A Prosperous Future: Space

Space industry opportunities for Australia and the United States.

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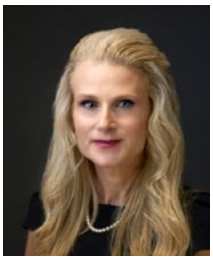
Foreword

The pursuit of space in many ways defines the human spirit. Exploration and discovery, risk-taking and perseverance, uncertainty and courage. Space is the ultimate representation of aspiration for people and nations.

DOUG FERGUSON
NSW Chairman, Head of Asia & International Markets
KPMG Australia



APRIL PALMERLEE
Chief Executive Officer
AmCham Australia

In its infancy, space was the exclusive purview of the superpowers. But through a decades-long journey, Australia has proven to be an integral and reliable partner for the United States.

The initial Australian space station was established in Woomera, South Australia; it was the first of seven space stations established in Australia during the 1960s. From Honeysuckle Creek, near Canberra, the vision of Neil Armstrong on the Moon was beamed to the world, connecting Australia to the historic moment that would continue to inspire us for decades.

In an era of immense change and challenge – in the 1960s as well as today – we make the choice to explore space, as President John F. Kennedy said, "Not because it is easy, but because it is hard." And yet, the atmospheric peak is becoming relatively easier to climb. Technology is advancing at unparalleled speeds, and in turn, barriers to entry are decreasing quickly. The exclusive domain of superpowers and governments no more, space today is an arena open to startups and scale-ups, as well as countries and corporations.

Expanded economic opportunity attracts additional actors across a range of sectors, which can make space congested, contested, and competitive. This new era demands a new covenant of cooperation. Australia and the United States are natural partners with joint knowledge, shared interests, similar cultures and a strong alliance.

The 2023 International Air Show at Avalon broke all previous records. All 50,000 people and 800 companies descended on Victoria for several days, including more than 100 US companies showcasing the latest in American innovation in Australia.

Enterprise and innovation are the launch pads for the Australian space industry. Free and open trade and investment between Australia and the United States provides economic opportunities for new and emerging space industries including smarter satellites, rare earth elements, scientific research, and even tourism.

Visits to Australia in 2023 by NASA Administrator Bill Nelson and Deputy Administrator Colonel Pamela Melroy, and engagement with AmCham signal increased agency-to-industry recognition and cooperation between the United States and Australia in this decisive decade in space.

AmCham Australia and KPMG Australia thank Fleet Space Technologies and Space Centre Australia for their consultation on this report.

Our sincere thanks to our colleagues Sara James and Josh Edwards from AmCham, and Daniel Bahyl, Dr Brendan Rynne, Dr Merriden Varrall, and Julie Bever from KPMG for their contributions towards this report series.

Australia's enduring partnership with the United States on space spans over 60 years. Australia has assisted in almost every US space exploration mission. Our role in broadcasting the Apollo 11 Moon landing to the world is the stuff of folklore.

The establishment of the Australian Space Agency in 2018 opened the door to new opportunities for this great legacy of space collaboration. Many of the Agency's significant achievements have been reached alongside the US, reflecting the strength of the relationship. For example, Australia being one of the original eight signatories of the Artemis Accords demonstrates our shared vision and values regarding space exploration and the importance of space bringing benefits to Earth.

The Australian space sector continues to grow and evolve. Despite significant economic challenges experienced globally following the COVID-19 pandemic there have been new private investment rounds, new partnerships domestically and internationally, technology maturing rapidly and new career opportunities.

Australia has embraced the commercial reality that space is no longer just the domain of governments. This is why Australia is actively pursuing a Technology Safeguards Agreement (TSA) with the US. A TSA is critical for enabling US launch providers to launch from Australia. As a result, this aims to open the door for a regular cadence of US launches which will provide new market opportunities and uplift the entire Australian space sector.

This activity is just one example of collaborative activities we are undertaking with the US to open markets and signal great commercial opportunity for our industries as the global space sector expands.

Australia's $150 million Moon to Mars Initiative under the flagship Trailblazer program will see an Australian built rover launched on a NASA mission to the Moon by 2026, further cementing this strong relationship. Trailblazer and the Moon to Mars program have created an ongoing momentum in our sector by catalysing opportunities for Australian industry to enter international supply chains.

Space is an international endeavour and an industry built on strong partnerships. These foundational relationships, agreements and activities we embark on now will shape the Australian sector for the next decade and beyond.

Any great partnership is founded on a shared vision. We look forward to working closely with the United States, as well as our other international partners, to accelerate the growth of the global space ecosystem and create jobs within our local workforces. This vision will be achieved sustainably and with national wellbeing in mind, so people on Earth can benefit from the technological advancements within the space sector now and into the future.

ENRICO PALERMO
Head of the Australian Space Agency

Report foundation

As outlined in KPMG's 2021 introductory report, *A Prosperous Future: Key industries for Australia/US collaboration*, in consultation with the Australian Department of Foreign Affairs and Trade, and the US Embassy in Australia, AmCham and KPMG identified six emerging industries will be key to the future of the US-Australia economic relationship: artificial intelligence, biotechnology, digital economy, energy and clean technology, quantum computing, and space. This report focuses on the space industry.

Executive summary

This report provides a state of play for the fast-moving world of the space industry. We offer insight and analysis regarding how Australian businesses can best participate in and profit from this technological renaissance.

Space is a key industry where the United States and Australia align when it comes to economic, security, and geopolitical considerations and where shared values and common interests deepen cooperation. This strategic alignment in combination with economic opportunities incentivises the private sector as well as the federal and state governments to explore deep collaboration in this industry into the future.

The United States requires international partnerships to expand its space industry and is actively looking to invest and partner with Australian space companies. To take advantage of these opportunities, Australia can leverage its natural and structural advantages, strong foundations in many areas of the space industry, and the relationship with the United States to realise the significant potential benefits from engagement in the space industry.

Australia's unique comparative advantages in certain areas of the space industry provide the United States with access to innovation, diversified supply chains, and reduction in cost of participation.

The space industry presents increasing opportunities for Australia. The Australian Space Agency targets to grow the size of the sector to AU$12 billion and create 20,000 new space jobs by 2030, with some of this growth likely to be driven by US investment.

> *KPMG modelling for this report indicates that by achieving accelerated growth in space industry trade directly with the United States, Australia could generate US$394 million in exports, US$434 million in incremental capital investment and more than 1,300 Australian jobs within 10 years.*

Table 1: Trade scenario estimates between Australia and the United States, 2020

	SPACE INDUSTRY
Australian exports to US 2020	US$94 million
% of US domestic industry revenue	0.05%
Projected Australian exports to US 2030	
Scenario 1: 'business as usual' – current market share	US$157 million
Scenario 2: continued historical export growth	US$247 million
Scenario 3: accelerated	US$394 million

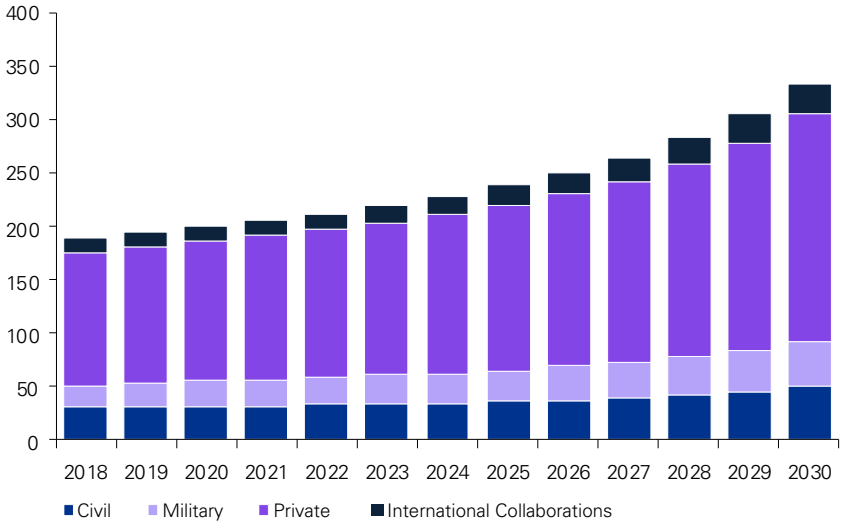
Source: KPMG analysis

In addition to export trade opportunities, further benefits will flow to Australia's domestic economy with greater uptake of space technologies, ranging from satellite communications to improved Earth observations in agriculture and mining.

In the United States, the private sector is the largest contributor to revenue in the space industry (Figure 1) and space technology has a wide range of applications across many industries (Figure 2), demonstrating that commercial applications are driving development of the industry.

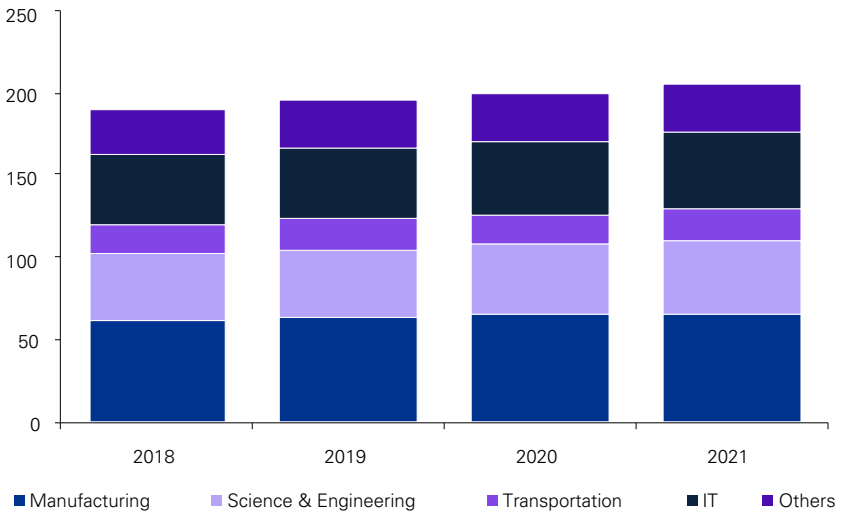
The size of the US space industry, measured in revenue terms, is expected to grow by 67% over the decade 2020-2030 from US$201 billion to US$335 billion, suggesting a large potential for Australian businesses to participate in the US space sector's supply chains.

Figure 1: US space industry revenue, by type of business, 2018-2030 (US$b)



Source: Grand View Research, KPMG analysis, 2022

Figure 2: US space industry revenue, by end use/application (US$b)



Cooperation is critical to the future of space

Space is accelerating innovation and driving positive social, environmental, and economic impacts. Its contribution to the future global economy is expected to substantially increase, with over 7,000 functioning satellites in orbit forecast to rise to tens of thousands over the next decade. The application of space technology to the economy is broad, ranging from Earth observation for mitigating climate change, imagery for agriculture, improved navigation and communications and the various industries that benefit from these. Economic opportunities also exist beyond orbital boundaries on the Moon, asteroids, and Mars.

Decades of US-Australia cooperation has promoted the peaceful use of space to be an effective global public good which serves the interests of humanity and the planet. Both countries are advocating for a robust system of norms and rules to create a space ecosystem that is resilient to natural hazards, cyber, and physical threats.

Aligned thinking between Australia and the United States, and wider partners and allies, on how to invest in establishing collaborative norms is a critical part of helping ensure security and keeping economic opportunities open. The Artemis Accords – which promote the responsible and sustainable use of space, signed in 2020 by the United States, Australia, and 19 other countries – are one demonstration of the leadership our countries are playing in this area.

The benefits of success

KPMG modelling has examined the potential growth in Australian space sector industry exports to the US, capital investment from the US and new highly skilled Australian space sector jobs created (Table 2). This considers the direct economic opportunities with the US space market alone, it does not estimate broader and indirect economic benefits or capture Australian space exports to other global markets.

Table 2: Incremental capital stock and labour force required to meet trade-uplift scenarios, 2030

	CAPITAL STOCK (2022)	FTE
Scenario 1: 'business as usual' – current market share	US$173 million	525
Scenario 2: continued historical export growth	US$272 million	825
Scenario 3: accelerated	US$434 million	1,315

Source: KPMG analysis

KPMG summarises the potential value of Australian exports to the US as a share of US domestic industry revenue, under three scenarios:

- The first scenario applies Australia's historical share of trade to the US space industries. Australia maintains a small share of the total US industry size, despite a significant increase for Australia's exports.
- The second scenario uses historical average growth rate of Australian aerospace exports to the United States.
- The third scenario assumes Australia can increase its share by combining the growth rates derived from scenarios 1 and 2. This represents growth in Australia/US trade due to increased exports in defence and security-related goods.

Getting this right could be a game changer for Australia. This highlights the export potential provided by the large US market, which will be further facilitated by close security ties.

Achieving accelerated growth could also directly result in US$434 million in incremental capital investment and around 1,300 specialised, high-paid jobs by the end of the decade.

Australia's economy will benefit beyond its increased exports to the United States. There will be additional indirect economic benefits. Greater penetration of the space industry to Australia's domestic economy will boost productivity and output, just as it has in the United States. Achieving this depends on both industry and government working cooperatively to maximise the opportunities that are presenting with ever stronger economic and security relationships. Governments have significantly increased their investment in space, with public funding for space increasing by nearly 20% in 2021 alone.

For the private sector to take advantage of this increased focus, this report identifies three factors for success:

01

Leverage Australian specialisations for space technology applications

Where Australia has a known technological advantage or sector expertise that is augmented with innovations in space technology, this can provide an innovation that the US market could welcome. Areas where Australia has strong foundation and reputation include:

- resources sector
- remote operations and robotics
- quantum science.

02

Working with US primes is a pathway into global supply chains

Most of the leading aerospace primes from the United States have a significant presence in Australia. The primes benefit from having a broad industrial base which forms their supply chain, both in the United States and for their Australian entities and a number of Australian companies have benefited from integrating with and supplying these primes. Additionally, companies that supply the primes often benefit from increased access to export, coaching and additional opportunities to qualify and flight test their hardware and software.

03

Accelerate the time taken from policy to procurement

Many Australian companies are waiting on space programs which have been announced though funding not yet available. The move from grants to contracted programs such as the National Space Mission for Earth Observation will enable capabilities to scale much faster and be export ready.

Glossary of terms

Space industry

The space industry is composed of the full range of technological, manufacturing and operational activities, as well as the use of natural resources, that create value, foster new discoveries, and provide benefits to human beings while exploring, understanding, managing, and utilising the realms beyond Earth's atmosphere.

Contents

01. Introduction 12

1.1 Purpose of study 14

1.2 Introduction to American Chamber of Commerce in Australia (AmCham) and KPMG 14

1.3 Report structure 14

02. Geopolitics of space 15

2.1 Space for wellbeing 16

2.2 Arcs of competition 16

2.3 Australia-US cooperation for the future of space 17

2.4 Conclusion 18

03. Space industry 19

3.1 Definition and main activities 20

3.2 Activities, products, and services 21

3.3 Relative importance to US economy and the United States 23

3.4 Australia's capacity to participate in the value chain 28

04. Australia's export potential to the United States 39

4.1 Advice for businesses expanding to the US market 40

4.2 Estimated trade uplift for increasing US engagement 41

4.3 Investment and employment implications 46

Appendices 47

Appendix A: Supplementary industry information 48

Appendix B: Prominent US businesses in the space industry 49

Appendix C: References 51

Introduction

01. Introduction

The desire to live better tomorrow than today is rapidly driving demand for solutions from emerging technology such as the space industry.

As outlined in KPMG's 2021 introductory report, *A Prosperous Future: Key industries for Australia/US collaboration*, in consultation with the Australian Department of Foreign Affairs and Trade, and the US Embassy in Australia, AmCham and KPMG identified six emerging industries that will shape the living standards of our citizens and drive the strategic competition between states: artificial intelligence, the digital economy, quantum science, biotechnology, energy and clean technology and the space industry. In September 2022, KPMG released *A Prosperous Future: Emerging tech*, the first of our report series, that explored opportunities for US and Australian technology partnerships in artificial intelligence (AI), quantum science and the digital economy.

This report explores the space sector. The pace and scale of change in our world is immense. Factors rapidly driving demand for solutions from the space industry include better connectivity in rural and remote areas, remote sensing data to improve business decision-making and monitor and manage climate change, a widely shared vision of space science and the benefits of exploration and human spaceflight, and the critical enabler space capabilities offer for our defence and national security. In the context of global economic uncertainty, vast technological change and expanding missions to the Moon, Mars, and beyond, the space sector is likely to play a leading role in ensuring the prosperity and security of current and future generations. As such, it is already fundamentally important and will become even more so in global trade, investment and broader economic development.

In keeping with the previous report, this report explores the industry's current state in the United States and Australia. This includes market size estimates, key companies, startups, how the technology has been adopted by various end-use industries and a supply chain analysis. The outlook for the space industry and its potential impact are also discussed. To identify potential opportunities for Australia to participate in the US supply chain, Australia's strengths in the space industry are assessed against the level of openness to the technology in the United States.

To understand the export potential for Australian businesses in the space industry, AmCham and KPMG consulted with space industry companies who have succeeded in generating new business in the US and Australian markets.

The report also examines the elements in assessing the future export growth potential for Australia in the space industry. Leveraging Australia's strengths and aligning them to the opportunities in the United States has the potential for a significant uplift in the already strong trade relationship between Australia and the United States.

01. Introduction

1.1

Purpose of study

AmCham and KPMG have undertaken a detailed assessment of the current and future growth potential of the space industry. The purpose of this study was to gain an understanding of how trade and investment between Australia and the United States in this sector could enable better outcomes for the two countries as opposed to 'doing it alone'.

1.2

Introduction to American Chamber of Commerce in Australia (AmCham) and KPMG

The American Chamber of Commerce in Australia (AmCham) was founded in 1961 and now has offices in Sydney, Melbourne, Perth, Brisbane, Adelaide and Canberra. AmCham aids US and Australian companies by promoting trade, commerce and investment to and from Australia.

KPMG is a global network of professional services firms providing audit, tax and advisory services. We operate in 144 countries and territories and in FY22 had close to 236,000 people working in member firms around the world. In Australia, KPMG has a long tradition of professionalism and integrity, combined with our dynamic approach to advising clients in a digital-driven world. We have approximately 10,000 people, including over 600 partners, with offices around the country.

1.3

Report structure

The remainder of this report has been organised into the following sections:

- **Section 1** (this section) has defined the purpose and the structure of this report
- **Section 2** describes the context on the geopolitical landscape
- **Section 3** explores the space industry in the United States and Australia
- **Section 4** assesses the future export growth potential for Australia in the space industry
- **Section 5** discusses economic benefits of achieving improved trade between the two countries
- **Appendix A** presents supplementary information on the space industry
- **Appendix B** lists the most prominent US businesses in the space industry
- **Appendix C** provides a bibliography list of references

Geopolitics of space

02. Geopolitics of space

Space technologies are integral to our everyday lives in the 21st century. The sophistication and pace of adoption present a myriad of opportunities to deliver positive impacts. However, in a future of polycrisis, characterised by rising competition and volatility, this positive potential also has many risks.[1]

As politics becomes more contested, so does space, given its increasing use as a tool for pursuing pre-eminence in strategic rivalries. In this uncertain geopolitical future, strengthening strategic cooperation between the United States and Australia could lead developments for the positive use of space, benefiting not only our two countries, but planetary wellbeing[i] and prosperity.

2.1

Space for wellbeing

Space has the potential to drive positive social, environmental, and economic impacts. Satellite communications enable ubiquitous connectivity, Earth observation provides geospatial data for multiple uses including agricultural management, climate monitoring, disaster relief, and monitoring infrastructure and trade routes, and financial services.

Space's contribution to the future global economy is expected to substantially increase. There are over 7,000 functioning satellites in orbit, forecast to rise to tens of thousands over the next decade as the number of commercial companies and participating countries rise.[2] This dramatic growth is the result of more affordable launch, miniaturisation, and a shift away from vertical integration into government programs.

Economic opportunities also exist beyond orbital boundaries, that is, on the Moon, asteroids and to Mars. Future in-space sectors[ii], including in situ resource utilisation, tourism, science, and manufacturing, have the potential to deliver major strategic and technological advantages. Combined with advanced robotics, these developments will lead to the manufacture of new materials, creation of more effective medicines, and improvement in semiconductor quality – the fundamental building blocks of our world.[3]

2.2

Arcs of competition

However, just as there is significant positive potential in space, rising geopolitical competition on Earth brings significant risks to how developments in space play out. Competition in space is being shaped by fragmentation and great power rivalry, and has the potential to reshape the global power map. Adversaries which seek to exploit reliance on space and monopolise technologies and services for their own advantage might limit the geopolitical advancements of others.

Space is also recognised as a potential warfare domain. The increasing militarisation of space and the development of counterspace technologies is evolving rapidly. Space can be and is already being used as a tool of statecraft for enhanced surveillance and espionage.[4]

i Planetary wellbeing is a state where the integrity of Earth system and ecosystem processes remains unimpaired to a degree that species and populations can persist to the future (Planetary well-being | Humanities and Social Sciences Communications (nature.com))

ii Space is typically divided into four operational segments: 'ground' – launch, operations centres, antennae; 'link' – communications to and from satellites; 'in-space' – any infrastructure or assets in orbit or beyond); and 'user'. There are three levels of orbit grouped by distance from Earth: 'low Earth orbit' (LEO), 'medium Earth orbit' (MEO) and 'geostationary orbit' (GEO).

02. Geopolitics of space

Whilst the Outer Space Treaty prohibits nuclear weapons in space, it does not address conventional weapons, creating an acute escalatory risk. The US and Australia have demonstrated leadership of what constitutes safe and responsible space activities by banning direct-ascent anti-satellite missile tests. However, the rapid development of non-kinetic energy weapons[iii] will intensify the use of space as a potential war-fighting domain, changing how weapons are used in and from space.

Adding to the complexity, space is no longer the sole domain of nation-states with the private sector able to access space for commercial programs. Commercial space companies have capability across the value chain including design, manufacture, launch, operations, and downstream applications. There are many areas where terrestrial rivalries are already being transferred into the realm of space including competition for geography where in-space resources and minerals can be exploited. The expanding use of space by private actors for commercial purposes and innovation intensifies the existing contention around policies and regulations regarding how space should be managed and by whom.

Both Australia and the United States[5] are advocating for a robust system of norms and rules to create a space ecosystem that is resilient to natural hazards, cyber, and physical threats.[6] The proliferation of space technologies, coupled with the dual-use nature of space for both commercial and military purposes, will not only reflect, but also further intensify existing competition.

With the broad adoption of space norms and regulations remaining low, trust between actors is paramount. However, the current geopolitical context means that trust in general, as measured by the Edelman Trust Barometer, is lower than it has ever been.[7] Trust is central to cooperative progress and stability in space and must be reinforced by voluntary norms of conduct. Mistrust, and different views on how the use of space should be regulated and governed, limits the collective ability to keep up with and manage technological advances and geopolitical competition.

Such fragmentation would compromise the development of beneficial space activities, which require shared international norms to function[8] as competing blocs would harden their positions to protect strategic advantages by developing parallel and counter-productive space policies and activities.

2.3

Australia-US cooperation for the future of space

For space to be an effective global public good which serves the interests of humanity and the planet, its governance must be built on cooperation. Aligned thinking between Australia and the United States, and wider partners and allies, on how to invest in establishing collaborative norms is a critical part of helping ensure security and keeping economic opportunities open.

In early 2023, governments around the world agreed to cooperate to govern and protect 30% of international waters, up from 1%. The legally binding United Nations treaty took almost two decades to finalise, but ultimately, major actors chose to cooperate for the benefit of the planet and the continued prosperity of humankind, despite divergent views and interests. In addition, the Artemis Accords – which promote the responsible and sustainable use of space, signed in 2020 by the United States, Australia, and 19 other countries – are one demonstration of the leadership our countries are playing in this area.

iii A non-kinetic energy weapon inflicts harm through the emission of different forms of radiation or sound, diffusion of chemical or biological agents or transmission of electricity, rather than the application of kinetic energy possessed by a fragment, bullet or other projectile (Past projects – The Geneva Academy of International Humanitarian Law and Human Rights (geneva-academy.ch)).

02. Geopolitics of space

2.4

Conclusion

The United States and Australia have had a long history of space cooperation. Below is a timeline of key events demonstrating the cooperation and public-private partnership in the space sector across the two countries.

1967

Signing of the peaceful uses of outer space treaty and other space treaties

1969

Beaming of the Moon landing

1984

Australian and American astronauts

2020

Joint signing of Artemis Accords

2022

Australia announces support to Artemis Moon/Mars Mission (semi-autonomous lunar rover)

2022

NASA sounding rocket launches from the Arnhem Space Centre in the Northern Territory, run by Equatorial Launch Australia – the first commercial launch partnership NASA has ever made

2023

NASA Admin visit and deliverables

2023

Australian Space Agency and NASA Jet Propulsion Laboratory announce launch of National Indigenous Space Academy

This is the kind of cooperation we need to see in space – but we do not have 20 years to achieve it. Australia and the United States can lead progressive momentum by deepening cooperation and investment across commercial, civil, and national security sectors. Strategic and technological priorities should be developed in cooperation with partners striving for shared prosperity, security, and scientific endeavour.

3.

Space industry

03. Space industry

3.1

Definition and main activities

Since the first satellite Sputnik 1 was launched in 1957, an increasing number of countries have contributed to the development of space-related technologies. Renewed government priorities and the accelerated growth of the commercial sector have driven significant progress and innovation in the global uses, and development, of space technologies across the industry.

While there is no single internationally recognised definition of the space sector, this study adopts the definition provided by the Organisation for Economic Cooperation and Development (OECD) as "all actors involved in the systematic application of engineering and scientific disciplines to the exploration and utilisation of outer space, an area which extends beyond the Earth's atmosphere". [10]

Sixty-five years of space exploration has led to substantial and ongoing scientific and technological progress.

This can be understood by grouping significant advancements into the following 'space eras':[9]

Table 3: The evolution of space activity

SPACE 1.0	This era is characterised by the first discoveries of shapes from outer space, their movement, and mechanics. The light emitted from these objects was used as a navigation tool.
SPACE 2.0	Political rivalry during this period led to substantial investment into the area to establish technological superiority and to strengthen national security. This period heavily influenced major accomplishments in the sector, such as the Apollo era, and formed the foundation for initiating a legal framework for outer space activities.
SPACE 3.0	This space era is characterised by the formation of the International Space Station (ISS), a multinational collaborative project that includes the USA, Russia, Japan, Canada and Europe.
SPACE 4.0	Represents the next chapter in space-related activities, following the initial phases of exploration. This space era is characterised by the growing number of space actors, ranging from governments to commercial entrepreneurs, who harness the potential of present-day technologies to participate and engage in space activity.

Source: Bohlmann & Petrovici (2019)

03. Space industry

3.2

Activities, products, and services

The space sector is built upon decades of space operations via national space programs and commercial enterprise. It can be divided into three areas:

Table 4: Defining the main areas of space industry

AREA	SCOPE	ACTIVITIES
Upstream space	Scientific and technological foundations of space programs, manufacturing and production of space infrastructure	Fundamental and applied research; scientific and engineering support; dedicated ancillary services (e.g. insurance); supply of materials and components; design and manufacturing of space equipment and subsystems; integration and supply of full systems; space launch
Downstream space	Daily operations of space infrastructure and 'down-to-earth' activities that directly rely on the provision of a space capacity (satellite technology, signals or data) to exist and function	Operations of space and ground systems; supply of consumer market devices, products, and services
Space-derived activities in other sectors	New activities in various economic sectors that derive from or have relied on space technology transfers	Activities, products, and services derived from space technology, but not dependent on it to function

Source: OECD Handbook on Measuring the Space Economy, 2nd Edition (2022)

Table 5: Activities and capabilities across the space sector

AREA	ACTIVITIES
Space manufacturing	Launch vehicles and subsystems, satellites/payloads/spacecraft and subsystems, ground segment systems and equipment, material and component suppliers, engineering support, test facilities
Space operations	Launch, brokerage services, satellite operation, ground segment operation, ground station networks, in-orbit servicing, debris removal, space tourism and spaceports, space surveillance and tracking, in-space manufacturing
Space applications	Direct-to-home broadcasting, fixed satellite and mobile satellite communication services, processors of satellite data (e.g. EO), terrestrial applications leveraging satellite signals (e.g. GPS), quantum computing and encryption
Ancillary services	Legal, professional, and financial services, launch and satellite insurance, software and data services, business incubation and development, policy, and regulation

Source: KPMG research

03. Space industry

According to the Space Foundation, the value of the global space economy reached US$469 billion in 2021.[11] Revenue and investment in the industry was primarily driven by the private sector. However, the sector has also been receiving support from the government sector, with government spending on space-related activities having increased by nearly 20% in 2021. This includes an increase of 18% in government spending in the United States, 23% in China and 36% in India.

The satellite industry, a subset of the space industry, is estimated to be valued at nearly US$386 billion in 2021.[12] The sector is comprised of satellite services, satellite manufacturing, ground equipment and launch industries.

These industries provide essential data and services used in day-to-day activities including banking, mapping services, and internet access. Data can also be used to inform weather forecasting, emergency management and planning.

The sector includes both public and private establishments that manufacture and provide space-related products and services. These products and services range widely from research and development, to the manufacture and use of ground stations, launch vehicles and satellite navigation equipment. As shown in Table 5 below, ground equipment contributes more than half (US$142 billion) to the global space sector revenue, followed by satellite services at 42.2% (US$118 billion), satellite manufacturing at 4.9% (US$13.7 billion) and the launch industry at 2% (US$5.7 billion).

Table 6: Global satellite sector – a subset of the global space industry, 2021

TOTAL SPACE INDUSTRY (US$469 BILLION) | TOTAL SATELLITE INDUSTRY (US$386 BILLION)				
	SATELLITE SERVICES	GROUND	SATELLITE MANUFACTURING	LAUNCH INDUSTRY
REVENUE	**$118b**	**$142b**	**$13.7b**	**$5.7b**
TOP REVENUE SOURCES	Consumer: $98.4b	GNSS equipment: $109.7b	Commercial communications: $11.2b	Commercially procured launches: US ($2.0b) and non-US ($3.7b)
	Enterprise: $17.2b	Consumer equipment: $17.3b	Remote sensing: $1.2b	
	Remote sensing: $2.7b	Network equipment: $14.7b	R&D: $0.5b	
			Military surveillance: $0.3b	

Source: Satellite Industry Association (2022)

03. Space industry

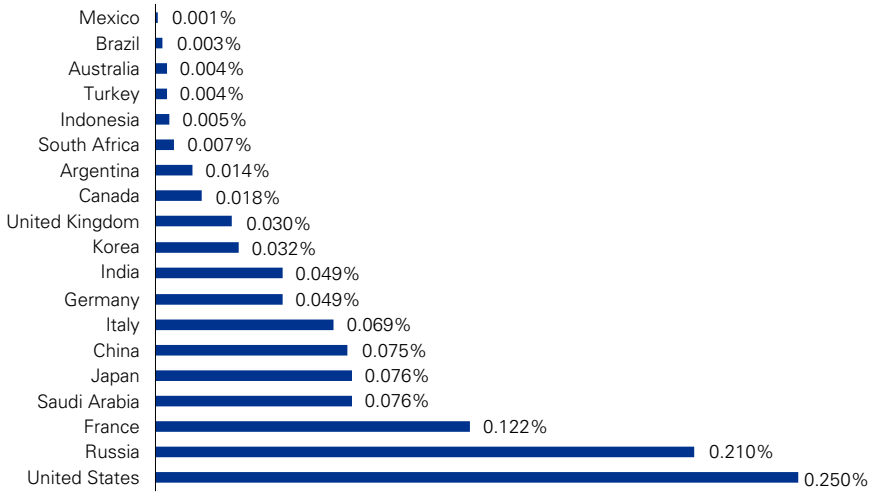
3.3

Relative importance to US economy and the United States

3.3.1 Current state and notable players

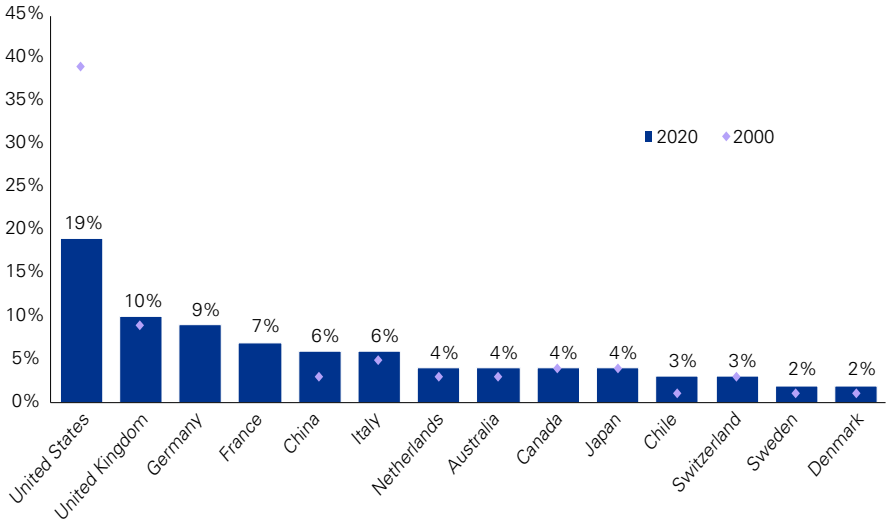
The United States is a world leader in the space sector and has the largest space program in the world. The program is made up of several civilian organisations led by the National Aeronautics and Space Administration (NASA), and by military organisations, including the United States Space Force, United States Space Command and National Geospatial-Intelligence Agency (NGA). The United States ranks first among all countries in terms of the size of government space budgets. In 2020, the US space budget was equivalent to 0.25% of GDP, which is more than three times the size of China's space budget.[13]

Figure 3: Government spending in the space sector, as a share of GDP



Source: OECD (2021)

Figure 4: Share of top 10% most cited publications in space literature



Source: OECD (2021)

Over the last two decades, the United States has dominated academic research in the space industry. In 2000, almost 40% of highly cited scientific papers were published in the United States.[14] While this proportion has fallen as the globalisation of space research has increased, the United States continues to rank first in terms of share of highly cited scientific papers in the OECD space literature. In 2020, nearly one in five highly cited scientific papers originated from the United States.[15]

03. Space industry

The government plays a pivotal role in the US space sector with world renowned organisations such as NASA or Sandia National Laboratories taking charge of research and development. The US Government also plays a significant role in providing foundational contracts to commercial companies such as SpaceX and Lockheed Martin. Examination of Figure 5 and Figure 6 is revealing. While the private sector dominates the US space industry having generated US$134.4 billion in revenue in 2021, most of the US sector is underpinned by government contracts to private companies. The civil, military and cross-country initiatives make up 35% of the US space industry. A list of major space organisations in the United States is presented in *Appendix B*.

Figure 5: US space industry revenue, by type of agent, 2019-2021 (US$b)

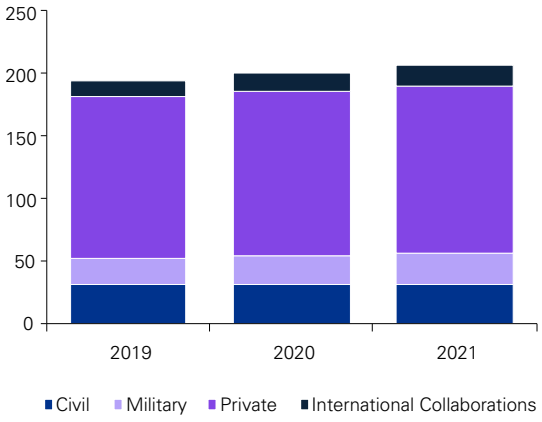
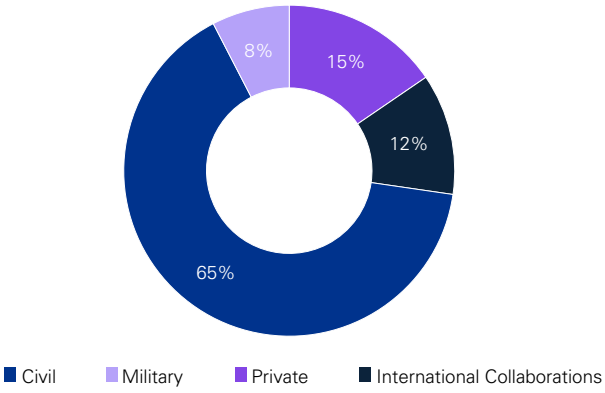


Figure 6: US space industry market share, by type of agent, 2020



Source: Grand View Research, KPMG analysis, 2022

3.3.2 Space industry adoption by industry

Figure 7: US space industry revenue, by end use/application (US$b)

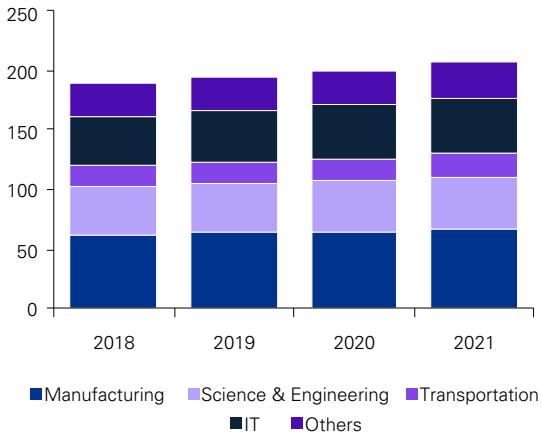
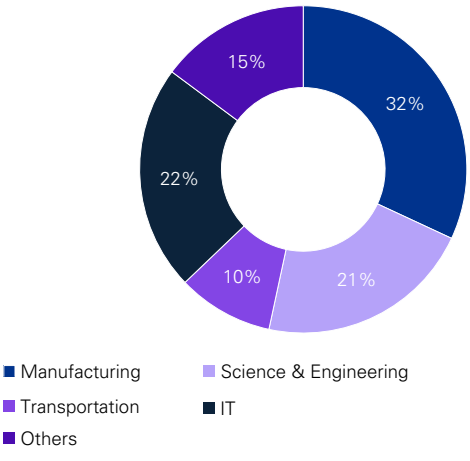


Figure 8: US space industry market share, by end use, 2021



Source: Grand View Research, KPMG analysis, 2022

03. Space industry

3.3.2 Space industry adoption by industry

To understand the nature of the space industry in the United States, the report investigated which countries and goods are involved in the industry's supply chain. Between 2017 and 2022, there were over 260,000 recorded shipments of physical goods to US businesses operating within standard industry classifications (SIC) most relevant to the space industry. For more detail on SIC codes used, please see *Appendix A*.

Shipment of origin

China ranks first in terms of exports to US businesses, contributing 46.9% of total exports, followed by Taiwan (6.8%) and Hong Kong (4.3%). Combined, these countries make up almost 60% of exports to the United States, Vietnam and Malaysia are also among exporters to US businesses, making up 7.8% of total exports.

Australia ranks 22nd on this list and currently contributes 0.4% of total exports. This data suggests that Australia does not have current strengths in the manufacturing of space-related goods. But as section 3.4 will discuss, there are specific goods and services in the space sector that Australia specialises in.

What inputs are used in the industry?

As shown in Table 6, the top item imported by US-based businesses are described by the 6-digit HS codes 8517.62 and 8517.12, contributing 9.7% of total shipments. Physical goods under these codes include communication apparatus, machines for the reception, conversion and transmission or regeneration of voice, images or other data, and telephones for cellular networks or for other wireless networks.

03. Space industry

Table 7: Number of shipments to the US, by imported goods

#	SIX-DIGIT HS CODE	HS CODE DESCRIPTION	%
1	8517.62	Communication apparatus (excluding telephone sets or base stations); machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus	5.1%
2	8517.12	Telephones for cellular networks or for other wireless networks	4.6%
3	8471.30	Automatic data processing machines; portable, weighing not more than 10 kg, consisting of at least a central processing unit, a keyboard and a display	4.3%
4	8544.42	Insulated electric conductors for a voltage not exceeding 1000 volts, fitted with connectors	4.0%
5	8504.40	Electrical static converters	4.0%
6	8517.70	Telephone sets and other apparatus for the transmission or reception of voice, images or other data, via a wired or wireless network; parts	3.7%
7	3926.90	Plastics; other articles n.e.c. in chapter 39	3.4%
8	8518.30	Headphones and earphones, whether or not combined with a microphone, and sets consisting of a microphone and one or more loudspeakers	3.1%
9	8471.60	Units of automatic data processing machines; input or output units, whether or not containing storage units in the same housing	2.3%
10	8803.30	Aircraft and spacecraft; parts of aeroplanes or helicopters n.e.c. in heading no. 8803	2.3%

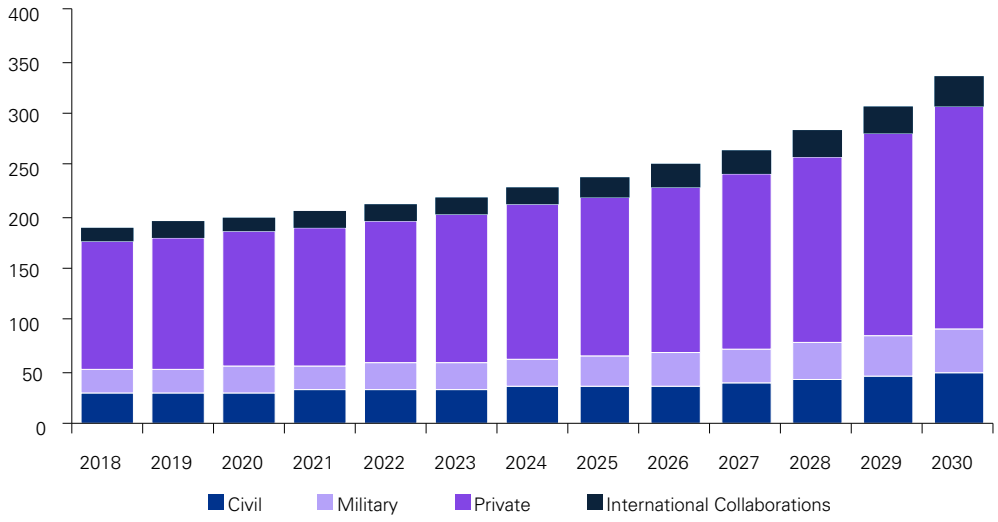
Source: Panjiva, KPMG analysis

Note: Given that there are no unique HS code identifiers for the space sector, we used HS codes most likely to apply for the space sector. It is possible that trade captured by these HS codes also contain elements of non-space sectors such as terrestrial cell networks. For more details on the SIC and HS codes used, see Appendix A.

03. Space industry

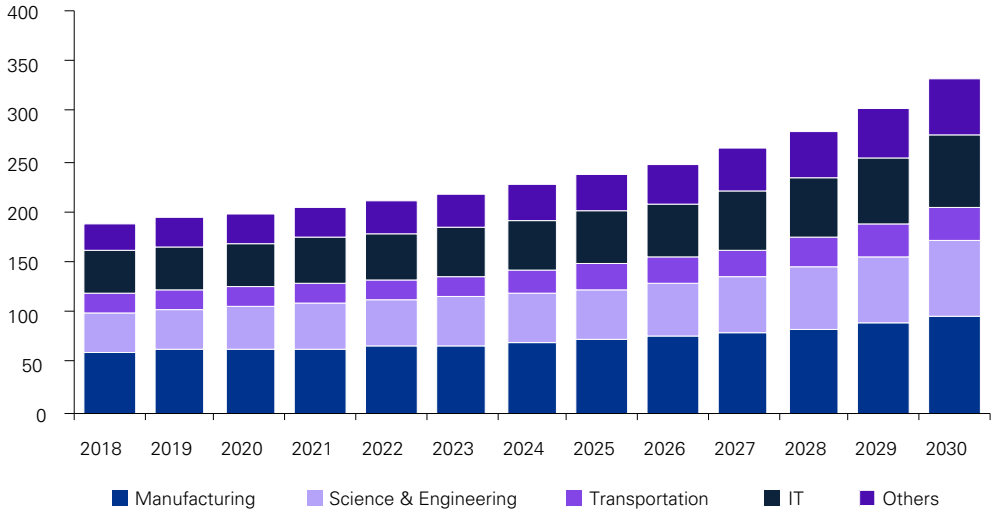
3.3.4 Future potential of US space industry

Figure 9: US space industry revenue, by type of business, 2022-2030 (US$b)



Source: Grand View Research, KPMG analysis, 2022

Figure 10: US space industry revenue, by end use, 2021-2030 (US$b)



Source: Grand View Research, KPMG analysis, 2022

03. Space industry

3.4

Australia's capacity to participate in the value chain

3.4.1 Australian space industry

Australia has a growing space sector, which has leveraged natural and structural advantages to become globally respected. Australia's geographic location and landscape, educational institutions, technical expertise, and international partnerships constitute an important foundation for the growth of this sector locally, and to access global space industry supply chains and develop sustainable commercial activities.[16]

The growing government support for a space sector resulted with the establishment of the Australian Space Agency in 2018 to advance Australia's space industry on the global stage. The agency aims to stimulate AU$1 billion pipeline of inbound capital investment in Australia's civil space sector between 2019 and 2028, as well as grow the size of the sector to AU$12 billion in revenue and create 20,000 new space jobs by 2030, with some of this growth likely to be driven by the US investment. Many US aerospace and defence primes have their presence in Australia and made investment in the Australian space sector.

Lockheed Martin Australia plans multi-million dollar investment to accelerate growth in Victorian space sector in February 2023

Lockheed Martin Australia proposed to invest in infrastructure and programs in Victoria to support the delivery of a Military Satellite Communications (MILSATCOM) solution for Defence.

Lockheed Martin Australia and New Zealand Chief Executive Warren McDonald expressed his commitment to Victoria and the relationship with the Victorian Government. The company has a well-established presence in Victoria, including their STELaRLab headquarter in Melbourne – Lockheed Martin's first multi-disciplinary research and development laboratory outside of the United States. Through STELaRLab, Lockheed Martin is currently partnering with universities from across Australia in key areas such as space-based image exploitation, automated AI-based knowledge generation using nuero-symbolic reasoning, and developing world-leading sovereign technologies for space domain awareness.

Their proposed investments in infrastructure, skilled jobs and STEM initiatives are designed to contribute to ensuring Victoria's space economy grows sustainably over the long term. The company aims to deliver a sovereign, operationally superior MILSATCOM system that meets Australia's strategic needs.

With Lockheed Martin's support in industry and research communities and the pursuit of cutting-edge space technologies, Victoria's space capabilities stand to be resilient into the future. In addition, future generations of Victorian students will be inspired to consider a career in the space industry.

Source: Lockheed Martin

03. Space industry

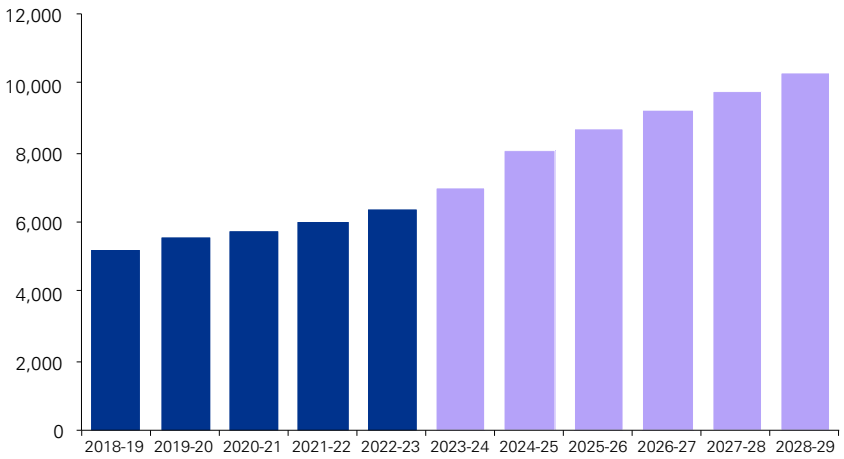
Australia has demonstrated its global capability in applications including remote and autonomous operations. Partnering with NASA, Australia will launch the G'Day Moon mission, its first mission to the Moon with an Australian-made, semi-autonomous rover.[17] A consortium of Australian businesses and research organisations will develop the foundation services rover with the support of international partners.

The Australian space industry is forecast to reach AU$10.3 billion by 2028-29 from AU$6.4 billion in 2023, at a compounded average growth rate of 8.4% (Figure 11).

Significant growth of the space industry in Australia can be attributed to the broad ecosystem of startup and scale-up companies which is enabled by civil, government and military interest in space capabilities and further enabled by reducing barriers to entry. Factors contributing to keeping barriers to entry down include falling cost of launch, manufacturing satellites and space-related technology.

Australia is already recognised as a world leader in remote equipment operation deploying autonomous trucks at remote iron ore mines in Western Australia.

Figure 11: Australian space industry revenue, historical performance and outlook (AU$m)

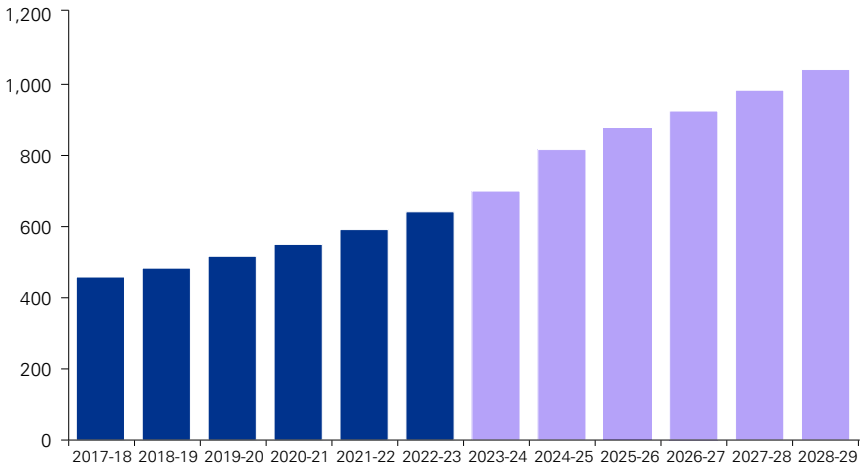


Source: IBIS, KPMG Analysis, 2023

03. Space industry

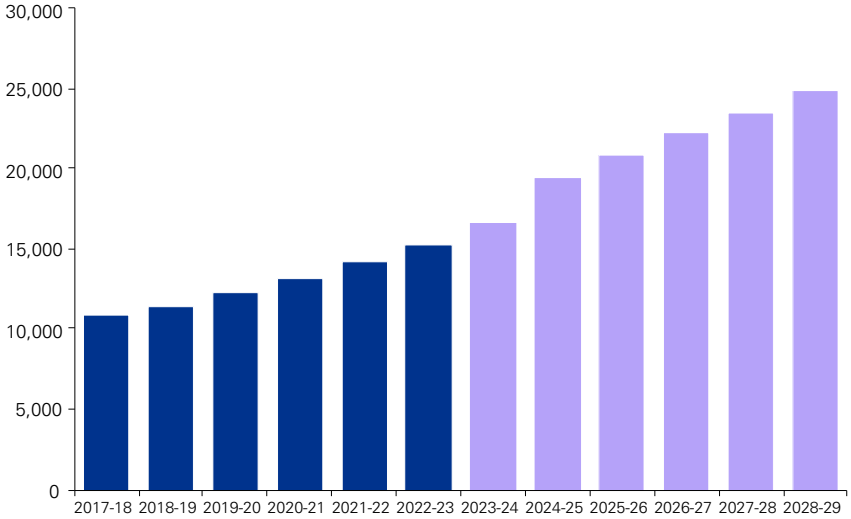
The number of space-related enterprises is rising in Australia and is expected to keep growing, reaching over 1,037 firms by 2028. The industry has witnessed quality growth, with value added in the space sector growing faster than Australia's GDP. Satellite communication and astronautics activities are surging in Australia, with research advancements opening new applications and markets.[i] As Australia's space industry is dominated by small scale companies, it is likely we will see a period of consolidation in the coming years, enabling companies to take on larger government programs with broader reaching, vertically integrated capabilities.

Figure 12: Space-related enterprises, historical performance and outlook (units)



Source: IBIS, KPMG Analysis, 2023

Figure 13: Space industry employment, historical performance and outlook (headcount)



Source: IBIS, KPMG Analysis, 2023

As the industry is growing rapidly, it generates more employment opportunities. The Australian space sector is forecast to employ 25,000 people by 2028-29, up from 15,247 in 2022. The employment includes permanent, full-time, part-time, temporary and casual employees, working proprietors, partners, managers and executives in the industry. While employment growth is anticipated to be strong, the nation has faced a challenge of retaining space industry workers due to competitive pay overseas and changing government priorities domestically.

i Satellite communications and astronautics activities include designing, manufacturing or operating space equipment and subsystems to provide value through exploring, managing or utilising space.

03. Space industry

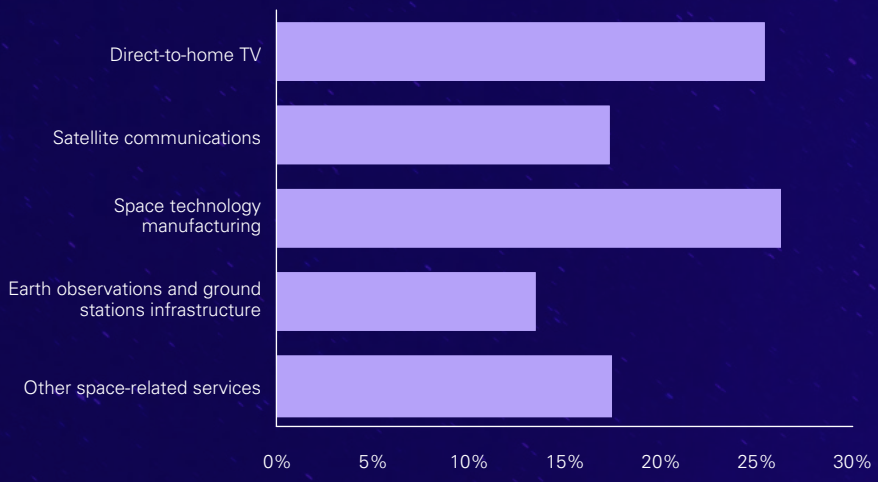
Technology manufacturing constitutes a significant market share of Australia's space industry (Figure 13). Australian manufacturers are engaged in high-technology materials, nanosatellites, nanosatellite components, satellite subsystems and other related products. This segment has seen reasonable growth over the last five years with the investments from Small to Medium Enterprises (SMEs).

Although direct-to-home TV is the second largest contributor to revenue, its share has fallen over the past five years because of Internet Protocol Television (IPTV) services.

Satellite communications including mobile satellite communications, satellite internet systems, satellite data, satellite imaging and other non-television satellite broadcasting has improved in quality over the last five years as advanced satellite technology allows them to offer better communications services.

The growing demand for satellite communications has boosted the demand for Earth observation and ground station infrastructure such as base stations, ground stations, observatories and radars. This infrastructure is critical to uplink, operate and monitor satellite systems.

Figure 14: Products and services segmentation, percentage of total revenue (2022)



Source: IBIS, KPMG Analysis, 2023

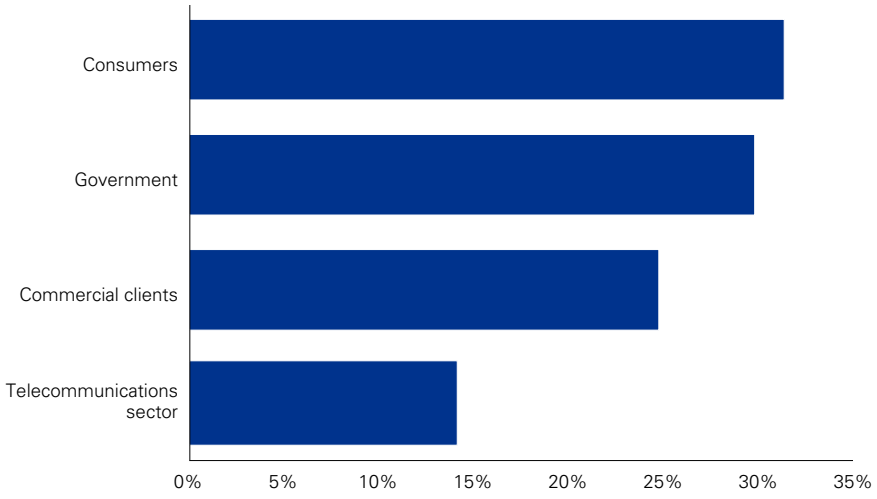
03. Space industry

Consumers are the largest users of space industry due to direct-to-home TV products, followed by government, commercial clients and telecommunication sectors. Though consumers make up the largest market share, this segment has fallen over the last five years because consumers are preferring IPTV services over direct-to-home TV services.

Government agencies are also customers of space services such as satellite communications, satellite imaging and space research. Several government agencies including the Bureau of Meteorology and the Australian Space Agency have made significant investments to mature their space-related capabilities.

Space technologies have been widely integrated across various other industries and 'non-traditional' markets, with agriculture, mining and transport significantly relying on satellite communications to enable their activities, particularly in remote areas. The demand for Earth observation is also increasing across many companies, with more use cases becoming viable.

Figure 15: Market segmentation, percentage of total revenue (2022)



Source: IBIS, KPMG Analysis, 2023

03. Space industry

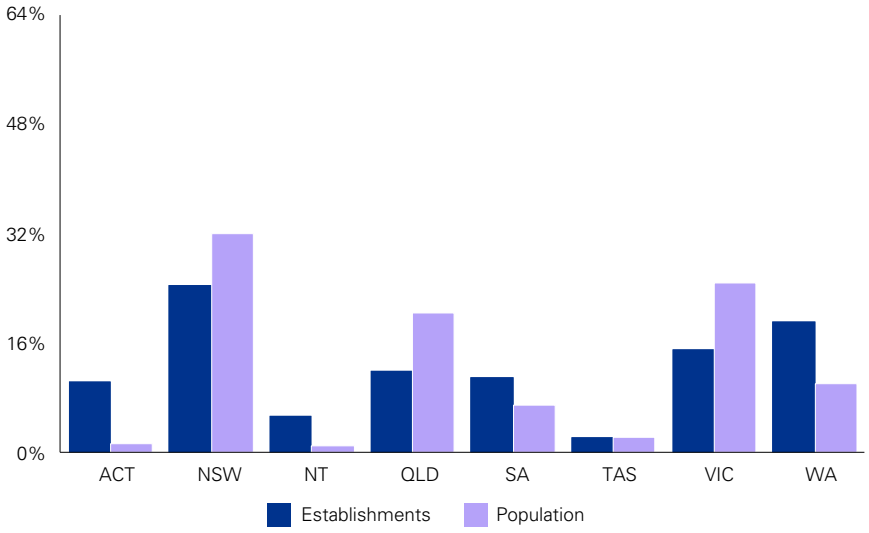
There is strong space sector interest across all states and territories in Australia although the number of space sector organisations are concentrated in western states and territories. The eastern states – Victoria, New South Wales and sections of Queensland – are not geographically suited for many astronautic activities because they are too built up.

The Australian Capital Territory has the highest number of establishments as a share of population, followed by the Northern Territory, Western Australia, and South Australia. The Australian Capital Territory is home to many space-related government agencies.[18]

The Australian government has undertaken several efforts including research and projects on satellite communications and astronautics.[19]

With the Woomera Range Complex restricted for military use, states and territories are exploring the creation of commercial and civil launch infrastructure, particularly in the Northern Territory, South Australia and Queensland. The Northern Territory contributes to revamping Australia's space launches, with the Arnhem Space Centre partnering with NASA having launched three sounding rockets in 2022.[20]

Figure 16: Distribution of space sector organisation vs population, percentage of national total



Source: IBIS, KPMG Analysis, 2023

03. Space industry

3.4.2 Government investments into the space industry in Australia

Since 2018, the Australian Government has made considerable investment to implement the Australian Civil Space Strategy over three phases. In Phase 1 (2018-19), delivered by the Australian Space Agency and Geoscience Australia, a AU$300 million space package was announced in the 2018-19 Budget, including AU$41 million over four years to establish the Australian Space Agency and a further AU$260 million to develop world-leading satellite capabilities through Geoscience Australia. In Phase 2 (2019-21), the government delivered the AU$15 million International Space Investment (ISI) initiative and the AU$19.5 million Space Infrastructure Fund. An additional AU$60 million has also been announced to support a Space Discovery Centre.[21]

The Space Infrastructure Fund covers seven projects aimed to provide foundational capabilities in testing, operations, and data analysis to enable the growth of the sector as outlined in Table 8.

Table 8: Space Infrastructure Fund projects

#	SPACE INFRASTRUCTURE FUND PROJECT NAMES	PROJECT WORTH	PROJECT OBJECTIVE
1	Space manufacturing facilities	AU$2 million	To enhance future space manufacturing capability To develop high-tech skills
2	Mission control centre	AU$6 million	To support small and medium enterprises and researchers to control small satellite missions
3	Tracking facilities upgrade	AU$1.2 million	To support precision tracking of satellites and spacecraft
4	Robotics, automation and artificial intelligence command and control	AU$4.5 million	To allow SMEs and researchers control over autonomous space operations, build capability in space technologies, and support development and operation of robotic and remote asset management activities in space
5	Space data analysis facilities	AU$1.5 million	Providing SMEs and researchers with space data analysis capability for agriculture, mining, emergency services and maritime surveillance
6	Space payload qualification facilities	AU$2.5 million	Providing capability for SMEs and researchers to test space equipment that is mission-ready including new facilities to support manufacturing, streamline testing of space equipment in Australia, and speed up the delivery of new space-based products and services
7	Pathway to launch	AU$0.9 million	Including projects to start addressing the active interest and growing readiness in industry for launch in Australia, and ensuring safety on Earth and in space

Source: Australian Communications and Media Authority 2021

03. Space industry

Phase 3 spans from 2021 to 2028 and is focused on priorities across each of the four Strategic Space Pillars, which are to 'open the door internationally; develop national capability in areas of competitive advantage; ensure safety and national interest are addressed; and inspire and improve the lives of all Australians'. [22]

In March 2022, the Australian Government announced a range new investments and reforms to further help Australian play a leading role in the region. This includes a AU$65 million investment to fast-track the country's access to space, covering four main areas: [23]

- Investing AU$32.3 million in spaceport development.
- Investing AU$32.5 million to procure spaceflights to get Australian technology into space sooner.
- Investing in human spaceflights to make Australia a regional hub for commercial human spaceflights.
- To send Australian astronauts into space.

The Australian Government has also allocated AU$150 million to the Australian Moon to Mars Initiative to assist Australian businesses and researchers to join NASA's aspirations to travel to the Moon and then to Mars. As part of this, around AU$50 million will be invested in Trailblazer program of the initiative to develop a lunar rover. This will help to accelerate the growth of the Australian space industry, enhancing Australia's space capabilities, and engage Australia in national and international supply chains.[24]

Another high-profile initiative supported by the Australian Government is the Southern Position Augmentation Network (SouthPAN), a joint initiative of the Australian and New Zealand governments.

The initiative is a Satellite Based Augmentation System (SBAS) that provides enhanced positioning and navigation services in the two countries, including reference stations, telecommunications infrastructure, computing centres, signal generators, and satellites. SouthPAN has been allocated AU$1.4 billion in funding over the next 20 years through Geoscience Australia.[25]

3.4.3 Australia's comparative advantages

The Australian space industry benefits from having relatively high uptake of space sector services across its other leading industries such as financial services, resources, transport and agriculture. This creates ongoing opportunities for Australian companies to provide services locally.

Australia is recognised for having certain comparative advantages, which have enabled the accelerated growth of the space sector in Australia, including:[26]

Geography

Australia plays an important role in the international space industry supply chain because of its geographic location in the southern hemisphere and in line with the longitude of Asia. The country possesses appropriate locations for ground station calibration and validation with low noise, clear skies and low light interference. Australia also has suitable locations for satellite communications and control operations, with many deep space missions being supported by NASA's Deep Space Communication Complex in Tidbinbilla, and ESA's New Norcia facility in WA. Australia also facilitates access to a large number of satellites for Earth observations and Global Navigational Satellite Services (GNSS).

03. Space industry

Research and development excellence

Australia is a global leader in space related research and development. Australian space science research accounts for 6.8% of worldwide publications between 2012-16, ranking 8th for citations of academic publications among G20 nations. The CSIRO has also developed a clear roadmap for Australian science and research to unlock future growth opportunities in the areas of space.

Australia has a robust education system and research capabilities for space technologies, with over 20 universities providing space related education. Many of Australia's space companies have been born out of universities, though there is significant opportunity to further commercialise the technological advances being made. Australia is recognised by the international space community for its technical expertise in the space sector, although workforce challenges are still present and many graduates work in adjacent sectors or move overseas.[27]

Technical expertise/experience

Australia has strong technical expertise in several fields that provides support for the space industry supply chain. Notably, wireless internet was invented in Australia and the nation has developed technical capabilities across communications, satellite imagery and PNT. These technical capabilities have created commercial opportunities for a national workforce utilising these STEM skills. Australian SMEs, startups and universities have also developed significant technical capabilities in photonics, quantum cryptography, optical design and adaptive optics, but their growth is limited due to a lack of funding or continuity to keep themselves within a full commercial supply chain.

The experience of Australian companies and institutions in Earth observation data collection and coordination and augmentation of GNSS services provide Australia with a comparative advantage relative to other international players.

International partnerships and relationships

The International Space Station serves as an example of international cooperation. Partnerships are critical for space missions and for the complex supply chains required to develop space technology products and services. The Australian Space Agency has signed 18 Memoranda of Understanding and Statements of Intent with major international space agencies including NASA, European Space Agency, Japan Aerospace Exploration Agency, UK Space Agency, Canadian Space Agency, France's National Centre for Space Studies, the German Aerospace Center and the Korea Aerospace Research Institute. These relationships enable the Australian space sector to access international programs and companies to support collaboration. Australia's CSIRO has also signed several bilateral agreements with other international space agencies including ESA, NASA, CNES and the UK to enhance space science research.

Australia works closely with international partners in defence and national security space applications through the Combined Space Operations (CSpO) initiative, the Five Eyes Alliance (FVEY), Australia-UK-US (AUKUS) and the Quadrilateral Security Dialogue (Australia-United States-India-Japan – QUAD) alliances.

Australia also benefits from many northern hemisphere aerospace primes operating in Australia, such as Lockheed Martin, Northrup Grumman, Raytheon, and Boeing. In addition, L3Harris, a US defence prime with interest in space, also has a presence in Australia. They maintain significant ties with their parent companies, which facilitates the transfer of skills into the Australian market, as well as increased export opportunities for local companies to be integrated into their supply chains.

03. Space industry

3.4.4 Identified space industry specialisations for Australia

Australia has developed significant capabilities along most of the space industry value chain with a stronger focus on applications. Australia has experience in Earth observation, Global Navigational Satellite Services (GNSS) and integrating space sourced data into communications.

The Australian Space Agency has highlighted several areas as having high potential for specialisation in Australia under their Civil Space Strategy.[28]

These areas are:

- **Communications technologies and services:** strengthening communications on land, marine jurisdiction and airspace, while advancing space-related emerging technologies including lasers for data communication, and quantum technologies for secure communication and hybrid radio and optical communications.
- **Space situational awareness and debris monitoring:** strategic geographic location for monitoring space debris, satellites, weather, and management of space traffic activities; climate of central Australia ideal for ground stations; prime location advantage to look directly into solar systems.[29]
- **Position, navigation and timing (PNT):** developing a world-class PNT infrastructure to expand growth; the Australian government has committed to undertake significant investment on the country's PNT infrastructure.
- **Earth observation services:** Geoscience Australia's Digital Earth Australia (DEA) initiative is a world leader in Earth observation services, providing routine, reliable and robust intelligence about the Earth (e.g. agricultural monitoring, water management, monitoring shipping routes), and the country continues to grow this capability further, with the Earth Observation Technology Roadmap developed in 2021.
- **Leapfrog research and development (R&D):** strong existing capabilities in space-related R&D (Australia accounts for 6.8% of the world's space publications from 2012 to 2016); significant potential to identify, expand and commercialise R&D to grow and transform the space sector and support the country's security interest, with the Future Space Medicine & Life Sciences Roadmap having been progressed by the Australian Space Agency.
- **Robotics and automation:** a critical area in space over the coming decade, with Australia being in a better position in the global market to leverage and transfer its expertise in the area for remote operation and exploration from the mining sector into the space environment.
- **Access to space:** due to the country's geographical location, significant emerging opportunities for Australia to leverage the international space missions and commercial launches from Australian land.

03. Space industry

There are several Australian companies that have successfully developed and deployed new products and services either directly in the space industry or using space technology. Several of these examples are described below.

- Fleet Space Technologies is a leader in low-power satellite networks. They have recently launched their Exosphere product, which uses real-time ambient noise tomography for mineral exploration. Using satellite connectivity and edge computing, the tool enables resources companies to profile critical mineral deposits present at a local level, faster and at lower cost and with less environmental impact than conventional exploration approaches.[30]
- Saber Astronautics provides space visualisation products and services for planning and operating missions. Their products include Predictive Interactive Ground-station Interface (PIGI), Terrestrial and Astronomical Rapid Observation Toolkit (TAROT) and Space Cockpit. PIGI is a standalone software without any external dependencies used for space missions. It enables users to plan and control a space mission from a laptop efficiently and effectively. TAROT enable users to visualise all objects in space such as space weather, auroras and conjunctions. Space Cockpit is a 3D space domain awareness tool that provide important information, enabling operators to make a quicker and accurate decision in space control.[31]
- Myriota leads direct-to-orbit satellite connectivity for the Internet of Things (IoT). It has developed a low-cost, long-battery-life and secured satellite connectivity solution that is being deployed for heavy equipment and tank monitoring that can reduce the time for asset management. Myriota developed a personal black box-style 'Fight Recorder' to be used by soldiers on the battlefield, which will enable satellites to quickly pinpoint the precise location of injured soldiers and record information which can be used to reconstruct what happened during an engagement with the enemy.[32]
- Regrow, originally named FluroSat in Australia, has established itself in the United States and provides crop and sustainability insights, and its MRV (Measure, Report and Verify) platform to customers. Their products enable collection of data across time to enable customers to monitor crop performance, soil health, nutrition and stress, ultimately improving efficiency in agricultural practices. They not only accompany their customers in the adoption of sustainable farming practices but have been able to document the adoption of sustainable practices in the field and the improvement in soil health and environmental outcomes brought about by the new practices. This data acquired through remote sensing can be used to encourage collaboration across different farms with a view to improving sustainability, as well as identify new investment avenues for firms seeking to lower their emissions.[33]
- Skykraft is an Australian space services company with a specialisation in designing, manufacturing, and operating satellite constellations for the delivery of global services. The company is developing a new space-based service targeting air traffic management clients to increase air safety and address gaps in surveillance and communications for aircraft travelling across oceanic or remote areas that are limited by ground-based communications infrastructure. Skykraft's first satellites were successfully launched in early 2023 as part of a project to create a global air traffic management system.[34]
- Advanced Navigation is an innovator in AI robotics and navigation technologies. The company leverages AI neural networks and deep learning algorithms to deliver capabilities and performance across land, air, sea and space applications. Advanced Navigation collaborates with prominent research institutions to uncover navigation and robotic breakthroughs. Partnering with Q-CTRL, the company are developing quantum sensors for NASA lunar exploration.[35]

Australia's export potential to the United States

04. Australia's export potential to the United States

4.1

Advice for businesses expanding to the US market

Leverage Australian specialisations for space technology applications

It is often assumed that the United States can easily source most space technology domestically without importing from countries like Australia. But, there are significant benefits to importing technologies and capabilities, including:

- access to innovations, particularly those translated from other sectors like resources;
- diversified supply chains to increase capacity and redundancy; and
- reducing the cost of participation – with space technology often prohibitively expensive, cross-border collaborations make more advanced capabilities increasingly viable.

Where Australia has a known technological advantage or sector expertise that is augmented with innovations in space technology, this can provide an innovation that the US market could welcome. Areas where Australia has strong foundation and reputation include:

- resources sector
- remote operations and robotics
- quantum science.

Working with US primes is a pathway into global supply chains

Most of the leading aerospace primes from the United States have a significant presence in Australia, providing sustainment support to existing capabilities, and seeking to support the provision of future capabilities, such as Australia's future satcom under JP9102. The primes benefit from having a broad industrial base which forms their supply chain, both in the United States and for their Australian entities, and a number of Australian companies have benefited from integrating with and supplying these primes.

Australian Industry Capability is a requirement under many Australian Government contracts, incentivising foreign suppliers to integrate local capabilities in their delivery. Additionally, companies that supply the primes often benefit from increased access to export, coaching and additional opportunities to qualify and flight test their hardware and software. Small to Medium Enterprises should seek appropriate guidance in entering these relationships to ensure they maintain IP and competitiveness for other opportunities.

Navigating the International Traffic in Arms Regulations (ITAR)

ITAR controls the export of any advanced defence- or security-related technology, materiel, or related data or information, to anywhere outside the United States, or to any non-US national in order to protect US national security interests from technology transfer. Due to the dual-use nature of space technology, much of the import/export surrounding US space technologies is classified as ITAR-controlled, requiring specific approvals and negotiations with the United States.

While it has been easier for commercial companies to work with non-defence customers to avoid ITAR regulations and to develop off-the-shelf technology that offers business opportunities outside of the US market, it is appealing to explore defence business opportunities and investigate further how to adhere to the export controls.

The Technology Safeguard Agreement (TSA) is an opportunity negotiated between the United States and other government entities to pursue launch activities between US commercial companies on foreign soil and to ensure the necessary technology security safeguards are in place to provide barriers on technology transfer. Offering US commercial launch companies access to space ports from Australian soil would open up access to space from the southern hemisphere, with ideal routes to the equatorial, polar and Sun-synchronous orbits. The Australian and US governments are currently in negotiation of a TSA with a final outcome expected in 2023.

Accelerating the time frame from policy to procurement

Many Australian companies are waiting on space programs which have been announced though funding is not yet available. The move from grants to contracted programs such as the National Space Mission for Earth Observation will enable capabilities to scale much faster and be export ready.

04. Australia's export potential to the United States

4.2

Estimated trade uplift for increasing US engagement

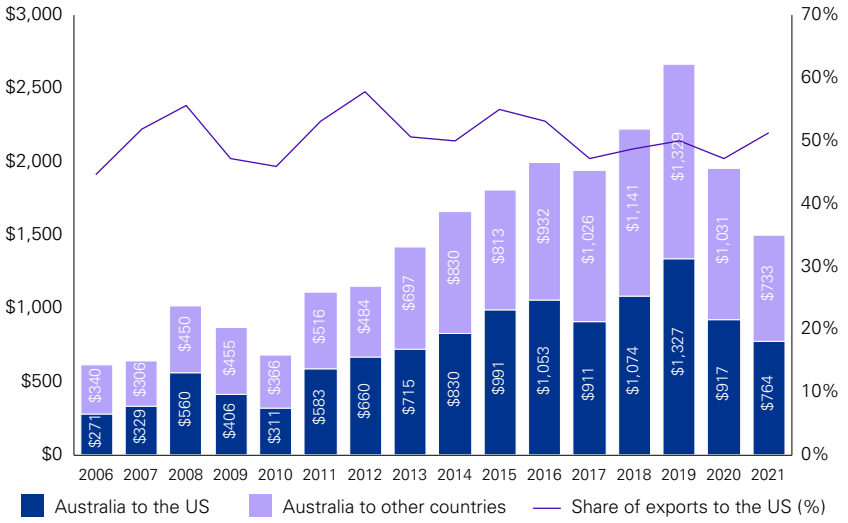
As space-specific trade data remains scarce, our analysis utilises data from the whole aerospace sector, in which space products are a component, to infer the broad trends of the United States and Australia trade in the space industry.

While data for the broader aerospace sector exists, it is challenging to separate the space and non-space components in statistics of the aerospace sector. In addition, trade in space products is rather constrained as it remains highly regulated and subject to government control, with a relatively small volume of production and a high degree of customisation.

The OECD has also acknowledged statistics can only capture a limited share of space-related trade, and the volume on record is likely to be considerably under-reported as compared to actual production levels.[36]

The United States has been a crucial market for Australia's exports of aircraft, spacecraft and parts thereof. From 2006 to 2019, Australia's total merchandise exports of this category in Australian dollars grew at a compounded annual growth rate of 12%, with exports to the United States constituting around half of the revenue. Australian merchandise exports to the United States also rose at a faster pace than to other countries, 13% as compared to 11% annually on average.

Figure 17: Australia merchandise exports of aircraft, spacecraft and parts thereof, 2006-2021 (AU$m)



Source: DFAT – Australia's merchandise exports and imports

Note: The export figures also include non-space goods, which means more than half of the exports may be not space-related.

04. Australia's export potential to the United States

The COVID-19 crisis took its toll on the aerospace sector due to widespread lockdowns, and there are concerns the pandemic will have a longer-term impact in the aftermath. Between 2019 and 2021, Australia's exports of aircraft, spacecraft and parts thereof to the United States decreased by 42%. It should be noted the actual impact on space exports due to COVID-19 remains unclear, with anecdotal evidence from industry experts suggesting the space industry in Australia did not lose out materially.

While the health crisis has faded and the global economy is returning to normal, there are long-term concerns that growth in the space sector could be negatively affected by changes in government priorities, agendas, the tightening of capital, and reduced customer demand. These concerns are amplified by a post-COVID challenging economic environment, including rising interest rates. The majority of commercial participants in the space sector are small and medium-sized enterprises. They often rely on single, predominantly governmental, sources of revenue. Over the medium and long term, many industry participants expect considerable funding cuts in future institutional programs.[37]

There is an opportunity to counter this, however, by leveraging the trade relationship Australia has with the United States and the agreements between the two countries.

KPMG has extrapolated three scenarios to estimate the benefit of an uplift in trade between the United States and Australia in the space industry. In all scenarios, the value of space product exports is estimated from Australia to the United States between 2020 and 2030.

4.2.1 Methodology

For the extrapolation, KPMG required estimates for the following: (1) the US space industry revenue from 2020 to 2030, (2) the US imports of space products from all countries and from Australia, and (3) projected growth in Australia exports of space products to the US. KPMG has obtained the US space industry revenue from GVR (2020) report, which is assumed to grow at a compounded annual growth rate of 5.3% from 2020 to 2030. The below explains the data sources and assumptions for the other two components.

International trade data in the space industry

The Aerospace sector as a whole provides the broader industry context for space-related activities as many large aerospace groups are involved in both aeronautics and space systems.[38] Therefore, the Aerospace sector (ISIC 3530) statistics have largely informed the trade assumptions in our analysis.

The Aerospace industry comprises the manufacture of all aircraft, spacecraft and parts thereof, including non-space items (passenger and military aeroplanes, helicopters, gliders, balloons, etc.) and space items (including spacecraft, spacecraft launch vehicles, satellites, planetary probes, orbital stations and shuttles). Space-related services such as telecommunications are not included, but they may be indirectly reflected in aerospace production as intermediate inputs.[39]

Due to the inherently complex nature of services trade flows, a lack of official statistics, and the challenges in separately identifying space-related services trade from the whole Telecommunications, Computer and Information Services sector, KPMG has not explicitly factored in space-related services trade in our analysis, assuming its addition would not change our estimates below materially.

04. Australia's export potential to the United States

The table below summarises the data sources and assumptions underpinning estimates relating to trade in the space industry:

INFORMATION	DATA SOURCES AND ASSUMPTIONS
Imports by the US space industry from all countries as a share of total revenue	Based on the 2012 Supply table for 405 industries from the US Input-Output Accounts, KPMG has estimated this measure at nearly 3%, using imports as a percentage of total product supply in *336414 – Guided missile and space vehicle manufacturing and 33641A – Propulsion units and parts for space vehicles and guided missiles.*[40] KPMG has then compared this estimate with the Aerospace statistics. The sales revenue of the US Aerospace and Defence sector in 2019 and 2020 was US$899 billion and US$874 billion, with imports being US$68.1 billion (8% of revenue) and US$50 billion (5.7% of revenue), respectively.[41] For a conservative estimate for the space sector, KPMG has adopted 3% to also take into account the factors that constrain trade in space products mentioned earlier.
Percentage of imports by the US space industry that comes from Australia	The main data source used was the OECD Bilateral Trade in Goods by Industry and End-use (BTDIxE) dataset. Australia's exports of aircraft, spacecraft and parts thereof to the United States in 2019 were US$995 million, comprising 1.6% of total US imports in this category. KPMG has observed an inconsistency in bilateral trade of aircraft, spacecraft and parts thereof between the United States and Australia within the OECD BTDIxE dataset, in which the Australia-reported exports of this category from Australia to the United States were significantly higher than the US-reported mirror imports. The drivers of the discrepancies may include differences in valuation of exports and imports, custom regimes, confidentiality policies, time of recording, or product classifications. In addition, by convention, merchandise trade statistics record imports by country of origin, while exports are recorded by country of last known destination.[42] The OECD has developed the Balanced International Merchandise Trade (BIMTS) dataset reconciling the observed asymmetries. Using this dataset, the US imports of aircraft, spacecraft and parts thereof from Australia as a share of its total imports in this category do not differ substantially from the estimates derived from the BTDxE data. For the analysis, KPMG has adopted 1.6% as the percentage of imports by the US space industry that comes from Australia.

Growth assumptions from 2020 to 2030 for each scenario

01

Scenario one
KPMG assume Australia exports of space products as a share of the US space industry revenue to remain unchanged.

02

Scenario two
KPMG assume the growth rate of Australia exports of aircraft, spacecraft and parts thereof to the United States (in US dollars) to resume its historical trajectory, growing at 10% each year.[43]

03

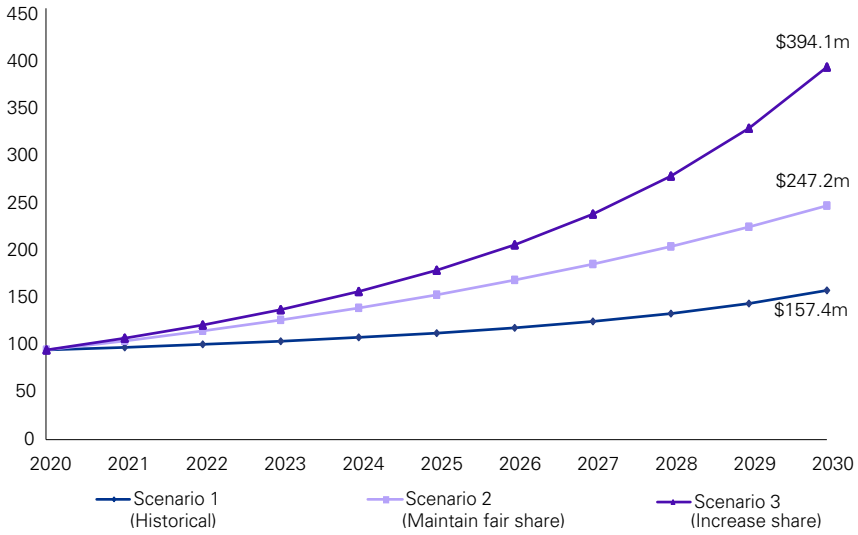
Scenario three
KPMG assume Australia exports of space products to the United States to grow by the combined growth of scenario one and scenario two in each year.

04. Australia's export potential to the United States

4.2.2 Trade uplift scenarios

As seen in Figure 18, scenario one, the baseline for the space sector estimates the value of service exports to the United States in 2030 to be approximately US$157 million. Scenario two indicates that if Australia can maintain its share of the US space market that is continuing to grow, the value of service exports to the United States will grow to US$247 million. Scenario three indicates that if Australia can increase its share of trade through arrangements such as the AUKUS agreement, the value of service exports could be as high as US$394 million.

Figure 18: Scenarios for increasing trade between the US and Australia (US$m)



Source: KPMG analysis, OECD, US Bureau of Economic Analysis

04. Australia's export potential to the United States

Table 9 summarises the estimated value of exports from Australia to the United States as a share of the US domestic industry revenue across the three scenarios. Across all scenarios, Australia maintains a small share of the total US industry size, despite the significant increase for Australia's exports. This highlights that the export potential may be constrained by heavy regulations and Australia's capacity to produce some space goods and services, rather than by a lack of opportunity in the United States. It also highlights that under the 'business as usual scenario', Australia could miss out on the opportunity to expand its market share if its growth in trade is lower than the historical trajectory.

Table 9: Trade scenario estimates as a share of US domestic industry revenue

	SPACE INDUSTRY
Australian exports to US 2020	US$94 million
% of US domestic industry revenue	0.05%
US imports from Australia as a share of 2030 US industry revenue	
Scenario 1: 'business as usual' – current market share	0.05%
Scenario 2: continued historical export growth	0.07%
Scenario 3: accelerated	0.1%

Source: KPMG analysis

04. Australia's export potential to the United States

4.3

Investment and employment implications

To enable greater participation of Australian businesses in the supply chain of the US space sector requires Australian firms to have an adequate workforce as well as the necessary physical capital. Underlying KPMG's figures for the trade potential scenarios, is a corresponding increase in capital expenditure and increase in space-sector jobs.

Using information from various ABS datasets, including the national accounts and datasets pertaining to multifactor productivity estimates, KPMG has estimated the incremental capex spend and employment that would be necessary in order for the trade uplift forecasts to be achieved. We note these are broad estimates using industry-wide averages and apply the latest available capital-labour ratios. Table 10 presents KPMG's estimates of necessary investment in new capital stock and incremental FTE workers required to achieve the potential trade-uplift forecast laid out in the previous sub-section.

Table 10: Incremental capital stock and labour force required to meet trade-uplift scenarios, 2030

	CAPITAL STOCK (2022)	FTE
Scenario 1: 'business as usual' – current market share	US$173 million	525
Scenario 2: continued historical export growth	US$272 million	825
Scenario 3: accelerated	US$434 million	1,315

Source: KPMG analysis

As can be noted from Table 9, the Australian economy stands to benefit from stronger ties with US space sector firms. The expected investment and employment outcomes in scenario 3 are more than twice the benefits compared to the 'business as usual' scenario. Through greater trade linkages with US space sector firms, Australian firms can improve efficiency by increasing investment in new space technology. Furthermore, intellectual capacity and necessary space-related knowledge and skill set would be developed by recruiting and retaining graduates in the space sector.

Appendices

Appendix A: Supplementary industry information

Using the Panjiva database, KPMG has extracted import data on the space industry in the United States. In extracting this data, KPMG has restricted our search to:

- Goods imported to the United States between 2017 and 2022
- Consignees with a Standard Industrial Classification (SIC) code relevant to the space industry
- Inputs with a Harmonised System (HS) code relevant to the space industry

The following SIC codes were provided by Grand View Research (GVR):

SPACE INDUSTRY	
SIC Code	**Description**
9661	Space Research and Technology
3764	Guided Missile and Space Vehicle Propulsion Units and Propulsion Unit Parts
3663	Radio and Television Broadcasting and Communications Equipment
3812	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments

Source: Grandview Research (2022)

Limitations

There are limitations to this approach. First, the SIC code system was last revised in 1987 and therefore may not fully capture emerging industries. SIC code definitions are also broad and no unique codes for the space industry have been defined. As such, searching by SIC codes is likely to include data relevant to industries that may not be directly related to industries we are interested in. Second, SIC codes most relevant to the space industry are similar and may overlap. Therefore, when extracting data, it is difficult to identify which industry trade data is associated with.

To overcome these limitations, we have used GVR reports which identify prominent companies from the space industry to supplement our data extract. A search in Panjiva is then conducted for these companies and trade data is collated. By so doing, KPMG are able to get an understanding of trade data for industries most relevant to the space industry and key companies within the industry.

Appendix B: Prominent US businesses in the space industry

#	COMPANY NAME	LISTING STATUS	COMPANY SIZE	LOCATION	YEAR OF INCORPORATION
1	AAR Corp.	Unlisted	Midsize	California	1987
2	Astrotech Corp.	Listed	Small	Texas	1984
3	Ball Aerospace & Technologies Corp.	Unlisted	Large	Colorado	1956
4	Blue Origin LLC	Unlisted	Midsize	Washington	2000
5	Boeing Co.	Listed	Large	Virginia	1916
6	Cinch Connectors Ltd	Unlisted	Midsize	Texas	1917
7	Composite Engineering Inc.	Unlisted	Midsize	California	1963
8	E Prime Aerospace Corp.	Listed	Small	Florida	1987
9	Firefly Aerospace Inc.	Unlisted	Small	Texas	2017
10	General Atomics	Unlisted	Large	California	1986
11	General Dynamics Corp.	Listed	Large	Virginia	1952
12	Hawkeye 360 Inc.	Unlisted	Small	Virginia	2015
13	Ils International Launch Services Inc.	Unlisted	Small	Virginia	1993
14	Kelly Space & Technology Inc.	Unlisted	Small	California	1993
15	L3Harris Technologies, Inc.	Listed	Large	Florida	1890
16	Leidos Holdings, Inc.	Listed	Large	Virginia	1969
17	Lockheed Martin Corp	Listed	Large	Maryland	1961
18	Masten Space Systems Inc.	Unlisted	Small	California	2004
19	Maxar Technologies, Inc.	Listed	Large	Colorado	1969
20	The Mitre Corporation	Unlisted	Midsize	Massachusetts	1958
21	Nasa Jet Propulsion Laboratory	Government	N/A	California	1958
22	Northrop Grumman Corp.	Listed	Large	Virginia	1939
23	Planet Labs Inc.	Listed	Midsize	California	2010
24	Primus Aerospace	Unlisted	Midsize	Colorado	1989
25	Raytheon Technologies Corp.	Listed	Large	Massachusetts	1922
26	Remmele Engineering Inc.	Unlisted	Midsize	Minnesota	1949
27	Rocket Lab USA, Inc.	Listed	Midsize	California	2006
28	Sandia National Laboratories	Government	Large	New Mexico	1993
29	Space Exploration Technologies Corp.	Unlisted	Large	California	2002
30	Spaceflight Inc.	Unlisted	Small	Virginia	2009

#	COMPANY NAME	LISTING STATUS	COMPANY SIZE	LOCATION	YEAR OF INCORPORATION
31	The Aerospace Corporation	Unlisted	Midsize	California	1960
32	Draper Laboratory	Unlisted	Midsize	Massachusetts	1972
33	Transition45 Technologies Inc.	Unlisted	Small	California	2005
34	United Launch Alliance	Unlisted	Large	Georgia	2005
35	United Space Alliance	Unlisted	N/A	Texas	1995
36	US Naval Research Laboratory	Government	Midsize	Washington	1999
37	Virgin Galactic Holdings, Inc.	Listed	Small	California	2004
38	Wallops Flight Facility	Government	N/A	Virginia	1982
39	Xcor Aerospace Inc.	Unlisted	N/A	California	1999
40	Zero-Gravity Holdings Inc.	Unlisted	Small	Virginia	1998

Source: KPMG Research, Factiva

Notes: Small, medium and large businesses refer to those with less than US$50m revenue, between US$50m and US$1b and over US$1b respectively.

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