Astra AYAA


ASTRA PROGRAM 2025

# WHITE PAPER SERIES

# Produced by the Astra Program

**Program Director**

Georgi Coddington

**Program Deputy Director**

Sam Kirkwood

**An initiative by the**


**Program Managers**

Karla Vincent
Zamara Rodriguez

**Communications Coordinator**

Anjalee Senarath

## Sponsored by






Australian Youth Aerospace Association (AYAA)
PO Box 4315, St Lucia South
QLD 4057, Australia
contact@ayaa.com.au

Published by the Australian Youth Aerospace Association
www.ayaa.com.au

# Executive Summary

While Australia takes pride in her Apollo-era contributions to the space sector, we grapple with a history that doesn't include space flight, endures risk averse administrations, societal resistance to commercialisation, and a culture where Tall Poppy Syndrome permeates. Australia does, however, possess many companies that service the space sector, and research groups that produce world-class advancements on space adjacent topics. To overcome these challenges and harness our potential, Australia must identify and strengthen our unique capabilities.

Australia's niche refers to the specific specialisations the nation can develop based on her geographical, economic and technological strengths. This White Paper aims to reveal Australia's unique position in the global space ecosystem by outlining strategic recommendations for transition and growth.

We have an opportunity to unify our research in quantum and space technologies to become leaders in low size, weight and power satellite instruments. Technologies already developed– for instance, automation technologies used for mining iron in the Pilbara– could be implemented on the Moon. By investing in a sustainable lunar prototype on Earth, we avail our strengths in automation, materials science and renewable energy. Other key focus areas include leveraging Australia's geographic and political stability for launch capabilities, as our proximity to the equator is advantageous, so is our view from Antarctica, which we propose Australia take advantage of to track space debris in LEO and GEO, and promote domain awareness. By fostering a skilled workforce via research sector engagement, and supporting startups in medicine and satellite technologies, we can combat the challenges Australia faces.

## Acknowledgement of Country

Team Banksia, alongside the Astra Program and the Australian Youth Aerospace Association, would like to acknowledge the Traditional Custodians of Country throughout Australia. The Banksia Team is based across Australia; Gadigal, Dharug, GuriNgai, Wangal, and Bediagal Land.

We pay our respects to Elders, past, present and emerging, and extend our respects to all Aboriginal and Torres Strait Islander peoples. We recognise the First Nations Peoples of Australia as the world's first astronomers, and their enduring knowledge in cultures and customs, which have nurtured and continue to nurture terrestrial, and astronomical knowledge.

# AUSTRALIA'S SPACE NICHE:

## Charting our Future in the Global Space Sector

**Contributors:** Julia Bell, Oliver Cook, Jackson Gourlay, Cameron Jones, Ashish Justs, Amogh Krishna, Tekkiya Larkins, Samuel Petrovic, Frosinni Piperias, Grace Rosier, Jay Shivanand, and Scarlett Wakelin

**Team Coordinators:** Jake Mackenzie Wood, Madeleine Taveira

## Introduction

Australia's space sector rests in a pivotal moment in our history. Australia must identify and develop a clear niche to secure a strong position in the global industry. Set to host the 2025 International Astronautical Congress, this presents us with a key opportunity to define how we can contribute meaningfully and competitively to the global space sector. Leveraging our unique strengths, such as geographic advantages, emerging technologies, and a growing commercial sector, we can establish a lasting presence in the international space landscape. With a strategic approach, Australia can build a resilient, future proof space sector that drives both innovation and economic growth, but first, we must ask ourselves.

***How can Australia strategically position itself in the global space industry to ensure long-term success and impact?***

This white paper aims to:

- Identify Australia's most promising space capabilities and niche areas.
- Benchmark against global space leaders to assess competitive advantages.
- Explore strategies for sustainable growth, innovation, and international partnerships.
- Provide policy, investment, and collaboration recommendations alongside actionable strategies and industry initiatives that strengthen Australia's role in the space sector and support its transition into a competitive and sustainable space market

The Australian space sector is expanding, as evidenced by growth in key areas such as Earth observation, access to space, and a substantial increase in space sector employment. Investment in the industry has also surged, reaching $2.88 billion (ASA, 2021). This growth is driven by national initiatives led by the Australian Space Agency (ASA) and strategic investments in emerging technologies, including spaceports, space mining, and quantum technologies. With projects like Gilmour Space Technologies' advancements in satellite development and launch facilities, Australia is positioning itself as a competitive player in the global space industry. This white paper explores the nation's strengths, challenges, and opportunities in defining sustainable space niches, ensuring long-term growth and innovation in the sector.

## Problem Statement

Despite rapid progress and a growing space industry worldwide, Australia lacks a clear niche and common goal, which puts the nation at risk to fall behind in the global space market. To be competitive we must identify and leverage our unique strengths while ensuring a strategic and sustainable role in space.

## Methodology

This methodology outlines the approach Banksia conducted for utilising data and information throughout the paper. To collate information for the Banksia white paper, the team used primary sources, such as academic papers and official government documents, along with Astra Subject Matter Expert (SME) presentations who provided valuable industry insight. This insight was investigated and verified. Ensuring transparency in the research process was essential to maintain the reliability and accuracy of this paper, while also safeguarding the credibility of the Astra Program hosted by the Australian Youth Aerospace Association.

The process of finding information varied, however, it was primarily conducted through online search utilising relevant keywords. Results were analysed and pertinent information was then assembled. Sources were also obtained through Astra participants or by directly traversing sites of known organisations, for instance the Australian Space Agency, and academic paper databases such as the MDPI. The reliability and accuracy of the information was ensured by cross-checking detail consistency through primary sources from institutions and experts with specialties in the desired topic. To ensure the credibility of sources, the backgrounds of the authors and organisations were investigated. Contrary to our abundance of academic research, Australia's current commercial space industry is young and limited compared to countries who have developed theirs over decades. This resulted in limited Australian research on emerging topics such as launch facilities (Recommendation 1), lunar research (Recommendation 2) and space education (Recommendation 5).

The Australian Space Agency is *a specialist division of the Australian Government Department of Industry, Science and Resources* and hence does not conduct first hand research.[1] Due to this, research papers were taken from individual Australian space companies and researchers which may have resulted in the information containing unintentional bias. Information from multiple companies and researchers were cross-checked to mitigate this. Additionally, as a result of the ASA being a specialist division, there is a lack of Australian centralised space research. Thus, space research complexities arise from not having a governing space agency as opposed to NASA or the ESA. This resulted in difficulties finding clear unified Australian plans to support this paper's recommendations. Hence, the approach for the formation of the following recommendations are strongly based on devising a plan and persistently carrying it out. Information could have been collected first hand in the form of public surveys, such as gathering perspectives on this paper's recommendations during the draft stages. This would have increased the diversity of information in the paper as opposed to solely relying on external primary sources. However, gathering information from research articles was ultimately deemed a higher-priority.

# Background

## Australia's Geographical Politics

Australia's reluctance to embrace industrialisation and manufacturing hinders her space ambitions. Despite our achievements and world-class research in areas of space science, governments fail to commit to the innovation required for global competitiveness. As a geologically and politically stable landmass, Australia is home to vast remote landscapes opportune for the development of launch facilities. Our location in the Southern Hemisphere leverages the Earth's rotation, optimising launches toward LEO as they require less energy when aimed eastward, reducing fuel consumption. Australia has only ever launched one satellite from her territory, WRESAT, for defence purposes in 1967.[2] Since then, satellites have become vital for earth observation, communication, transport, and intelligence. Bec Shrimpton of the Australian Strategic Policy Institute warns that ignoring space opportunities risks economic and security setbacks.[3] With increasing air traffic and overpopulation constraints at Cape Canaveral and other major U.S. launch sites, Australia has a key opportunity to develop launch facilities and advance space logistics.[4]

## Space Mining

Space mining refers to the collection of regolith on extra-terrestrial bodies, a practice that mirrors current on-Earth mining operations. Australia is positioned as a major player in lunar exploration because of its proficiency in material science, distant logistics, and autonomous mining. The creation of printable regolith-based structures may be aided by developments in 3D printing and durable composites, including experimental dwelling construction. Based on its mining industry blueprints, Australia can contribute to off-world resource use by utilising these advantages to build facilities for testing and preparing lunar regolith extraction vehicles. This aligns directly with current long term space missions to establish a permanent human presence in space (Lunar colonies), such as NASA's plan of The Artemis Program while making heavy utilisation of our strengths and expertise. [5] [6] These same technologies have major cross over with national interest in sustainable living and energy production, and improving efficiency and sustainability of mining; which composed 12.2% of our industry output in 2024.[7]

## Space and Quantum Technologies

Quantum technology proves to be a contender in the advancing technology sector for space research and exploration. It is vital to foresee the unification of industries that have capabilities in areas of quantum computing and machine learning, with the industries that specialise in Radio Frequency (RF) and optical communications, to effectively capitalise on Australia's technological strengths. Australian research laboratories have expressed particular interest in the matters of quantum technology as it carves the path for an efficient entry into the global space market. Australia is recognised as a global quantum leader and is Australia's third largest industry.[8] Although there is an incongruity between the microscopic world of quantum physics and the astronomical size of space-based ventures, recent scientific breakthroughs in quantum based machine learning, artificial intelligence, data transfer, sensing and other technologies, prove to be vital in the future successes of the Australian space industry.

### Antarctica's Role in Space

Antarctica is a promising area to conduct astronomical observations, as it is relatively untouched and has potential to become a multinational domain for space research if Australia actualises it. The cooler, less turbulent air, as well as sustained periods of darkness, allows telescopes to capture readings that compete with orbital telescopes.[9] Utilising this, as well as exploiting Australia's close proximity to the southern pole, enables access to Antarctica's potential offerings to the space industry. Such a movement could be led by Australia by way of her current excellence in radio frequency technology.

### Diverse Space Workforce

A healthy diverse workforce is essential not only for a positive corporate identity, improved reputation, and workplace morale, but has also proven to create more innovative and productive outputs than more conservative workplaces. Both gender and ethnic diversity increase the profitability of a company, as such, there must be an active effort for companies to combat the pervasive culture of prejudice in the workplace.[10] Companies with above average diversity in corporate structuring had an average of over 50% higher innovation revenue than companies with below average diversity.[11] Diversity in the space industry is a necessity to encourage wider participation by students and develop a more sustainable workforce.

### Space Startups in Medical Technologies

Australia's geographic size and dispersed population have driven advancements in remote healthcare, making the nation a global leader in telemedicine and space medicine. As approximately 28% of Australians live in remote areas, access to healthcare remains a critical challenge, particularly for indigenous communities.[12] Remote healthcare innovations, such as telehealth services and mobile diagnostic tools, can pave the way for technologies that can support human spaceflight. The need for such an operation is evident, with rural deaths rates being 1.8 times higher than in major cities.[13] Space medicine, which focuses on protecting astronauts' health during long missions, has significant crossover with terrestrial healthcare, offering solutions that improve healthcare access and quality for remote populations.

## Topic Assessment

Australia's constrained fiscal capacity and fragmented political commitment necessitate a targeted approach to space-sector development. Rather than pursuing broad parity with global superpowers, Australia must prioritise strategic niches where its unique geographic, industrial, and technological advantages intersect with growing international demand. Specialisation in such niches ensures Australia becomes a critical node in global supply chains, rather than a passive consumer of foreign space technologies. In order to isolate these strategic niches, Australia must accurately identify her place in the space sector. This involves understanding both internal strengths and weaknesses, as well as external factors that either constrain or amplify her opportunities.

| Strengths | Weaknesses |
|---|---|
| **Geographic Advantage**: Australia's geographical position offers several key benefits. Her location in the Southern/Eastern Hemisphere provides optimal sky access for Space Domain Awareness (SDA) and communications.[14] We have large sparsely populated areas, usable for spacecraft return, and proximity to the equator for sun-synchronous orbit launch.[15]<br><br>**Stable Geopolitical Landscape**: Australia's stable political environment and adherence to the international rules-based order provides a secure foundation for long-term investment and international collaboration.<br><br>**Strong Applied Science Expertise**: Australia possesses a strong foundation in applied sciences relevant to the space industry. In particular, strengths lie in robotics, automation, space medicine, quantum technologies, optical communications and various other areas. | **International Logistics**: The costs and challenges associated with long distance logistics may hinder the competitiveness of Australia as an international partner.<br><br>**Limited and Risk Averse Capital**: Private capital in Australia is notoriously risk averse, and as a result Australian deep technology R&D is under-capitalised.[16] [17]<br><br>**Strong dependency on government with a limited political appetite**: The commercial space industry is still in its renaissance worldwide, and is thus highly dependent on government grants. Furthermore, the Australian government has proven to be unreliable in its commitment to funding the industry long term.[18]<br><br>**Lack of Flight Heritage**: Australia has limited experience in launching and operating spacecraft, which presents a challenge in gaining credibility and attracting international partnerships.[19] |
| **Opportunities** | **Threats** |
| **U.S. Spaceport Congestion**: The increasing demand on U.S. spaceports (especially Cape Canaveral Space Force Station and Kennedy Space Center) presents an opportunity for Australia to offer alternative launch sites and capabilities as the U.S. government looks to increase capacity and expand site diversity.[20]<br><br>**Visibility into gaps in allied capabilities**: Australia's vantage point allows it to identify and address gaps in allied SDA and optical and RF communications.[21]<br><br>**International Collaboration**: Involvement in international collaborations, such as the MoonToMars program for Artemis, offers opportunities to develop specialised expertise and integrate into the global space ecosystem. International collaboration in the space industry often works within a barter economy, such as the European Space Agency's (ESA) Barter Agreements for the International Space Station.[22] | **Undercut by cheaper markets:** Australia's high labour costs and expensive logistics chains make it vulnerable to being undercut by competitors in countries with lower operating costs.<br><br>**Applied science breakthrough squandered by lack of capital investment:** Lack of sufficient capital investment can prevent the commercialisation of Australian-developed technologies.<br><br>**Political Risk:** The industry's reliance on government is a major risk as space is likely to be seen as a luxury expense during inflationary periods, and or recessions.<br><br>**Geopolitical Conflicts:** Since Australia is unable to take a whole mission approach, we are at risk of reliance on partners who may pull out, or attempt to negotiate. |

### The Cost of Inaction: Risks to Australia's Space Future

Space infrastructure is increasingly vital to the Australian economy, but systemic underinvestment and fragmented policy frameworks threaten her resilience. Space technology encompasses Global Navigation Satellite Systems (GNSS) including GPS, Earth Observation (EO), and defence capabilities. Falling behind in any of these sectors could undermine national resilience across economic, environmental, and defence domains.

Of particular importance to Australia is EO which impacts sectors including weather forecasting, climate measurement, agriculture, mining, infrastructure, natural disaster planning, and defence. Earth Observation represents $283 million in direct investment within the Australian economy in 2020, and underpins over $2.5 billion of economic activity annually (0.2% of Australian GDP).[23] Without sovereign capabilities, Australia could face delays in accessing real-time data during crises, exacerbating economic losses. Similarly, GNSS systems are essential not only for consumer navigation purposes, but also key to logistics and autonomous systems. For example autonomous hauling systems being developed by the mining industry.[24] The defence sector is also becoming increasingly dependent on space-based assets.[25] Failure to develop a strong domestic space capability could directly impact defence strategies and risks perceptions of free-riding in the eyes of AUKUS allies, weakening her role in Indo-Pacific security. As such the risks of delayed investment in Australia's space infrastructure extend far beyond immediate operational challenges, threatening the nation's economic resilience, strategic autonomy, and global leadership. For this reason, key actions ought to be taken to secure Australia's future in space.

## Recommendations: Strategic and Economic Advantages of Implementation

The successful implementation of this white paper's recommendations will result in highly beneficial outcomes for Australia. Economic growth and international collaboration are the primary benefits that will arise as a result of implementing the outlined recommendations. These benefits will transpire through upskilling students, providing further research opportunities, commercial careers, and enhancing existing sovereign capabilities. Furthermore Australia is in an advantageous position to leverage our niches to become world leaders in research areas such as space medicine or utilising our landscape for lunar regolith retrieval and launch sites. These will not only make us a desirable partner for unique missions or research that international space agencies are conducting, but will also grow the Australian economy as a result of the new job opportunities. In addition, by implementing these recommendations investor confidence will be boosted through the demonstration of Australia's commitment to strengthen new areas of research. Australia has the potential to become a world leader in emerging areas such as quantum technology or space medicine. Strengthening these pre-existing areas will lead to new breakthroughs that will take the world stage. Enhancing international confidence in Australia's research initiatives is crucial. If these six recommendations are implemented effectively, they are poised to deliver considerable benefits to the country.

## Recommendation 1: Promote Australia's strategic position in the Southern Hemisphere, her stable geology and geopolitics for the development of launch facilities.

The current developments of Gilmour Space Technologies and SouthernLaunch demonstrates the willingness of industry to build domestic launch capabilities; however, additional government support is required to ensure sustained growth. Gilmour Space Technologies has developed a launch facility at Abbot Point, Queensland, but the launch of the Eris 1 rocket has been delayed.[26] Southern Launch is currently constructing the Whalers Way Orbital Launch Complex, South Australia, aiming to support high-frequency launches to polar and sun-synchronous orbits for commercial clients.[27]

***Strategic Benefits for Australia***

- Economic growth: domestic space manufacturing creates high-skilled jobs, generates revenue from commercial launch services, and will attract international partnerships and investment in Australia's space sector.
- National security: sovereign launch capabilities allow for the rapid deployment of defence-related satellites, and reduces dependence on foreign nations for satellite launches in general, which enhances national security.
- Science and technology leadership: establishing launch facilities cements Australia's role in global space exploration and encourages homegrown innovation and technology transfer from international partners.
- Building partnerships: when international organisations use Australia's launch and retrieval sites, the government could leverage land access in exchange for job opportunities for Australians within the customer's company or technology transfer agreements.

Outlining the potential users of the spaceports, the payload capacity, and launch frequency is crucial for implementing this recommendation. Commercial Australian and American space companies, such as Gilmour Space Technologies, REDARC Defence & Space, Skykraf, Blue Origin, Rocket Lab, Relativity Space, Astroscale and SpaceX, along with international agencies like NASA, ESA, JAXA, ISRO will have vested interest as customers. Australia can accommodate small to medium satellite launches and niche markets like cube satellites. With the proper investment, high-cadence launches can support global space operations.

Australia must consider balancing space regulation for commercial growth while safeguarding national security as a top priority. Australia's space sector is primarily supported by the ASA, but funding remains limited, thus government incentives can attract private-sector investment and international clients. Australia has launch regulations in place, governed by the ASA and the Space (Launches and Returns) Act 2018, yet further legal frameworks are required to streamline approval processes and ensure safety compliance.[28]

For the recommendation to be realised we have to distinguish between the role of private versus state-backed launch facilities. Private-sector partnerships are the most viable option, as government-led initiatives often suffer from bureaucratic delays. A hybrid approach, where the government co-invests in infrastructure while allowing private operators to run launches, could provide flexibility. Before full-scale launch operations become possible, Australia needs to establish testing and payload retrieval facilities as understanding optimal orbits for retrieval will improve space logistics and mission planning. Australia needs to promote our launch capabilities internationally and engage allies such as the United States, UK, ESA, Japan, and India to encourage usage of Australian launch sites for the plan to be tangible. Therefore, a body, named the Australian Spaceport Development Authority, operating under the ASA, should be created to coordinate public-private partnerships, oversee infrastructure development for both retrievals and spaceports, and streamline regulatory approvals.

## Recommendation 2: The Australian Space Agency should fund and support a consortium to model a sustainable lunar habitat prototype by utilising strengths in automation, materials science, and renewable energy.

Australia's strengths in autonomous mining, remote logistics, and material science allows her to lead the development of a sustainable lunar habitat prototype. Long-term space missions benefit from the development of regolith-based structures made possible by progressions in 3D printing and composite materials.

"The Lunar bases and space activities of the 21st century" airs a collection of short papers dealing with various aspects of a manned lunar base.[29] In the area of sustainable manufacturing of lunar bases, common setbacks are faced. Due to lunar regolith's sharp, irregular particles, the processing of these composite materials becomes difficult. Along with this, manufacturing involving sintering-based additives proves energy-intensive. The ideal binder, sulfur, has a low melting point, limiting its usability which leads to dependence on alternatives like thermoplastics which would need to be transported from Earth. To combat this, ISRU and ISFR can be tested using the lunar regolith simulants that are now available.[30] Their advancement aids in the improvement of industrial processes, and "lunar cement," which is comparable to Earth-based procedures. This can be produced by substituting liquid binders for sintering. Flexibility and little preparation are provided by additive manufacturing. Lunar cement can be made with a variety of binders, such as sulphur, thermoplastics, and geopolymers. Superior compressive strength is achieved when concrete is combined with Martian or lunar regolith. For building on the moon, a variety of additive manufacturing techniques, including binder jetting and selective solar sintering show potential.

By establishing specialised lunar regolith facilities in isolated Australian regions, the country can improve excavation, processing, and construction methods that could be vital for future lunar missions.[31] By partnering with industry giants such as Rio Tinto and BHP, Australia can utilise her advanced mining automation and remote operations technology for lunar applications, paving the way for efficient, sustainable and autonomous mining systems on the Moon. Furthermore,

Australia has a unique possibility to combine her material research with CSIRO and Australian universities to explore and develop 3D printable and regolith composites for building on the Moon.[32] Australia should continue to form industry partnerships with international space organisations including NASA and the ESA, along with private Australian space organisations, Fleet Space and Gilmour Space Technologies to drive forward efforts for large international projects, for instance, the Artemis Program. This can be done through the aid of developing technology, such as In-Situ Resource Utilisation, by funding the public and private sectors through industrial partnerships and government grants.[33] This will allow Australia to solidify her position as a key contributor to lunar exploration and the future of space infrastructure.

Australia has the capability to become a world expert in humanity's first, and thus far, only extra terrestrial colony. Participating in this consortium would skyrocket our space industry into a thriving sector, all while utilising skills we already established and developing new technologies that directly relate to national interests domestically.

## Recommendation 3: Unify Australia's quantum and space strategy to take advantage of existing expertise and exploit synergies.

Australia possesses expertise in quantum and photonic systems; however, this potential is currently undercapitalised.[34] [35] A similar sentiment is often expressed regarding Australia's space industry, with key issues raised across all three sectors being remarkably consistent.[36] Quantum photonic technology, particularly when paired with scalable machine learning techniques, offers critical capabilities for Space Domain Awareness (SDA), Earth Observation, and Space Defence capability.[37] [38] These applications extend across both space and ground segments:

| Space Segment | Ground Segment |
|---|---|
| LIDAR for proximity operations, landing, and Earth Observation. [39] [40]<br><br>Pointing, Navigation, and Timing.[41]<br><br>Quantum Sensing.[42]<br><br>High Capacity Data Transfer.[43] | Quantum Key Distribution (QKD).[44]<br><br>Satellite-mediated quantum internet for quantum communication. |

Quantum technologies inherently possess favourable Size, Weight, and Power (SWaP) characteristics, making them ideally suited for small satellite missions like CubeSats, which align with the Australian government's risk appetite. The Australian company QuantX has been conducting cutting edge quantum-technology based research, specifically in the realms of quantum sensor and precision timing technologies.[45]

With $3.7m funding from the ASA Moon to Mars initiative, QuantX has partnered with Surrey Satellite Technology Limited (SSTL) to "*Propel Australian quantum clock technology into space.*"[46] Such technology has effectively exploited national interest in government, industry, and academia efforts being put towards the meshing of space exploration and quantum technologies.

Australia's quantum, photonic, and space industries have independently appealed to the government for a clear strategic direction to capitalise on existing research excellence.[47] Given that Australian corporations demonstrate comparatively low levels of R&D funding, public-private partnerships should be strategically employed to incentivise corporate investment in R&D.[48] To achieve these aims, CSIRO and the Australian Space Agency (ASA) must collaboratively develop a joint plan that leverages the expertise of Australian SMEs in quantum and photonic technologies. This plan will streamline and focus academic and industrial R&D efforts, fostering investor confidence in the long-term viability of these markets.

While this strategy presents a higher risk - relying on developing institutional knowledge as opposed to leveraging geography - it offers greater opportunity for export and international collaboration. Furthermore, the favourable SWaP properties of quantum technology means it is easier to integrate into limited scope missions, complementing the risk tolerance of the Australian government.

## Recommendation 4: Unify Australia's Space and Antarctic Strategy, to leverage our view of the sky for space domain awareness of accumulating space debris.

Australia's locational monopoly with respect to her proximity to the southern pole, as well as her expertise in radio frequency (RF) technology, enhances the nation's sovereign capabilities in effective space domain awareness (SDA).[49] Australia can secure international support by leveraging the aforementioned and Antarctica's ideal conditions for astronomical observations—prolonged darkness, polar climate, and radio-friendly atmosphere – to strengthen SDA architecture.[50] [51] This will enhance international protection from accumulating space debris, progress the technological development of emerging radio and optical communications technology, as well as enhance global synergy and cooperation with space-dominant nations.

A promising initiative to be employed by Australia would see distributed sensor networks deployed in Antarctica to strengthen the current SDA infrastructure. Such networks would effectively monitor dynamic polar orbits that prove difficult to track by non-polar observation centres while reinforcing existing SDA architecture such as the Defence Science and Technology Group (DSTG).[52] The use of electro-optical sensors for tracking space debris also encourages compliance with the Outer Space Treaty 1967 (OST) by inducing accountability upon nations that irresponsibly use LEO and GEO.[53] By collecting and processing space debris data Australia could efficiently detect and prevent violations of the OST, greatly encouraging global cohesion in space-based activities.

Building on the prior proposal, Australia should invest in Antarctic-based ground stations for spacecraft tracking telemetry, control, and deep space communication capitalising on RF capabilities. This assists in supporting existing ground stations in collecting astronomical data to amplify SDA and extend scientific research.[54] A study published in 2016 analysed the radar capabilities of telescopes at Arecibo, Goldstone, Greenbank, Canberra and Parkes to detect near-Earth asteroids.[55] Located in the Southern Hemisphere, the DSS-43 antenna in Canberra and the Parkes Radio Telescope, in bistatic configuration, enabled high southern declination observations and their longitudinal offset allowed for tracking targets that were below the horizon at the other facilities

Additional geographical diversity is provided through the use of Tasmanian telescopes as demonstrated through a study led by the University of Tasmania.[56] This study outlined further advantages through the addition of the Southern Hemisphere telescopes in research. These included reduced uncertainty in object orbits, further object characterisation and better estimates of pole direction through sequential observations in the northern and southern hemispheres. The implementation of such electro-optical technology in a climate and geographical location like Antarctica with its aforementioned, RF-favourable conditions, would most likely mirror the advantages of the Tasmanian program while producing more informative data.

The proposed Antarctica initiative yields multifaceted benefits in the realms of technological development, the responsible use of space, and space exploration. Capitalising upon Antarctica's potential for a space observation ground segment enables Australia to insert herself into the global space community as a dominant player. Such alliances not only support Australia's technological niche in space management but also propagate the demilitarisation of the Antarctic territory by fostering a platform for responsible space operations.[57]

## Recommendation 5: The Australian Space Agency should leverage Australia's world-leading research sector to promote educational infrastructure to develop and sustain a diverse space workforce.

While Australia has a strong research base, there are significant barriers in terms of educational infrastructure and workforce development. In a survey conducted by SmartSat CRC in 2021, it was found that, of 319 skills employers deemed essential to the space industry, almost all were facing a shortage in Australia.[58] This skills shortage is a reflection of the current state of the Australian space industry; a highly research-focused industry that requires a considerable amount of experience to get involved in. Better support in secondary and tertiary institutions would work towards diversifying the industry, developing these skills, and facilitating careers in the space industry.

Australian education, both secondary and tertiary, is sorely lacking when it comes to preparing students for the space industry. Although TAFE South Australia has a focus on upskilling their students for the space industry and provides a list of "space-aligned" courses on their website,

there are currently no courses specifically designed to prepare students for a career in the space sector.[59] Australian space research could greatly benefit from more diverse workforce programs, as well as specialised and University courses. In particular, Australia has research strengths in space medicine, satellite imaging, space debris tracking and many other specialised areas. In order to capitalise on these strengths, the Australian Space Agency and Australian Government should work to establish education programs that feed into each of these areas. This may include specialisations in Bachelor's degrees (E.g. Space Medicine in MD), dedicated VET courses, and including more space-related content in the high school science curriculum.

In a speech at the Space Industry Association of Australia's (SIAA) Southern Space Symposium, Head of ASA Enrico Palermo said that "We need space apprentices. We need space tradies."[60] The ASA recognises the importance of developing industry skills, and the best way to do this is by providing support within the education system. This includes programs such as AvComm's "Space Tradie" initiative, which was created in response to Palermo's speech at the Symposium.[61] This program includes an apprenticeship, as well as "formal Vocational Education and Training", teaching participants essential skills for satellite communications maintenance.[62]

Tradies and Skilled Workers are necessarily a part of the space industry - the circuitry and wiring on satellites and rockets is extremely delicate, and must be worked on, handled and delivered by people with experience.[63] A strong educational background is essential for developing a sustainable and diverse space sector in Australia. The proposed Government-endorsed programs and initiatives within secondary and tertiary institutions will help upskill and inspire students to participate in the space industry, bringing much-needed relief to the skills shortage it currently faces.

## Recommendation 6: Expanding Funding and Grants for Australian Space Startups in Medical and Satellite Technologies.

Australia is recognised as a leader in space medicine, remote healthcare, and satellite technology. The nation has invested approximately $1.1 billion in space organisations and projects since 2019, indicating a strong foundation in the space sector. By channelling funds and grants specifically into startups that specialise in medical applications and satellite technologies, Australia can solidify its position in these niches.[64] This targeted investment can lead to advancements in telemedicine, remote diagnostics, and satellite communications, areas where Australia already has significant expertise.

Fostering these niche sectors can stimulate the growth of related industries, such as advanced manufacturing and data analytics. This approach aligns with the Australian Government's goal to grow the space sector to be worth $12 billion per annum by 2030, supporting an additional 20,000 space industry jobs.[65] Australia's leadership in remote medicine is well-established, making it a natural hub for developing space medicine technologies. The nation's capabilities in satellite technology are supported by numerous organisations and research institutions dedicated to space research.

The Australian Government has demonstrated a commitment to the space sector through various initiatives and funding programs. Adjusting existing funding allocations to prioritise medical and satellite technology startups is feasible within current frameworks. For instance, the Moon to Mars initiative provides $150 million over five years to support the Australian space sector.[66] These initiatives should target both current and future startups focused on space medicine, remote healthcare solutions, and satellite communications, fostering innovators capable of developing technologies that can operate effectively in remote or space environments. Aligning these efforts with programs like the National Reconstruction Fund can provide additional support and accelerate growth in these sectors.[67]

Australia's leadership in space medicine and satellite technology is evident in the success of startups like *Safety from Space* and *AICRAFT*, which have leveraged targeted funding to advance innovative solutions. *Safety from Space*, funded by the South Australian Space Collaboration and Innovation Fund, is developing advanced satellite communications for astronaut search and rescue operations on the lunar surface, with potential terrestrial applications in emergency communications.[68] Similarly, *AICRAFT* is creating a lightweight spacecraft equipped with artificial intelligence capabilities, enhancing data processing and analysis in orbit to improve satellite communications and Earth observation.[69] These examples demonstrate how strategic investment can accelerate technological breakthroughs, foster economic growth, and position Australia as a global leader in niche space technologies.

Australia is already recognised as a global leader in space medicine, remote healthcare, and satellite technology. By strategically prioritising startups within these fields, Australia can establish a competitive advantage in the global space industry. Supporting these niche businesses can stimulate the growth of complementary sectors, such as advanced manufacturing and data analytics, creating additional economic opportunities. By implementing this recommendation, Australia can leverage its existing strengths to build a thriving space ecosystem, driving sustained innovation, economic growth, and international collaboration.

## Conclusion

With growing global engagement and significant national investments in space, Australia's space industry faces a crucial turning point. This White Paper has outlined key challenges and opportunities that must be addressed to carve out a sustainable and competitive niche in the international space sector. Banksia has recommended these solutions to aid Australia in excelling within key space industry niches. By capitalising on her geographic advantages, Australia can establish itself as a leader in launch capabilities and space domain awareness, supporting national security and commercial operations. By investing in emerging technologies such as quantum-optical technologies will enable high-value contributions to global space exploration and communication systems. Integrating Antarctic research into Australia's space strategy presents a unique opportunity to enhance space debris tracking and deep-space communication infrastructure. At the same time, strengthening research and workforce development will ensure a pipeline of skilled professionals, while targeted funding for space medicine and satellite startups will position Australia as an innovator in critical space applications, solidifying a skilled and competitive industry. A coordinated effort across government, industry, and research institutions is essential to drive progress across these areas by committing to policy refinement, international collaboration, and strategic investment, Australia can solidify her niche and become a key player in the global space economy. If Australia is to act in this pivotal moment, we will be able to leverage our advantages to foster the development of our domestic space industry.

## Recommendations

**Recommendation 1:** Promote Australia's strategic position in the Southern Hemisphere, her stable geology and geopolitics for the development of launch facilities.

**Recommendation 2:** The Australian Space Agency should fund and support a consortium to model a sustainable lunar habitat prototype by utilising strengths in automation, materials science, and renewable energy.

**Recommendation 3:** Unify Australia's quantum and space strategy to take advantage of existing expertise and exploit synergies.

**Recommendation 4:** Unify Australia's Space and Antarctic Strategy, to leverage our view of the sky for space domain awareness of accumulating space debris.

**Recommendation 5:** The Australian Space Agency should leverage Australia's world-leading research sector to promote educational infrastructure to develop and sustain a diverse space workforce.

**Recommendation 6:** Expanding Funding and Grants for Australian Space Startups in Medical and Satellite Technologies.

# Acknowledgements

Team Banksia would like to acknowledge the immense support from several organisations and individuals within the Australian Space Industry.

We would like to begin by thanking The Andy Thomas Space Foundation, for their tremendous support of the Astra Program and for being our generous team sponsor.

We would also like to extend our sincere gratitude to all of the industry supporters whose expertise, wisdom and graciously sacrificed time allowed this white paper to come to fruition.

- **A/Prof. Matthew Richardson,** Director of Space Education Programs at iLAuNCH Trailblazer, for his valuable insight into Australia's strengths in space, a review of our preliminary white paper recommendations and his additional considerations in technological capabilities.
- **George Campbell,** Satellite Consultant and **Josh Kassulke,** Technical Consultant at Av-Comm Space & Defence, for providing their experiences in ground segment infrastructure development and insights into Australia's sovereign capabilities.
- **Michelle Keegan,** Director of Resources and Space at AROSE, for an interesting introduction into the AROSE Consortium and remote capabilities, and her valuable knowledge on lunar mining and its associated future innovations.
- **Henry Lourey,** Project Engineer at Lunar Outpost Oceania, for presenting detailed information on the Lunar Outpost Oceania Consortium, the Trailblazer Program and his support through a SWOT analysis of Australia's space niches.

We thank the Astra Program Executive Committee for voluntarily committing the time to ensure the program was executed to the highest standard and for the creation of each team's program. We also thank the Australian Youth Aerospace Association for allowing students and young professionals to increase their awareness of space-related issues.

Particular thanks goes to our enthusiastic Topic Coordinators, Jake MacKenzie Wood and Madeleine Taveira for the countless hours of time they invested into preparing, organising and presenting for Team Banksia and their unwavering guidance, engagement and support throughout the Astra Program.

# Endnotes


[1] Australian Space Agency, "Home | Australian Space Agency," https://www.space.gov.au/

[2] Australian Department of Defence, "WRESAT - Weapons Research Establishment Satellite," *Defence Science and Technology Group* (2012). https://www.dst.defence.gov.au/innovation/wresat-%E2%80%94-weapons-research-establishment-satellite#:~:text=It%20was%20launched%20at%20Woomera,research%20stations%20around%20the%20world.

[3] Bec Shrimpton, "Australia's Space Future Is at Risk, with Massive Implications," *The Strategist (Australian Strategic Policy Institute)*, (June 2023). https://www.aspistrategist.org.au/australias-space-future-is-at-risk-with-massive-implications/.

[4] Jeff Foust, "Cape Congestion: World's Busiest Spaceport Stretched to Its Limits," *SpaceNews,* (March 2023). https://spacenews.com/cape-congestion-worlds-busiest-spaceport-stretched-to-its-limits/.

[5] National Aeronautics and Space Administration, "NASA's Plan for Sustained Lunar Exploration and Development." (2020). https://www.nasa.gov/missions/artemis/nasa-australia-sign-agreement-to-add-rover-to-future-moon-mission/

[6] Garrett Shea, "NASA, Australia Sign Agreement to Add Rover to Future Moon Mission," *National Aeronautics and Space Administration* (October 2021). https://www.nasa.gov/missions/artemis/nasa-australia-sign-agreement-to-add-rover-to-future-moon-mission/

[7] Reserve Bank of Australia, "Composition of the Australian Economy Snapshot," (February 2025). https://www.rba.gov.au/snapshots/economy-composition-snapshot/

[8] Department of Industry, Science and Resources, "Australia's quantum opportunity," *National Quantum Strategy* (2023). https://www.industry.gov.au/publications/national-quantum-strategy/australias-quantum-opportunity

[9] Tokovinin, Andrei. "Exceptional astronomical seeing conditions above Dome C in Antarctica." Nature. July 29, 2020. https://www.nature.com/articles/nature02929.

[10] Sundiatu Dizon-Fyle et al., "Diversity matters even more: The case for holistic impact," *McKinsey & Company*. (December 2023). https://www.mckinsey.com/featured-insights/diversity-and-inclusion/diversity-matters-even-more-the-case-for-holistic-impact

[11] Rocio Lorenzo et al., "How Diverse Leadership Teams Boost Innovation," *The Boston Consulting Group*. (2018). https://web-assets.bcg.com/img-src/BCG-How-Diverse-Leadership-Teams-Boost-Innovation-Jan-2018_tcm9-207935.pdf

[12] Australian Institute of Health and Welfare, "Australia's Health 2024: in brief," *AIHW* 249. (2024). https://www.aihw.gov.au/getmedia/6b19e493-0ebe-420f-a9a3-e48b26aace9f/aihw-aus-249-ib.pdf?v=20240715154739&inline=true

[13] Australian Institute of Health and Welfare, "Australia's Health 2010: The twelfth biennial health report of the Australian Institute of Health and Welfare," *AIHW* 122 no. 12 (2010). https://www.aihw.gov.au/getmedia/42ab3686-c2ad-4495-b0f7-5c5e7889d46b/ah10.pdf?v=20230605153007&inline=true

[14] Marcus Birch et al., "Availability, Outage, and Capacity of Spatially Correlated, Australasian Free-Space Optical Networks," *Journal of Optical Communications and Networking*. (June 2023). https://doi.org/10.48550/arXiv.2211.09248.

[15] Equatorial Launch Australia (ELA), "The Unique Benefits of Launching from an Australian Equatorial Spaceport," (8 August 2023). https://ela.space/news/the-unique-benefits-of-launching-from-an-australian-equatorial-spaceport.

[16] Brad Jones, "Uncertainty and Risk Aversion – Before and After the Pandemic | Speeches," *Reserve Bank of Australia* (June 2, 2021). https://www.rba.gov.au/speeches/2021/sp-so-2021-06-02.html.

[17] Simon Pool, "Photonic and Quantum Technologies in Australia and New Zealand: 2024 Industry Report," *The Australian and New Zealand Optical Society* (2024). https://cdn.prod.website-files.com/61db64b3baa31805a7b020d6/66e207c333b1e63df1c4afb4_Photonic%20and%20Quantum%20Technologies%20in%20Au%20and%20NZ%20%202024%20Industry%20Report.pdf

[18] Bec Shrimpton, "Australia's space future is at risk, with massive implications," *ASPI* (2023). https://www.aspistrategist.org.au/australias-space-future-is-at-risk-with-massive-implications/

[19] Engineers Australia, "Growing and Sustaining Australia's Space Engineering Capability and Competency," (2024). https://www.engineersaustralia.org.au/sites/default/files/2024-02/Space-Policy-Advice-Paper.pdf

[20] Brett Loubert et al., "Navigating New Frontiers: Assessing the Opportunity for US Entities to Launch and Return Space Missions in Australia." *The Space Review* (16 September 2024). https://www.thespacereview.com/article/4858/1.

[21] Marcus Birch et al., "The Availability, Outage, and Capacity of Spatially Correlated, Australasian Free-Space Optical Networks," *arXiv* (2022). https://doi.org/10.48550/arXiv.2211.09248.

[22] Robert Veldhuyzen and Elena Grifoni, "No Exchange of Funds – The ESA Barter Agreements for the International Space Station," *European Space Agency* Bulletin 99 (September 1999). https://www.esa.int/esapub/bulletin/bullet99/veld99.pdf

[23] Symbios, The University of Queensland, & Earth Observation Australia Inc, "Continuity of Earth Observation Data for Australia: Risks," *Earth Observation Australia Inc* (March 2024). https://www.eoa.org.au/news/2024/4/9/continuity-of-earth-observation-data-for-australia-risks-report-released

[24] Rio Tinto, "Scania and Rio Tinto Agree to Develop Autonomous Haulage Solutions Supporting a Pathway to Lower Emissions Mining," (14 October 2022). https://www.riotinto.com/en/news/releases/2022/scania-and-rio-tinto-agree-to-develop-autonomous-haulage-solutions-supporting-a-pathway-to-lower-emissions-mining.

[25] Bec Shrimpton, "Australia's Space Future Is at Risk, with Massive Implications," *The Strategist - Australian Strategic Policy Institute*, (June 2023). https://www.aspistrategist.org.au/australias-space-future-is-at-risk-with-massive-implications/

[26] Australian Space Agency, "Statement of Intent Between Australian Space Agency and Gilmour Space Technologies," *Australian Space Agency* (December 2019). https://www.space.gov.au/about-agency/publications/statement-intent-between-australian-space-agency-and-gilmour-space-technologies.

[27] Australian Space Agency, "Australian Space Industry Capability: A Review," *Australian Space Agency* (October 2017). https://www.space.gov.au/sites/default/files/2023-11/australian_space_industry_capability_-_a_review_0.pdf.

[28] Australian Government, Space (Launches and Returns) Act 2018 (Cth), *AustLII* 2018. https://www.austlii.edu.au/cgi-bin/viewdb/au/legis/cth/consol_act/sara2018259/.

[29] Wendell W. Mendell, "Lunar Bases and Space Activities of the 21st Century," *Lunar and Planetary Institute* (1985). https://www.lpi.usra.edu/publications/books/lunar_bases/

[30] Maxim Isachenkov et al., "Regolith-Based Additive Manufacturing for Sustainable Development of Lunar Infrastructure – an Overview," *Acta Astronautica* 180 (March 2021): 650–78. https://doi.org/10.1016/j.actaastro.2021.01.005.

[31] Australian Space Agency, "Moon to Mars Initiative | Australian Space Agency," (2025). https://www.space.gov.au/moon-to-mars-initiative.

[32] Kevin Farries, "Lunar Construction – Novel Materials Production" *Andy Thomas Centre for Space Resources | University of Adelaide* (2022). https://set.adelaide.edu.au/atcsr/lunar-construction-novel-materials-production

[33] CSIRO, "Moon-in-a-room: CSIRO's new facility to advance off-planet science exploration," (December 2021). https://www.csiro.au/en/news/all/articles/2021/december/moon-in-a-room

[34] Anna Verboeket, "Photonic and Quantum Technologies in Australia and New Zealand: 2024 Industry Report," *The Australian and New Zealand Optical Society* (2024). https://cdn.prod.website-files.com/61db64b3baa31805a7b020d6/66e207c333b1e63df1c4afb4_Photonic%20and%20Quantum%20Technologies%20in%20Au%20and%20NZ%20%202024%20Industry%20Report.pdf

[35] CSIRO, "Growing Australia's Quantum Technology Industry: Positioning Australia for a four billion-dollar opportunity," *CSIRO Futures, Australia.* (2020). https://www.csiro.au/-/media/Do-Business/Files/Futures/Quantum/20-00095_SER-FUT_REPORT_QuantumTechnologyRoadmap_WEB_200518.pdf

[36] Australian Government Department of Industry, Science and Resources, "State of Australian Quantum Report 2024," (November 2024). https://www.industry.gov.au/publications/state-australian-quantum-report-2024.

[37] Nadine M. Trummer et al., "Machine learning-based classification for Single Photon Space Debris Light Curves," *Space Research Institute* (November 2024). https://arxiv.org/pdf/2411.18231

[38] Nedasadat Hosseinidehaj and Robert Malaney, "CV-QKD with Gaussian and Non-Gaussian Entangled States over Satellite-Based Channels," *IEEE Global Communications Conference.* (2016): 1-7. https://ieeexplore.ieee.org/document/7841711

[39] John A Christian and Scott P Cryan, "A Survey of LIDAR Technology and Its Use in Spacecraft Relative Navigation," *American Institute of Aeronautics and Astronautics* (August 2013). https://ntrs.nasa.gov/citations/20140000616

[40] National Research Council, "The Role of Small Satellites in NASA and NOAA Earth Observation Programs," *Washington, D.C: National Academies Press* (2000). https://doi.org/10.17226/9819.

[41] Ministry of Defence, Defence Science and Technology Laboratory and The RT Hon Maria Eagle MP, "Top secret lab develops atomic clock using quantum technology," *GOV.UK.* (2 January 2025). https://www.gov.uk/government/news/top-secret-lab-develops-atomic-clock-using-quantum-technology

[42] Australian Space Agency, "Quantum Meets Space | Australian Space Agency," n.d. [Accessed February 18, 2025]. https://www.space.gov.au/news-and-media/quantum-meets-space.

[43] Farzana I Khatri et al., "Optical Communications Operations Concept for the Artemis II Crewed Mission to the Moon," *In . San Francisco, CA* (2023). https://ntrs.nasa.gov/citations/20220010371.

[44] Marcus Birch et al., "Availability, Outage, and Capacity of Spatially Correlated, Australasian Free-Space Optical Networks," *Journal of Optical Communications and Networking.* (June 2023). https://doi.org/10.48550/arXiv.2211.09248.

[45] Khatri et al., "Optical Communications Operations Concept for the Artemis II Crewed Mission to the Moon." https://ntrs.nasa.gov/citations/20220010371.

[46] NASA, "NASA's Laser Navigation Tech Enables Commercial Lunar Exploration - NASA," n.d. [Accessed February 18, 2025]. https://www.nasa.gov/centers-and-facilities/langley/nasas-laser-navigation-tech-enables-commercial-lunar-exploration/.

[47] Ching W. Sooi, "Australia's Growing Space Agency Amid a Renewed Push to the Stars," *Australian Institute of International Affairs* (24 April 2024). https://www.internationalaffairs.org.au/australianoutlook/australias-growing-space-agency-amid-a-renewed-push-to-the-stars/.

[48] Verboeket, "Photonic and Quantum Technologies in Australia and New Zealand: 2024 Industry Report." https://cdn.prod.website-files.com/61db64b3baa31805a7b020d6/66e207c333b1e63df1c4afb4_Photonic%20and%20Quantum%20Technologies%20in%20Au%20and%20NZ%20%202024%20Industry%20Report.pdf

[49] Australian Space Agency, "Communications Technologies and Services: Roadmap 2021-2030," *Advancing Space* (December 2020): 11. https://www.industry.gov.au/sites/default/files/2020-12/communications-services-and-technologies-roadmap.pdf

[50] Jon S. Lawrence et al., "Exceptional Astronomical Seeing Conditions Above Dome C in Antarctica," *Nature* 431 (September 2004): 278-281. https://doi.org/10.1038/nature02929

[51] Australian Space Agency, "World-class Observatory to Track Space Objects," (November 2022). https://www.space.gov.au/news-and-media/world-class-observatory-track-space-objects

[52] Gongqiang Li et al., "Space Debris Observation Performance Research of CSTAR at Kunlun Station in Antarctica," *Advances In Space Research* 64, no. 8 (October 2019): 1527-1536. https://doi.org/10.1016/j.asr.2019.07.023

[53] Malcolm Davis, "Technological Dimensions of Security in Antarctica and the Southern Ocean - The Oceans, Space and Near Space," *United Service* 74, no. 1 (March 2023): 8-11. https://www.rusinsw.org.au/Papers/20220616A.pdf

[54] CSIRO, "Space: A Roadmap for Unlocking Future Growth Opportunities for Australia," *CSIRO Futures* (2018): 13. https://www.csiro.au/-/media/Do-Business/Files/Futures/18-00349_SER-FUT_SpaceRoadmap_WEB_180904.pdf

[55] Shantanu P. Naidu et al., "Capabilities of Earth-based Radar Facilities for Near-Earth Asteroid Observations," *The Astronomical Journal* 152, no. 4 (October 2016): 99. https://iopscience.iop.org/article/10.3847/0004-6256/152/4/99/meta

[56] Oliver J. White et al., "Development of Radar and Optical Tracking of Near-Earth Asteroids at the University of Tasmania," *MDPI* 17, no. 3 (January 2025): 352. https://doi.org/10.3390/rs17030352

[57] "The Antarctic Treaty." U.N.T.S. 71 (December 1959): 402. https://documents.ats.aq/recatt/att005_e.pdf

[58] National Science and Technology Council, "Rapid Response Information Report," *Space Industry and the STEM Workforce* (July 1st, 2021). https://www.chiefscientist.gov.au/sites/default/files/2021-09/Rapid%20Response%20Information%20Report%20-%20Space%20Industry%20and%20the%20STEM%20workforc....pdf

[59] tafeSA, "Innovation and Emerging Technologies," [Accessed February 12th, 2024]. https://www.tafesa.edu.au/industry/innovation

[60] Australian Space Agency, "Southern Space Symposium: speech by Enrico Palermo," (6 December 2021). https://www.space.gov.au/news-and-media/southern-space-symposium-speech-enrico-palermo

[61] Av-Comm Space and Defence, "Av-Comm's Space Tradies Program," [Last modified 28 August, 2024]. https://avcomm.com.au/av-comms-space-tradie-program/

[62] Av-Comm, "Av-Comm's Space Tradies Program." https://avcomm.com.au/av-comms-space-tradie-program/

[63] Swinburne University of Technology, "Give me some space tradies," (16 February 2022). https://www.swinburne.edu.au/news/2022/02/Give-me-some-space-tradies/

[64] Australian Government Business, "Moon to Mars Supply Chain Capability Improvement Grants - Grant Recipients," [Accessed February 12 2025]. https://business.gov.au/grants-and-programs/moon-to-mars-supply-chain-capability-improvement-grants/grant-recipients

[65] Australian Communications and Media Authority (ACMA), n.d. *Official Website of the Australian Communications and Media Authority*, [Accessed February 12, 2025]. https://www.acma.gov.au.

[66] Australian Space Agency, "Moon to Mars initiative: Launching Australian industry to space," (16 February 2021). https://www.space.gov.au/news-and-media/moon-mars-initiative-launching-australian-industry-space

[67] Department of Industry, Science and Resources, "National Reconstruction Fund: diversifying and transforming Australia's industry and economy," (27 October 2022). https://www.industry.gov.au/news/national-reconstruction-fund-diversifying-and-transforming-australias-industry-and-economy

[68] Simon Thomsen, "Two Space Startups Score $100,000 Each from a New South Australian Government Fund," *Startup Daily* (September 2024). https://www.startupdaily.net/topic/funding/two-space-startups-score-100000-each-from-a-new-south-australian-government-fund/

[69] Thomen, "Two Space Startups Score $100,000 Each from a New South Australian Government Fund." https://www.startupdaily.net/topic/funding/two-space-startups-score-100000-each-from-a-new-south-australian-government-fund/

[24] ELA, "The Unique Benefits of Launching from an Australian Equatorial Spaceport," (2023). https://ela.space/news/the-unique-benefits-of-launching-from-an-australian-equatorial-spaceport.

[25] Birch et al., "Availability, Outage, and Capacity of Spatially Correlated, Australasian Free-Space Optical Networks," (June 2023). https://doi.org/10.48550/arXiv.2211.09248.

[26] ELA, "The Unique Benefits of Launching from an Australian Equatorial Spaceport," (2023). https://ela.space/news/the-unique-benefits-of-launching-from-an-australian-equatorial-spaceport.

[27] Jones, "Uncertainty and Risk Aversion – Before and After the Pandemic | Speeches," (2021). https://www.rba.gov.au/speeches/2021/sp-so-2021-06-02.html.

[28] Simon Pool, "Photonic and Quantum Technologies in Australia and New Zealand: 2024 Industry Report," *The Australian and New Zealand Optical Society* (2024). https://cdn.prod.website-files.com/61db64b3baa31805a7b020d6/66e207c333b1e63df1c4afb4_Photonic%20and%20Quantum%20Technologies%20in%20Au%20and%20NZ%20%202024%20Industry%20Report.pdf

[29] Ben Shrimpton, "Australia's space future is at risk, with massive implications," *ASPI* (2023). https://www.aspistrategist.org.au/australias-space-future-is-at-risk-with-massive-implications/

[30] Engineers Australia, "Growing and Sustaining Australia's Space Engineering Capability and Competency," (2024). https://www.engineersaustralia.org.au/sites/default/files/2024-02/Space-Policy-Advice-Paper.pdf

[31] Brett Loubert et al., "Navigating New Frontiers: Assessing the Opportunity for US Entities to Launch and Return Space Missions in Australia." *The Space Review* (16 September 2024). 'https://www.thespacereview.com/article/4858/1.

[32] Marcus Birch et al., "The Availability, Outage, and Capacity of Spatially Correlated, Australasian Free-Space Optical Networks," *arXiv* (2022). https://doi.org/10.48550/arXiv.2211.09248.

[33] Robert Veldhuyzen and Elena Grifoni, "No Exchange of Funds – The ESA Barter Agreements for the International Space Station," *European Space Agency* Bulletin 99 (September 1999). https://www.esa.int/esapub/bulletin/bullet99/veld99.pdf


Astra AYAA

Astra Program 2025