

SPECIAL REPORT

Australia's north and space

A S P I



Malcolm Davis

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About the author

Malcolm Davis joined ASPI as a Senior Analyst in Defence Strategy and Capability in January 2016. Prior to this he was a Post-Doctoral Research Fellow in China-Western Relations with the Faculty of Society and Design at Bond University from March 2012 to January 2016. He worked with the Department of Defence, both in Navy Headquarters in the Strategy and Force Structure area, and with Strategic Policy Division in the Strategic Policy Guidance and Strategic External Relations and Education sections from November 2007 to March 2012. Prior to this appointment he was a Lecturer in Defence Studies with Kings College London at the Joint Services Command and Staff College, in Shrivenham, UK, from June 2000 to October 2007. He holds a PhD in Strategic Studies from the University of Hull as well as two masters degrees in Strategic Studies, including from the Australian National University's Strategic and Defence Studies Centre. His main research focus is on defence strategy and capability development, military technology, and the future of warfare.

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ASPI
Level 2
40 Macquarie Street
Barton ACT 2600
Australia

Tel Canberra + 61 2 6270 5100
Tel Washington DC +1 202 414 7353
[Email enquiries@aspi.org.au](mailto:enquiries@aspi.org.au)
www.aspi.org.au
www.aspistrategist.org.au

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Executive summary

This report examines opportunities for the development of sovereign space capability in the Northern Territory, Queensland, and Western Australia. Given that those northern jurisdictions are closer to the equator, there's a natural focus in the report on the potential opportunities offered by sovereign space launch, particularly in the Northern Territory and Queensland. However, I also consider the potential for other aspects of space besides launch, including space domain awareness, the establishment of satellite ground stations, and space industry. I explore the potential for the co-location of space industry—domestic and international—within or close to launch sites, which would result in the development of 'space hubs' in strategic locations in Australia.

Benefits are gained by situating space-launch sites as close to the equator as possible, and two sites—Nhulunbuy near Gove in the Northern Territory and Abbot Point near Bowen in Queensland—are now under development. The closer a launch site is to the equator, the greater the benefit in terms of reduced cost per kilogram of payload to orbit, due to velocity gained by a rocket from the Earth's rotation.

The report then explores the transformation of Australia's space sector that's occurred within the past decade, from one solely dependent on foreign-provided satellite services and locally developed ground-segment capabilities, including for space domain awareness, to the growth of sovereign space industry and the establishment of the Australian Space Agency in 2018. I note that, since the establishment of the agency, Australia's commercial space sector has expanded rapidly, but now faces headwinds, with the recent cancellation of the National Space Mission for Earth Observation being a serious blow to Australia's space industry. The Australian space industry sector must now fight to sustain funding. In this report, I argue that the best way to achieve success is to emphasise sovereign launch as a focus for Australian space activities and to reinforce the potential opportunities offered by the north, including for defence and national-security requirements in space.

I then examine the space strategy statements released by the Northern Territory, Queensland, and Western Australia. The chapter notes the risk that the absence of a national space policy—the development of which is currently frozen—could see the return of state-versus-state competition, rather than national coordination, which could see investment leading to oversaturation of the sovereign launch market. The absence of a national space policy, or a national space strategy, is a key weakness in the Australian space sector.

The report then finally considers how establishing space launch in the north, as well as an associated ground segment, can best leverage the operational requirements of defence and national security to provide a future path. I note the importance of Australia doing more to 'burden share in orbit', particularly to strengthen space deterrence via resilience and assured access. Sovereign launch has a key role to play in supporting the needs of the ADF, as well as key allies and partners, in a contested and congested space domain. I conclude by emphasising the importance of sovereign launch, both for defence and national-security requirements and for broader civil and commercial needs, with the north—the Northern Territory, Queensland, and Western Australia—playing a critical role in growing our nation's future in space.

The report makes the following recommendations:

1. Australia must fully recognise and exploit its natural advantage in geographical terms for space launch from the north. The proximity of northern launch sites to the equator allows lower cost per kilogram of payload to orbit, and that makes Australia a commercially advantageous location for launch in comparison to other space-launch sites around the world. Therefore, *the establishment of sovereign space launch, and continuing support for it by government, should be a high priority.*
2. Making sovereign launch the central focus of space activities in the north should be part of establishing a complete space ecosystem, including *commercial space hubs co-located close to launch sites.*
3. The priority for national development of space capability should be to identify opportunities for sovereign space capability and to avoid overdependency on foreign-provided space systems, particularly in the space segment and for launch. Risks associated with a reversion to the dependency of previous decades should be highlighted, while the advantages of sovereign capability—though not necessarily autarky—must be emphasised.
4. In terms of space and defence, the report recommends that *Australia do more to burden share in orbit.* Australia already makes a valuable contribution in space domain awareness, but the establishment of sovereign space launch in the north will enable a much more expansive approach to defence space activities, including responsive space access for augmentation and reconstitution as part of enhancing deterrence through resilience in space.
5. The commercial space sector, supported by the Australian Space Agency and the Department of Defence, should work vigorously to *ensure that momentum gained, and progress made since the establishment of the space agency in 2018 isn't lost.* Funding cutbacks emerging from the 2023–24 federal Budget, the cancellation of the National Space Mission for Earth Observation, and the lack of progress on the preparation of a national space policy (formerly, the 'Space Strategic Update') is creating worrying headwinds in Australia's space future.
6. Accordingly, as an early priority, *work on a national space policy for Australia should be renewed,* to be completed within the current term of government. The policy should unify the commercial, civil and defence aspects of Australian space activity into one coherent strategy that enables future milestones in national space endeavours to be achieved, and would ensure that resources—people, funding, infrastructure—are applied to whole-of-nation goals in space over the coming two decades.

In the introduction that follows, I begin with a glimpse forward 20 years, to what might be possible if Australia doesn't waver in its support for establishing a vibrant national space sector, with northern Australia playing a key role in shaping that very positive future for our nation.

Introduction: A positive future for Australia in space

It's 2043, and a new golden age of space exploration is underway. Humanity has returned to the Moon, after a successful landing by Artemis III in late 2027. That landmark moment led to the establishment of permanent lunar bases in the mid-2030s to support the mining and utilisation of space resources that are the basis for a new space-based global economy.

Looking up at the night sky from northern Australia, people in Darwin, Gove, Townsville, Exmouth and Broome can see the lights of lunar bases inside shaded craters, and what looks like bright stars near the moon, which are large solar-power satellites being constructed from lunar resources that are mined with Australian remotely operated mining technology developed initially in Western Australia.

In Australia, there's a vibrant space-industry sector that continues to grow, and which includes a key role for companies, people and infrastructure operating from northern Australia. At space launch sites in Nhulunbuy in the Northern Territory, and at Bowen in Queensland, there are regular launches—and returns—of large, low-cost, fully re-usable rockets that carry payload and people into low-earth orbit, and that supply cargo to cislunar space to support activities on and around the Moon. From spaceports further south, at Wellcamp near Toowoomba, Queensland, hypersonic space planes fly daily to commercial orbital platforms in low Earth orbit. Further south again, Southern Launch operates its Whalers Way spaceport near Port Lincoln, South Australia, making regular launches into polar and Sun-synchronous orbits on essential defence tasks and on scientific missions related to analysis of climate change.

It's a future that goes beyond the original dreams of the early leaders of the Australian Space Agency, and in 2043 Australian astronauts now stand on the lunar surface and are set to participate in humanity's first crewed mission to Mars, which will arrive at the Red Planet in 2046.

Our dependency on satellites to provide real-time Earth observation for understanding our planet is growing rapidly, giving us ever more detailed, dynamic, and accurate perspectives on human activities and their influence on the environment, and has ensured a growing market for sovereign space-launch activities.

The role of the space domain in defence and national security has also expanded. The establishment of Defence Space Command in March 2022 saw a rapid expansion of sovereign ADF defence space capabilities, which, by the end of the 2020s, took full advantage of the commercial space industry, including for the sovereign launch of satellites for the ADF and its partners and allies. The goal of 'Australian satellites launched regularly on Australian launch vehicles from Australian launch sites' has become the basis for our future in space. That approach extends to defence and national-security missions, and greater sovereign defence space capabilities, including for ground- and space-based space domain awareness, will enable us to burden share in orbit with allies and partners to a much greater extent than ever before.

The above scenario represents a positive future for Australia in space, in which our country's northern region will play a crucial role. In 2023, Australia is moving into a major expansion of its national space sector, and the role of northern Australia—the Northern Territory, Queensland and Western Australia—in this national endeavour will grow over time. Space is a national endeavour, and, although this analysis focuses on opportunities for the northern jurisdictions to expand their role, particularly in relation to sovereign space launch, any such activity is inevitably complemented by an equally strong participation from the entire national space sector.

A key issue for Australia's future in space is the case for increasing sovereign space capability, as opposed to continued dependency on others to provide space access and capability for us. The case for increasing sovereign space capability is strengthened by Australia's natural advantages—notably, our geography—to rapidly generate the greatest benefits to the country's economy and security. Australia's terrestrial geography facilitates its ability to reach the vital equatorial low-earth orbit, known as 'EqLEO', as well as geostationary (GEO) and Sun-synchronous and polar orbits from Australian launch sites. That represents a significant advantage that can't be ignored, and it must drive government to facilitate the development of northern Australia as a key global launch hub, or risk being left behind in a rapidly expanding global space economy. The relationship to the science of space launch and orbital mechanics is important in this regard and opens opportunities for Australia not only to exploit its natural advantage for its own space needs, but also 'the opportunity to be the primary space launch location for Asia, and a provider for launch activities globally'.¹

By establishing Australian launch sites, we won't require locally built satellites to be shipped overseas to join a potentially lengthy queue before they reach the launch pad. Instead, with an ability to employ locally established ports, airports, and urban centres to support a local workforce, we can use Australian launch sites at locations that are ideal for *both* equatorial and polar orbit missions.

At the same time as those launch sites are developed, there are Australian commercial space companies developing launch vehicles. For example, Queensland-based Gilmour Space is currently aiming for its first launch of its Eris 1 booster from the Bowen launch site to deliver small-satellite payloads into orbit from late 2023 onwards. Both launch vehicles and launch sites can be developed such that Australia's ideal location would be open to support launch requirements for allies and partners. For example, Southern Launch's site at Whalers Way and test range at Koonibba in South Australia are supporting ATSpace, an Australianised subsidiary of Taiwan's TiSpace, in continuing efforts in preparing to launch its Kestrel I and V boosters.²

A space launch site ideally should be located near launch-vehicle providers' facilities to make it an ideal path to ensure the growth of a sovereign launch industry and, in turn, the secondary and tertiary growth of local economies. This 'space hub' approach would also include local development, design and manufacturing of small satellites and satellite components to allow easier payload integration on site. The ability for Australian satellites to be launched on Australian-developed launch vehicles from Australian launch sites marks a degree of maturity in our space endeavours that would have been unthinkable a mere decade ago.

Looking forward, there's clearly a trend towards the transformation of space launch in a manner that dramatically reduces the cost to access and use space, while increasing the operational tempo of space access. Re-usable rocket technologies are now the leading edge of commercial space-launch companies such as SpaceX, and it's likely that Australian launch providers will also eventually go down the path of re-usability. In addition to reducing the cost to orbit, and increasing the operational tempo of space launches, re-usability also opens innovative new approaches to rapid global logistics, such as 'point to point' services. The possibility of regular (potentially daily) launches to orbit to support the establishment of megaconstellations of satellites, as well as space manufacturing services for building large structures in orbit, and also providing logistics to support lunar operations, including space resource use through lunar mining, suggest an expanding market for Australian launch in terms of the development of future launch vehicles and the growth of launch-site infrastructure, including 'space hubs' located near the launch sites.

For northern Australia, this future potentially opens much more than just a few launch sites at Nhulunbuy or Bowen. It demands a bold vision and large ambition for the north to play a role in Australia's space activities. *There needs to be a long-term plan going forward—a national space strategy—that looks at least two decades into the future, aligned and integrated with an evolving Defence Space Strategy.*

As I've noted, this report focuses primarily on the development of sovereign space-launch capabilities from Australia's north, but it's important to reinforce that there's a broader story to tell. Australia's space efforts across the commercial, civil and defence sectors are on the verge of embracing an ambitious and comprehensive approach to developing a full range of sovereign space capabilities. But Australia needs to commit in a policy, investment, and strategic planning sense to how it pursues those capabilities. At present, much is being done in and by industry.

Yet government policy, planning and investment aren't playing the role here that they do in other developed economies. Australia's commercial space sector and the Australian Space Agency now face a new crisis emerging out of the 2023–24 federal Budget.

The establishment of a vibrant Australian commercial space sector, and the changing approach of Defence to embrace a more ambitious approach to space as an operational domain, demands that an Australian national space strategy be prepared. An attempt was made to begin that process under the previous Morrison government, in what was called a 'Space Strategic Update', announced in September 2022, that would have led to a coherent national space policy. That effort seems to now be on hold, and its future is uncertain.

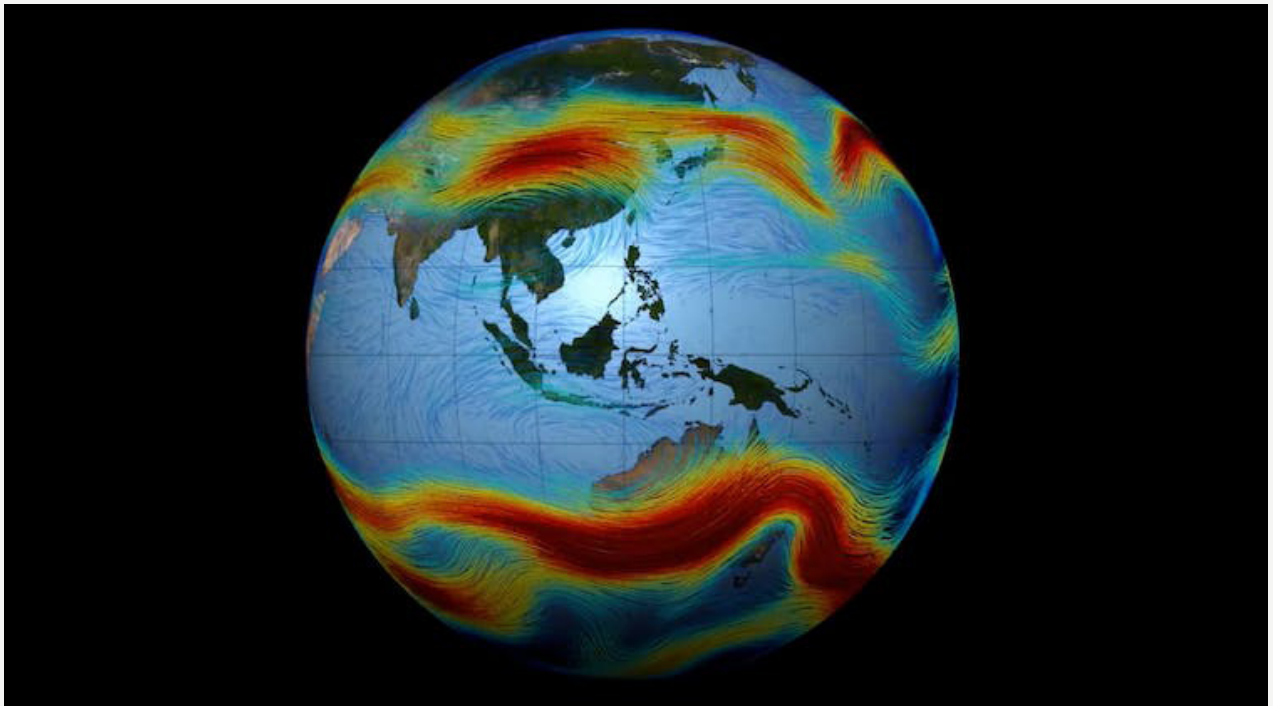
This failure to complete a national space policy represents a gap in Australia's future opportunities in space. Australia needs a national space strategy to inform policy outcomes, for both commercial and civil space activities and for defence and national security. Having an overarching national space strategy that brings together commercial, civil, defence and national-security interests, as well as managing international space partnerships, is a logical step forward for Australia as a new space power. A strategy that manages defence requirements in a contested, congested, competitive and complex space domain, and that fully exploits the ability of Australia's growing commercial space capabilities to provide ways and means to achieve defence policy ends, is the missing part of Australia's approach to space.

With that in mind, in this report I lay the groundwork for a follow-on report that will consider the case for a national space strategy with the perspective of the importance of space to defence and national security. With that planned report in mind, it should be emphasised that southern states, especially South Australia, play an equally important role in the national space enterprise.

Understanding the link between Australia's geography and access to space

To understand why Australia has natural advantages for space launch, and Australia's north in particular, some 'Rocket Science 101' is necessary. Simply put, the closer to the Earth's equator a rocket is launched, the lower the cost per kilogram of payload to low-Earth orbit (LEO), due to the rocket picking up energy from the Earth's rotation, with the effect of generating an increase in launch velocity, and this being greatest at the equator.³ This means that it's either cheaper to launch payloads into an equatorial orbit from the north or, conversely, larger payloads can be launched at the same cost as smaller payloads from launch sites more distant from the equator. That's a huge natural advantage for Australia in comparison to most other launch sites around the planet. Add to that a stable Australian political environment and a relatively stable climate, including, most notably, the lack of a jet stream in the lower atmosphere over much of northern Australia. The absence of a lower atmosphere jet stream, highlighted in Figure 1, increases availability for launch and was one of the major factors in selecting Nhulunbuy as the location for the Arnhem Space Centre. These factors make northern Australia a premium location for space launch. It's a natural asset that shouldn't be wasted.

Figure 1: Jet streams across our region



Source: Winds of Change, University of Technology Sydney, 21st June 2022, [online](#).

The north's proximity to the equator is of key importance. There are two prospective Australian space-launch sites in the north that are advanced in development and have strong backing from state and federal government. The Arnhem Space Centre, operated by Equatorial Launch Australia at Nhulunbuy near Gove in the Northern Territory, is 12.1° south of the equator.⁴ The Abbot Point launch site at Bowen, Queensland, lies a bit further south at 20° south and will be used by Gilmour Space for the launch of its Eris 1 launch vehicle as early as late 2023.⁵ These two locations can provide the basis for a networked Australian sovereign launch infrastructure. It would allow launch vehicles to reach key orbits over the equator, including out to geostationary orbit at 36,500 kilometres from Earth, while the co-location of these launch sites to nearby urban areas and port and airport facilities makes them commercially viable. A third northern launch site in Weipa on Cape York has also been proposed. It's important to ensure that all future launch-site development is based on keeping pace with demand for launch services, or risk that a saturation of the launch market could occur that could reduce the competitiveness of Australia's space sector.

That important natural advantage of launch sites close to the equator makes it easier to consider expanding space activity in the north to such an extent that it then opens the potential for establishing space hubs that could more easily allow launch operations and grow a local space industry around a launch site. Such an approach can be replicated in the south, for example at the launch sites at Whalers Way and Koonibba in South Australia that are operated by launch provider Southern Launch.⁶ Those southern sites are well placed for polar and Sun-synchronous orbit (SSO) missions.

A deliberately planned and strategic approach to the development of a network of Australian spaceports and launch sites (which could also include facilities at established airports to leverage future launch technologies such as single- and two-stage-to-orbit spaceplanes) needs to include consideration of the investment necessary from targeted and appropriate foreign investors, domestic private investors, and Australian Government funding. It should seek to optimise the full range of options inherent in Australia's vast and favourable geography for the greatest strategic return to Australia's national security, resilience, and prosperity.

Once again, some 'Rocket Science 101' is necessary to understand the significance of these locations for accessing space. Equatorial LEO orbits occur within the LEO region, which extends from about 200 kilometres up to around 2,000 kilometres from the Earth's surface, with orbital inclinations plus or minus 15° south and north of the equator.⁷ This spatial region will be increasingly in demand as a preferred location for satellites to support high-bandwidth communications, satellite broadband, digital television and Earth observation, among other roles, and it's this region that will be the basis for a future LEO economy that will see space-based manufacturing in commercial LEO platforms that ultimately will replace the International Space Station.⁸ LEO can be distinguished from geostationary orbit at 36,500 kilometres, where satellites' orbital velocity matches the rotational velocity of Earth, and they thus appear fixed in one location when viewed from the surface. It's geostationary orbit that's the ideal location for communications satellites, such as Defence's JP-9102 satellites that will begin to enter service in 2027.⁹ Other locations, such as medium-earth orbit (MEO) that lie between the upper edge of LEO and geostationary orbit, are the most common location for global navigation satellite systems such as GPS, while high-earth orbits (also known as 'Molniya orbits') that are highly eccentric in terms of a high apogee (greatest distance from Earth) and perigee (closest approach to Earth) are often used for Earth observation and surveillance.

Unlike equatorial LEO orbits, polar and Sun-synchronous orbits are inclined to around 90°, which means satellites in those orbits pass close to the Earth's poles, rather than being centred on Earth's equator. The orbital motion of satellites in polar and Sun-synchronous orbits is ideal for Earth observation roles from LEO. Having a launch site in higher latitudes, ideally with a launch trajectory facing south over an open ocean, is ideal for accessing these important polar and sun-synchronous orbits. Alongside Southern Launch's Whalers Way launch site, other southern-based launch sites have been suggested for future development. For example, in Western Australia, 'WA Spaceport' is being proposed for Albany and would offer similar advantages for launching satellites into polar and Sun-synchronous orbits as Whalers Way in South Australia.¹⁰ Two such launch sites – one at Whalers Way, and a second at Albany, would offer Australia the potential for double the launch capacity into polar and sun-synchronous orbit, which would be useful to quickly augment or reconstitute critical space capabilities in the event of a national

security crisis or future war, and also add to Australia's international competitiveness for commercial space launch services. But care must be taken to avoid saturating Australia's commercial launch services market, and multiple launch sites must be carefully managed at a national level to meet to domestic and international demand.

Even with the need to avoid saturating Australia's launch market, compared to traditional launch sites overseas, such as Cape Canaveral in Florida at 28° north latitude, or Japan's Tanegashima launch site at 30° north, Australia is a 'lucky country' when it comes to space launch. Among currently active launch sites near the equator, only Kourou in French Guiana, the European Space Agency's principal launch site at only 5° north of the equator, is closer to the equator. Future launch sites even closer to the equator have been considered—for example, a launch site has been proposed on Indonesia's Biak Island, which lies at 1° south of the equator; however, the region suffers from political instability.¹¹

Australia as a new and rising space power

Australia's approach to space policy and the development of sovereign space capabilities has gone through a remarkable transformation in the past 10 years. It's important to reflect on that transformation to understand the importance of Australia's north in this country's future ambitions in space, both for civil and commercial activities and for defence and national security tasks. The growth and diversity of Australia's commercial space sector, together with the establishment of the Australian Space Agency and, more recently, the Defence Space Command, represent a decisive break with a past that eschewed—for too long—any ambition for Australia to play a meaningful role in space. The Apollo era of space exploration costing billions of dollars and necessarily therefore monopolised by the governments of the largest global powers has steadily become eclipsed by the rapid expansion of commercial space ventures, which are leveraging new technologies—re-usable launch, low-cost expendable launch vehicles and small-satellite technologies—in a manner that's seen the 'cost of space' fall dramatically, yet has also seen a return on investment of between US\$7 and US\$15 per US\$1 investment back into the economy, and that could see the global space industry generate revenue of US\$1 trillion or more in 2040, up from US\$350 billion in 2020.¹² That transformation in space technology and the huge potential in space have opened up new opportunities and incentives for middle powers such as Australia, and even small states, to become 'space actors.'

Australia's role in space had been primarily focused on the 'ground segment' from the end of rocket testing by the European Launcher Development Organisation (ELDO—later the European Space Agency—ESA) at Woomera in the late 1960s through to just recently.¹³ That wasn't an inconsequential contribution. Australia directly supported NASA's Apollo program, providing essential deep-space communications links, including the Honeysuckle Creek deep-space communications facility (now part of NASA's Deep Space Communication Complex at Tidbinbilla), which received the first transmissions from Apollo 11 as Neil Armstrong stepped onto the surface of the Moon on 20 July 1969. Australia also provided data-management and analysis services and the Parkes Radio Telescope, which has been a key facility for radio astronomy and supporting NASA space missions, as highlighted in the classic Australian movie *The Dish* (2000).

However, it wasn't until a review of Australia's commercial space sector by the then Turnbull-led Coalition government in 2017 that new opportunities were quickly identified.¹⁴ Announced subsequently to that review, at the International Astronautical Congress in Adelaide in October 2017, was the government's decision to establish the Australian Space Agency and to ensure that the agency was tasked with growing Australia's commercial space sector.¹⁵ That was a fundamental shift in Australian thinking on space and has seen Australia's space sector 'take off' in terms of rapid growth and growing sophistication. The forces driving this change are noted above: falling launch costs, combined with lower cost small-satellite architecture and a greater demand for space services to support a broader information-based society and economy. The 'exploration' part of space was increasingly being complemented by the new 'exploitation' of space capabilities to facilitate rapid economic growth in new sectors on Earth. The decision for Australia to pursue a future once again in space was timely and opportune.

The 2019 release of the Australian Space Agency's *Advancing space: Australian Civil Space Strategy 2019–2028* highlighted the agency's key role in stimulating the growth of Australia's commercial space sector, supporting new regulatory development and leading international space collaboration, among other key tasks.¹⁶ Rather than embracing a traditional role of dependence on other nations for the provision of space capabilities, including

satellites in orbit, the decision by the Australian Government from 2017 onwards has been to prioritise the growth of a local commercial space sector and to pursue the opportunity for establishing greater sovereignty in space capabilities.

There's undeniably a broad basis of support within the wider Australian space community for the establishment of sovereign space launch as a major element of Australia's space activities. That support has grown consistently since the establishment of the space agency. However, it's now challenged by the current federal government's hesitancy on investment which, in the 2023–24 Budget, led to significant cuts to funding for investment into launch sites and space access and a reduction of funding for Australia's efforts to support 'Moon to Mars' activities.¹⁷ And, most recently, the proposed National Space Mission for Earth Observation has been scrapped by the Albanese government for the purposes of 'budget repair'.¹⁸ Those cuts are a serious setback for Australia's space sector and suggest that the current government is yet to understand the importance of sustaining investment to ensure that Australia remains a credible player in space.¹⁹

It will therefore be important for the Australian commercial space sector to play a more proactive role in promoting the importance of growing the Australian space sector, and to support the development of a strategy to achieve the goals laid down in the Australian Space Agency's 2019 Civil Space Strategy, which are to 'triple the size of the space sector to \$12 billion and create up to another 20,000 jobs by 2030'.²⁰ Any national space strategy must be consistent with the approach of the space agency, which sets out seven priority areas:

- Positioning, navigation and timing
- Earth observation
- Communications technologies and services
- Robotics and automation
- Space situational awareness and debris monitoring
- Leapfrog research and development
- Access to space.

One of the key programs that encompassed many of those priority areas included the 'Moon to Mars initiative' to support NASA's Artemis project for returning humans to the Moon this decade in anticipation of crewed missions to Mars by the late 2030s. A subprogram of the Moon to Mars initiative has now been axed by the current government, although other aspects, such as the planned lunar rover ('G'Day Moon'), look set to continue.²¹ The Moon to Mars program has grabbed the attention of most of the Australian space community with projects such as 'G'Day Moon' and the 'Seven Sisters' project, to establish positioning, navigation and timing capabilities and satellite communications around the Moon.²²

The key challenge now facing Australia's space community is a political one to sustain funding. That battle isn't close to being won in Australia, but it's important to move forward and establish key infrastructure such as the northern spaceports and demonstrate deliverable achievements such as launches. The reality of Australia as an active participant in the space sector, in a manner that does grow jobs and increase financial returns, will then go a long way towards sustaining government investment.

Progress in Australia's space activities is not only dependent on commercial and civil applications: the role of space for defence and national-security purposes is increasingly clear and vital. The 2020 Defence Strategic Update and Force Structure Plan began the process of elevating Defence's role in space and highlighted the space domain to a level never seen before in the history of Australian defence white papers, committing A\$7 billion in funding over 10 years towards developing new Australian space capabilities for the ADF.²³ Notable was the importance placed on space domain awareness and 'space control', as the 2020 Force Structure Plan stated:

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.²⁴

The establishment of Defence Space Command in March 2022, and the release of the Defence Space Strategy and the *Space Power eManual*, have reinforced the approach that Australia is no longer content to simply be a passive consumer of space, or to rely on others for the provision of security in space.²⁵ Specifically, the Defence Space Strategy highlights the importance of assuring access to space and building resilient space capabilities that support both defence and national-security requirements, as well as enabling civil and commercial activities that contribute to economic growth and national prosperity.²⁶ It recognises that Australia's space capabilities must operate in a more challenging domain, which is increasingly contested and congested: 'contested' in terms of the reality that space isn't a peaceful common, that sits serene and unaffected by geopolitical competition below and by growing adversary counterspace threats, and 'congested' in that there are increasing numbers of active satellites and amounts of space debris driving a challenge of space situational awareness and traffic management to avoid collisions in orbit.

Space is also 'competitive', as the falling cost of reaching orbit and utilising cheaper space capabilities such as small satellites open access to the space domain to a much greater number of users, including small and middle powers, as well as commercial non-state actors. Had traditional approaches based on state-controlled space not been challenged and overtaken in the 1990s by commercial space actors within the 'Space 2.0' or 'NewSpace' community, it's arguable that Australia would still be stuck in embracing a mindset of dependency, rather than pursuing a capability, including launch, that will enable the country to become an active provider of sovereign space capability. In the future, space will also be increasingly 'complex' as new types of space activities are made possible, including on-orbit manufacturing, space resource utilisation, space mobility and even space tourism.²⁷

The 2023 Defence Strategic Review, released on 24 April 2023, has continued to reinforce the importance of the space domain. First, it moved Defence Space Command from RAAF headquarters to the Joint Capabilities Group, firmly entrenching it in a 'joint and integrated' role and allowing Defence Space Command to play a leading role in supporting the acquisition of new space capabilities for the ADF. The review's recommendation for the command to have a dedicated funding line and appropriate authority to manage funding for defence space capabilities, while establishing and sustaining a trained defence space workforce, is agreed in principle.²⁸ The 2023 Defence Strategic Review leads to the release of a National Defence Strategy on a biannual process from the second quarter of 2024, which represents a further opportunity to chart more ambitious goals for defence and national security in the space domain and open up new opportunities for Australia's vibrant commercial space sector (including sovereign space launch in the north) to support defence needs.

For Australia's emerging national space community, on balance, while there are concerns about the current government's commitment to supporting the commercial and civil space sectors, the continued importance of defence space capabilities highlights that there's been a remarkable shift in thinking, accompanied by rapid growth in space-related activities and organisations. In 2025, Sydney will host the International Astronautical Congress (one of the world's leading space symposiums), which will attract the globe's community in space exploration, space science and astronautics. The choice of Sydney as the venue is indicative of the international space community's recognition of the growing importance of Australia.²⁹ Each year now, numerous workshops, conferences and masterclasses are held across the nation, and there's a rapid expansion of publication and research on space science and commercial space development. Despite short-sighted budget cuts to some aspects of Australia's space activities by the current government, progress has been made, and the space sector is increasingly well established—and that future postulated at the beginning of this report beckons.

The choice of Adelaide as the headquarters of the Australian Space Agency, co-located with numerous commercial space companies, has strengthened the resilience of Australia's growing space sector, and made South Australia the heart of Australia's national space community. Yet, space is ultimately a national endeavour by companies located across the nation and connected through exports, investments, or supply- and value-chain involvement to the burgeoning global market. Satellites are being built, missions are being planned, cooperation with overseas partners is expanding, and Australian companies are now at the forefront of a rapidly growing global space sector.

Australia's space sector is likely to grow at 7.1% per annum over five years to 2024, or even as fast as 8.6% through to 2023. In 2018–19, the space industry generated A\$4.8 billion in revenue and employed 9,000–10,000 workers.³⁰ Sovereign launch is the logical next step for Australia's fast-growing space sector.

This marks a stark difference from a decade ago, when, simply put, apart from a few ground facilities, there was no active space sector in Australia. This country has come a long way, and the path forward to the future is wide open. With the global space market worth potentially up to A\$1.5 trillion by 2040, Australia has everything to gain by continuing to expand and grow its sovereign space industry. Going backwards is unthinkable. Australia must go forward to launch.

Northern Australia goes forward to launch

In a practical sense, the expansion of Australia's space sector must embrace sovereign launch as a key element if it's to maximise sovereign capability and assure access to space in a responsive manner. It's here where Australia's northern regions must be prioritised for development. Centred around the developed and emerging launch site of the Arnhem Space Centre at Nhulunbuy in the Northern Territory, established and run by Equatorial Launch Australia, and the launch site at Abbot Point in Bowen, Queensland, that's being developed with the support of Gilmour Space (which is the recipient of a recent \$52 million dollar Modern Manufacturing Initiative grant), these two locations could serve a growing Australian commercial space sector and can also directly support the space requirements of defence and national security, both for the ADF and for Australia's key allies. Other potential launch sites are proposed, but it's Arnhem Space Centre in the Northern Territory and Abbot Point in Queensland that are most developed in Australia's north and are best placed to directly complement Southern Launch's Whalers Way launch site near Port Lincoln in South Australia.

It's vital that these sites aren't seen as isolated infrastructure but should become emerging space hubs that bring together co-located industry that directly supports launch activities. Looking forward, and considering the potential opportunities offered by the 'fourth industrial revolution' centred on simulation, digital design and synthetic development, and additive manufacturing, a space-hub approach could see small satellites developed either locally in the north, or designed digitally in the southern space belt, but then integrated close to the launch sites.

For example, the southern space belt comprises Lot 14 in Adelaide and Southern Launch's Whalers Way and Koonibba launch sites in South Australia. Potentially, in the future, the proposed spaceport at Albany in Western Australia could be added along with other space industries, notably a major space hub, iLaunch, which is a new space consortium that's now emerging comprising the University of Southern Queensland, the Australian National University and the University of South Australia.³¹ Adding companies located in Victoria, New South Wales and the Australian Capital Territory builds a network of space actors that are well placed to best use the co-location of industry close to launch sites. A similar approach needs to emerge in the north that can in turn generate greater returns from economies of the north, while enhancing the ability of Australia to assure rapid and responsive access to space. In short, Australia's approach to space should be geographically diverse, but digitally and geographically well connected, rather than just a few isolated launch sites distant from concentrations of industry in the south of the country.

So, how does the north best exploit an emerging national space market that's hoped to grow to A\$12 billion by 2030? What's the role of space in Australia's north from the perspective of states and territories, and what are the implications for the ADF's space requirements?

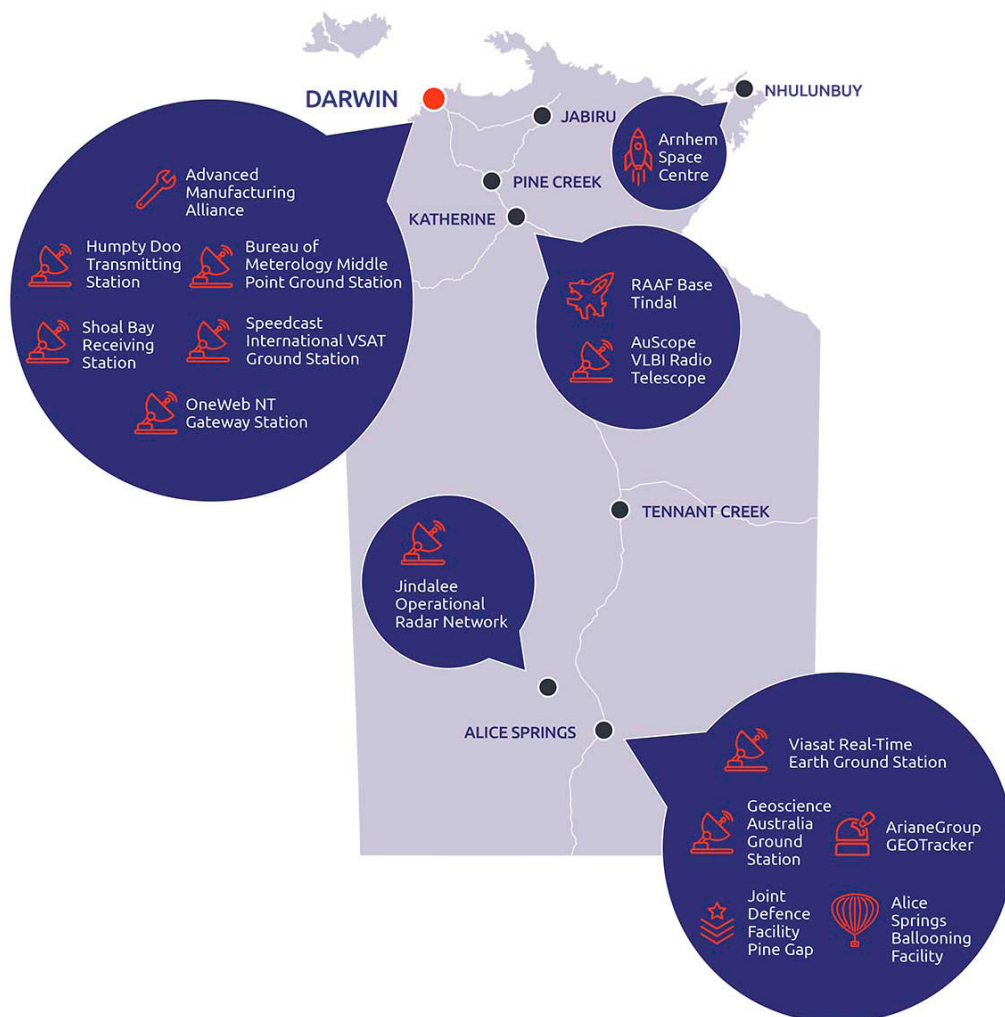
The Northern Territory's approach to space

The Northern Territory Government has released its Northern Territory Space Strategy 2022–2026 following the *Territory space industry 2020* report, the latter being a short-term strategy 'to lay the foundations for growth in the emerging Northern Territory space sector while national priorities were being solidified by the Australian Space Agency'.³² The 2022–26 strategy has as its overarching vision for the Northern Territory four main goals, which

are to be recognised as ‘the home of high-altitude pseudo-satellites (HAPS) and stratospheric ballooning in the Indo-Pacific region; to become Australia’s premier space launch location; and, emerge as a leading regional centre for ground station facilities, including for space domain awareness and space surveillance missions that support the needs of Defence and Australia’s five-eyes partners.’³³ It also prioritises the development of applications for space-enabled and facilitated information on the surface of the Earth, known as ‘downstream activities’, including making full use of enhanced Earth observation from orbit.

Also of key importance is the memorandum of understanding between the Australian Space Agency and the Northern Territory Government ‘regarding the advancement and growth of the space industry sector’.³⁴ The 2022–26 Northern Territory Space Strategy reinforces the key focus on space sectors mentioned in the 2020 memorandum, which include launch and launch supply chains and the establishment of the Arnhem Space Centre, as well as other upstream activities. It emphasises HAPS as an important opportunity for the Northern Territory, and ground facilities such as the Alice Springs–based Centre for Appropriate Technology (Figure 2). This is a facility that’s wholly owned and operated by Indigenous Australians, and which provides two 7.3-metre satellite antennas that support ‘southern hemisphere access to low earth orbit, medium earth orbit, and geosynchronous earth orbit space missions.’³⁵

Figure 2: The Northern Territory’s space infrastructure



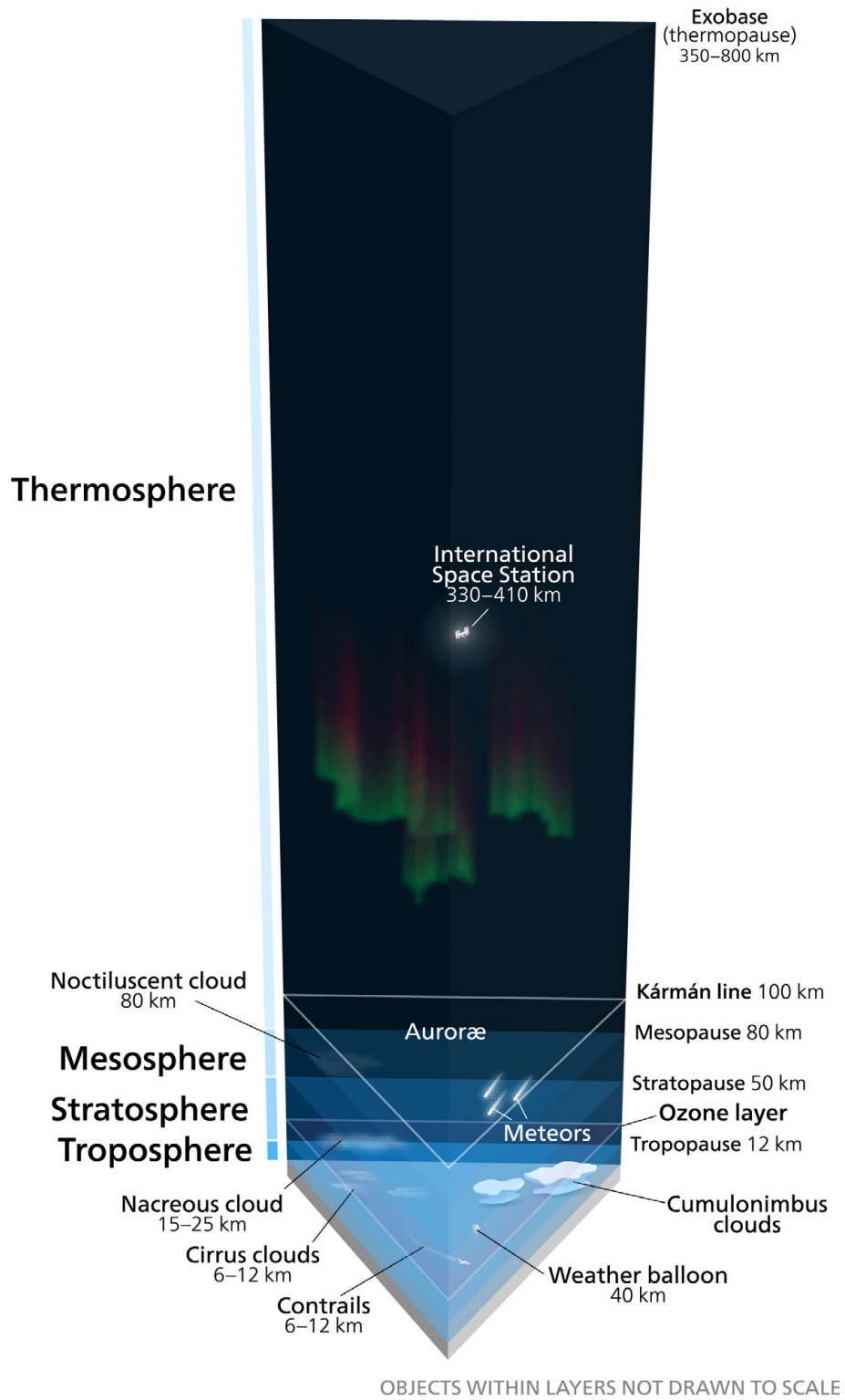
Source: Department of Industry, Tourism and Trade, ‘Overview of Northern Territory space infrastructure’, Northern Territory Government, 2023, [online](#).

The growth of the Northern Territory's space future has been highlighted by the launch of a series of NASA sounding rockets from the Arnhem Space Centre in June 2022 under purely commercial arrangements—a first for Australia—but it's important to emphasise that the territory's space strategy is more expansive than just launch.³⁶ Also important are ground-segment facilities that provide a vital link between satellites in orbit and terrestrial user networks, and the role of ground facilities in supporting space domain awareness missions that are likely to expand under defence project JP-9360.³⁷ The importance of the space domain awareness task cannot be overstated. Even as the focus is on an emerging sovereign launch capability, it's also important not to ignore the potential benefits of the Northern Territory for ground-based space domain awareness to complement the existing space surveillance telescope and C-band radar facility at Exmouth, Western Australia. The dark skies of inland Australia, away from large urban areas, are ideal for space surveillance.

This role will also extend the Northern Territory's opportunity to support Australia's collaboration with key allies and partners. The importance of both AUKUS and the Quadrilateral Security Dialogue as pathways for multilateral collaboration in space open a potential role in space domain awareness that can directly support the operational requirements of fellow members within the Combined Space Operations (CSpO) Initiative through Operation Dyrura as part of Operation Olympic Defender, and through providing additional ground-segment support for allied space operations under the CSpO.³⁸

Finally, HAPS creates the opportunity for the Northern Territory to play a key role in exploiting the region known as 'near space', which exists below the Karman line (100 kilometres) which is largely accepted as the beginning of outer space, and above the troposphere, at an altitude of 19 kilometres, or the beginning of the layer of Earth's atmosphere known as the stratosphere (Figure 3). High-altitude, long-endurance autonomous vehicles, particularly when powered by solar panels built into their wings, can operate within near space for days and weeks to undertake Earth observation and act as a communications relay in support of both civil requirements and defence missions. Likewise, stratospheric balloons have similar endurance, can reach altitudes up to 42 kilometres and can carry much greater payload than HAPS, but are less manoeuvrable.

Figure 3: From near space to space



Source: 'Earth's atmosphere', Wikipedia, [online](#).

The 2022–26 strategy identifies a number of strategic advantages and opportunities that will drive the future development of the territory's space activities and compensate for the challenges it currently faces, such as limited resources and a low population spread over a vast geographical region.³⁹ Some of the advantages suggested include the Northern Territory's geographical location, which is ideal for space launch, ground systems and HAPS, while it has established expertise in hosting and maintaining ground-segment facilities. The strategy suggests that Alice Springs is recognised internationally as one of the best locations for HAPS and stratospheric ballooning. In this sense, both for launch and HAPS as well as ground facilities, the Northern Territory has natural advantages in terms of location. Furthermore, the territory has a long history of supporting defence activities and defence industries, many of which have natural synergies with the space industry. Those synergies include Earth observation as it relates to both civil and defence requirements, the provision of ground facilities for satellite communications, and local manufacturing capacity that can support space industry development. The investment by the Northern Territory in ground infrastructure, including digital connectivity, such as National Broadband Network connectivity, and reliable power systems is a key component in supporting space infrastructure.

By leveraging those advantages, the Northern Territory sees the space industry as a means to ensure regional growth and boost local participation in activities in this sector. The Northern Territory Government emphasises the synergies between the space sector and other key territory industries, such as agriculture, mining, and oil and gas.⁴⁰ Importantly, the strategy sees the opportunity to deepen the involvement of Indigenous Australian communities to establish their own space-related businesses, and Indigenous support for the Arnhem Space Centre is a very clear example of that effort. Other opportunities would include strengthening the potential role of the territory's advanced manufacturing capability.

A Queensland perspective on space

As with the Northern Territory, Queensland has released its Queensland Space Industry Strategy 2020–2025, the most recent edition of which was delivered by the Department of State Development, Infrastructure, Local Government and Planning in February 2023.⁴¹ The strategy states that the space industry is supporting 'over 2,200 full time equivalent jobs, and generates A\$810 million in annual revenue, with a further A\$520 million in value added to industries that have realised the benefits of world-class space-enabled services such as Earth observation'.⁴² It argues that Queensland is well placed to dramatically expand growth from investment into the space sector:

Queensland's space industry has enormous potential if nourished, with up to 6,000 jobs and between A\$3.5 billion and A\$6 billion added to the state economy by 2036.⁴³

The Queensland space strategy identifies a number of key space investment areas for future development.

First, it seeks to exploit the state's geographical strengths on Australia's east coast for space launch. It notes that Queensland benefits from being well located to launch rockets over the ocean from the coastline, in an eastward trajectory, and with proximity to the equator to pick up additional energy from the Earth's rotation, nominating about 460 metres per second of speed, which reduces payload costs. It argues that:

Queensland is the only state on Australia's eastern seaboard with direct access to equatorial orbits. Ideal latitude, clear skies, and open waters to the east means that Queensland can launch larger payloads, and into more orbits, than any other place in Australia.⁴⁴

Those advantages include the ability to launch into both LEO—polar and inclined—as well as into GEO, and it makes a direct comparison with Cape Canaveral in the US, arguing that Queensland is better situated for launch activities than the Kennedy Space Center.

With that in mind, it's no wonder that Queensland boasts a substantial 'space supply chain'. The strategy highlights Queensland-based companies such as Black Sky Aerospace, Gilmour Space Technologies, and Hypersonix Launch Systems, with Gilmour and Black Sky developing traditional rockets, and Hypersonix developing hypersonic

spaceplane systems for small-satellite launches. But with opportunity also comes some risk, illustrated by a deal between the local Wagner Corporation and Virgin Orbital for launching its 'Launcher One' air-launched rocket system. Virgin Orbital has since gone into bankruptcy, demonstrating that even large corporate players have no guarantee of success in a still-emerging commercial space-launch market.⁴⁵ Virgin failed after a launch anomaly in January 2023 that led to the loss of nine satellites. Even though the failure occurred after a number of successful launches, the share price of the company fell, making it impossible for it to secure additional funding and generating ensuing cashflow problems. In a downward spiral, the company had to lay off 85% of its staff and was forced into bankruptcy. It was a commercial, rather than technological failure, involving a bloated workforce and an unworkable business plan that had little chance of breaking even on sunk investment, let alone reaching profit.⁴⁶ The failure of the launch from Cornwall, UK, was a failure from which it couldn't recover. The lesson of the failure of Virgin Orbital isn't just that space is hard, but that commercial space enterprise must be based on a viable business plan that's aimed at generating profit. Australian launch companies will always need to balance opportunity and risk.

In terms of launch sites, the Bowen Orbital Spaceport is being developed by Gilmour Space Technologies and is the most advanced in development in Queensland. Located at Abbot Point, which is 20° south of the equator, the launch site is well placed for launching small satellites into 20° to 65° low-to-mid-inclination equatorial orbits. Gilmour Space Technologies plans to launch two Block 1 Eris rockets per year from later this year through to 2025, after which it will seek to increase the launch rate to monthly. Increasing launch rates and launcher capacity will need to be balanced against the risk of launch failure in proximity to urban areas and critical infrastructure, but it's Gilmour Space Technologies that seems to be leading the national space-launch sector, at least in terms of the development of launch vehicles. Even so, Gilmour must address inevitable concerns about launch trajectories and stages dropping over environmentally sensitive areas such as the Great Barrier Reef.

In the ground segment, the Queensland Space Strategy highlights the role of western Queensland as an ideal area for satellite ground stations, being in largely radio-free areas that enjoy clear skies and dry weather and have essential internet connectivity. The strategy notes the potential for ground-based space domain awareness and space surveillance as a key task that could be supported from western Queensland:

With clear skies and proximity to the equator, Queensland—particularly Western Queensland—offers multiple locations for ground stations than can scan both the Northern and Southern Hemispheres.⁴⁷

A location that's ideal for optical surveillance from LEO is also ideal for exploiting the electromagnetic spectrum for satellite communications and the control of satellites. The lack of ground facilities in the Southern Hemisphere and the ideal location of western Queensland means that investment into ground stations 'can be an industry enabler by connecting the space economy with data analytics and broader industry customers.' A greater number of ground facilities for both space domain awareness and satellite control would be necessary as the numbers of satellites in orbit increase and bandwidth demands grow. That then generates new opportunities for a greater range of space-enabled services, such as satellite communications, satellite navigation, positioning and timing, and Earth observation. In turn, that feeds into the creation of space-enabled supply-chain opportunities that generate new economic opportunities and growth for the users of space products. That drives demand for more space-enabled services, which influences the growth of sovereign launch, in an end-to-end ecosystem.

The final element of the space strategy is how it sees the use of manufacturing and robotics. The strategy correctly identifies the potential benefit for future in-space activities such as manufacturing and resource utilisation that the state can be well placed to support. Robotics opens up new opportunities for exploration, and the strategy argues that Queensland 'has a long history in robotics and remote asset management through its mining and advanced manufacturing industries', which could be applied to activities in space, particularly on the lunar surface.

The view from Western Australia

The West Australian *Space sector overview*, published in August 2022, highlights a range of focus areas for the development of a state space sector. Although launch is mentioned as one of those areas, the focus in the document is more on ground-based space-related activities, compared with Queensland and the Northern Territory. Western Australia's remote geography and environment give it natural advantages for a number of ground-based space activities—most notably, space domain awareness and space surveillance, satellite ground stations for satellite communications and potentially, from some locations, launch. Western Australia's extensive mining industry uses remotely controlled vehicles in the operations of mines, so it's also very well placed to support the development of autonomous and remotely operated systems related to space resource use.

The most significant role for Western Australia is to exploit its geography and environment for the ground segment, particularly in supporting space situational awareness that's vital for space traffic management and space domain awareness. This is a crucial task, given the increasingly congested nature of the space domain and the challenges associated with the growing numbers of satellite megaconstellations. The overview document lists existing infrastructure and activities occurring in the state in relation to space situational awareness, the most significant of which include the US–Australia Space Surveillance Telescope and C Band Radar at the Naval Communications Station Harold E Holt in Exmouth and the newly established West Australian Space Radar built and operated by LeoLabs, near Bunbury.⁴⁸ Other key projects underway include the construction of a facility for LEO and deep-space surveillance at Learmonth by EOS Australia and Lockheed Martin, as well as a 'Fire Opal' space surveillance capability being established by Curtin University and Lockheed Martin.

In terms of launch, the main opportunity exists with polar and Sun-synchronous orbit missions from Western Australia's south coast. A proposal has been made for establishing a launch site in Albany, the Western Australian Spaceport, to service those orbits, and it's planned to be operational in 2025.⁴⁹ Western Australia is also hosting the flight base and launch sight for the Airbus Defence and Space Zephyr HAPS in Wyndham. A third launch-site provider, Space Angel, in collaboration with India's Skyroot Aerospace, is seeking to establish a space-launch facility in Western Australia as part of a network of launch sites, which it's referring to as an 'Australian Space Super Corridor'.⁵⁰ The challenge facing launch from Western Australia is that, as in South Australia, the launch trajectories are oriented to the south and southeast, safely away from populated areas, but from locations that are high in south latitude, making such sites unsuitable for easily reaching equatorial orbits.

Like Queensland and the Northern Territory, Western Australia can exploit its substantial experience in remote and autonomous systems for mining to develop space capabilities that will support future lunar missions. Two key projects—the Space Automation, AI, and Robotics Control Complex (SpAARC) and the Australian Remote Operations for Space and Earth (AROSE), both located in Perth—are established to leverage expertise and technology from the mining sector and to develop future space capabilities that will contribute not only to science and exploration, but also to space resource utilisation. AROSE has recently been awarded a grant to pursue the development of the 'G'Day Moon' lunar rover under the Australian Space Agency's Trailblazer program that will see Australian support for NASA's Artemis missions to the Moon.⁵¹ The development of the rover will rely on expertise and technologies from terrestrial mining activities in Australia, and it will be required to be operated remotely to gather lunar material for processing to extract oxygen. Achieving success in this mission will be critical to ensuring that a sustainable human presence on the Moon is possible.

A summary: what's needed now

Queensland, Western Australia and the Northern Territory are fully embracing an active and growing role in this nation's space sector, comprising launch, the establishment of significant ground-segment facilities, and supporting space science and engineering research and development of technologies and capabilities that will have applications across the breadth of national space activities. That lays the basis for a future expansion of space activity, including to support defence and national-security tasks and missions. There are potential

opportunities for developing Australian space infrastructure and capabilities in the north as they relate to future ADF space requirements, focusing on launch, but also considering future ground-segment capability and the opportunity offered by co-locating space industry with launch sites in what might be referred to as ‘space hubs’ or ‘space corridors.’

The missing part of Australia’s approach to sovereign launch, and more broadly, to space in general, is a credible national space policy that ensures a coherently managed approach to national space activities in the civil and commercial sectors and is coordinated with space activities in the defence and national-security arena. The previous Morrison Coalition government announced a ‘Space Strategic Update’ in March 2022 that would provide just such a plan through to the 2040s and would align efforts within the broader space sector.⁵² The goal would be the preparation of a national space policy that would align both civil and defence aspects of space to provide a clear vision for objectives and goals, that would then inform resources, funding and capability to achieve those goals.⁵³ However, with the change of government, the work on such a national space policy has ground to a halt, with no commitment from the Albanese government to complete the space strategic update. The Minister for Industry, Science and Technology’s office hasn’t committed to continuing the initiative, as it was ‘an initiative of the previous government’.⁵⁴

Absent a national space policy, risks begin to emerge that could threaten the success of Australia’s broader ambitions in space, and that are compounded by recent budget cuts to areas such as Australia’s ‘Moon to Mars’, spaceport and space-access activities. In particular, the failure of the government to support the completion of a national space policy will see the commercial space sector increasingly at risk of losing direction and focus. Instead, state-versus-state competition would re-emerge, in which multiple bidders for space-launch activities emerge in a manner that isn’t consistent with national interests. The launch market could quickly become saturated and unable to realise its ambitions. Rather than focus on a few select launch sites that best exploit our natural advantages, there’s a risk that overdevelopment of a launch market in Australia could see failures of companies, like what happened to Virgin Orbit. Worse, a failure of government support and leadership, combined with indifference about ensuring funding, could see progress slow, confidence ebb, and jobs being lost. Australia’s credibility as a rising space power will come under question, and it will be exceedingly difficult to regain such credibility in a very intense and competitive international market. A failure in government leadership, which I’ve alluded to in relation to budget cuts, presents the greatest challenge to Australia’s aspirations in space. Meeting this challenge will demand that the commercial sector play a more proactive and forward-looking role in achieving goals, in a manner that then creates incentive for government to follow. This is indeed the very basis of ‘Space 2.0’, in which innovation and progress are made through the commercial sector first and then sustained by government investment. But, if the commercial sector is to lead, government *must* follow through with sustained investment to boost confidence in future growth.

Thankfully, Australia’s emerging space sector isn’t just focused on commercial and civil roles, and Australia’s defence and national-security requirements for space will increasingly drive progress and demand government support for defence capabilities. Australia’s commercial space sector needs to focus heavily on defence and national-security requirements to sustain operations, while continuing to plan for and deliver other commercial capabilities to support civil tasks.

The role of northern Australia and future ADF space requirements

The key to the future of Australia's space capabilities, at least in terms of their role in supporting defence and national security, is identified in the 2022 Defence Space Strategy, released by Defence Space Command.⁵⁵ The Defence Space Strategy highlights the ADF's reliance on space capabilities not only for expeditionary operations but also for national activities and characterises space as contested and congested. The rapid growth of counterspace capabilities—both soft kill and hard kill—by competitors and potential adversaries is designed to exploit modern militaries' dependence on space systems in a crisis. Burgeoning commercial and government space activity globally is increasing the number of satellites and other space objects, seemingly exponentially.

The threat from counterspace systems is growing more acute. China and Russia are developing and demonstrating hard-kill direct-ascent and co-orbital anti-satellite (ASAT) weapons, and also demonstrating technologies related to soft-kill ground-based and co-orbital ASAT systems. In 2021, Russia tested a direct-ascent ASAT that created a huge cloud of space debris, which has continued to pose a hazard to other satellites and spacecraft, including the International Space Station and China's Tiangong space station.⁵⁶ China tested a similar system in 2007 and has probably operationally deployed a direct-ascent ASAT that can threaten LEO-based satellites. It has subsequently demonstrated the ability to threaten satellites in geostationary orbit with a direct-ascent system that could be used to deliver an ASAT weapon. In addition to undertaking provocative rendezvous and proximity operations (RPOs) that would be used to employ co-orbital ASATs, both states have demonstrated ground-based uplink and downlink jamming, developed directed-energy weapons for dazzling satellite sensors, and have the means to employ cyberattacks on the satellites directly or on their supporting ground segment.⁵⁷

The Defence Space Strategy is responding to this increasingly threatening environment and notes that 'Defence must improve the reconstitution, resilience, and defence of the Defence Space Enterprise capabilities.'⁵⁸ It adopts a 'shape, deter and respond' approach, from the 2020 Defence Strategic Update, to shape the international diplomatic and legal frameworks to constrain space weaponisation or at least strengthen international norms against irresponsible behaviour in space. The Defence Space Strategy seeks to work with partners on critical activities such as space domain awareness, where space domain awareness can be defined as 'the detection, tracking, characterisation, and understanding of a fusion of multiple [local] space situational awareness activities within the Space Domain, and which facilitates decision-making at the domain scale'.⁵⁹ The strategy seeks to deter the use of counterspace capabilities, particularly in the grey zone, through denying anonymity and ensuring attribution of irresponsible or threatening activity, and to strengthen the Five-Eyes-based CSpO initiative as a means to mitigate threats and respond to challenges. In this case, Australia's contribution to space domain awareness must be matched by sovereign launch, which contributes assured access to space and which, in turn, boosts resilience and ensures a space architecture that's highly responsive to a rapidly changing and increasingly contested and congested space domain. This is consistent with calls in the strategy for Australia to 'develop sovereign space capabilities that contribute to its partnerships and assure Australian civil and military access to capabilities in space'.⁶⁰

Besides counterspace, the challenge of the space domain becoming ever more congested is real and growing, particularly as the falling cost of accessing and reaching space is allowing space to become democratised, as more and more state and commercial actors deploy capabilities.

In both cases, the response by Defence is initially through sovereign space surveillance and domain awareness capabilities, but, ultimately, to ensure access to space, the growing importance of sovereign space launch is coming very much to the fore. In this regard, northern Australia will play an ever more important role and thus contribute more broadly to the success of defence and national-security activities in orbit.

Sovereign launch, as an aspect of national space development, needs to grow. This report has highlighted that the Northern Territory, Queensland and Western Australia all have ambitions when it comes to sovereign space launch, which must be synchronised to avoid unnecessary competition. There are clearly economic gains to be made by Australia undertaking sovereign launch, but, for defence and national-security purposes, launch is vital. The Defence Space Strategy highlights five lines of effort, with the first ('LOE 1') being to 'enhance Defence's space capability to assure joint force access in a congested, contested and competitive space environment'.⁶¹

Access can certainly be achieved through relying on support from foreign partners, but only at the risk that that access will be severed in a crisis in which political, commercial, or industrial constraints could limit cooperation. Specifically, it's conceivable that key allies would prioritise their own operational needs for space support in a crisis at the expense of Australia's requirements, including for vital intelligence, surveillance, and reconnaissance data from satellite coverage, including of our northern approaches. Australia is currently 100% reliant on foreign partners for launch, as well as for access to data from space assets that are on orbits and providing coverage as stipulated by their owners, and shared by processes that introduce time lag and therefore reduce operational utility.

Continuing to rely on foreign-provided space capabilities risks creating an Achilles heel. That could best be addressed by expanding sovereign space capabilities that are developed locally, launched from Australia and operated as sovereign national assets. Nor is complete reliance on the commercial space sector an answer to the risk to our national interests in space, although commercial capabilities are definitely part of the mix that militaries do and will continue to draw upon. The recent example of SpaceX seeking to change the conditions on which Ukraine's access to Starlink was being provided should be a clear warning about any assumption of access through dependency on others, and especially corporate players with their own set of incentives and interests.

The Defence Space Strategy calls for a space architecture that's 'resilient, can be reconstituted if compromised and defended if under attack' and recognises the benefits of a commercial 'NewSpace' or 'Space 2.0' approach to gaining such capability. Significantly, the strategy states:

To sustain a mix of orbital regimes and satellite classes and respond quickly to reconstitute battle damaged assets, Defence anticipates it will need access to a responsive and assured space launch capability in the future.⁶²

It's therefore fortunate for Defence Space Command that Australia's commercial space sector, including in the Northern Territory, Queensland and Western Australia, is vibrant and rapidly growing and includes not just an expanding ground segment but also sovereign launch capabilities. The ability for the commercial space sector to provide an end-to-end ecosystem—from satellite design and development, through manufacturing, to payload integration and launch, and then through utilising the expanding ground segment, to control of space assets, as well as space domain awareness, should be the basis for Defence's desire for assured access to space. The space-launch component of Australian space activities gives Defence the means to have access to a responsive and assured space-launch capability as part of that national end-to-end ecosystem, within Australia, rather than having to depend on foreign or commercial partners.

The Defence Space Strategy talks of resilience, assured access and the reconstitution of lost capability. Those are important goals, particularly in the face of growing threats posed by counterspace capabilities. The sovereign launch capability emerging in Australia, and in northern space ports such as Nhulunbuy and Bowen, gives Australia first access to a means to launch small satellites and, eventually, larger payloads on medium- to heavy-lift rockets. Those space-launch capabilities can be developed quickly, using advanced manufacturing, to augment or reconstitute space capabilities in a crisis. The northern jurisdictions, together with the rapidly growing space industries in South Australia, Victoria and New South Wales, are poised to be able to develop small-satellite technologies that are well suited to the types of launch capabilities emerging in the north.

A 'deterrence by resilience' approach in space can make it more difficult for an adversary to employ counterspace capabilities in a 'space Pearl Harbor' style mass attack early in a conflict to bring about the rapid and catastrophic collapse of ADF space support. Such an approach can best utilise locally made small satellites, launched on Australian launch vehicles from Australian launch sites, to fill gaps ('reconstitute') and to expand capabilities ('augment'), initially of allies and partners and eventually future ADF capabilities as they're developed.

In this sense, Australia can use sovereign space capabilities—satellites, launch vehicles, launch sites and a ground segment, including for space surveillance—to burden share in orbit to a much greater extent in the future, particularly if investment is made to develop space infrastructure in northern Australia. In space surveillance, Australia already makes an important contribution to space domain awareness. Through projects such as JP-9360, and collaboration with commercial space surveillance providers, it's possible to develop networked and integrated sensors across the full breadth of Australia's territories. Expanding our coverage of Sun-synchronous orbits, particularly as they cross the equatorial LEO region, and developing national surveillance capabilities to provide Australia, its allies, partners and commercial customers with high-quality near-real-time space domain awareness in the heart of the Indo-Pacific would be a basis for superior space operations in a contested and congested space environment.

Therefore, government should fully support both the development of sovereign launch capability, such as that being developed by Australian companies such as Gilmour Space Technology, Hypersonix Launch Systems and Black Sky Aerospace, as well as the development of sovereign spaceport infrastructure for sovereign and foreign commercial launch. There are huge opportunities for attracting overseas launch companies to launch—and recover—from Australia. With that in mind, it's significant that Australia and the US have announced in May 2023, on the sidelines of the G7 summit in Hiroshima, a technology safeguards agreement (TSA) that will allow for the transfer of US space technology, including rockets and satellites, to be launched from Australia.⁶³ The TSA states that:

Space collaboration is a rich opportunity to build high-skilled, well-paying jobs and increase investment between our countries. Australia and the United States have reached agreement in principle, subject to final domestic authorisations, on the Technology Safeguards Agreement, to allow for the controlled transfer of sensitive US launch technology and data while protecting US technology consistent with US non-proliferation policy, the Missile Technology Control Regime and US export controls.

The Department of Industry, Innovation, Science and Resources, in which the Australian Space Agency is based, notes that the TSA will help 'our domestic launch sector and spaceports to grow and is expected to create jobs in developing infrastructure to support US launch activities'.⁶⁴

The head of the Australian Space Agency, Enrico Palermo, notes that the TSA:

... will create commercial opportunities for our launch sector and send a signal to the global market that Australia is 'open for launch'. Australia is already a place that the world wants to launch from thanks to our geography and ability to access multiple orbits, wide open ranges, focus on responsible operations and trusted alliances to protect sensitive technologies—a TSA will cement that.⁶⁵

The TSA, and the growth of Australian space-launch capabilities, open up the possibility not only for Australian satellites launched on Australian launch vehicles from Australian launch sites to become the key basis of a national space capability, focused on the north, but the launch—and return—of US launch vehicles, such as SpaceX Starship Super Heavy and other future re-usable launch systems, to fully exploit the advantages of accessing space from Australia's north.

The revolutionary potential of re-usable launch technologies such as SpaceX Starship Super Heavy, Blue Origin New Glenn and, eventually, single-stage-to-orbit spaceplanes that could emerge from development by companies such as Queensland-based Hypersonix Launch Systems would allow Australia to leapfrog into the 21st century as a high-volume commercial space-launch nation. The combination of Australian and foreign launch providers provides the nation with a sustainable basis for a rapid expansion of space infrastructure in the north.

Finally, the growth of this aspect of national space capability will drive the expansion of space hubs and corridors, which will see supporting industries co-located to launch sites and greater investment in infrastructure such as road, rail and port facilities to sustain high-volume launch activities in an economic and competitive manner.

Space in the north is the key to Australia's future success in space and to Defence's ability to respond to an increasingly challenging, contested and congested space domain of the future.

Recommendations

In 2013—a mere decade ago—the idea that Australia would be seeking to establish a comprehensive and national space industry, which includes both satellite manufacturing and space launch—would have been dismissed by many observers as ludicrous.

A decade later, Australia is well positioned to become a comprehensive space power, with northern Australia playing a key role. Most notable is the role of sovereign launch that's emerging in northern Australia as Nhulunbuy in the Northern Territory and Bowen in Queensland emerge as key launch sites that can service key orbital locations. In Western Australia, Queensland and the Northern Territory, the ground segment is also flourishing, both for the provision of satellite downlinks and for space domain awareness roles. The combination of launch together with the ground segment sits alongside supporting industries and hubs such as i-Launch and AROSE, which are laying the basis for a further expansion of space activities and the north.

Defence and national security have a key role to play in growing this infrastructure further, and the Defence Space Strategy essentially lays the basis for growth in the space sector in the north through its requirement for responsive space access and resilience. Defence can't have assured access to space by relying on foreign launch providers, and it's nonsensical to do so when local launch providers are rapidly emerging. It would be sensible for Defence to invest in the growth of a northern space-launch capability in the Northern Territory, in Queensland and in Western Australia, and to support the establishment of supporting industry that can be co-located to launch sites to create further benefits for regional economies. The growth of space hubs and space corridors in which supporting industries are established near launch sites reinforces the potential responsive nature of the commercial space sector in meeting government requirements by minimising supply chains. Such arrangements can more easily ensure connectivity with a more distributed ground-segment network. Building a space ecosystem that's fully integrated offers all sorts of benefits, compared to an isolated launch site distant from industry centres. The signing of the TSA on space launch between Australia and the US this year further opens up opportunities for growing this sector and reinforces the economic viability of developing sovereign launch capabilities in the north.

The best path forward is for government to fully support the development of Australia's commercial space sector, including and with specific attention to the establishment of an Australian sovereign space-launch capability. Indifference or hesitancy in funding the commercial space sector would be a mistake made at a crucial point when Australia's space sector has developed momentum to move forward and would undermine confidence in the sector's future ability to grow and generate revenue and jobs. It would be very much an own goal by government if future federal budgets continue to see space as not being 'aligned with government priorities' or to mistakenly characterise space initiatives as 'not delivering value for money for the taxpayer'.⁶⁶ The rapid growth of the commercial space sector at the global level is opening up a huge market for Australian participation that will propel the expansion of Australia's space sector. Australia has a fundamental choice. We can be an active participant in this global growth area, or we can choose to be a passive bystander looking on from the sidelines.

For Defence, the ideal strategy is to fully integrate Australian commercial space capabilities, including sovereign launch, into policy formulations for ADF space capabilities in the future. Investing in and supporting the establishment of sovereign launch capabilities opens up new opportunities for the ADF to exploit new ways

of accessing space rapidly, both to support the ADF's ability to undertake a full range of joint and integrated operations, both at home and in expeditionary roles, and as part of a coalition, and to burden share in orbit to a level far greater than merely providing a suitable piece of real estate for ground facilities.

Perhaps most importantly, the commercial space sector in Australia, including sovereign launch, can provide Defence with space support for responsive space access without Defence having to fully fund or maintain the capability—provided that government understands its importance and invests in commercial space companies such as Gilmour Space, Equatorial Launch Australia, Southern Launch and others that are now leading Australian space development in a sustained and stable manner. There must be a long-term commitment from government to Australia's future in space, irrespective of which political party holds power.

Government now has a golden opportunity to rapidly grow the north's space infrastructure by ensuring that it's fully tethered to defence and national-security requirements. As the 2022 Defence Space Strategy makes clear, those requirements are clear: assured access to space, resilience, and an ability to reconstitute in the face of a contested and congested space domain. Now is the time for the government to accept the motto that 'fortune favours the bold' and commit to go forward to launch—from the north.

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Acronyms and abbreviations

ADF	Australian Defence Force
AROSE	Australian Remote Operations for Space and Earth
ASAT	antisatellite
CSpO Initiative	Combined Space Operations Initiative
ELDO	European Launcher Development Organisation
EqLEO	equatorial low-Earth orbit
ESA	European Space Agency
GEO	geostationary orbit
GPS	Global Positioning System
HAPS	high-altitude pseudo-satellites
LEO	Low-Earth orbit
MEO	Medium-Earth orbit
NASA	National Aeronautics and Space Administration (US)
RPOs	rendezvous and proximity operations
SpAARC	Space Automation, AI and Robotics Control Complex
SSO	Sun-synchronous orbit
TSA	technology safeguards agreement

WHAT'S YOUR STRATEGY?

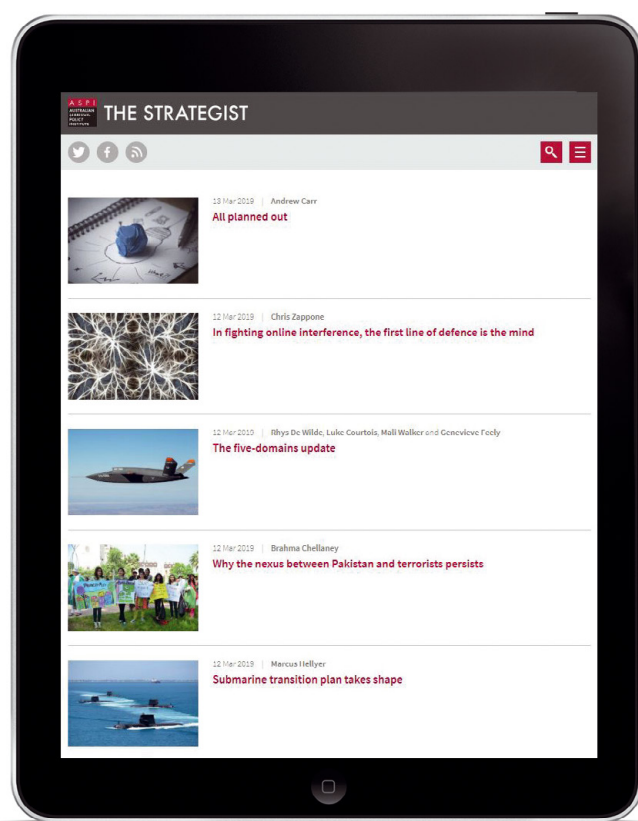


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