satellites for communications; intelligence, surveillance and reconnaissance; and positioning, navigation and timing services, the Australian Defence Force (ADF) would be far more limited in their ability to understand the modern battlespace, undertake coordinated operations as part of a coalition, and use force in a manner that is consistent with the laws of armed conflict.

There would be a much greater risk of military failure on the battlefield leading to strategic defeat in future war.[16] The consequences of threats to key space systems, whether through deliberate action on the part of an adversary, or through the growing hazard of space debris, extends well beyond implications for Australia's military capability, as much of our national economy and society directly depend on space systems to function effectively. National supply chains, civil

communications and data systems, stock markets, manufacturing, and transportation infrastructure all depend heavily on space to function.[17]

With this reality in mind, there has been growing awareness that access to space can't be taken for granted and there are continued risks of dependency on foreign states as providers for the key 'space segment' – satellite networks and launch capacity. The establishment of the Australian Space Agency on July 1st, 2018 reinforced government's desire to be more self-sufficient in space – to be an active provider of space capability rather than merely a passive consumer. For both Defence and the civil sector, through the Australian Space Agency, the task of space surveillance and space domain awareness is becoming a key element of Australia's national space endeavor.

Defence broadly conceptualizes space capability in terms of 'space services' and 'space control'. Space services includes satellite communications; positioning, navigation, and timing services; and, space-based geospatial support and intelligence, surveillance, and reconnaissance systems. The 'Space Control' component of defence space capability has '…Space Domain Awareness (SDA) [as] its foundation. SDA is the effective identification, characterization and understanding of any factor, passive or active, associated with the space domain that could affect space operations and thereby impact the safety, security, economy or environment of a nation.'[18] In the 2020 Force Structure Plan, Defence notes that:

> *"Australia holds a unique geographical position to contribute significantly to collective space domain awareness with our allies and partners. Space domain awareness enables better tracking and identification of space objects and threats, such as space debris, as well as predicting and avoiding potential collisions."*[19]

The 2020 Force Structure Plan highlights the importance of space surveillance as a key component of space control, essentially repeating the 2016 Defence White Paper, which itself 're-announced' the hosting of a U.S. Space Force (formerly USAF Space Command) owned C-Band radar system and a U.S. optical space surveillance telescope at the Harold E. Holt U.S. Naval Communications Facility at Exmouth, Western Australia.[20] Those key sensors are remotely operated from No. 1 Remote Sensor Unit (1RSU), located at RAAF Edinburgh, near Adelaide, South Australia. They represent the first joint endeavor between the U.S. and Australia and allow an important expansion of the U.S. Space Surveillance Network into the southern hemisphere.

The establishment of an Australian-hosted space surveillance capability was first implied in the 2009 Defence White Paper, and then first formally announced in the 2013 White Paper.[21] In an Australian Defence Doctrine Publication, 'Operational Employment of Space – ADDP.318', that was

released in 2016, the importance of space situational awareness is highlighted as a key element of assured space support, and a 2019 doctrine note (AFDN 1-19), 'Air-Space Integration' goes into more detail on specific SDA capabilities, including those facilities at Exmouth, WA.[22] Defence's approach to SDA capability acquisition is occurring under Joint Project 9360, with Defence stating:

> *"Through Joint Project 9360 – Space Domain Awareness, Defence is seeking to acquire sovereign SDA capabilities including space surveillance sensors and associated mission systems. Defence are in the process of investigating and developing options to further enhance ADF space control capability."*[23]

That highlights that Australia's approach to Space Domain Awareness won't be constrained to a C- Band radar and optical space surveillance telescope operated jointly with the United States but is set to expand beyond these capabilities. The role of Australia's commercial space sector will be critical in realizing this outcome, in a manner that builds a sovereign space domain awareness capability and allows Australia to burden share in orbit with key partners in the 'five eyes' and beyond. The 2019 'Spacefest' exercise brought together a number of commercial companies and universities that are producing innovative space domain awareness capabilities which can support Australian Defence Force requirements, with a follow-on exercise to occur in 2020.[24] For example, the Western Sydney University's International Centre for Neuromorphic Systems (ICNS) is developing 'event-based sensors' that detect and track satellite activity based on movement based sensors in a mobile containerized observatory, even during daytime, allowing a low-cost network of space surveillance sensors across Australia, and to support ADF expeditionary operations.[25] Inovor Technologies in South Australia is developing the Hyperion system of space-based space situational awareness based around a constellation of 12U CubeSats deployed into LEO to observe activity in MEO and GEO.[126] HEO Robotics at the University of New South Wales in Sydney are developing space-based space surveillance capability with its Argus project that will monitor GEO, whilst Curtin University is using the Murchison Widefield Array (MWA) low frequency radio telescope in Western Australia as a wide-field passive sensor for space surveillance through detecting reflected FM transmissions of satellites.[27] Finally, EOS Space Systems, one of Australia's leading companies that focus on space surveillance technologies using laser-optical sensors, operates fixed sites at Mt Stromlo in Canberra, and in Learmonth, Western Australia.[28]

[1] Low Earth Orbit (LEO) can be defined as an orbit at an altitude of less than 2000km but as low as 160km above the Earth's surface, with earth-observation and tactical communications satellites predominantly used in this orbit. Medium Earth Orbit (MEO) are orbits ranging from 1600km to the geosynchronous belt at 36,000km, and is home to global navigation satellite systems. Geosynchronous (Geostationary) Earth Orbit (GEO) lies at 35,786km above the Earth's equator, with communications satellites located on this orbit able to match the rotation of Earth, and thus appear stationary over a particular part of Earth's surface.

Certainly, Australia's approach to space domain awareness is not purely limited to government-run facilities for the ADF, and there is a wide and growing commercial space industry involvement. That is also reflected in the Australian Space Agency's civil space strategy document, released in 2019, which emphasizes space surveillance as one of Australia's National Civil Space Priority Areas.[29] This is echoed in the Defence 2020 Force Structure Plan which sees Space Domain Awareness as integral and essential to ensuring space control, and assured access to space. That prioritization is driven by growing threats from adversary counterspace capabilities.

Defence now sees space as a key operational domain of equal importance to air, sea, land, and cyber domains, and recognizes that space is 'contested, congested and competitive'. The growth of counterspace systems being developed by China, Russia and other adversaries highlights the risks for the ADF to access to space capability in future conflict and undermines the credibility of previous assumptions that Australia will always have uninterrupted access to space capabilities. Part of the basis for making that assumption was a complacent over-reliance on the U.S. for the provision of the space-segment, underpinned by an increasingly out-of-touch assessment that space wasn't a warfighting domain but a peaceful common. That assessment was widely held by government whilst counterspace capabilities were not visible. China's January 2007 ASAT test, and its subsequent development of a full range of counterspace capability has altered mindsets and reshaped the debate within Defence, as the credibility of the argument that space access was assured and that space was a common of cooperation look increasingly eroded. The challenge of space debris, and the rapid 'democratization' of space through 'Space 2.0' technologies which is making space an increasingly competitive environment, with many more space actors – both state and non-state has further undermined the case for space as a sanctuary, sitting untouched by geopolitical rivalries below.

Although there are still advocates for the non-militarization of space, a more realistic assessment of the current and emerging space domain has largely replaced previous assumptions. Defence is confronting a more challenging reality where Australia must do more on its own, to burden share with allies, and to assure space access for the ADF and the nation. This is now resonating within government policy, and understanding how Australia thinks about space control, especially in the context of a rising challenge posed by an assertive China, must be the next focus in this paper.

**A contested space domain for the ADF**

The 2020 Force Structure Plan that accompanied the Defence Strategic Update highlighted the importance of the space domain for the ADF, and as noted above saw space as equal in standing and importance to other operational domains. In addition, and for the first time, it pushes Australia's

policy settings towards embracing greater sovereign space capability. This would entail the means to produce facilities for the ground segment, as well as local development and construction of satellites and space launch capabilities, locally in Australia, for supporting Australia's space requirements, both civil as well as national defence purposes, as well as opening up an opportunity towards expanding Australia's ability to burden share with key allies in space. Key defence projects now underway reinforce this. The acquisition of sovereign geospatial intelligence capability including space-based intelligence, surveillance and reconnaissance systems under Project DEF-799 Phase 2 and Phase 3 imply Australia will look to acquire its own 'spy satellite' capability before the end of the 2020s and into the 2030s, whilst the next generation satellite communications system to be acquired under Project JP-9102B will be 'sovereign controlled'.[30]

These are bold moves forward for a country which previously had eschewed such a step under what might be considered a cultural cringe that somehow implied Australia either could not or did not need to develop sovereign space capability beyond the ground segment, as suggested in the 2013 Satellite Utilisation Strategy noted above. The ground segment itself is highly important for Australia, and will be rapidly expanded in coming years to support key projects for space, including for the Advanced Satellite Communications System (JP-9102B), geospatial services (DEF-799), and for enhancing positioning, navigation and timing (PNT) capability within the ADF, including through civil-controlled satellite-based augmentation system (SBAS) being developed by Geosciences Australia in partnership with New Zealand, that can have both defence and civil applications.[31]

As Australia pursues new space capability it faces a growing array of counterspace threats from adversary states that will leave its new space capability vulnerable if it doesn't boost the resilience of those space capability at the same time. One approach being pursued by the Defence Science and Technology Organisation (DSTO) is augmentation and disaggregation of space support through the 'small and many' rather than the 'large and few'. Investing in resilient multi-mission space capability via small satellites is a priority for DSTO as a science, technology, and research objective – known as a 'STaR Shot' - through experimentation with low-earth orbit based SmartSat constellations.[32]

The need to assure space access and build space resilience is important for the ADF's operational capability and can also make an important contribution towards 'burden sharing in orbit' with key allies. Australia is already a key member of the CSpO Initiative within the 'Five Eyes' structure, with the CSpO having been expanded to include France and Germany. The opportunity to expand CSpO to other partners – such as Japan and in time potentially India – could be a good first step forward, together with broadening the initiative's activities to include cooperation on joint development of space-related technology and boosting coalition operational capability.

Australia's commercial space sector is clearly well placed to enjoy 'second mover advantage' in Space 2.0 and leapfrog in key technology areas such as small satellite and fractionated 'CubeSat' architectures, as well as low-cost space launch capability. There's no need to reinvent the wheel in pursuing future space capability, and Australia should be able to move rapidly towards harnessing new technologies and embracing rapid innovation through experimentation and spiral development, rather than long and slow acquisition cycles that traditionally plague defence capability acquisition.

There is also potential for Australia to directly support international partners in building space resilience. As noted above, space resilience should include measures towards augmentation of existing space capability prior to, or in the lead-up of a major crisis ('Phase 0'), in a manner that can quickly disaggregate space support across a more resilient and distributed space architecture, which is not so vulnerable to a 'pearl harbour in space' type ASAT campaign.[33] Such an approach lends itself to 'space 2.0' type technologies that can exploit rapid innovation cycles for small satellite and CubeSat development – an approach that Australia is already demonstrating an ability to support.

Secondly, boosting space resilience within a coalition can include expanding the means for rapid reconstitution of lost space capability through building responsive space launch. Once again, Australia is well placed – geographically, and technologically – to support space launch using sovereign space launch providers and launch sites. The establishment of two, and potentially three, launch sites in Australia – at Nhulunbuy near Gove in the Northern Territory; at Whalers Way near Port Lincoln in South Australia – and possibly, at Abbot Point in Bowen, Queensland – is underway.[34] The site at Nhulunbuy, being prepared by Equatorial Launch Australia, is well placed for equatorial LEO missions and its close proximity to the equator allows it to take best advantage of Earth's rotation for lower cost per kg into orbit.[35] The Whaler's Way launch site, being established by Southern Launch, is ideal for polar orbit missions that would be useful for LEO-based space surveillance tasks.[36] Matching rapid progress in launch site development, Australian commercial space launch companies, led by Gilmour Space Technology in Queensland, are developing space launch capabilities, with Gilmour looking towards an orbital space launch capability on its Eris launch vehicle by 2022.[37]

The manufacture of small satellites in Australia, launched by Australian launch vehicles from Australian launch sites, would mark the maturation of Australia as a space power, and dramatically boost Australia's ability to reinforce space resilience for the ADF, as well as contribute towards burden sharing in space with key allies.[38] The ability to rapidly develop satellites through exploiting

'fourth industrial revolution' ('4IR') technologies and concepts, and ease dependency on foreign launch providers, would boost assured access to space in a crisis, and reduce the risk posed by Chinese and other adversary counterspace capabilities. This future vision – Australian developed satellites launched on Australian launch vehicles from Australian launch sites should be at the heart of government's response to the requirement for boosting space resilience and access.

Yet, Australia's government has yet to formally commit policy to support the establishment of sovereign space launch. This seems incongruous given that the commercial sector is moving ahead with just such a capability, even as Defence and the Australian Space Agency offer these companies verbal and financial assistance.[39] It is also out of step with government declared objectives for growing Australia's commercial space sector in a manner that promotes an expanding number of jobs, and revenue, or, from Defence's perspective, easing dependency on foreign providers whilst moving towards greater sovereign capability.[40]

The challenge posed by adversary counterspace capabilities, particularly those being developed by China, will only get worse. The following section examines the key developments in the PLA's space capabilities, considers the broader implications of China's ambitions in space, and explores how Australia will respond in the light of China's future space activities, and then concludes with recommendations for responding to this growing challenge based on future capability aspirations suggested in the 2020 Defence Strategic Update and Force Structure Plan.

**The Dragon in Space – PLA space and counterspace capability**

Space is going to become even more contested between now and 2035 as adversary counterspace capabilities mature. China and Russia are both developing a suite of counterspace capabilities to match their existing and evolving space support systems based around a suite of satellites for 'C4ISR and PNT' tasks, including:

a) Direct-Ascent anti-satellite weapons (DA-ASATs) designed to be launched from the Earth and physically destroy a target satellite through kinetic or explosive mechanisms.

b) Co-Orbital ASATs that can maneuver close to a target satellite, and then either destroy it through collision, or disable it via a 'soft kill' mechanism such as electronic warfare or physical interference.

c) Terrestrial counterspace capability such as satellite uplink and downlink jamming and spoofing techniques, laser dazzling, and ultimately, cyber-attack.

China and Russia are the most advanced in terms of counterspace capability development, undertaking organizational reform (e.g., the formation of the PLA Strategic Support Force (PLASSF) in 2015 to manage space operations) and developing conceptual thinking for space warfare.[41] For example, China has operationally deployed DA-ASATs for targeting LEO-based satellites as of 2010.[42] It is seeking to have the means to deploy other counterspace capabilities, including potentially, the means to threaten U.S. and allied satellites in GEO. It has undertaken the operational testing of co-orbital technologies, including undertaking Rendezvous and Proximity Operations (RPOs), that demonstrate potential application for ASAT roles. The threat is not just limited to major powers such as China and Russia. As counterspace technologies mature, the nature of some types of counterspace systems, such as jamming and spoofing systems, as well as cyber-attack, make them more likely to proliferate to other state and non-state actors over the period through to 2035, expanding the counterspace threat facing the U.S. and its allies, including Australia.

With this challenge in mind, the 2020 Force Structure Plan highlights space control as a key task, and states that:

> *"…Defence will need capabilities that directly contribute to war fighting outcomes in the space domain using terrestrial and/or space-based systems. The government's plans include the development of options to enhance ADF space control through capabilities to counter emerging space threats to Australia's free use of the space domain and that assure our continued access to space-based intelligence, surveillance and reconnaissance."*[43]

The key line is 'development of options to enhance ADF space control through capabilities to counter emerging space threats to Australia's free use of the space domain…' That would imply a means to defend against, or neutralize counterspace threats directed against the space segment, or potentially the ground segment. Current ADF Space Doctrine as laid out in ADDP 3.18, 'the Operational Employment of Space', echoes U.S. space control language. Both Australia and the United States defines counterspace in terms of offensive counterspace (OCS) and defensive counterspace (DCS), with their view being that counterspace integrates offensive and defensive operations to attain and maintain the desired control of and protection in and through space.[44] ADDP 3.18 states:

> *"Space control supports freedom of action in space for friendly forces. When necessary, it also supports defeat of adversary efforts to interfere with or attack friendly space systems and negates adversary space capabilities. The components*

*of space control include offensive space control (OSC) and defensive space control (DSC). OSC [includes] measures taken to prevent an adversary's ability to interfere with or attack friendly space systems. DSC includes measures taken to preserve the ability to exploit space capabilities via active and passive actions, while protecting friendly space capabilities from attack, interference or unintentional hazards."*[45]

Australia has to a large extent copied U.S. counterspace doctrine rather than develop its own. The establishment of the U.S. Space Force, and the June 2020 release of Space Capstone Publication, *Spacepower*, will increase the urgency for the ADF to develop its own updated Space doctrine, and also, address a key missing piece of policy – a declaratory Defence Space Strategy Document, akin to the U.S. equivalent, also released in June 2020.[46]

Chinese counterspace capability development won't wait for Australia to catch up, and there will be increasing pressure on Australian space leaders to establish clear and up to date defence space strategy and doctrine that could inform future capability development which meets policy goals stated in the 2020 Force Structure Plan, preferably in the coming ten years. Failure to address the growing counterspace challenge not only would place the operational efficacy of the ADF to deliver credible effects in any future major power conflict at risk, but also leave Australia's national society and economy more exposed to the effects of a Chinese use of space weapons in a future conflict.[47]

Of great concern must be the prospect of Chinese 'grey zone' operations in orbit, exploiting rendezvous and proximity operations (RPOs) by commercial capabilities for satellite inspection, repair and refueling in a manner that could hide the use of co-orbital ASATs equipped with a soft-kill capability. In particular, the nature of co-orbital RPOs means that they can exploit electronic warfare, high powered microwave weapons, jamming, or physical interference, to generate scalable or reversible effects that can disable, damage, and disrupt a target satellite, rather than only destroy it. That avoids the risk of fratricide created by the physical destruction of a target satellite, denying space to both the aggressor state and the would-be target.

Secondly, ground-based counterspace capabilities, notably cyber-attack against both satellites themselves, and their controlling ground facilities, are also likely to be a rising challenge for the ADF as it embraces a rising space power role. Cyber-attack on satellites is emerging as an important future counterspace capability. A key 2016 Chatham House report argued that satellites are vulnerable to cyber-attack, both directly and indirectly through ground stations, or through the

supply chain of satellite technology.[48] Although military satellites are often hardened against cyber-intrusion, commercial satellites (COTS) used by military forces often are not. The very character of cyber warfare and computer network operations means that states can exploit this form of power without necessarily incriminating themselves, they can do so well before a declaration of war or an outbreak of overt military hostilities, and the nature of cyber threats allows them to be insidiously planted inside critical systems in a dormant state.

Cyber-attacks on satellites might begin not on the day of war breaking out, but months or even years beforehand when malicious code is slipped into critical components on a commercial production line and carried out by undeclared cyber-forces acting on behalf of a state.[49] The nature of cyber warfare suggests some important risks for maintaining access and freedom of action in space for the ADF, and opens up the prospect that lesser tier adversaries such as WMD-armed rogue states, or non- state actors, could undertake counterspace and 'space denial' campaigns against the ADF in future operations using 'soft kill' techniques through cyber operations.

China, Russia, and more recently, India, have all demonstrated hard-kill or 'hit-to-kill' ASAT capability including direct-ascent ASAT systems.[50] Although China has demonstrated a means to deploy a hit to kill capability in 2013, that could hold at risk satellites in GEO, the risk with the use of hit-to-kill direct-ascent ASATs is creating rapidly expanding debris clouds that denies space to all.[51] China is likely to have operationally deployed a direct-ascent hit-to-kill ASAT for LEO targets, and could also exploit mid-course BMD systems for a counterspace role against LEO constellations, but its capability against MEO or GEO is unlikely to have been fully realised operationally. It is more likely that China will emphasize 'soft kill' systems that disrupt, disable, and deny space support, rather than physically destroy satellites. These could include co-orbital and ground-based systems, including electronic warfare (both uplink and downlink jamming), ground-based laser dazzling, and cyber-attack capabilities. Soft-kill capabilities, especially cyber-attack, can offer a degree of deniability which is useful for grey zone operations in orbit, and reversible effect, both of which can increase their utility for coercion in scenarios short of war. The 2020 Defence Strategic Update highlighted the challenge posed by political warfare and grey zone operations against Australia, but the focus was very much on terrestrial activity. The ADF, as it forges new capability for operating in the space domain, must get ready for grey zone operations in orbit as well.

China's military space capabilities beyond the counterspace dimension, encompassing the full range of space support systems for satellite communications for command and control (C3), intelligence surveillance and reconnaissance (ISR), and positioning navigation and timing (PNT) are also of key importance for Australia.[52] These space systems form an essential component of China's

anti-access and area denial (A2AD) potential – they comprise the sensor in the 'sensor to shooter' kill chain, and a means to manage long-range expeditionary and counter-interventional operations. The ability of PLASSF controlled ISR satellites, such as Yaogen and Gaofen satellites, to monitor naval operations by U.S. and allied forces, or to monitor radio and electronic emissions through orbital SIGINT and ELINT platforms, is central to targeting long-range antiship missile systems such as the DF-26 and DF- 21D, or to target land-attack missile capabilities. China's *Beidou* PNT satellite network is now largely complete and allows not only precision navigation and targeting in all weather, but timing information for integrated command and control networks that are essential for PLA joint operations.

The 2020 Strategic Defence Update's key message was that with the increasing risk of major power conflict in coming years, Australia could no longer afford to forego long-range strike capability and rely on close-in defence of the 'sea-air gap' to our north. This is largely due to a recognition of the possibility that Chinese long-range strike capability could threaten Australia's air and maritime approaches, and its northern land-mass – and PLA Space capability would play a vital role in enabling China to use those long-range strike capabilities against us. This might occur if Australia directly participated alongside the United States in responding to a Chinese attack on Taiwan, or, if Australia were to host U.S. forces operating from Australian Defence Force base facilities in our north. PLA space support would facilitate long-range PLAAF bomber operations against ADF facilities or deployed forces, and PLARF long-range missile strikes to deny ADF or U.S. forces freedom to operate against China unmolested.

With that threat in mind, Australia's 2020 Defence Strategic Update and Force Structure Plan emphasizes the re-acquisition of long-range strike capability for the ADF for the first time since the retirement of the RAAF's F-111C fleet in 2010.[53] This will initially be based on acquisition of the AGM-158C Long-range antiship missile (LRASM) for RAAF's F/A-18F fleet, but the Force Structure Plan makes clear that there will be investment in other long-range strike capabilities including hypersonic weapons and advanced manned-unmanned teaming capabilities.[54]

Australia must boost its own sovereign space capabilities to support such long-range strike capability if it is to operate well north of Australia's sea-air gap.[55] Key projects now being pursued by Australia for sovereign controlled satellite communications, and space-based intelligence, surveillance and reconnaissance systems, as well as enhancements to satellite provided positioning, navigation and timing services from GNSS systems such as GPS all contribute towards facilitating longer and swifter reach for the ADF to deter, or defend against Chinese anti-access and area denial capabilities, including PLA Navy and long-range missile and air forces. It would seem quite likely that

our A2AD capabilities will meet their A2AD capabilities at sea, in the air and in orbit in any future conflict.

**Going forward to Space – six recommendations**

With these challenges evident, the ADF and Australia's Department of Defence, as well as the broader national space sector, have a challenging task ahead. In becoming a space power, Australia will enjoy huge dividends in terms of boosting Australia's prosperity over time, and enhancing ADF capabilities in the future, but it will also requiring that Australia do more to contribute to allied space activity, including by strengthening space deterrence through more resilient space capability. Far from going into a peaceful common, in which international cooperation is assured, space is contested and an operational warfighting domain, and the prospect of warfare in space is real, or even likely. How should Australia respond to this challenge?

Firstly, if Australia's Defence Force is to be serious about embracing sovereign space capability it needs a clear and coherent space strategy that is unclassified and open to all. This declaratory strategy is currently absent and preparation of such a strategy is long overdue. The 2020 Defence Strategic Update and Force Structure Plan provides some high-level policy statements and elevates the profile of the space domain, embracing greater sovereignty for space capabilities. That is all welcome, but its only one small step rather than a giant leap forward. Releasing a space strategy for defence, which builds on the guidance in the 2020 documents would then trigger an update for space doctrine and drive capability development and resourcing to achieve key projects already under way, but shape future capability development.

Secondly, Defence must fully engage with the commercial sector to provide near-term capability development. Key projects such as DEF-799 Phase 2 for space-based ISR, and JP-9102B for next generation satellite communications, are all long-term projects, with capability being realised late in this decade. In the interim, Defence remains heavily dependent on U.S. and foreign provided capability and is less able to shoulder burden beyond ground-based space domain awareness. As noted in this report, there is a vibrant and growing commercial space sector in Australia that can contribute new capability quickly. The 2020 Defence Strategic Update highlights growing strategic risk, and notes that a ten-year warning period for major power war is no longer credible. Defence must look to 'fast track' space capability acquisition rather than just maintaining a steady glide forward on autopilot, at a pace established under the former 2016 Defence White paper.

Thirdly, Australia benefits from a prime geographic location for sovereign space launch, with a large, predominantly empty, landmass, much of it close to the equator or coastal in nature. The establishment of space launch sites in the Northern Territory, South Australia and possibly Queensland, and the development of space launch capability in the commercial sector is happening, but government is yet to firmly commit to declaring full support for sovereign responsive space launch, with internal debate over regulatory arrangements and funding continuing. Australia must get past this policy block, and firmly seize the opportunity to support the rapid growth of a sovereign responsive space launch capability that can support not only Australia's commercial and civil needs, but also Defence missions and requirements, as well as allow Australia to burden share in space to a greater degree.

Fourthly, Australia should fully support a space architecture based around 'smallsat' technologies for smart, resilient multi-mission space systems that can be less vulnerable to emerging adversary counterspace capabilities discussed earlier. It should not move down a 'Space 1.0' path of small numbers of large, high cost satellites alone. A 'high-low' mix of space capabilities, with larger satellites complemented by distributed space architecture of smallsats, will allow greater space resilience through augmentation, disaggregation, whilst sovereign responsive space launch will allow reconstitution in the event of an attack by adversary counterspace capability.

Fifthly, the ADF and Defence recognize that space is increasingly contested and are preparing for operations where space may be operationally limited. Boosting space deterrence through enhanced resilience in the manner discussed above is the first step but having the ability to negate adversary counterspace operations also needs to be considered, ideally in concert with key allies in the Five Eyes community. Space domain awareness is not a complete solution. The next step is enhanced space resilience, and the final step is defensive and offensive space control capability, ideally based around soft-kill capability. This last step is controversial, but it should be considered to strengthen deterrence by denial rather than a means for space dominance. The technological solution may be realised through more maneuverable and flexible satellite technologies, hardened satellites, and rapid reconstitution of lost space capability, *as well as* targeted cyber and electronic warfare systems.

Sixthly, and lastly, there needs to be ever closer cooperation with key allies, through Five Eyes ' CSpO' arrangements, and beyond to partners outside the CSpO Initiative, including Japan, and ultimately India. The opportunity presented by the rejuvenated Quadrilateral Dialogue ('the Quad') would be a logical path for expanding and deepening space cooperation. The ADF needs to enhance cooperation with the U.S. Space Force in particular, and one way this could be achieved would be

through reorganization of the ADF's space elements into a cohesive and complementary 'ADF Space Command' nested within RAAF Headquarters. That would, in turn, imply reform in how the ADF manages space as a domain, with greater emphasis on establishing a permanent cadre of space professionals to run such a command on an on-going basis, rather than a constant rotation in and out of personnel. The formalization of ADF and Defence Space policy starts with a coherent strategy, that drives doctrine and operational concepts which in turn informs near and long-term capability development; engagement with the commercial sector as part of a 'whole of government' approach to space, and allows rapid innovation through experimentation and spiral development of new capability from that sector; recognizing the importance of space launch for Australia, and responding to the growing challenge posed by adversary counterspace systems. A professional cadre of space experts, operating within a stable organizational structure such as an ADF Space Command within RAAF HQ – as opposed to disparate projects scattered across the Defence organisation – is the best path for Australia to go forward to space.

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