PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

The Now Frontier: Developing Australia's Space Industry

House of Representatives Standing Committee on Industry, Innovation, Science and Resources

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Chair's Foreword

Space is an industry that inspires, fascinates and excites people. Generally, rockets and astronauts come to mind when we think about the space industry, but its technology and equipment are very much a part of our day-to-day lives. There are enormous opportunities for individuals, organisations, and communities to take advantage of this growing sector, particularly in rural and regional areas.

Australians are most familiar with our nation's involvement in the moon landing. In 1969, tracking stations at Honeysuckle Creek and Parkes in New South Wales, relayed images back to Earth of Neil Armstrong and Buzz Aldren walking on the moon. This followed the rocket testing program in the late 1950's at Woomera in South Australia as part of the Australian Government's Weapons Research Establishment.

Perhaps less familiar to Australians is the continued use of space-based technologies and applications in our daily life. Mobile phones, the internet, weather forecasting, GPS technology and banking services all rely on data derived from space. Space related technologies were once considered those of the future – robots, drones, remote sensors, and artificial intelligence – but are very much where we are now. For Australia to be competitive, we need to not only foster these technologies and their applications but ensure we have people with the right skills and expertise to make it happen.

The pace at which space-based technologies and innovation are developing is set to revolutionise the way we live. Space 2.0 refers to utilising and accessing space here on Earth. It includes a range of new technologies such as artificial intelligence, remote sensing, smart sensors, nanotechnology, microelectronics, big data, robotics, drones, autonomous systems, quantum computing and the internet of things. The significance of Space 2.0 is that it will create the jobs of the future.

In addition to improving our lives, this transformation will present real opportunities for Australia to be part of a growing and lucrative global space industry. Australia needs to position itself to capitalise on these opportunities.

Australia enjoys natural and structured advantages that can be leveraged to benefit socially and economically. Our geography and landscape, education and training system, technical expertise and international partnerships and agreements all combine to form an important foundation for access to the global space industry supply chains and the development of sustainable commercial activities. Furthermore, Australia is renowned for its innovation, research and development.

The Australia' space industry is enjoying a renewed focus and interest. The establishment of the Australian Space Agency in 2018 has helped to galvanise an industry and signal Australia's commitment to a globally competitive industry. It is fair to say it has invigorated the domestic space industry. However, more can be done.

The Australian Government has a set a goal to grow the domestic space sector by $12 billion and create an additional 20,000 jobs. This report makes recommendations designed to support this growth and beyond. It has identified key reforms that the Committee hopes will help the Australian space sector to be more globally competitive while preserving and protecting the space environment. Some of these reforms include the call for an overarching vision for the industry in Australia, to inspire confidence and investment in our space capabilities, and an increased visibility of space across the Government and the Parliament.

The report acknowledges the importance of the Australian Space Agency, its dedicated staff, and the role it has played in strengthening the Australian space industry. At the same time, the Committee believes it is timely that important consideration be given to the agency's funding, operations and status, including whether it be a made a statuary authority. This is to ensure it can even better support the industry and hold its own with other international space agencies.

Importantly, this inquiry helped to uncover that space is an accessible industry to those wishing to pursue a career in this field. The sector presents a lot of opportunity for Australia and the need to grow a workforce to support it is paramount. Beyond rockets and astronauts, there are many and varied jobs that can be undertaken. The Committee heard that there are a range of professions – not generally associated with space – such as law,

medicine, project management, communications and business that will all be required to support Australia's space industry and facilitated to grow an internationally competitive sector. The report recommends that community education and outreach programs to promote these opportunities are developed, and that diversity is sought across the sector.

Further, there is so much potential for our rural and regional areas to benefit from, and get involved in Australia's space sector. This includes the links between our regional industries and the space sector, the application of space related technology and infrastructure to agriculture, health and telecommunications; and of course the uptake of regional education and training to better equip young people to build their careers in this industry. The report calls for an examination of ways to maximize these benefits.

This inquiry was the second undertaken by this Committee during COVID-19 conditions, where travel and lockdown restrictions challenged the way we engaged with stakeholders and met as a committee. For the industry, COVID-19 highlighted the vulnerability of Australia's reliance on other countries for space related technologies and services, and global supply chains. It reinforced the need for sovereign space capability, so that Australia has what it needs to design, build and maintain our own space requirements. In turn, the Committee has made recommendations with a view to this. For example, we have recommended a national assessment of Australia's current and future space infrastructure requirements with particular emphasis on developing sovereign capability in identified areas, while acknowledging the need for industry to access a range of infrastructure for research and development, and manufacture.

This is an exciting time for the Australian space industry, with awe-inspiring work already being done here. I believe I speak on behalf of the Committee in saying we hope this report acknowledges the wonderful things happening now, and that it goes further to encourage and support the future promise and potential of the industry. This bipartisan report therefore makes 38 recommendations designed to drive growth and investment, encourage commercialisation of research and development, better facilitate international collaboration and grow a future space workforce.

The Committee appreciates the contribution of witnesses and those who hosted the Committee on site visits, and those joining us remotely from home studios and offices.

I would like to thank the former Chair, the Hon Barnaby Joyce MP for his stewardship of this inquiry, the Deputy Chair, the Hon Sharon Bird MP, and Committee Members for all their work.

I also extend my thanks to all the Committee Secretariat staff involved in the public hearings and preparation of this report.

Pat Conaghan MP

Chair

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Terms of Reference

The House of Representatives Standing Committee on Industry, Innovation, Science and Resources will inquire into and report on developing Australia's space industry, including:

- Development of space satellites, technology and equipment;
- International collaboration, engagement and missions;
- Commercialisation of research and development, including flow on benefits to other industry sectors;
- Future research capacity, workforce development and job creation; and
- Other related matters.

The Committee will focus on how the Australian Government can support and encourage the space industry while preserving and protecting the space environment.

Abbreviations

3D	Three Dimensional
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
ADF	Australian Defence Force
AI	Artificial Intelligence
AM	Member of the Order of Australia
AMC	Acceptable Means of Compliance
ANSTO	Australian Nuclear Science and Technology Organisation
ANU InSpace	Australian National University Institute for Space
ANZSIC	Australian and New Zealand Standard Industrial Classification
APAC	Asia Pacific Aerospace Consultants
ARC	Australian Research Council
ASA	Australian Space Agency
ASAM	Australasian Society of Aerospace Medicine
ASPI	Australian Strategic Policy Institute
AST	Office of Commercial Space Transportation
AUSNZ	Australia and New Zealand
AWS	Amazon Web Service
BHP	Broken Hill Proprietary Company Limited
BoM	Bureau of Meteorology

C4 EDGE	Command, Control, Communications and Computers Evolutionary Digital Ground Environment
CEOS	Committee on Earth Observation Satellites
CPR	Commonwealth Procurement Rules
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEF 799	Defence Project 799
DFAT	Department of Foreign Affairs and Trade
MTCR	Missile Technology Control Regime
DIH	Defence Innovation Hub
DST	Defence Science and Technology
EO	Earth Observation
EOA	Earth Observation Australia
EOS	Electro Optic Systems
ESA	European Space Agency
FAA	Federal Aviation Administration
FFRDC	Federally Funded Research and Development Centre
G20	Group of 20
GDP	Gross Domestic Product
GEO	Group on Earth Observations
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HAILI	Hybrid All Inclusive Learning Instrument
ICN	Industry Capability Network
ICT	Information and Communications Technology
IMEWG	International Mars Exploration Working Group
IoT	Internet of Things
IP	Intellectual Property
ISECG	International Space Exploration Coordination Group

ISS	International Space Station
ITAR	International Trade in Arms Regulations
JAXA	Japan Aerospace Exploration Agency
KTR	Koonibba Test Range
LAN	Local Area Network
LEO	Low-Earth Orbit
MOU	Memorandum of Understanding
MSP	Melbourne Space Program
NASA	National Aeronautics and Space Administration
NBN	National Broadband Network
NCI	National Computational Infrastructure
NSW	New South Wales
NT	Northern Territory
OECD	Organisation for Economic Co-operation and Development
PFi	Products for Industry
PhD	Doctor of Philosophy
PNT	Position, Navigation and Timing
PULSE	Pulsar Student Exploration
QUT	Queensland University of Technology
R&D	Research and Development
RDC	Research and Development Corporation
SASIC	South Australian Space Industry Centre
SATCOM	Satellite Communications
SBAS	Satellite Based Augmentation System
SCOOP	Southern Cross Outreach Observatory Project
SDA	Space Domain Awareness
SHINE	Swinburne Haileybury In Space Experiment
SIAA	Space Industry Association of Australia
SLCANZ	Space Law Council of Australia and New Zealand

SME	Small and Medium Enterprise
SSA	Space Situational Awareness
STaR	Science, Technology and Research
STEM	Science, Technology, Engineering and Mathematics
TAFE	Technical and Further Education
TRL	Technology Readiness Level
TSA	Technology Safeguards Agreement
UARC	University Affiliated Research Centre
UK	United Kingdom
UN	United Nations
UNSW	University of New South Wales
US	United States
USA	United States of America
USQ	University of Queensland
VET	Vocational Education and Training
VSSEC	Victorian Space Science Education Centre
WMO	World Meteorological Organisation

List of Recommendations

Recommendation 1

2.104 The Committee recommends that the Australian Government in consultation with industry seek to define:

- an overaching vision for the Australian space industry
- a set of long term national space priorities to guide and galvanise the Australian space industry

with the aim of inspiring the Australian public, providing investment confidence, developing Australian space capabilities, and positioning Australia as a globally competitive player.

2.105 The Committee recommends that these national missions be informed by the seven civil space priority roadmaps under development.

Recommendation 2

2.106 The Committee recommends that the Australian Government review the way it delivers funding to the Australian space industry with a focus on the development of space capability and capacity. This includes:

- broadening the funding streams to include contracts for specific space capability
- the necessity for industry co-funding where private entities are likely to be commercially disadvantaged.

Recommendation 3

2.107 The Committee recommends that the Australian Government examine ways to better coordinate and align civil and defence space priorities and investment.

2.108 The Committee recommends that the Australian Government work with industry to identify current and future opportunities for the civil space sector to support Australian defence space requirements, including on projects such as DEF 799.

Recommendation 4

2.109 The Committee recommends that the Australian Government establish a whole of government Ministerial Council on Space that comprises representatives from Commonwealth and State and Territory governments, stakeholders and industry groups to oversee the further development and coordination of the Australian space industry as a whole.

Recommendation 5

2.110 The Committee recommends that the Australian Government review or strengthen procurement policies and guidelines to ensure that Australian owned and operated space industry content is used where reasonably possible.

2.111 As part of these procurement guidelines Australian Government departments and agencies be required to set out the rationale for procurement of any space products and services obtained from overseas, including why such a capability could not be sourced domestically.

2.112 The Committee recommends that the Australian Government identify suitable points of contact within the Australian Space Agency or the broader Department of Industry, Science, Energy and Resources to assist industry navigate government procurement processes.

Recommendation 6

2.113 The Committee recommends that the Australian Government examine the feasibility of establishing an expert technical advisor, similar to the model adopted in the United States, to support government with procurement of

space based products and services, and the development of national missions.

Recommendation 7

2.114 The Committee recommends that the Australian Government examine options to increase the visibility of space across the Government and Parliament to emphasize its importance and communicate its relevance to Australians. This could include but not be limited to:

- incorporating space as a specific focus of a joint or house parliamentary committee, including in the name of the committee
- ensuring that a research position within the Parliamentary Library covers space related issues to ensure that adequate research support is available to Members and Senators
- ensuring that adequate positions across the Australian public service can cover the breath of space related issues and matters as they relate to particular departments and agencies.

Recommendation 8

2.115 The Committee recommends that, as part of the Australian Space Agency's post operational review, the following matters be given careful consideration:

- establishing the Australian Space Agency as a statutory authority
- separating its industry engagement and regulatory functions
- future workforce requirements, including engaging more staff with industry experience and technical expertise as required
- budget and resourcing to ensure that it is adequately positioned to meet its stated goals and objectives.

Recommendation 9

3.136 The Committee recommends that the Australian Government define Australian sovereignty as it relates to the development of Australian space

capability to ensure that Australia's space related interests are promoted and protected.

Recommendation 10

3.137 The Committee recommends that the Australian Government identify in consultation with the Australian space industry particular national space capabilities that can be designed, built and delivered by industry.

Recommendation 11

3.138 The Committee recommends that the Australian Government consider ways to encourage stronger commercially attractive partnerships between global space primes and Australian businesses. These strategies should seek to engage and prioritise those companies that can demonstrate a commitment to growing the Australian space sector.

3.139 The Committee recommends that this includes establishing a program to assist SMEs connect with primes and navigate the broader global space industry more generally.

Recommendation 12

3.140 The Committee recommends that the Australian Government pursue policy settings that incentivise private sector investment in industry development including such things as matched funding or co-funding, taxation incentives, and public and private partnerships.

Recommendation 13

3.141 The Committee recommends that the Australian Government expand support to SMEs to improve connections in global supply chains.

3.142 The Committee recommends that the Australian Government streamline access to funding mechanisms and increase efficiency of investment by reducing complexity and enhancing transparency.

Recommendation 14

3.143 The Committee recommends that space be identified as a key infrastructure priority area. It recommends a national assessment of Australia's current and future space infrastructure requirements with particular emphasis on developing sovereign capability in identified areas.

3.144 This assessment should acknowledge the need for industry to access a range of infrastructure for research and development, and manufacture. It should build on the preliminary work set out by the SmartSat CRC.

3.145 The Committee recommends further consultation with Infrastructure Australia to establish whether it is best placed to undertake this work in consultation with industry.

Recommendation 15

3.146 The Committee recommends that the Australian Government, in consultation with industry, examine the requirement to use international standards such as those used by the European Space Agency and NASA for all Commonwealth space procurements.

Recommendation 16

3.147 The Committee recommends that the Australian Government develop a specific ABS classification to provide a more accurate picture of the size of the Australian space industry and to help track its value and growth.

Recommendation 17

3.148 The Committee recommends that the Australian Government foster the growth of Earth Observation from space and data processing capabilities that benefit Australia across ever sector of the economy.

Recommendation 18

3.149 The Committee recommends that the Australia Government identify other off-earth opportunities in partnership with international agencies.

3.150 The Committee recommends that consideration be given to developing a mechanism to identify and develop innovative space proposals such space solar power technology in Australia.

Recommendation 19

3.151 The Committee recommends that the Australian Government undertake broader industry engagement to:

- create awareness in adjacent sectors of opportunities to participate in the Australian space industry

- identify relevant skills and expertise within adjacent industries that could be transferable to the Australian space industry

3.152 The Committee recommends that the Australian Government better promote and engage non-STEM industries such as law, economics, finance, business and advisory services to ensure that these sectors are well equipped to support and maintain the operation of the Australian space industry and provide a specialist service in an international market.

Recommendation 20

3.153 The Committee recommends that the Australian Government examine ways to better support and coordinate space medicine research, training and development to ensure that the translational benefits of aerospace medicine can be applied on Earth.

Recommendation 21

4.77 The Committee recommends that the Australian Government consider a national launch plan or strategy to support a sovereign capability in Australia including the investment, infrastructure and expertise required. This includes development of policies that preference Australian launch capability to support government space requirements.

Recommendation 22

4.78 The Committee recommends that the Australian Government give consideration to further reforms to the *Space (Launch and Returns) Act 2018* and Rules 2019, in consultation with industry to ensure that regulatory provisions:

- support the growth and competitiveness of the Australian domestic industry
- ensure the safe and responsible management of the space environment
- are in line with the regulations used by similar space countries.

It is recommended that further engagement be undertaken with government and industry to determine the most suitable regulatory changes to best benefit growth and investment. Consideration may be given to the Adelaide Law School supplementary submission given to the inquiry.

Recommendation 23

4.79 The Committee recommends that the Australian Government give consideration to further suspending or amending the Australian launch permit application fees to ensure that Australian businesses are not financially or commercially disadvantaged, and remain competitive with other space countries.

Recommendation 24

4.80 The Committee recommends that the Australian Government establish dedicated and effective industry engagement mechanisms to guide stakeholders through the application and regulatory processes. This includes designated staff within the Australian Space Agency to work with industry, and the development of publicly available guidance documents.

Recommendation 25

5.65 The Committee recommends that the Australian Government continue its investment in sovereign situational space awareness and situational domain awareness capability including the infrastructure to support it.

Recommendation 26

5.66 The Committee recommends that the Australia Government take a lead role internationally in implementing the Long Term Sustainability Guidelines for the United Nations Committee on the Peaceful Uses of Outer Space.

Recommendation 27

5.67 The Committee recommends that Australian regulators prioritise post-mission disposal, debris-neutral missions plans, and organisational capacity in identifying viable space projects.

Recommendation 28

5.68 The Committee recommends that the Australian Government continue to participate in international forums to:

- clarify how international law impacts commercial activities in space
- lead the development of enforceable and internationally agreed norms of behaviour in outer space.

Recommendation 29

5.69 The Committee recommends that the Australian Government examine the feasibility of more green technology in the Australian space sector, and ways to ensure that the industry is not contributing to an already congested environment.

Recommendation 30

6.89 The Committee recommends that the Australia Government prioritise and promote the importance of space science as fundamental to innovation and growth of the Australian space sector. This includes:

- specific reference to space science in the Australian Space Agency's Charter and Australia's Civil Space Strategy;
- examining options for better coordination of space science across Commonwealth and state and territory agencies; and
- identifying a set of national space science research and innovation priorities to enable stakeholders to make informed decisions regarding investment and research and development.

Recommendation 31

6.90 The Committee recommends that the Australia government review the model for research and industry collaboration to ensure that it fosters the best outcomes to support innovation, development of space capability, and industry growth.

6.91 This includes access by academia and industry to cross sector research funding streams and programs.

Recommendation 32

6.92 The Committee recommends that the Australian Government examine options to protect the intellectual property security of stakeholders within the Australian space industry to ensure that collaboration between academics, industry and government can occur in a secure environment.

6.93 The Committee recommends that the Australian Government consider options for industry to commercialise publicly funded research and

development and intellectual property creation in a competitive environment.

Recommendation 33

7.80 The Committee recommends that the Australian Government develop a community education and outreach program to promote the diversity of employment, careers and opportunities within the space sector.

7.81 This campaign should also target underrepresented groups within the space industry to help increase diversity across the sector.

Recommendation 34

7.82 The Committee recommends that the Australian Government promote the value of STEM through primary, secondary and tertiary years to ensure a continued pipeline of specialist and technical expertise is available to support and sustain the Australian space sector.

Recommendation 35

7.83 The Committee recommends that the Australian Government examines options to improve education to industry pathways within the sector.

Recommendation 36

7.84 The Committee recommends that the Australian Government introduce a program to better connect adjacent industries with transferrable skills to the space industry.

Recommendation 37

7.85 The Committee recommends that the Australian Government examine ways to maximise the benefits of rural and regional Australia to foster the growth of the Australian space industry.

Recommendation 38

7.86 The Committee recommends that the Australian Government examine options to improve engagement and relocation of international workers and commercial enterprise to the space industry.

Executive Summary

When we think about space, we tend to think about the fascinating and extraordinary experiences of astronauts. That is, of rockets and space stations, of space exploration and discovery, and of walking on the moon. The reality of the space industry, however, is much closer to home.

Australians engage with space and its technology on a daily basis, often without realising it. It is difficult to comprehend a world without the use of space and its applications. Space technology underpins the use of mobile phones, the internet, and GPS services. It is central to a number of Australian industries such as agriculture, emergency services and mining.

The global space industry is valued at approximately $471 billion, and is predicted to be worth almost $1.5 trillion over the next 20 years. Countries around the world are positioning themselves to maximise the social and economic benefits of this global industry, including Australia.

The Australian Government has set a goal to increase its space revenue to $12 billion and create an additional 20,000 jobs over the next decade. The aim of this inquiry was to examine how the Australian Government can facilitate this growth and best support the Australian space sector to be globally competitive while preserving and protecting the space environment.

The Australian space industry presents enormous opportunities to increase employment, strengthen the economy, and improve lives. To this end, the Committee has made 38 recommendations which are designed to overcome current barriers to growth, drive investment and commercialisation of research and development, better facilitate international collaboration, and grow a future space workforce.

There is little doubt that stakeholders are buoyed by an invigorated Australian space sector. While acknowledging the infancy of the revived domestic industry, key areas of strategic reform were identified, including:

- increasing Australian Government funding
- establishing a national space program and missions
- Government being a primary customer for industry
- aligning civil and defence space programs
- improving national coordination across and between governments
- greater investment in space infrastructure
- regulatory reform

The Committee heard that Australia needs a national space plan or strategy consisting of a series of space missions to grow the domestic space industry. This involves determining what Australia wants to do as a space-faring country, what capabilities are needed to do it and seeking that from the Australian space sector.

There is overwhelming support and praise for the Australian Space Agency (ASA), its establishment, and achievements to date. Notwithstanding the significant difference the ASA has made to the Australian space industry, several suggestions were put forward for improving its current structure, operation and administration. These include establishing the ASA as a statutory authority, separating its industry engagement and regulatory functions, and improving education and awareness of regulatory processes including the provision of regulatory guidance documents.

The upcoming operational review of the ASA is a timely opportunity to consider the issues raised by the domestic space industry. The Committee recommends that important consideration be given to the status of the agency, its future funding and operational requirements needed to support and potentially exceed the stated 2030 goals of government.

Over the next decade, the Australian Government will invest around $7 billion in defence space capabilities under its 2020 Force Structure Plan. A common theme in this inquiry was that Australian defence and civil space priorities and programs should be better aligned and coordinated. This is because space and defence are closely related and interdependent. It was argued that by recognising the existing civil-defence space relationship and supporting its growth, technology and expertise will flow between the two sectors, and production and adoption of new systems and IP will accelerate and be mutually beneficial. Furthermore, given Defence's access to considerable funding for R&D and capability development, and the civil

industry's wealth of academic research and private entrepreneurship, both sides have a great deal to gain.

Growing the Australian space industry

A sovereign space capability will enable Australian industry to design, build and maintain its space requirements. This will foster the development of skills, expertise and 'know-how', position Australia as a globally competitive player, strengthen national security and defence capabilities, and stimulate innovation. It will also help to grow the economy and assist in post-COVID recovery.

Underpinning calls for sovereign space capability is Australia's reliance on the space assets and capabilities of other countries. This includes space related goods, services, infrastructure and skilled people. If access to these international assets is restricted or closed, Australia is likely to be left without the space based services and programs on which it depends.

While Australia has some manufacturing and technological capabilities that can contribute to the space sector, this will need to be more strategically developed and grown to sustain an industry. Stakeholders highlighted the need for Australia to develop and maintain an 'ecosystem' of space -related companies, infrastructure, research institutions, investment avenues, education and training streams, and employment opportunities to ensure that it has the necessary foundation to build sovereign capability.

The Committee heard that the investment of the largest venture capital firms in Australia barely match the smallest funds invested elsewhere. This means there is limited funds to strategically invest in many local space technology businesses, and it also increases the probability that space technology companies will eventually move overseas to access larger capital markets.

Start-ups and businesses not only require funding support. Ensuring availability and access to necessary space infrastructure to support industry develop, design, test and manufacture technology is also fundamental to developing the domestic industry. There is a need to examine how Australia's space infrastructure can be incorporated into future national infrastructure plans. The Committee recommends that space be identified as a key infrastructure priority area and that a national audit be undertaken of current and future space infrastructure needs.

Supporting and maintaining the domestic space industry alone will not be enough to sustain Australian businesses nor contribute to the broader

growth of the industry. The Australian space industry will need to export its products and services and connect to global supply chains. Government has an important role to play here. This includes by facilitating partnerships with primes, advocating for Australian businesses in international markets, providing timely and tailored access to funding, and ensuring the policy settings provide confidence to stakeholders to invest.

Australia can capitalise on its strengths, particularly in downstream activities. Earth observation, space based applications and expertise in calibration and validation are significant strengths that can be leveraged to position Australia in a global market. Opportunities also exist within supporting sectors as specialist space advisory services can be developed for an international market.

Launch

In Australia, it is estimated that launch service providers could contribute up to $2 billion of direct, indirect and induced value in the coming decade and beyond. Growth in this part of the sector is considered likely to contribute to between 10 – 20 per cent of the 20,000 new jobs by 2030.

Australia has a number of inherent advantages for space launch capability including its geography, environment and political stability, as well as potential interest from strategic partners. The ability to service both geostationary (equatorial) and high inclination (sun synchronous, polar orbits) satellite markets is a particular strength for Australia. It builds on the opportunity to be a primary launch location for Asia and a preferred provider for launch activities globally.

Despite the benefits of developing a domestic launch industry, stakeholders identified current challenges inhibiting the sector's growth. These primarily relate to investment and infrastructure, and the current regulatory framework and administration. Timeliness and approval processes are also issues affecting the launch sector. A more coordinated approach to developing the nation's launch industry, including the development of a national launch strategy would be welcomed by industry.

As with other sectors, success will depend on the ability of launch providers to market themselves globally. This means that Australia's regulatory framework must facilitate easier collaboration with international stakeholders–helping rather than hindering space companies wanting to launch in Australia. Given Australia's proximity to other launch destinations in the region, it must establish itself as a competitive and comparable destination for launch.

Space environment

Access to space-based capabilities is critical to a broad range of Australian sectors including agriculture, telecommunications, financial services and meteorology. It also underpins the operational effectiveness of the Australian Defence Force. A consequence of this dependency is that Australia has a strong interest in maintaining a stable, secure, resilient and safe space environment.

Evidence to the inquiry suggested that space is a relatively unregulated environment or that rules and regulations are not keeping pace with the reality that space is now accessible to more nations and, increasingly, private entities.

The space environment is becoming increasingly congested, contested and competitive. In this context, 'congested' refers to the amount of space infrastructure and debris orbiting the earth; 'contested' refers to the range of potential threats—including deliberate disruption to space infrastructure and services such as satellites—posed by adversaries; and 'competitive' refers to the number of countries and commercial entities vying for access to and control of space and its resources.

The Committee heard about a significant increase in the amount of debris—sometimes referred to as 'space junk' or 'space pollution'—orbiting the earth. Given the volume and threat posed by space debris, there were calls to address this compounding issue domestically and internationally.

Much like efforts to protect and care for the physical environment, the space environment is no different. Not contributing to the growing issue of space debris was a consistent theme in evidence. Australia has an opportunity to take the lead globally on undertaking space activities in a responsible and sustainable way, particularly as a developing space industry.

With threats to space assets having significant consequences for the way we live, strengthening capability across situational space awareness and situational domain awareness is important. Continued investment in these areas is recommended.

Research and development

Most developments and innovation in the space sector can be attributed to discoveries grounded in scientific research. Basic space science research is

necessary for the development, long-term success, and competitiveness of the Australian space industry.

The Committee heard that Australian space science needs to be 'reprioritised and funded'. National coordination of space science across government agencies, and a defined set of national space science priorities will help to inform decision making around investment and space science research programs.

Collaboration between the Government, industry and universities is essential to grow the space industry, domestically and internationally. Collaborations between commercial companies and universities (or other research organisations) can sometimes be challenging because of differing R&D strengths, key objectives and financial time frames. The Committee recommends that the model for research and industry collaboration be reviewed to ensure that it supports the best outcomes for innovation, development and industry growth.

Converting R&D into commercially viable products is one of the challenges in innovation policy. While Australia has a strong history in space R&D and a significant research base, it struggles to commercialise its R&D. There is a need to protect Australian space related IP, ensure fair access to it, and that collaborative efforts involving transfer of IP or discussion of ideas between stakeholders can occur in a secure environment.

Future workforce

Traditionally, those interested in pursuing a career in the space industry would leave Australia to do it. Now people are not only finding employment opportunities in Australia, there are early signs that people are coming back from overseas to continue their careers. While much of this is due to a growing national industry, it is also due to the changing nature of work within space more generally and the opportunity to work in a broader range of space related fields, particularly those associated with 'downstream' or 'from space' activities.

Space 2.0 refers to using space on Earth. It includes a range of new technologies such as artificial intelligence, remote sensing, smart sensors, nanotechnology, microelectronics, big data, robotics, drones, autonomous systems, quantum computing and the internet of things. The significance of Space 2.0 is that it will create the jobs of the future.

The skills and expertise needed to support this future workforce will need to be drawn from three key areas – within the domestic education and training

sector, other Australian industries and sectors, and internationally. Strategies designed to grow a future space workforce must foster the development of expertise in these areas ensuring a positive transition from education and training to industry, and that people are 'job ready'.

Many of the recommendations made by the Committee will go a long way to shape and develop a future workforce. Perhaps the strongest message conveyed to the Committee is that a future workforce needs to know that Australia's space industry is not just for astronauts and rocket engineers. Rather, there are a range of professions – not generally associated with space – such as law, medicine, project management, communications and business that will all be required to support Australia's space industry. It is this message that should be communicated and facilitated to grow an internationally competitive sector.

1. Introduction

Background

1.1 In 1984, Dr Paul Scully-Power AM became the first Australian-born astronaut to make a space flight.[1] As a Payload Specialist on-board a NASA Space Shuttle mission, Dr Scully-Power, an oceanographer, discovered that 'spiral eddies' – which are spiral currents in the ocean – are a common rather than rare feature of the world's oceans.[2]

1.2 Eight years later, Dr Andrew Thomas became the first Australian-born member of NASA's astronaut corps. Over four space flights and 177 days in space, Dr Thomas spent four months on the Russian Mir Space Station, completed a spacewalk to install components on the exterior of the International Space Station and undertook various scientific tests and experiments.[3]

1.3 When people think about space, they tend to think about the fascinating and extraordinary experiences of astronauts such as Dr Scully-Power and Dr Thomas; of rockets and space stations, of space exploration and discovery, and of walking on the moon. The general perception of space and the space industry is that of an exclusive and highly specialised domain for exceptional people, or at the very least, for other countries. The reality of the space industry, however, is much closer to home.

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1 K Dougherty, *Australia in Space: A History of a Nation's Involvement*, Space Industry Association of Australia (SIAA), 2017, p. 135.

2 K Dougherty, *Australia in Space: A History of a Nation's Involvement*, SIAA, 2017, p. 135.

3 K Dougherty, *Australia in Space: A History of a Nation's Involvement*, SIAA, 2017, pp. 136-137.

1.4 Australians engage with the space industry and its technology on a daily basis. Space technology underpins the use of mobile phones, the internet, and GPS services. It is also central to a number of Australian industries such as agriculture, mining and emergency services. It is difficult to comprehend a world without the use of space and its applications. As described by the Australian Space Agency (ASA):

> Space improves the lives of Australians every day. Space technology is critical to the modern economy, enabling services on Earth such as modern navigation, weather forecasting, internet access, online banking and crop management. The space sector creates high-tech jobs, supports a strong and agile manufacturing base, and inspires young Australians and career-changers to pursue skills and jobs in science, technology, engineering and maths.[4]

1.5 In the last five years, the world has witnessed a wave of new space activity.[5] Rovers on Mars, mega constellations of small satellites, and commercial rockets with civilian crews are changing the way we interact with space.

1.6 The global space industry is valued at approximately $471 billion, and is predicted to be worth almost $1.5 trillion over the next 20 years.[6] Countries around the world are positioning themselves to maximise the social and economic benefits of this global industry, including Australia.

1.7 In 2018-19, the Australian space industry generated an estimated $4.8 billion in revenue and employed approximately 9,000 - 10,000 workers.[7] This revenue equates to 0.25 per cent of national GDP and 1.3 per cent of global space revenue.[8] Sources suggest that the Australian space sector will grow at 7.1 per cent per annum over the five years to 2024.[9] Other figures point to the sector achieving an estimated average of 8.6 per cent per annum to 2023.[10]

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4 Australian Space Agency (ASA), *Submission 55,* p. 4.

5 Gilmour Space Technologies, *Submission 59,* p. 1.

6 Boeing Australia, *Submission 80,* p. 1.

7 AlphaBeta Australia, 'The Economic Contribution of Australia's Space Sector in 2018-19', report prepared for the ASA, February 2021, p. 7.

8 AlphaBeta Australia, 'The Economic Contribution of Australia's Space Sector in 2018-19', report prepared for the ASA, February 2021, p. 7.

9 Surveying and Spatial Sciences Institute (SSSI) and the Spatial Industries Business Association (SIBA) | Geospatial Information Technology Association (GITA), *Submission 34*, p. 4.

10 Virgin Orbit, *Submission 33,* p. 1.

1.8 Given the rapid growth of the space industry globally and the enormous opportunities the sector presents to increase employment, strengthen the economy, and improve lives, the Australian Government has set a goal to increase space revenue to $12 billion and create an additional 20,000 jobs over the next decade.[11] The aim of this inquiry was to examine how the Australian Government can facilitate this growth and best support the Australian space sector in a globally competitive industry.

Inquiry process

1.9 On 11 November 2020, the Standing Committee on Industry, Innovation, Science and Resources adopted an inquiry into *Developing Australia's Space Industry*, referred by the then Minister for Industry, Science and Technology, the Hon Karen Andrews MP. The Committee was asked to focus on how the Australian Government can support and encourage the space industry while preserving and protecting the space environment. A copy of the Terms of Reference can be found at page xi.

1.10 The Committee announced its inquiry via media release on 30 November 2020, and called for written submissions. Eighty nine submissions, which are listed at Appendix A, were received.

1.11 The Committee held 15 public hearings in Canberra, Adelaide, Sydney, Armidale and Brisbane. Due to COVID-19 travel restrictions, a final public hearing was held via video conference with predominantly Melbourne-based witnesses. A series of site visits was also undertaken. These site visits were designed to showcase the breadth of organisations and institutions that comprise the Australian space industry and enable the Committee to see first-hand the manufacture and application of space related technologies in different environments.

1.12 Transcripts for all public hearings can be found on the Committee's website, and details of the public hearings and site visits are listed in Appendices B and C.

Recent space industry reports

[11] ASA, 'Advancing Space: Australian Civil Space Strategy 2019-2028', April 2019, p. 3. <publications.industry.gov.au/publications/advancing-space-australian-civil-space-strategy-2019-2028.pdf>, accessed 8 June 2021.

1.13 A number of reviews and inquiries have been undertaken into the Australian space industry. Key reports include:

- *Lost in Space? Setting a new direction for Australia's space science and industry sector*, Senate Standing Committee on Economics (November 2008)
- *Analysis Report: Public Submissions into the Australian Government's Review of the Space Activities Act 1998*, Professor Steven Freeland (August 2016)
- *Review of Australia's Space Industry Capability: Report from the Expert Reference Group*, Dr Megan Clark AC, Chair (March 2018); and
- *Space Activities Amendment (Launches and Returns) Bill 2018 [Provisions]*, Senate Economics Legislation Committee (August 2018).

1.14 The Adelaide Law School contends that while the focus of space industry reports over the last three decades has varied, the submissions and recommendations are generally consistent; 'there is a need to provide support to the space industry to foster its development and remove barriers to entry for new businesses.'[12] This includes:

- reductions in operating costs and unnecessary regulatory burdens;
- support to overcome barriers to entering markets (both domestic and international); and
- clarity and certainty with respect to operating conditions.[13]

1.15 Similar issues were raised in this inquiry.

Outline of report

1.16 This report is structured into seven chapters, including this introduction:

- Chapter two provides an overview of the Australian space industry, and highlights some areas of reform identified by stakeholders including overall investment, national coordination, establishing national missions, and aligning civil and defence priorities.
- Chapter three discusses key areas related to growing Australia's space sector such as developing sovereign capability, leveraging Australia's strengths, supporting start-ups, and adjacent and spill-over sectors.
- Chapters four and five focus on access to space. This includes the Australian launch sector, current challenges to its growth, and the broader space environment. It discusses how space is regulated, the

12 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [3].

13 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [3].

growing problem of space debris, and Australia's ability to access and defend space assets.

- Chapter six highlights the importance of space science as the foundation of the space industry, and examines the path from research and development (R&D) to commercialisation.
- Chapter seven concludes the report with a discussion of how to create a future workforce that will support the evolving space industry.

1.17 Various case studies are featured throughout the report. These case studies highlight people currently working in the sector, education and training programs, community involvement, and remarkable innovation. It is hoped that these stories will inspire people to become more engaged in the space industry and its related areas.

Acknowledgements

1.18 The Committee would like to thank everyone who provided written submissions, attended public hearings, and hosted the Committee on site visits. The Committee was impressed by the commitment and enthusiasm of those making a concerted effort to build a globally competitive and sustainable Australian space industry.

2. Australia's Space Industry

2.1 Space is a global industry. Nearly every country accesses and uses space based technologies and data. In the last 10 years, over 15 countries, including Australia, have established national space agencies to capitalise on a rapidly growing sector of the global economy.[1]

2.2 International space economies are different, characterised by each country's diverse strengths and priorities, levels of development and amount of investment.[2] While the Australian space industry is often described as 'fledgling' or 'nascent', it has a long history in space tracking, launch, earth observation, and space science research.[3]

Defining the space industry

2.3 The Australian space sector is defined as a set of space-related activities along the space value chain.[4] The sector is part of the broader space economy and includes private, public and academic stakeholders.[5] Four broad segments make up the 'space value chain':

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1 Gilmour Space Technologies, *Submission 59*, p. 1.

2 United Nations Office for Outer Space Affairs, Space Economy Initiative, 2020 Outcome Report, January 2021, p. 4. Also refer to: https://www.oecd.org/sti/inno/space-forum/measuring-economic-impact-space-sector.pdf.

3 For example see Boeing Australia, *Submission 80*, pages 1-2, https://www.industry.gov.au/sites/default/files/2021-02/the-economic-contribution-of-australias-space-sector-in-2018-19.pdf
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4 Australian Space Agency, *Submission 55*, p. 33.

5 Australian Space Agency, *Submission 55*, p. 33.

- **manufacturing and core inputs:** includes satellite or payload manufacturing and the building and integration of ground-based facilities and equipment that perform space-related activities
- **space operations:** includes launch activities and the management of objects in space
- **space applications:** includes producing the hardware and software to process earth observation imagery or direct to home television
- **enablers:** includes essential service delivery, infrastructure and capabilities, research, development and engineering, and specialised support services.[6]

2.4 This definition is drawn from the Organisation for Economic Co-operation and Development (OECD) and is used by New Zealand, Canada and the United Kingdom. The use of it allows for consistency with international space sectors, and for inclusion of other activities as the Australian space sector changes and grows.[7]

2.5 The space industry can be separated into 'in space' and 'from space' activities. In space refers to commonly perceived space activities such as launch, rockets and satellites while 'from space' refers to the use of data and information that is captured from space infrastructure.[8]

2.6 Similarly, the space industry can be segmented into 'upstream' and 'downstream' activities.[9] Upstream is focused on sending objects into space and space exploration. This part of the industry is characterised as 'providers of technology'. Alternatively, downstream activities use the research and technology from upstream operations in different applications on Earth. This part of the industry is characterised as 'exploitation of

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6 Australian Space Agency, *Submission 55*, p. 33. Also see *Activities included in the space sector*, www.industry.gov.au/data-and-publications/definition-of-the-australian-space-sector/activities-included-in-the-space-sector, accessed on 10 June 2021.

7 Australian Space Agency, *Submission 55*, p. 33.

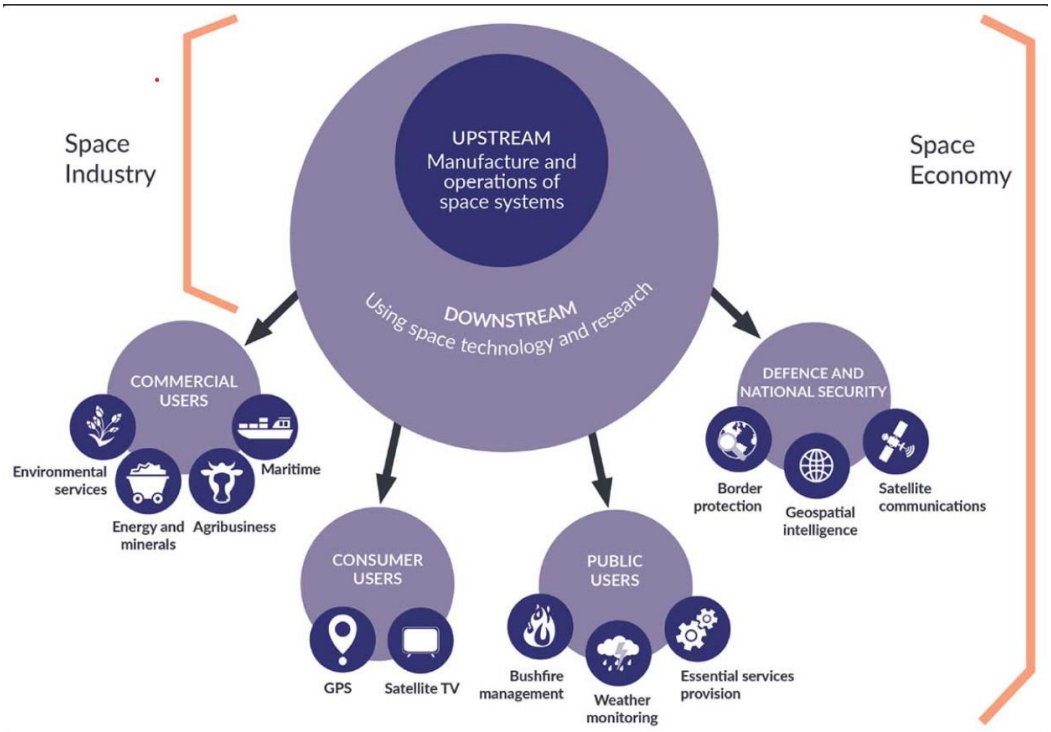
8 Mr Graeme Dunk, Head of Strategy, Shoal Group, *Committee Hansard*, Adelaide, 10 March 2021, p. 41.

9 Northern Territory Government, 'Territory Space Industry 2020: Market Analysis,' p. 4. https://industry.nt.gov.au/__data/assets/pdf_file/0006/657051/territory-space-industry.pdf

technology',[10] and is considered the area of greatest growth and opportunity.[11]

2.7 Figure 1 illustrates the different areas of the space economy.[12]

Figure 2.1



Source: Territory Space Industry 2020: Market Analysis, Northern Territory Government, page 5.

Commonwealth Government

2.8 The Australian Space Agency (ASA) is the Commonwealth entity responsible for coordinating civil space matters across government, providing advice on civil space policy, and supporting the growth and transformation of the industry. Established in 2018, the ASA is a non-

10 Northern Territory Government, 'Territory Space Industry 2020: Market Analysis,' p. 4. https://industry.nt.gov.au/__data/assets/pdf_file/0006/657051/territory-space-industry.pdf

11 Gianluca M. Strada and Nicola Sasanelli AM, *Growing the Space Economy: The Downstream Segment as a Driver,* May 2018, http://www.piar.it/report09today/Strada2018.pdf.

12 Northern Territory Government, 'Territory Space Industry 2020: Market Analysis,' p. 5. https://industry.nt.gov.au/__data/assets/pdf_file/0006/657051/territory-space-industry.pdf

statutory, separately branded body that sits within the federal Industry, Science, Energy and Resources portfolio.

2.9 Guiding the work of the ASA is the *Advancing Space: Australian Civil Space Strategy 2019-2028 (*the strategy*).* The strategy sets out the Australian Government's plan to triple the Australian space sector to $12 billion and create up to 20,000 jobs over the next decade. It is structured around seven national civil space priority areas and four strategic pillars. The four strategic pillars – international (open doors), national (increase capability), responsible (regulation, risk and culture), and inspire (build future workforce) – focus on creating an environment for the industry to grow, and promoting Australia as a responsible country in civil space.[13]

2.10 The seven priority areas include:

- Position, navigation and timing
- Earth observation
- Communications technologies and services
- Robotics and automation
- Space situational awareness and debris monitoring
- Leapfrog research and development
- Access to space.[14]

2.11 The ASA is currently developing roadmaps for each of these areas, which are expected to be released over the coming year.[15] The first roadmap, *Communications Technologies and Services 2021-2030,* was released in December 2020.[16]

2.12 Since 2018-2019, the Australian Government has committed over $700 million to develop Australia's space industry.[17] This investment has included:

- $150 million over five years for the Moon to Mars initiative

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13 Australian Space Agency, *Submission 55,* p. 13.

14 Australian Space Agency, *Submission 55,* pages 12-13.

15 Mr Enrico Palermo, Head of Agency, Australian Space Agency (ASA), *Committee Hansard*, Monday 20 September 2021, Canberra, pages 30, 32.

16 Department of Industry, Science, Energy and Resources, 'Communications Technologies and Services Roadmap 2021-2030,' www.industry.gov.au/data-and-publications/communications-technologies-and-services-roadmap-2021-2030.

17 Australian Space Agency, *Submission 55,* p. 4.

- $15 million over three years for the International Space Investment initiative
- $19.5 million for the Space Infrastructure Fund targeting seven projects
- $6 million each for the Australian Space Discovery Centre and Mission Control Facility.[18]

2.13 Space is a priority industry under the Australian Government's Modern Manufacturing Strategy. Announced on 1 October 2020, the Australian Government will invest $1.5 billion over four years to help manufacturers 'scale-up, become more competitive and build more resilient supply chains'.[19]

2.14 Commonwealth agencies that work across the civil space sector include the Bureau of Meteorology (BOM), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Geoscience Australia, and the Australian Nuclear Science and Technology Organisation (ANSTO). Further information about the space related work of these agencies, including the ASA can be found in their submissions to the inquiry.[20]

Box 2.1 CSIRO PULSE@Parkes

PULSE@Parkes is CSIRO's education program, designed to provide school students the opportunity to observe with the radio telescope located in Parkes.[21] Students have the opportunity to control the Dish, select pulsars to observe, as well as gather and analyse their data.[22] In addition, students

18 See Australian Space Agency, *Submission 55*.

19 The Hon Karen Andrews MP, Minister for Industry, Science and Technology, 'Media Release: Transforming Australian manufacturing to rebuild our economy,' Media Release, 1 October 2020, https://www.minister.industry.gov.au/ministers/karenandrews/media-releases/transforming-australian-manufacturing-rebuild-our-economy; and Department of Industry, Science, Energy and Resources, 'Make it Happen: The Australian Government's Modern Manufacturing Strategy,' www.industry.gov.au/sites/default/files/October%202020/document/make-it-happen-modern-manufacturing-strategy.pdf.

20 Australian Space Agency, *Submission 55*, p. 13.

21 Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission 11: 2*, Answer to Question on Notice, p. 2.

22 CSIRO, *Submission 11: 2*, p. 2.

meet with CSIRO scientists and PhD students, and can discuss study options and career pathways in astronomy and space.[23] In 2019-2020, more than 160 students and 25 teachers across 19 schools participated in the program.[24]

Due to COVID-19, all PULSE@Parkes sessions have taken place remotely since March 2020.[25] As a result, the program has reached more schools (approximately 25) and more than 200 students, in locations across Australia.[26] CSIRO has also run sessions for groups including CSIRO's Young Indigenous Women's STEM Academy, BHP Foundation Science and Engineering Award finalists, and for a large public session at Perth Astrofest.[27]

Reforms

2.15 There is little doubt that stakeholders are buoyed by an invigorated Australian space sector. It presents an opportunity to compete for a share of the lucrative global industry while enabling the broader economy via space based technology and services. Acknowledging the infancy of the revived domestic space sector, stakeholders identified several areas of strategic reform including:

- increasing Australian Government funding of the ASA
- establishing a national space program and missions
- government being a primary customer for industry
- aligning civil and defence space programs
- improving national coordination across and between governments
- encouraging greater collaboration across industry sector.

2.16 Investment in space infrastructure and regulatory reform, particularly relating to launch, was also raised. These issues are discussed in chapters three and four.

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23 CSIRO, *Submission 11: 2*, p. 2.

24 CSIRO, *Submission 11: 2*, p. 2.

25 CSIRO, *Submission 11: 2*, p. 2.

26 CSIRO, *Submission 11: 2*, p. 2.

27 CSIRO, *Submission 11: 2*, p. 2. See supplementary submission 11.1 for other examples of CSIRO space education program and activities.

Australian Space Agency funding

2.17 Data shows there is a strong economic return from government investment in space. For every $1 invested in the space industry, there is a direct return of between $2 and $10 while the indirect return could be up to $17, depending on the part of the space sector.[28]

2.18 The Committee consistently heard that compared to other countries, Australia's funding of its space agency is small, restricting what the ASA can achieve, and insufficient to meet the goals of the strategy. For example, the Queensland Government stated:

> The Space Agency has had a positive impact on growing Australia's space industry. However, its relatively small budget has limited its capacity to undertake both its national leadership and regulatory roles. The demands of the growing space industry and the Space Agency's responsibility to deliver the civil space strategy and its seven subordinate roadmaps will exacerbate this issue.[29]

2.19 The same point was made by the ANU Institute of Space. It called for the ASA to be funded at a level equivalent to countries with a similar GDP[30]:

> The Space Agency is currently funded at a level that prohibits these kinds of missions and does not reflect the GDP of our nation. It is truly underfunded for the growth level we need to triple the size of our space workforce now and create a clear pathway to build the next generation of Australia's space workforce.[31]

2.20 According to OECD analysis, Australia ranks 18th among the G20 countries for government investment in space as a percentage of GDP (0.003).[32] As shown in Figure 2, Turkey has the same level of investment as Australia, while Mexico is the only country that is ranked lower (0.001). This compares to the United States (0.243), United Kingdom (0.024) and Canada (0.016).

Figure 2.2

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28 Mr James Brown, Chief Executive Officer, Space Industry Association of Australia (SIAA), *Committee Hansard,* Sydney, 19 April 2021, p. 33; Space Industry Association of Australia, *Submission 83*, p. 6.

29 Queensland Government, *Submission 60*, p. 5.

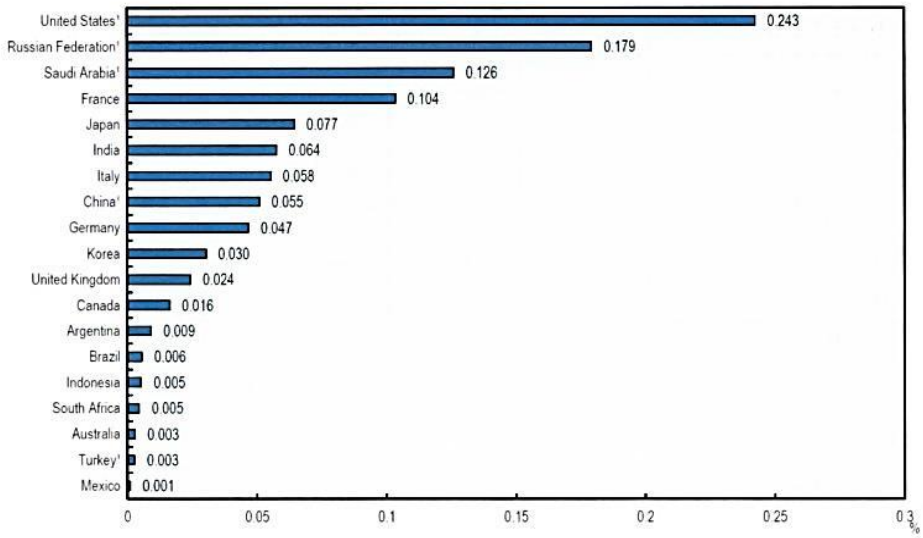
30 ANU Institute for Space, *Submission 18*, p. 4.

31 ANU Institute for Space, *Submission 18.1*, p. 2.

32 Space Industry Association of Australia, *Submission 83*, p. 5.

Figure 1. Government space budget estimates for G20 countries

As a share of GDP in 2019 (%)



Source: Space Industry Association of Australia, Submission 83, p. 6. See https://www.oecd.org/innovation/inno/measuring-economic-impact-space-sector.pdf.

2.21 There was general consensus that Australian Government investment should be increased. The Space Industry Association of Australia (SIAA) argued that despite considerable government and industry effort to kick-start Australia's space industry, it remains a 'late and lagging' participant from a government investment perspective. It recommended that government investment be lifted to a level at least comparable to Indonesia and South Africa, on a relative GDP basis.[33]

2.22 Asia Pacific Aerospace Consultants (APAC) also argued that Australia requires more funding to grow the Australian space industry.[34] Citing research which compares the space agency funding of the UK, Canada, France, and Norway, APAC recommended that the budget for ASA space programs be increased to $250 - $350 million per annum to enable it to meet its 2030 goals.[35] Small World Communications recommended that this figure

[33] Mr James Brown, Space Industry Association of Australia (SIAA), *Committee Hansard*, Sydney, 19 April 2021, p. 32; Space Industry Association of Australia, Submission 83, pages 2 and 5.

[34] Asia Pacific Aerospace Consultants, *Submission 76*, p. 7.

[35] Asia Pacific Aerospace Consultants, *Submission 76*, p. 7.

be even higher. It suggested an eventual budget of 0.1 per cent or $500 million a year, to be provided within 5 years.[36]

2.23 The strategic value of comparable funding was highlighted by Moonshot, Australia's first space technology incubator. It noted that without government support, Australia does not have the 'heritage' or 'capital' available to operate at the same pace as other global space sectors. Specifically it said:

> Today, other governments are spending relatively larger amounts into space programs and procuring space services that help their local sectors establish a base level of space sector capability. This creates a platform on which the private sector can build from, as it can develop differentiated products and services for other private sector customers both local and global.[37]

2.24 Building on this, Sitael Australia recommended that increased government funding should be aligned to the *Australian Civil Space Strategy 2019 – 2028*. It stated that the strategy was released without a significant funding announcement to deliver it, and that the Moon to Mars initiative, which comprises the majority of ASA funding, is not incorporated into the overall strategy.[38]

Statutory authority

2.25 There is overwhelming support and praise for the ASA, its establishment, and achievements to date. Many submissions and witnesses described the game-changing nature of a central agency to signal government intent, drive growth and provide a front door to Australia's space industry.

2.26 Earth Observation Australia (EOA) stated that the ASA's formation and its activities have 'galvanised the Australian space industry and given Australia credibility in the global space sector.'[39]

2.27 The SIAA noted the 'extraordinary growth in [its] membership in the four years since the ASA was announced[40] , and international companies, Airbus,

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36 Small World Communications, *Submission 4*, p. 1.

37 Moonshot, *Submission 58*, p. 3.

38 Sitael Australia, *Submission 36*, p. 2.

39 Earth Observation Australia, *Submission 21,* p. 1.

40 Mr James Brown, Space Industry Association of Australia (SIAA), *Committee Hansard*, Sydney, 19 April 2021, p. 32.

Sitael Australia and MDA all cited the establishment of the ASA as a catalyst for increased engagement with Australia's space industry.[41]

2.28 Notwithstanding the significant difference the creation of the ASA has made to the Australian space industry, stakeholders made several suggestions for improving the current structure, operation and administration of the agency. In addition to increasing the ASA's budget, these included:

- establishing the ASA as a statutory authority
- separating its industry engagement and regulatory functions
- establishing separate deputy positions within the current agency
- engaging more staff with industry experience or technical expertise
- improving education and awareness of regulatory processes including the development and provision of regulatory guidance documents.

2.29 Establishing the ASA as a statutory authority is in keeping with the recommendation of the Expert Reference Group Report and was widely supported in evidence to the inquiry.[42] Southern Launch Space argued that the ASA as a statutory authority would allow for 'better coordination on space matters across government, greater efficiency in the application assessment process and could allow Federal Parliament to delegate some of its legislative power to the agency'.[43] It contends that a statutory authority would be in a better position to 'respond to the rapidly developing space industry in a timely and proactive manner.[44]

2.30 Similarly, Dr Graeme Kernich, Chief Executive Officer, FronterSI set out the value of such a change:

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41 Mr Martin Rowse, Key Account Manager, Airbus, *Committee Hansard*, Canberra, 26 February 2021, p. 10; Mr Mark Ramsey, General Manager, Sitael Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 9; Mr Ian McLeod, Vice President, International, MDA, *Committee Hansard*, Canberra, Friday 28 May 2021, p. 8.

42 The final report of the Expert Reference Group for its Review of Australia's Space Industry Capability was released in March 2018. Department of Industry, Science, Energy and Resources, 'Review of Australia's Space Industry Capability – Report from the Expert Reference Group for the Review,' March 2018, www.industry.gov.au/sites/default/files/June%202018/document/pdf/review_of_australias_space_industry_capability_-_report_from_the_expert_reference_group.pdf?acsf_files_redirect

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43 Southern Launch, *Submission 46*, p. 30.

44 Southern Launch, *Submission 46*, p. 30.

> …the establishment of the Australian Space Agency as a statutory body with sustained funding will provide a focal point for an established space strategy that builds on the current space priorities. This provides a capability and avenue for procurement of sustained national space missions and provides confidence to industry to invest in space in the long term. Coordination of national programs of work is key to ensuring alignment of space endeavours with national challenges.[45]

2.31 Other stakeholders including Inovor Technologies, Sitael Australia, the SIAA, APAC, and the Space Law Council of Australia and New Zealand (SLCANZ) all supported the ASA rebranding as a statutory authority.[46]

2.32 Separating the industry and regulatory functions of the ASA is discussed in chapter 4.

National space plan and missions

2.33 Governments around the world have been central to building a national space industry. Retired Air Vice-Marshal Hart, AM, Queensland Defence Advisor for Aerospace argued that due to the complex nature of the space industry and the range of infrastructure, regulation and cooperation required to support it, national leadership is needed to provide direction and focus. He told the Committee:

> Space is probably recognised, I think, as one of the most challenging environments, requiring a really heavily multidisciplinary approach. And that's why around the globe there's no space capability or no space nation that hasn't been led by a government, by a national level government, or supported by that national level government. It's not something you can see organically grow out of commercial enterprise. It needs that national leadership…And so no matter what we do we need that focus, not just on regulation, but on building capability and understanding what we want to do as a nation.[47]

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45 Dr Greame Kernich, Chief Executive Officer, FrontierSI, *Committee Hansard,* Canberra, 16 September 2021, p. 5.

46 Dr Matthew Tetlow, Chief Executive Officer, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 14; Mr Mark Ramsey, General Manager, Sitael Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 15; Mr James Brown, Space Industry Association of Australia (SIAA), *Committee Hansard,* Sydney, 19 April 2021, p. 33; Space Law Council of Australia and New Zealand, *Submission 14*, p. 8; Asia Pacific Aerospace Consultants, *Submission 76*, p. 7.

47 Air Vice-Marshal Hart, AM (Retired), Queensland Defence Advisor for Aerospace, *Committee Hansard,* Brisbane, 6 May 2021, p. 48.

2.34 Stakeholders told the Committee that Australia needs a national space plan or strategy consisting of a series of space missions to grow the domestic space industry. This means determining what Australia wants to do as a space faring country, what capabilities are needed to do it and seeking that from the Australian space sector.

2.35 Professor Paul Tregoning promoted the value of a 'very good, overarching, well-thought-out plan' to help Australian industry understand 'where Australia wants to go' and what is needed to achieve it.[48] Dr Peter Woodgate, Chair of Board, SmartSat CRC made a similar point, highlighting the importance of a national space plan that ties into the ASA roadmaps:

> This needs to lay itself out, in an overarching set of priorities, a set of space missions looking forward over the next decade. We need the detail. We must also identify what we need to own as a nation. This should absolutely be a critical priority for us over the next couple of years. We need to control our own destiny and this is the way of doing it. The plan should build on the very good work of the Australian Space Agency on its national plan and all the roadmaps which are under development.[49]

2.36 The benefits of a more strategic space program are far reaching and include:

- offers a sustained pipeline of work for industry
- provides clarity and certainty about the type of space related work required over the coming decades
- helps to manage and address national problems and challenges
- enables Australian businesses to build global credibility
- stimulates innovation and facilitates a 'disruptive capacity'
- attracts investment by providing certainty
- increases opportunities for international collaboration
- inspires and encourages people to be part of a future space workforce

2.37 Underpinning the success of a national space program is the 'planning of missions across time and planning continuity'.[50] Investment in long term space missions is central to models adopted by other countries.[51]

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48 Professor Paul Tregoning, Head, Geodesy Group, Australian National University, *Committee Hansard*, Canberra, 26 May 2021, p. 4.

49 Dr Peter Woodgate, Chair of Board, SmartSat CRC, *Committee Hansard*, Adelaide, 10 March 2021, p. 44.

50 Ms Eva Rodriguez Rodriguez, Space Lead, FrontierSI, *Committee Hasnsard*, Canberra, 16 September 2021, pages 8-9.

2.38 Fronter SI advocated for a 'firm commitment' to a series of space missions which address national challenges, and explained:

> This serves to engage and develop capability in industry and Australian SMEs in particular, and to showcase research and technology outcomes to the public and the world. It also provides opportunities to partner in to the global space industry and demonstrate the impact of integrating space solutions further into our existing industry supply chains. This should build on our strengths and focus on end-user driven application areas and markets of interest in the national economy, areas such as natural resource management, disaster resilience and urban and regional development.[52]

2.39 Establishing a national program and space missions allows industry and stakeholders to make informed decisions about where they want to invest and develop capabilities. Mr James Brown, Chief Executive Officer, SIAA told the Committee:

> If you're a small company looking to scale and you're trying to convince investors to put their money behind your activity, you need to show that there's an opportunity or a market. Small grants from the Space Agency don't achieve that. But if you were able to say, 'Well, the Space Agency has said that Australia, in the next 10 years, on this time line, is going to build a constellation that does bushfire detection,' for example, or, 'is going to build a constellation that does water monitoring,' or, 'is going to do what Israel did,' for example, 'and put a spacecraft on the moon for civilian science reasons,' then you'd have that predictable time line; you'd have that long-term time line.[53]

2.40 Moonshot made the same point. Chief Executive Officer, Mr Troy McCann told the Committee:

> I think one of the things we need to do is strike a balance of government investment into the space sector as well as private investment.
>
> ... But one of the things that I've noticed, if we want to increase that amount, is that the private sector is kind of stepping back and waiting to see: 'What is the vision of the Australian government? What are they looking at doing in space? If we're going to put our money somewhere, are they going to put it in

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51 Mr James Brown, Space Industry Association of Australia (SIAA), *Committee Hansard,* Sydney, 19 April 2021, p. 33.

52 Dr Graeme Kernich, Chief Executive Officer, FronterSI, *Committee Hansard,* Canberra, 16 September 2021, p. 5.

53 Mr James Brown, Space Industry Association of Australia (SIAA), *Committee Hansard,* Sydney, 19 April 2021, p. 34.

> competition? How do we work together more collaboratively with that?' So, when we're talking to international investors and saying, 'Come on board with us; have a look at the groups that we're growing,' they're looking at those sorts of things as well.[54]

2.41 Moonshot suggested that the ASA be provided with a mandate to collaborate with allied space agencies in conducting strategic government-funded space missions.[55] This was identified as being critical to defining a unifying vision for the space sector to assemble around, while allowing the sector to leverage knowledge and capability transfer of international partners as Australia creates a base level of essential space capability.[56]

2.42 The opportunity to work on national space programs and missions can spark further opportunities for those within the space industry to develop their own space capabilities domestically, and use their skills and experience to win international contracts. APAC noted that the majority of major space companies have developed their space capability by working on national Government programs.[57] It argued that without such programs Australia will continue to have a 'credibility gap', and this gap will prevent the space industry from performing economically and internationally. APAC explained the flow on effect of accessible national space programs:

> At a basic level delivering the type of growth desired for the Australian space sector will require an increase in Australian exports in space products and services. At its core the pathway to export growth is an issue of establishing credibility which requires successful demonstration of capability on a platform and in a way that is widely visible to others. The traditional method of achieving this credibility in the space industry has initially been through participation in national space programs.[58]

2.43 Professor Russell Boyce, Director, University of New South Wales (UNSW) Canberra Space argued that Australian space missions should be research-led and given priority alongside operational and capability building missions. This is because research-led missions are likely to drive disruptive innovation which is needed for a globally competitive domestic space

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54 Mr Troy McCann, Chief Executive Officer, Moonshot, *Committee Hansard*, Sydney, 19 April 2021, p. 22.

55 Moonshot, *Submission 58*, p. 5.

56 Moonshot, *Submission 58*, p. 5.

57 Asia Pacific Aerospace Consultants, *Submission 76*, pages 7-8.

58 Asia Pacific Aerospace Consultants, *Submission 76*, p. 8.

industry.[59] Here, disruptive innovation describes a process whereby a smaller company with fewer resources is able to successfully challenge established incumbent businesses, and develop commercially competitive skills and products as a result.[60]

2.44 In articulating its support for an ambitious civil national space program, Sitael Australia summarised the following key elements:

- provide a uniting vision and purpose for the ASA, driving an outcome focussed culture, and inspiring the Australian public
- include multiple projects under each of the Australian Civil Space Strategy priority areas
- be funded to deliver value to the nation, driving economic growth and social benefit, whilst maintaining an inspirational focus particularly in Science Technology Engineering and Mathematics (STEM) outreach
- include a high level of Australian industry content in its delivery, and used to deliver against the goal of tripling the Australian space industry by 2030
- include a technology development stream, with regular calls for proposals (i.e. quarterly) to supercharge innovation and grow space research and development in Australia
- include international cooperation through bilateral Agency contribution to mutually agreed projects, to drive sustainable cooperation with partner nations
- directly address the lack of space qualified and experienced individuals in Australia.[61]

2.45 Several witnesses identified the benefits of communicating a vision for space, not just for industry but for the country. SkyKraft called on the ASA to drive an Australian space vision to 'rally the Australian people around a dream that can be achieved'.[62] This vision needs to 'raise the interest of the Australian public and be of suitable breadth and scale to grow the Australian space eco-system'.[63] Shaol noted that government can stimulate and foster the growth of new space industries with a vision of Australia as a

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59 University of New South Wales (UNSW) Canberra Space, *Submission 73,* p. 6; UNSW Canberra Space, *Submission 73.1*, Answer to Question on Notice, p. [4].

60 UNSW Canberra, *Submission 73*, p. 5.

61 Sitael Australia, *Submission 36*, pages 1-2.

62 Skykraft, *Submission 10*, pages 2-3.

63 Skykraft, *Submission 10*, p. 3.

resilient Space 2.0 age society, articulating its inclusiveness and benefits to all Australians.[64]

2.46 In promoting the need for a national space vision, SmartSat CRC identified the following key elements:

- a vision supported by a nationally conceived space architecture addressing national security, economic prosperity and social benefit
- a collective commitment by government and key stakeholders to stay the course in implementing the vision over the decade to come
- coordination through the leadership of the ASA
- an increase in the tempo of decision making and actioning
- a willing R&D ecosystem that is collaborative and agile and focussed on high impact needs.[65]

2.47 As a starting point, SmartSat CRC offered the following vision statement for wider public consideration: *Australia is the recognised leader in space systems and services in our part of the hemisphere by 2030.*[66]

2.48 In his evidence to the Committee, Mr Enrico Palermo, Head of Agency, ASA, told the Committee that the ASA roadmaps currently under development will address many of the issues raised by stakeholders regarding a national vision, space missions, and investment priorities. Mr Palmero also shared his thoughts on the ASA becoming a statutory authority. He told the Committee:

> …in the coming months we will be publishing the remainder of our road maps. That's going to be very key to addressing a lot of the things that we've discussed today: What is the infrastructure we need? What are the market opportunities? What are the missions we want in the future? Our CTO and wider team across government is working on those road maps, which are really going to set the vision and aspirational targets and also guide government on where best to invest. We've touched on the statutory authority piece. I think that's something the nation wants and it should be considered as part of this review.[67]

Government contracts and procuring locally

64 Shoal, *Submission 5.2*, p. 10.

65 SmartSat CRC, *Submission 29.1,* p. 4.

66 SmartSat CRC, *Submission 29.1*, p. 3.

67 Mr Enrico Palmero, ASA, *Committee Hansard*, Canberra, 20 September, p. 30.

2.49 Governments are still the major clients for most space activity.[68] This is no different in Australia, with the Australian Government being one of the largest purchasers of space data and services in the country.[69] However, a large percentage of Australian Government purchases are made to companies overseas.[70] This may be due, in part, to a perceived lack of capability within the Australian space sector.

2.50 Restructuring the way funding is provided to industry was raised as a way to build this domestic capacity as well as confidence and certainty within the sector. Stakeholders consistently advocated for a shift from grant based funding to industry contracts. For example, the Queensland Government stated:

> Federal space grants and funding programs, such as Moon to Mars and Payload Qualification, are capability agnostic in that they do not guide industry towards known sovereign capability requirements or market gaps. Instead, when applying for funding programs, an applicant's challenge is to build a case about why their capability or project should be funded. While this potentially might identify previously unknown capabilities it may not optimise the resources allocated to developing Australia's sovereign space industry.[71]

2.51 Southern Launch Australia stated that providing contracts to Australian companies is more beneficial than other forms of funding such as grants, as it delivers guaranteed work.[72] This creates more certainty for small start-ups and small and medium enterprises (SMEs) looking to grow their business. For government, contracts help to build a resilient supply chain, create jobs, and allows for the collection and distribution of more accurate, custom data for the Australian context.[73] In their joint submission, Gilmour Space and Equatorial Launch Australia joined Southern Launch Australia to recommend that future government investment in the space sector be

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68 Mr James Brown, Space Industry Association of Australia (SIAA), *Committee Hansard,* Sydney, 19 April 2021, p. 34.

69 Asia Pacific Aerospace Consultants, *Submission 76*, p. 10.

70 Asia Pacific Aerospace Consultants, *Submission 76*, p. 10.

71 Queensland Government, *Submission 60,* p. 3.

72 Southern Launch, *Submission 46*, p. 35.

73 Southern Launch, *Submission 46*, p. 35.

provided in the form of contracts that preference Australian owned and operated industry content.[74]

2.52 The current grants based funding was described as problematic for industry. Dr Matthew Tetlow, Chief Executive Officer, Inovor Technologies, told the Committee:

> …we've got to have a look at how some of the programs are structured, where you have this co-investment or you have these grant-type mechanisms that don't allow profit—and, in fact, oblige the company to make a loss—to try to find the in-kind support.
>
> … what we need is industry to grow up and deliver contracts to say, 'We'll deliver this capability,' and learn to do that. If we just continue with these grants which don't necessarily have a concrete outcome and they are partially funded then industry is going to really struggle to make ends meet or basically justify going after them.[75]

2.53 Furthermore, the Committee heard there is a risk the Australian Government is acting as a welfare provider to the space industry by providing one-off non-recurring grants.[76] This is because a grant-based approach does not prepare industry to be commercially competitive.[77]

2.54 Sitael Australia made a similar point. It advocated for the ASA to be restructured to acquire and deliver national capability and projects, moving away from a grant focussed 'industry supporting' agency.[78] It argued that requiring industry co-funding on ASA activities not only presents 'a significant competitive disadvantage', but is ultimately unsustainable, particularly in non-commercial activities.[79] Sitael Australia suggested that grants should only be limited to small innovation and development projects.

2.55 Stakeholders advocated for Australian governments to preference procurement of Australian space products and services. This is fundamental

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74 Southern Launch, *Submission 46*, p. 4; Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 4;

75 Dr Matthew Tetlow, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 14.

76 Professor Russell Boyce, Director, University of New South Wales Canberra Space, *Committee Hansard*, Canberra, 12 May 2021, p. 5.

77 Professor Russell Boyce, University of New South Wales Canberra Space, *Committee Hansard*, Canberra, 12 May 2021, p. 6.

78 Sitael Australia, *Submission 36*, p. 2.

79 Sitael Australia, *Submission 36*, p. 2.

to the Australian space industry establishing credibility. This occurs by providing industry the opportunity to develop space capabilities which can then be sold nationally and internationally. As explained by APAC:

> Australian space companies will have diminished credibility on the international stage if they cannot sell their products and services to their own government. Conversely, the purchase of Australian space products by the Australian Government gives a strong endorsement to the Australian companies and enhances their credibility internationally as a supplier of space products and services.[80]

2.56 Evidence to the Committee suggests there is a tendency for government to look overseas for its space needs either because it is perceived that local industry does not have the capability, or the procurer does not have the time or appetite to take on the perceived risk of an untested Australian space company. Furthermore, there is no requirement in government procurement contracts for Australian content to be used. This can result in missed opportunities for the Australian space sector.

2.57 Mr William Barrett, Senior Vice President, APAC stressed the significance of engaging Australian space companies and encouraged the Australian Government to be less risk adverse. Specifically Mr Barrett said:

> Rather than saying, 'we're only going to buy someone who's actually put this up there and has this experience' et cetera, we ought to be able to find a way to open the envelope a little bit so that you can take a slightly higher risk profile. That may mean the project might take a little bit longer. But, since we've waited 20-odd years for this, maybe that's not such a risk, in order to give a chance to Australian companies to participate in these things and earn their spurs. Once they've earned their reputation—done a good job in a project like that—the world is their oyster. They actually have the ability to point to that, say: 'We have done this for the Australian government. This is a successful program. We can deliver for what you are looking for, NASA or ESA or JAXA.' So that is one of the ways that the Australian government could do this.[81]

2.58 Mr Barnett referred specifically to the procurement of SBAS - a space based augmentation system for GPS signals - by the Commonwealth Department of Defence which has 'no requirement for Australian participation'. He

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80 Asia Pacific Aerospace Consultants, *Submission 76*, p. 10.

81 Mr William Barrett, Senior Vice President, Asia Pacific Aerospace Consultants Pty Ltd, *Committee Hansard*, Sydney, 19 April 2021, p. 39.

emphasized that Australia '[needs] to build some slack in there so that perhaps we accept a little bit of a broader risk profile'.[82]

2.59 Mr Troy McCann, Chief Executive Officer, Moonshot emphasized the same point when highlighting the purchase of a satellite by the Office of National Intelligence from American company, Spire, without giving the Australian space industry an opportunity to do it. He told the Committee:

> I 100 per cent believe that in Australia we had the capability to put something like that together. There are no companies at the moment, to my knowledge, that are selling that specific thing, which, as I understand it, was the reason why no Australian companies were selected. I think the line that I heard was that Spire could produce one of these satellites within 48 hours, so that's why it was decided that they'd go for them, which was a little bit unfortunate, because we have the capability here. We can form those supply chains. If we had given ourselves an opportunity to try it, we could have done that here and we could have built up a few more businesses that can start selling those capabilities internationally ourselves, because we know that governments around the world all want that. So I feel like we missed a great opportunity here.[83]

2.60 Mr McCann described this as another example of a government department that is 'very risk averse' prioritising the product over the policy to build the domestic space industry.[84]

2.61 Stakeholders suggested that more needs to be done to ensure that at least some Australian content is mandated for government procurement, particularly when this is a policy of international competitors. Dr Matthew Tetlow told the Committee:

> Most other countries have specific policies to ensure that space technology and know-how is locally owned and controlled, as they understand the commercial value of the space industry to their economies, not to mention the issue of sovereign priority access to technology when they need it. Australia, by comparison, does not mandate this federally or at the state level to support the Australian commercial space sector. Australian space tenders are usually

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82 Mr William Barrett, Senior Vice President, Asia Pacific Aerospace Consultants Pty Ltd, *Committee Hansard*, Sydney, 19 April 2021, p. 39.

83 Mr Troy McCann, CEO, Moonshot, *Committee Hansard,* Sydney, 19 April 2021, p. 24.

84 Mr Troy McCann, CEO, Moonshot, *Committee Hansard,* Sydney, 19 April 2021, p. 25.

> open to all international companies and sometimes don't even consider Australian industry content as part of the evaluation criteria. [85]

2.62 Strengthening procurement policies to consider Australian space content over potential cost savings from outsourced or imported capability was identified as a needed change.[86] For example, Vocus, an Australian-owned specialist fibre and network solutions provider, stated:

> the Australian Government is likely to face decision points where it will be faster and more affordable to procure infrastructure and services developed overseas. While such an approach may deliver short-term results, policy settings and procurement frameworks should be tuned to develop long-term local capacity which builds Australian industry expertise and will position Australia to be an exporter of space and satellite products – as well as serving the local market.[87]

2.63 In addressing the policy and funding arrangements Australia will require for the long term growth of the space sector, Mr Enrico Palmero, Head of Agency, ASA told the Committee, that he takes an 'integrated view'. Specifically, Mr Palmero said:

> I think it's widely understood across government and in the sector, as you've received through feedback, that the grants alone won't be enough to grow the sector to its full potential. That said, grants have their place—low technology readiness level development or perhaps investing in some key infrastructure. It's horses for courses with different mechanisms for investment. It's not always investment; it may be policy, regulation or other financial stimulus that all need to come together into an integrated suite of investments. We've seen other jurisdictions having procurement programs as a stimulator for the sector; we've seen that in the US, with various things in its program. As we look to the future, I think there's definitely consideration to be given to how we can signal government as a potential customer for programs.[88]

2.64 Noting the challenges faced by industry to engage with government, the SLCANZ made a series of recommendations aimed at supporting the Australian space industry navigate government markets for space products and technologies, particularly government procurement processes. It suggested:

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85 Dr Matthew Tetlow, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 9.

86 Vocus, *Submission 45*, p. 2.

87 Vocus, *Submission 45*, p. 2.

88 Mr Enrico Palmero, ASA, *Committee Hansard*, Canberra, 20 September, p. 27.

- reviewing the Commonwealth Procurement Rules (CPR) with a focus on the impact on Australian space industries
- resourcing Business Advisers with specific space industry expertise to assist government customers (for example similar to the Centre for Defence Industry Capability Business Advisor roles)
- supporting new space industry participants with navigating the CPRs when they are participating in government procurements for space goods and services
- working with industry and lawyers to draft a suite of appropriate contracts based on common types of space goods and services that government departments are procuring.[89]

2.65 Providing guidance to industry for dealing with government and procurement processes was also raised by other stakeholders.

Alignment of civil and defence programs

2.66 Australian civil and defence space matters are managed by separate Commonwealth entities. While the ASA coordinates civil space matters, the Department of Defence is responsible for Australia's national security and defence in space. Both agencies work together where civil and space activities interact.[90]

2.67 Over the next decade, the Australian Government will invest around $7 billion in defence space capabilities under its 2020 Force Structure Plan. This plan aims to improve the resilience and self-reliance of Defence's space capabilities, and enhance a large number of space-dependent capabilities, including communications satellites and ground control stations.[91]

2.68 A common theme in the inquiry was that Australian defence and civil space priorities and programs should be better aligned and coordinated. This is because space and defence are closely related and interdependent. As explained by Electro Optic Systems (EOS):

> A lot of defence functions depend on space technology to operate, while space technology often develops as a result of defence investment and expertise. The same applies to space and defence industries, which often share skills,

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89 Space Law Council of Australia and New Zealand, *Submission 14*, p. 6.

90 Australian Space Agency, *Submission 55*, p. 36.

91 Department of Defence, '2020 Force Structure Plan,' https://www1.defence.gov.au/about/publications/2020-force-structure-plan .

> facilities and technology. Understanding and leveraging this interrelationship at both the capability and industry level will be crucial for expanding Australia's space sector.[92]

2.69 By recognising the existing civil-defence space relationship and supporting its growth, EOS argues that technology and expertise will flow between the two sectors, and production and adoption of new systems and intellectual property (IP) will accelerate and be mutually beneficial.[93] Furthermore, given Defence's access to considerable funding for R&D and capability development, and the civil industry's wealth of academic research and private entrepreneurship, both sides have a great deal to gain.[94]

2.70 Symbios Communications noted that 'smart national space programs optimise leverage between civil and defence program spending'.[95] In its submission it stated that:

> In particular for small national space budgets, complementarity between civil and national defence spending needs to be maximised. There is no room for protectionism by the military and there should be maximum overlap where practical with civil programmes. This is especially apparent in the Earth observation domain, where there can be a high degree of overlap between the requirements of both communities. If well executed and well constructed, shared capital expenditure and operations can provide efficiencies and strengthen national capacity.[96]

2.71 Space technology is often described as 'dual use'; that is, it can support both industries. The CSIRO explained:

> a significant proportion of the space industry, particularly those parts relating to Earth observation, communications, position, navigation and timing, space domain awareness, and space launch, can equally service civilian and Defence markets. With Defence as the primary Australian customer for space capability, Australia's space capability and industry growth goals should be complementary to Defence space capability needs, particularly with regard to areas in which it would be desirable to develop sovereign capability.[97]

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92 Electro Optic Systems, *Submission 47*, p. 16.

93 Electro Optic Systems, *Submission 47*, p. 16.

94 Electro Optic Systems, *Submission 47*, p. 16.

95 Symbios Communications, *Submission 30*, p. 2.

96 Symbios Communications, *Submission 30*, p. 2.

97 Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission 11*, p. 11.

2.72 Northrop Grumman made the same point. It submitted that the industry does not reflect a clear distinction between military and civil capabilities since many technologies are dual use.[98] It called for an increased level of coordination and oversight to help focus industry investments and ensure a coherent national strategy that achieves civil and military objectives. For example, it noted that while the ASA has identified six National Civil Space Priorities, there are many military space pursuits that would align with these priorities.[99] A national governance framework would give foreign and domestic industry the investment certainty to skill their workforce appropriately and strive towards commercialising their products to an economically viable level.[100]

2.73 Boeing Australia also stressed the need for a consolidated set of space priorities to help target space investments. It asserted:

> By aligning Australia's cross-domain space requirements, industry can better understand and target future space investments in Australia, and this is especially critical given ongoing work to support the men and women of the Australian Defence Force with satellite communications and other space based capabilities. These are critical, not just for our ADF mission success but also for our allies, particularly in the Five Eyes community.[101]

2.74 The Committee heard that while Australia's defence budget 'will do more than any other initiative to assist the Australian space industry in reaching a sustainable scale and capability level' there is a risk that these opportunities will be missed or at the very least, not fully realised.[102] Greater coordination of defence and civil space industry policy and investment is therefore needed to minimise these risks. The SIAA stated:

> Whilst the Space Agency liaises extensively with defence, there is currently no formal mechanism to resolve differing space priorities between Australia's defence space program and civilian space activities.

98 Northrop Grumman Australia, *Submission 27,* p. 7.

99 Northrop Grumman Australia, *Submission 27,* p. 7.

100 Northrop Grumman Australia, *Submission 27,* p. 7.

101 Dr Brendan Nelson, President, Boeing Australia, *Committee Hansard,* Brisbane, 6 May 2021, p. 2.

102 Space Industry Association of Australia, *Submission 83*, p. 8.

> …a significant risk to Australia's 2030 space goals is that the cadence of defence acquisition decisions may not be optimally aligned to the evolution of Australian space industry.[103]

2.75 While acknowledging that some operational requirements offer little flexibility to coordinate national security space programs with domestic industry capabilities and timelines, the SIAA argued for high level government oversight of space industry development to ensure that defence and civilian space industry investment and development are coordinated and mutually reinforcing.[104] The SIAA recommended:

- a National Space Strategy to better coordinate whole of government efforts and priorities for space
- appointment of a National Space Adviser within the Department of Prime Minister and Cabinet, with responsibility for strategic space issues and international liaison on national security space matters
- development and publication of unclassified space policy and doctrinal documents that provide a more comprehensive insight into the operational drivers of major space acquisitions.[105]

2.76 Sitael Australia also suggested that consideration be given to how civilian and defence space activities could be coordinated at a ministerial level, to maximise national outcomes[106] while EOS recommended that the ASA be empowered to help shape Defence programs to better consider civil space priorities, particularly the capabilities, potential and interests of civil space companies.[107]

DEF 799

2.77 Professor Stuart Phinn, Director, Earth Observation Australia used the example of DEF 799, a geospatial defence intelligence project to highlight the benefit of national coordination. He told the Committee:

> the coordination across civil and defence, and that high-level in camera meeting you were talking about would help tremendously. Particularly in the earth observation space, you have DEF 799, which is a geospatial intelligence

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103 Space Industry Association of Australia, *Submission 83*, p. 8.

104 Space Industry Association of Australia, *Submission 83*, p. 8.

105 Space Industry Association of Australia, *Submission 83*, p. 8.

106 Sitael Australia, *Submission 36*, p. 3.

107 Electro Optic Systems, *Submission 47*, p. 17.

> project, which is sort of sitting out separate to what we're doing in the civil space. Those two really would benefit from being brought together...[108]

2.78 Other submitters also noted the potential of DEF 799 to the civilian industry. For example the South Australian Government recommended support for industry to design, build, launch and deliver a constellation of sovereign satellites for Australian needs, including Defence projects such as DEF 799.[109] Mr Martin Rowse, Key Account Manager, Space, Airbus told the Committee that DEF 799 'should be a sovereign capability for Australia' noting that it has smallsat, launch and payload capability to support the project.[110]

2.79 The ASA provided further information about DEF 799 stating that Defence will continue to engage with stakeholders to understand how this capability could be supported by Australian industry.[111]

2.80 In response to calls throughout the inquiry for a national space strategy and better alignment of civil and defence priorities and programs, Mr Enrico Palermo told the Committee that a refresh of the Civil Space Strategy, which was published in April 2019, presents a good opportunity to address these issues.[112]

National coordination

2.81 The Australian space industry spans across federal and state governments, with a presence in each state and territory. The Committee received submissions from each jurisdiction highlighting the breadth of space related capability, technology, and infrastructure across the country.

2.82 In addition to coordinating civil and defence space priorities, the Committee heard there is a need to coordinate overlapping and sometimes competing state and territory policies and initiatives. Furthermore, the success and continued growth of the Australian space industry will require a nationally collaborative approach which draws on the particular strengths of Australia's states and territories.[113]

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108 Professor Stuart Phinn, President, Earth Observation Australia, *Committee Hansard,* Brisbane, 6 May 2021, p. 32.

109 South Australian Government, *Submission 56*, p. 8.

110 Mr Martin Rowse, Airbus, *Committee Hansard*, Canberra, 26 February 2021, p. 13.

111 ASA, *Submission 55*, p. 38.

112 Mr Enrico Palermo, ASA, *Committee Hansard*, Canberra, 20 September 2021, p. 32.

113 ACT Government, *Submission 82*, p. 10.

2.83 The NSW Government called for greater collaboration within and between states. In particular, it suggested that the strengths and capabilities of each jurisdiction be mapped so that national initiatives can be strategically designed and implemented in appropriate locations.[114] While acknowledging that competition is important for ensuring that capabilities are robust and effective, the NSW Government stressed that collaboration be prioritised given the relatively small size of the Australian space industry.[115]

2.84 Mr Blake Nikolic, Chief Executive Officer, Black Sky Aerospace also emphasized the need to prioritise the strengths of state and territories and work together. He told the Committee that a lack of states and territory cooperation is one of the challenges experienced by his company:

> Many seem to have forgotten that, first and foremost, we—Australia—are a country that can unite as one. Instead we have a state-versus-state rivalry which detracts from the objectives and, frankly, is often embarrassing in the international arena. Of course there'll be crossovers; however, states should cooperate to each prioritise their strengths—for example, Queensland in manufacturing, the Northern Territory with opportunities for equatorial launches and South Australia with satellite and sensor development. The list is extensive.[116]

2.85 ANU InSpace expressed the same view calling for space initiatives, funding and goals to remain national for 'maximum future benefits and economic growth':

> Our greatest concern about the Australian space industry today is the potential fracturing of the national industry into state sub-industries. The creation of these smaller, competing, state-led space efforts stops us from maximising national growth, harnessing areas of regional strength for the wider good and taking a holistic view of jobs and growth. We need to preserve national strength to compete on a global scale.[117]

2.86 Southern Launch recommended the ASA explore options to integrate with existing state and Commonwealth authorities who regulate other aspects of space activity, for example, import and export controls, emergency management, and environmental approvals. It sees potential for the ASA to

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114 NSW Government, *Submission 75*, p. 13.

115 NSW Government, *Submission 75*, p. 13.

116 Mr Blake Nikolic, Chief Executive Officer, Black Sky Aerospace, *Committee Hansard*, Brisbane, 6 May 2021, p. 8.

117 ANU Inspace, *Submission 18*, p. 3.

be a 'one-stop shop' for all regulatory matters, increasing efficiencies and coordination on Australian space activity.[118]

Commonwealth bodies and forums

2.87 With renewed focus on the domestic space industry, and the critical role of space to our lives, stakeholders identified mechanisms to better coordinate national efforts and improve access to industry expertise. This included giving space a more visible presence across government and the Parliament.

2.88 Boeing Australia advocated for co-ordination of Australia's defence, commercial and civil space strategies as a key priority.[119] It stated that multiple activities are currently occurring in many areas of government and the private sector and by aligning Australia's cross-domain space requirements, industry will be able to better understand and target future investments in Australia, as well as risks to its broader security.

2.89 Dr Brendan Nelson, President, Boeing Australia, New Zealand and South Pacific, told the Committee:

> There needs to be an overall coordination of our entire space effort not just for the development and manufacture of sovereign domestic space related technologies and capabilities, but also to ensure that everybody in every part of the sector is aware of the potential risks to our economic, social and other forms of security. From our point of view, at the moment there is a lot of money in defence, there's money in different parts of government supported programs and there are different areas of responsibility for space held in different portfolios. For us, what ideally should happen is there should be a single, overarching process which brings together the defence, commercial and institutional elements of space.[120]

2.90 To facilitate this strategic direction and coordination, Boeing Australia recommended the establishment of a Ministerial Council – comprising key federal and state ministers, industry players, researchers and stakeholders – to oversee the further development of the space industry, and bring together the disparate elements of the industry and government agencies supporting it.[121]

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118 Southern Launch, *Submission 46*, p. 30.

119 Boeing Australia, *Supplementary submission 80.1*, p. 2.

120 Dr Brendan Nelson, Boeing Australia, *Committee Hansard*, Brisbane, 6 May 2021, p. 4.

121 Boeing Australia, *Supplementary submission 80.1*, p. 2.

2.91 In setting out a framework for the operation of the Ministerial Council, Boeing Australia identified the following features:

- the Council would meet three times a year and be chaired by the Ministers for Defence Industry, Industry Science and Technology, Education, Transport and Regional Development, Employment and Workforce Skills.
- the Council would be supported and coordinated by the Department of Prime Minister and Cabinet and the Chief Scientist, and could include representatives from the ASA, the Department of Defence, peak engineering, science and technology organisations in the field of space, the CSIRO, a cross section of industry, universities and vocational education providers, state and territory governments and eminent persons in the field of space research, innovation and manufacturing, and regional Australia.
- Members of the Council would be required to canvas widely within their sector for issues to be considered and views to be placed before the Ministerial Council.
- the Council would establish working groups to address key challenges and issues for each meeting at which presentations would be made for consideration by Ministers.
- meetings could be held in Canberra but also elsewhere, providing opportunities to stimulate further public interest in Australia's Space Program. It would also expose Council members directly to infrastructure and activities related to Council's work.
- Council meetings could be preceded or followed by a dinner addressed by a speaker on a topic relevant to the work program.[122]

2.92 The concept of a whole-of-government Ministerial meeting to oversee the development of the space industry was supported by other stakeholders.

2.93 Other suggestions included those put forward by the SIAA, Southern Launch and Mr Scott Schneider. The SIAA suggested establishing a Joint Standing Committee on Space as part of the Parliamentary committee system, and a specific space researcher position within the Australian Parliamentary Library to assist the work of Members and Senators.[123]

2.94 Southern Launch recommended that a taskforce or inquiry be established to examine the 'practical uses, and opportunities to use, emerging space

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122 Boeing Australia, *Supplementary submission 80.1*, p. 2.

123 Space Industry Association of Australia, *Submission 83*, p. 2.

technologies in the Australian context'.[124] It advocated for any findings to be made public to inform industry decision making.[125]

2.95 Mr Scott Schneider suggested the Government consider input from industry and stakeholders in a more comprehensive manner, in particular by improving engagement between industry and the Space Industry Leaders Forum (the forum) and undertaking a review of the effectiveness of the forum as a mechanism for reaching the 2030 space targets.[126]

Expert advisers

2.96 Some stakeholders advocated for specific expert advisers to assist government in its procurement of space products and services, and to inform the development and implementation of national missions.[127] This was described as trusted 'above-the-line expert advice'; similar in style to rural research and development corporations (RDCs), and the USA's federally funded research and development centres (FFRDCs) and university affiliated research centers (UARCs) such as Aerospace Corporation.[128]

2.97 Professor Russell Boyce recommended that the Australian Government establish a separate independent body to provide expert technical advice to inform space procurement, space investment and space missions.[129] He described this entity as an extension of the ASA and Defence:

> The Australian Space Agency was not established to be a technical agency like, for example, NASA. It was established to be a coordinating agency to ensure that space industry grows in the country, to set strategy and policy. Therefore, unless government chooses to expand the remit of the Australian Space Agency, there will be a small amount of space hard-core expertise within the agency that can assist, but not to the extent that is needed for what I'm talking

124 Southern Launch, *Submission 46*, p. 34.

125 Southern Launch, *Submission 46*, p. 35.

126 Mr Scott Schneider, *Submission 49*, pages 2-3.

127 Mr Roger Franzen, Director, Earthspace, *Committee Hansard,* Canberra, 26 February 2021, pages 36-40; Earthspace, *Submission 23*, p. 6.

128 Mr Roger Franzen, Earthspace, *Committee Hansard,* Canberra, 26 February 2021, pages 36-40

129 Professor Russell Boyce, University of New South Wales Canberra Space, *Committee Hansard,* Canberra, 12 May 2021, p. 2.

about. But, even if you look at NASA, they rely on entities like Aerospace Corporation, as does the US Air Force, as do other agencies in the US.[130]

2.98 Professor Boyce suggested that UNSW Canberra Space could be the basis for such an entity; bringing together key national capability and the provision of 'trusted advice to government, built on deep space engineering and operations expertise'.[131]

130 Professor Russell Boyce, University of New South Wales Canberra Space, *Committee Hansard*, Canberra, 12 May 2021, pp. 2-3.

131 Professor Russell Boyce, University of New South Wales Canberra Space, *Committee Hansard*, Canberra, 12 May 2021, p. 1; University of New South Wales Canberra Space, *Submission 73*, pages 3-4.

Committee comment

2.99 The Australian space industry is enjoying a renewed focus across government and commercial sectors. The benefits to be gained from a globally competitive domestic space industry will have far reaching benefits across all sectors of the economy, greatly improving the way we live and interact with each other. The enthusiasm and commitment of stakeholders to drive these outcomes was evident to the Committee.

2.100 The overwhelming message from the Australian space industry is the need for more national leadership and direction. While the sector has been invigorated by the establishment of the ASA and its achievements, it wants to know what Australia wants to achieve in space. In other words, for the Australian Government to clearly articulate how Australia wants to cement itself and be recognised as a space nation. This will provide confidence and certainly for stakeholders to make informed decisions about investment, capability development, research and development, as well as the education, training and expertise required to support the industry into the future.

2.101 The Committee notes the evidence provided by the ASA regarding the release of its upcoming roadmaps and updated Civil Space Strategy. The Committee supports this work and agrees it will work with the Agency to develop a national direction, including the opportunity to identify national space missions and better align civil and defence priorities and programs.

2.102 Given the renewed interest in Australia's space industry, the rapidly growing global market, and the enormous potential the space industry offers to grow the economy, create jobs and fundamentally improve Australian lives, the Committee supports efforts to strengthen its visibility and prominence across the Australian Government and the Parliament. In particular, it considers the establishment of a Ministerial Council with stakeholders across government and the states and territories as an important means to further develop the industry and improve coordination across and between governments.

2.103 The Committee also considers the upcoming operational review of the ASA a timely opportunity to take stock of the ASA's achievements, the progress and issues raised by the domestic space industry, and the broader changes occurring across the global space sector. It recommends that this review give important consideration to the status of the agency, its future funding and operational requirements needed to support and potentially exceed the stated 2030 goals of government.

Recommendation 1

2.104 The Committee recommends that the Australian Government in consultation with industry seek to define:

- **an overaching vision for the Australian space industry**
- **a set of long term national space priorities to guide and galvanise the Australian space industry**

with the aim of inspiring the Australian public, providing investment confidence, developing Australian space capabilities, and positioning Australia as a globally competitive player.

2.105 The Committee recommends that these national missions be informed by the seven civil space priority roadmaps under development.

Recommendation 2

2.106 The Committee recommends that the Australian Government review the way it delivers funding to the Australian space industry with a focus on the development of space capability and capacity. This includes:

- **broadening the funding streams to include contracts for specific space capability**
- **the necessity for industry co-funding where private entities are likely to be commercially disadvantaged.**

Recommendation 3

2.107 The Committee recommends that the Australian Government examine ways to better coordinate and align civil and defence space priorities and investment.

2.108 The Committee recommends that the Australian Government work with industry to identify current and future opportunities for the civil space sector to support Australian defence space requirements, including on projects such as DEF 799.

Recommendation 4

2.109 The Committee recommends that the Australian Government establish a whole of government Ministerial Council on Space that comprises representatives from Commonwealth and State and Territory governments, stakeholders and industry groups to oversee the further development and coordination of the Australian space industry as a whole.

Recommendation 5

2.110 The Committee recommends that the Australian Government review or strengthen procurement policies and guidelines to ensure that Australian owned and operated space industry content is used where reasonably possible.

2.111 As part of these procurement guidelines Australian Government departments and agencies be required to set out the rationale for procurement of any space products and services obtained from overseas, including why such a capability could not be sourced domestically.

2.112 The Committee recommends that the Australian Government identify suitable points of contact within the Australian Space Agency or the broader Department of Industry, Science, Energy and Resources to assist industry navigate government procurement processes.

Recommendation 6

2.113 The Committee recommends that the Australian Government examine the feasibility of establishing an expert technical advisor, similar to the model adopted in the United States, to support government with procurement of space based products and services, and the development of national missions.

Recommendation 7

2.114 The Committee recommends that the Australian Government examine options to increase the visibility of space across the Government and Parliament to emphasize its importance and communicate its relevance to Australians. This could include but not be limited to:

- **incorporating space as a specific focus of a joint or house parliamentary committee, including in the name of the committee**

- **ensuring that a research position within the Parliamentary Library covers space related issues to ensure that adequate research support is available to Members and Senators**

- **ensuring that adequate positions across the Australian public service can cover the breath of space related issues and matters as they relate to particular departments and agencies.**

Recommendation 8

2.115 The Committee recommends that, as part of the Australian Space Agency's post operational review, the following matters be given careful consideration:

- **establishing the Australian Space Agency as a statutory authority**

- **separating its industry engagement and regulatory functions**

- **future workforce requirements, including engaging more staff with industry experience and technical expertise as required**

- **budget and resourcing to ensure that it is adequately positioned to meet its stated goals and objectives.**

3. Growing the Space Industry

3.1 Space has long been the domain of government. The high costs and significant risks associated with space has meant that governments around the world have taken the lead on investment in space related research, development and operation.[1] This, however, is changing. A growing number of private entities are now working with space agencies to support missions and supply new space technology and services.[2]

3.2 The changing nature of the global space industry brings new opportunities for Australian businesses. The Australian Space Agency (ASA) stated:

> This rapid transformation of industry and the space sector is one of the many reasons why Australia can harness a greater share of the global space economy. There are a growing number of business opportunities and Australian businesses have a range of capabilities that can diversify into the space sector. This means that, unlike traditional systems and structures for involvement in space, government's role can be one of a partner and facilitator.[3]

3.3 The Committee heard that while the Australian Government has made a 'good start' in supporting the Australian space sector, this will not be sufficient to meet the 2030 targets, and additional support is required.[4]

Sovereign capability

1 Queensland Government, *Submission 60*, Attachment A: 'Queensland Space Industry Strategy 2020-2025', p. 8.

2 Queensland Government, *Submission 60*, Attachment A: 'Queensland Space Industry Strategy 2020-2025', p. 8.

3 Australian Space Agency (ASA), *Submission 55*, p. 7.

4 Asia Pacific Aerospace Consultants (APAC), *Submission 76*, p. 6.

3.4 The Australian space industry recognises that it needs to develop sovereign space capability. This means that it has what it needs domestically to design, build and maintain its space requirements. Stakeholders argued that developing a sovereign space capability would:

- reduce Australia's reliance on other nations for space
- stimulate the domestic space industry by fostering the development of skills, expertise and 'know-how'
- position Australia as a globally competitive player in space
- strengthen national security and defence capabilities
- stimulate innovation
- help grow the economy and assist in post-COVID recovery.

3.5 As summarised by Gilmour Space Technologies:

> In this contested and competitive world, there is no question that Australia will need to develop sovereign space capabilities. We currently spend over half a billion dollars a year on imported space data and capabilities. The global commercial potential is huge. The national security risks are high. And beyond just being inspiring, new space technologies will offer tremendous benefits to everyday Australians.[5]

3.6 Underpinning the call for sovereign space capability is Australia's reliance on the space assets and capabilities of other countries. This includes space related goods, services, infrastructure and skilled people. If access to these international assets is restricted or closed, Australia is likely to be left without the space based services and programs on which it depends. Asia Pacific Aerospace Consultants explained:

> At the moment all of Australia's weather and earth observation data, position navigation & timing data and most of its satellite communications (with the exception of the NBN and to a degree the Optus satellites) is obtained from foreign owned and operated satellites. …space-related products and services are used in every sector of the Australian economy. Hence the Australian economy is highly vulnerable to the loss of these space-related products and services.[6]

3.7 The NSW Government also noted Australia's vulnerability, particularly regarding defence and national security. It stated:

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5 Gilmour Space Technologies, *Submission 59*, p.1.

6 APAC, *Submission 76*, p. 7.

> Sovereign capability in space technologies enhances Australia's economic and national security. Australia, like every other nation, is increasingly dependent upon the space domain for communications, navigation, intelligence, surveillance and reconnaissance, and scientific endeavours. Space will have significant implications for national security, and so Australia needs access to space technologies and the ability to deploy and utilise space assets to support national defence objectives. Relying on other nations to provide critical parts of this capability, such as satellite development, increases Australia's vulnerability.[7]

3.8 Dependency on foreign owned space assets has been acutely heightened during the COVID-19 pandemic, which has restricted access to global supply chains. It has also restricted access to skilled international workers.

3.9 While there was consensus that Australia should develop sovereign space capability, it was acknowledged that 'sovereignty' needs to be defined. In its submission, Airbus Defence and Space stated:

> There is no official and widely-used Australian definition of 'sovereignty'. We recommend that the Australian Government defines the term and applies it to a settled strategy, ensuring that all federal procurement supports future sovereign industrial and research capability, as well as freedom of action.[8]

3.10 Similarly, Electro Optic Systems (EOS) encouraged the Committee to consider what sovereignty means and what a sovereign industry capability is, noting that this is central to how Australia's space industry will evolve.[9] It argued that 'there are certain space capabilities and services that must be developed, manufactured, managed and owned by Australian entities'.[10] This is because some technologies and capabilities are too vital 'to be left in the hands of overseas production and management'. Professor Craig Smith, Chief Executive Officer, Space Systems, EOS said:

> If nothing else, the last year of COVID has taught us that, while global supply chains have some benefits, they also come with risks and liabilities. So, to us, 'sovereign' means that Australia's space industry, and any industry for that matter, doesn't fall over just when the global supply chain hits a speed bump.[11]

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7 New South Wales Government, *Submission 75*, p. 12.

8 Airbus, *Submission 25*, p. 4.

9 Professor Craig Smith, Chief Executive Officer, Space Systems, Electro Optic Systems (EOS), *Committee Hansard*, Canberra, 26 February 2021, p. 1.

10 Professor Smith, EOS, *Committee Hansard*, Canberra, 26 February 2021, p. 1.

11 Professor Smith, EOS, *Committee Hansard*, Canberra, 26 February 2021, p. 1.

3.11 EOS recommended that Australia 'confirm a strict definition of "sovereignty" with a requirement to protect and advance Australia's space-related interests'.[12]

Space ecosystem

3.12 A strong manufacturing base will be central to developing a sovereign space capability.[13] While Australia has some manufacturing and technological capabilities that can contribute to the space sector, this will need to be more strategically developed and grown to sustain an industry. Stakeholders highlighted the need for Australia to develop and maintain an 'ecosystem' of space related companies, infrastructure, research institutions, investment avenues, education and training streams, and employment opportunities to ensure that it has the necessary foundation to build sovereign capability.

3.13 Air Vice-Marshal Hart, AM (Retired), Queensland Defence Advisor for Aerospace stated:

> We've got some really smart people who are very focused and very deep but until we build those capacities to actually build the vehicles, do the data analysis and grow those skilled pathways to get people into technical and engineering and other roles, in my mind we don't have a national capability. We've got some great technology, but we actually need to build that sovereign and national capability as we go through.[14]

3.14 Mr Matthew Opie, Director, Defence and Space, University of South Australia referred to a 'broad ecosystem' and drew similarities with growing Australia's defence industry. Mr Opie told the Committee:

> …a successful space industry in Australia needs a broad ecosystem. That ecosystem would include a range of international companies and partners mixed with local industry, local and international funding mechanisms and an ecosystem to support the development of a sovereign industrial capability. This cannot be done by research funding or isolated funding alone. It needs to be a broad base.

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12 EOS, *Submission 47*, p. 7.

13 ASA, *Submission 55*, p. 5.

14 Air Vice-Marshal Neil Hart, AM (Retired), Queensland Defence Advisor for Aerospace, *Committee Hansard*, Brisbane, 6 May 2021, p. 48.

> I draw some comparisons with the defence industry, which enjoys significant acquisition projects and research funds, resulting in a sovereign industrial capability in certain areas for defence. [15]

3.15 Mr Opie identified the need to support start-ups to turn ideas into product and profit, and for 'a resourcing, skills, training and jobs plan'.[16]

3.16 Mr Roger Franzen, Director and Principal, EarthSpace, also emphasised the need for specialised education and training, highlighting a lack of 'know-how', particularly of deep space engineering knowledge, and the absence of a sovereign space supply chain. Mr Franzen used Australia's car industry to highlight the point:

> Take the car industry, for example. We no longer have it, but before that it was the peak integrator, and underneath it there was a pyramid of supply, capability, capacity and know-how to make cars. We don't have that pyramid under the space industry at this time, so there is an essential step that we need to take to build that. Some of that's going to be the responsibility of industry. Some of it will be aided by government intervention.[17]

3.17 Earthspace concluded that the Australian Government will need to be 'proactive and interventionist' to support ground up development and the supply pyramid that is currently missing.[18] This includes the development of space capability that meets international space engineering standards.

3.18 Earthspace recommended that all Commonwealth space procurements mandate international standards as it will force 'Australian companies to become familiar with these standards and thereby, familiar with the expectations of the international marketplace'.[19] Earthspace further called for training and guidance to assist with the implementation of these standards in participating companies.[20]

3.19 Shaol made the same recommendation regarding government procurement and international space engineering standards. It identified two international standards – the European Cooperation for Space

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15 Mr Matthew Opie, Director, Defence and Space, University of South Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 23.

16 Mr Opie, University of South Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 23.

17 Mr Roger Franzen, Director, Earthspace, *Committee Hansard*, Canberra, 26 February 2021, p. 35.

18 Earthspace, *Submission 23*, p. 7.

19 Earthspace, *Submission 23*, p. 5.

20 Earthspace, *Submission 23*, p. 5.

Standardization (ECSS) and the NASA Technical Standards – that could be adopted by Australia.[21]

Partnering with primes

3.20 The Committee heard that to develop sovereign capability, Australian businesses can benefit from the support of larger space companies or 'primes'. This is because established, reputable and experienced space primes can essentially give smaller Australian businesses a 'leg-up' to develop space expertise and access global markets. Boeing Australia highlighted the role that space primes can play in developing Australia's space industry:

- help accelerate industry development by transferring skills and knowledge developed through decades of space operations in the United States and Europe
- flatten the learning curve in areas such as manufacturing, certification, and operations by involving primes with a high level of expertise
- send skilled international space experts to work with Australian counterparts
- invest in R&D with Australian research organisations and specialist SMEs to develop local IP and grow technical and research capability
- invest in education programs for space at the secondary and tertiary level, offering a variety of learning opportunities to attract and grow talent
- include Australian SMEs in global supply chains
- assist Australian industry to focus on sustainable opportunities.[22]

3.21 Other space primes highlighted the same advantages. Mr Martin Rowse, Key Account Manager, Space, Airbus Defence and Space identified the role that space primes can play in bridging the gap between civil space capability and Australia's defence requirements. He told the Committee:

> there's a commercialisation gap between the companies that Australia has at the moment—the small, very niche and very capable companies and the large budgets that are required to meet Australia's defence requirements. There are ways that we can look to meet in the middle. There are ways in which we can

21 Shoal, *Submission 5*, p. 13.

22 Boeing Australia, *Submission 80*, p. 13.

> commercialise that. That really needs partnerships with large companies that are able to do that.[23]

3.22 In its submission, Airbus recommended that Australia adopt a 'hub and spoke' approach to space, drawing on a large prime company to assist Australian industry develop a critical mass of space expertise and global access.[24] It also identified the 2017 Naval Shipbuilding Plan and the 2018 Defence Export Strategy as useful approaches to partnering with primes.[25]

3.23 Thales Australia noted it signed a statement of strategic intent with the ASA to support industry growth through technology transfer, collaboration, and connecting SMEs into global supply chains.[26] It explained these elements:

> We think technology transfer is the No. 1 element because it enables Australia to benefit from the work that's been done globally…we don't need to reinvent the wheel… A lot of the IP is company owned, so it requires that company link to facilitate the technology transfer and then build on it in Australia. This is the model we've used in defence and in air traffic management…
>
> … you need a solid, in-country base of engineering expertise, science expertise, to capitalise on that technology and to develop it and work globally with experts in the field. That's the collaboration element.
>
> One of the characteristics of the Australian industrial sector, and certainly the space sector, is the proliferation of small and medium enterprises, many of which are in very smart, niche technologies. Bringing them into the global supply chain of a big global company like Thales Alenia Space is a way to build their capability and also make their business more sustainable by accessing export markets.[27]

3.24 Thales Australia noted the value of accessing global supply chains as a means of evening out the 'peaks and troughs' of domestic space programs.

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23 Mr Martin Rowse, Key Account Manager, Space, Airbus, *Committee Hansard*, Canberra, 26 February 2021, p. 12.

24 Airbus, *Submission 25*, p. 6.

25 Airbus, *Submission 25*, p. 6.

26 Mr Gary Dawson, Vice President, Strategy and Communications, Thales Australia, *Committee Hansard*, Canberra, 16 September 2021, p. 1.

27 Mr Gary Dawson, Vice President, Strategy and Communications, Thales Australia, *Committee Hansard*, Canberra, 16 September 2021, p. 2.

This was identified as a broader whole-of-government challenge across civil and defence sectors.[28]

3.25 Northrop Grumman also discussed the role of primes in supporting start-ups and SMEs, however identified a lack of incentives for primes.[29] It said:

> As it currently stands, there is no incentive for Primes to help SMEs increase their technology readiness levels (TRL) to a commercially viable model. Government support through grants is commendable, and a necessity; however, developing strong business-to-business relationships is the next step in growing the industry.[30]

3.26 Northrop Grumman recommended that the Australian Government consider a publicly available investment program that encourages business to business collaboration, and supports businesses of all sizes, including primes, to achieve long term capability investment that supports sector growth.[31]

3.27 Boeing Australia recommended that primes seeking to bid on major space programs should demonstrate their commitment to supporting Australian industry, including meaningful investment in Australia's space capabilities.[32] It drew an important distinction between primes conducting business from overseas in Australia, and primes that 'extend and integrate' their global businesses into Australia.[33]

3.28 Fostering partnerships between primes and SMEs serves to primarily assist businesses to develop capability and grow the domestic space industry. However, the Committee heard that support for SMEs is needed more generally. This is independent of a relationship with primes. For example, Mr Mark Skidmore, Executive Chair, SkyKraft expressed the view that smaller competent companies do not necessarily need larger companies to succeed: He told the Committee:

> I think small companies can play in the global market. I can't see any reason why they can't. That's exactly what we want to do. We want to play in the

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28 Mr Dawson, Thales Australia, *Committee Hansard*, Canberra, 16 September 2021, p. 2.

29 Northrop Grumman Australia, *Submission 27*, p. 7.

30 Northrop Grumman Australia, *Submission 27*, p. 7.

31 Northrop Grumman Australia, *Submission 27*, p. 7.

32 Boeing Australia, *Submission 80*, p. 12.

33 Boeing Australia, *Submission 80*, p. 12.

> global market. There's no reason why you can't put a constellation of small satellites up and provide global services.[34]

3.29 Swinburne University argued that SMEs are proven in their ability to innovate and develop products with significant commercial potential and called for access to funding in the earlier stages, and direct petitioning by the Commonwealth in international markets to accelerate SME progress and prevent businesses from being locked out.[35]

3.30 Shoal agreed that Government spending is required to encourage entrepreneurs, and argued that it must be directed to those that have an export disciple so they can become internationally competitive.[36]

Access to capital

3.31 The availability of venture capital was identified as a particular challenge facing the Australian space sector. The Committee heard that the largest venture capital firms in Australia barely match the smallest funds elsewhere.[37] This puts a low ceiling on the financial viability of funds to strategically invest in many local space technology businesses. It also increases the probability that space technology companies will eventually move overseas to access larger capital markets.[38]

3.32 To kick-start space businesses, people need an idea, support and financial backing. Australia however was described as being 'risk adverse' in taking on new challenges and investing in space related start-ups. For example, Mr Troy McCann, Chief Executive Officer of Moonshot said:

> We're very risk averse over here. We're on the other side of the earth. We're very far removed. We have tall poppy syndrome incredibly. If you are someone who steps outside of that, generally it's very hard to say, 'I'm going to go and start a company,' let alone, 'I'm going to go and start a space company.' It's very hard to get that support… How do we change the culture

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34 Mr Mark Skidmore, Executive Chair, Skykraft, *Committee Hansard*, Canberra, 26 February 2021, p. 27.

35 Swinburne University of Technology, *Submission 63*, p. [4].

36 Shoal, *Submission 5*, p. 12.

37 Moonshot, *Submission 58*, p. 4.

38 Moonshot, *Submission 58*, p. 4.

> of our people and how do we empower them to say, 'I'm going to go and try to do something that no-one else has done before'?[39]

3.33 Cultural change and incentives for investors were suggested as ways to address this problem. Mr McCann identified a role for government in this process:

> If the government, through the Space Agency, for example, could provide incentives for investors—matched funding and things like that—to make more of those more risky bets in space startups, then that would be an incredible service to help raise more people and give them that opportunity to try to invent, to fail, to succeed and to pull themselves up above the market.[40]

3.34 In its submission, Moonshot emphasized that matched funding requirements not only help to align the interests of private investors with government, it will help to encourage more private capital for investment into an inherently risky asset class.[41]

3.35 Symbios Communications also noted the lack of venture capital in Australia to support industry and the risk adverse nature of financial institutions. It remarked that Australia has a global reputation for being innovative, however, the small size and scope of its early stage venture capital investment relative to Europe and the USA means that targeted strategic support from the government takes on extra importance.[42] Specifically it stated:

> We do not have a technical incubation and angel investor heritage anywhere near the USA and our financial institutions are notoriously conservative. This places additional focus on the support from government to ensure that good ideas are recognised, encouraged, and practically supported.[43]

3.36 Symbios Communications suggested a number of approaches to better support the industry including:

- direct funding - to address a clear requirement

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39 Mr Troy McCann, Chief Executive Officer, Moonshot, *Committee Hansard*, Sydney, 19 April 2021, p. 26.

40 Mr Troy McCann, Chief Executive Officer, Moonshot, *Committee Hansard*, Sydney, 19 April 2021, p. 21.

41 Moonshot, *Submission 58*, p. 5.

42 Symbios Communications, *Submission 30*, p. 3.

43 Symbios Communications, *Submission 30*, p. 3.

- targeted investment - in developing capabilities with demonstrated or anticipated economic potential
- attracting private investment - via taxation incentives for venture capital investors, incubators, clusters, and providing other public resources and facilities
- public-private partnerships - via commercial-government co-investment, and government anchor tenancy of a service or system.[44]

3.37 Gilmour Space Technologies noted that space companies funded by venture capital are often unsuccessful in government grant applications, potentially because they are thought to not need funding.[45] It argued that significant resources are required for space development and the private sector should not be solely responsible for this.[46] Instead, 'government funding should favour relevant venture capital backed companies as they will leverage any assistance to accelerate growth … often at a ratio of 1 to 5'.[47]

3.38 Vocus, an Australian-owned specialist fibre and network solutions provider, argued that private sector investment is fundamental to enabling competition, building scale and developing capability.[48] It submitted that the Australian government should pursue policy and regulatory settings for the space and satellite sector that incentivise private-sector investment and local industry development, for example by using its purchasing power to develop local industry rather than directly funding a Government Business Enterprise – as was the case with the NBN's two Sky Muster satellites.[49]

3.39 The South Australian Space Industry Centre (SASIC) noted that for private investment to play a leading role in space sector growth, the following factors need to be considered:

- technology investors value speed and agility; which can be adversely impacted by local regulation or international regulation, such as the US International Trade in Arms Regulations (ITAR)
- investors value proof of revenue earning and therefore contracts for products and services are more valued than traditional grants

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44 Symbios Communications, *Submission 30*, p. 3.

45 Gilmour Space Technologies, *Submission 59*, p. 5.

46 Gilmour Space Technologies, *Submission 59*, p. 5.

47 Gilmour Space Technologies, *Submission 59*, p. 5.

48 Vocus, *Submission 45*, pages 1 and 2.

49 Vocus, *Submission 45*, p. 3.

- an extant supply chain is a known risk in an inherently risky activity and is therefore difficult to substitute without a business imperative for change
- new suppliers must demonstrate space flight heritage to displace other providers.[50]

3.40 In framing Australia's polices, SASIC states that there is a need to understand these factors and carefully balance these interests.[51]

3.41 Swinburne University of Technology advocated for streamlined access to funding mechanisms and increased efficiency of investment by reducing complexity and enhancing transparently. Professor Alan Duffy, Director, Space Technology and Industry Institute told the Committee:

> …it's not always entirely clear what the intended outcome of the scheme was versus the stated goals or at least the rules by which the funding scheme had been set up. A maturing sector and a maturing involvement of government in funding that sector will lead to a more streamlined and transparent process.[52]

Infrastructure

3.42 Start-ups and businesses not only require funding support. Essential infrastructure and testing facilities are also needed to support the Australian space industry. Smartsat CRC stated that Australia either lacks, or is at a very early stage of development, of the following critical infrastructure and capabilities that are essential for a space faring nation:

- Satellite design, manufacturing and testing capabilities
- Earth observation sensors, both design and build capabilities
- Internet of Things (IoT) sensors; whilst Australia has the design capabilities it lacks the manufacturing capabilities
- Satellite launch facilities; none exist at present although two are proposed (Southern Launch and Equatorial Launch Australia)
- Operational in-country rocket construction and infrastructure for manufacturing
- Mission control; will be operational in 2021. Optus provide mission control capabilities for geo-stationary satellites from Belrose, NSW

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50 South Australian Space Industry Centre (SASIC), *Submission 56*, p. 8.

51 South Australian Space Industry Centre (SASIC), *Submission 56*, p. 8.

52 Professor Alan Duffy, Director, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, p. 17.

- Satellites:
  - Earth observation: Australia neither owns nor operates any earth observation (remote sensing satellites) although it relies on around 25 satellites for fundamental services
  - Telecommunications (broadband): NBN Co owns and operates two Skymuster satellites supplying broadband internet to regional, rural and remote users. The Singapore owned Optus operate a fleet of five geostationary satellites that provide metropolitan and some limited regional communications services
  - Telecommunications (IoT sensor communications): Australia is well positioned to benefit from this emerging market segment through Fleet Space and Myriota which have plans to launch a combined total of around 200 satellites into LEO
  - Position, Navigation and Timing (PNT) (that is GPS and similar satellite systems): Australia does not own or operate any of the six global and regional GPS-like systems. In 2018 the Government funded Geoscience Australia to acquire a SBAS (a single geostationary satellite) that will operate as supporting capability for the GPS-like systems.[53]

3.43 The Committee heard that Australia could do more to leverage its existing infrastructure; facilitating national and international opportunities for industry. ANU InSpace argued that Australia has many advantages in the global space industry. Building, expanding or using essential infrastructure across priority areas will enable international recognition of the Australian space ecosystem outside of communications and launch capabilities.[54] It stated:

> We have unique opportunities for industry growth and the spinning-off of cutting-edge research. We have experience successfully opening essential infrastructure to grow the national space industry, but we need government help to make that access available nationally and deliver exceptional translational outcomes.[55]

3.44 Stakeholders stressed the need for appropriate space infrastructure to support industry reach its technology readiness level (TRL), which can

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53 SmartSat Cooperative Research Centre (CRC), *Submission 29.1*, pp. 3-4.

54 Australian National University (ANU) Institute for Space (InSpace), *Submission 18.1*, p. 2.

55 Australian National University (ANU) Institute for Space (InSpace), *Submission 18.1*, p. 2.

involve 'an expensive series of steps.'[56] As explained by Mr Rod Drury, Vice President International, Lockheed Martin Space, Lockheed Martin Australia:

> There are two very significant valleys, if you like, where we need a lot of investment to make progress, and you need access to that infrastructure, whether that be test chambers or other ground facilities.
>
> … As you develop the technology, you need it for a particular period of time, but then you may not need access to the particular vacuum chamber or anechoic chamber to shake a table. You may not need access to that thing for some period of time, but another company that's doing the same capability—what we don't need is every company, every university, all investing in similar technologies.[57]

3.45 Earthspace commented on access to space test facilities noting its expense and suggested that the Commonwealth consider subsidising the cost of testing during the first 10 years of the ASA's industry development plans.[58]

3.46 Similarly, the SASIC recommended that common use space engineering laboratories be established for development and testing of space hardware and sensors thereby reducing barriers to entry for local design and manufacture.[59]

3.47 Professor Rod Boswell highlighted a role for government to support the development of tools and infrastructure to allow Australian entities 'to conduct research and development and arrive at creative and innovative solutions to the challenges faced in space focusing on the areas of minerals, materials and agriculture'.[60]

3.48 Regulatory issues were raised in relation to space infrastructure. For example, Mr Drury encouraged the Committee to consider existing infrastructure and regulations around space parks:

> Clearly, we're already here, so I just want to amplify that we believe there are already capabilities on the ground here in the region. Clearly, that's why we're here. Clearly, that's why we've taken decisions to put other technologies and capabilities here. Our intention is actually to optimise that facility, in a

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56 Mr Rod Drury, Vice President International, Lockheed Martin Space, Lockheed Martin Australia, *Committee Hansard,* Armidale, 20 April 2021, pp. 24-25.

57 Mr Drury, Lockheed Martin Australia, *Committee Hansard,* Armidale, 20 April 2021, pp. 24-25.

58 Earthspace, *Submission 23*, p. 5.

59 SASIC, *Submission 56*, p. 8.

60 Boswell Technologies, *Submission 31*, p. 6.

> footprint sense, completely. Some of the activities government may wish to consider would be to do with the regulatory authority around space parks, for example. Right at the moment, previous governments have approved a space park, as I understand it, in the area of Kootingal, just south of Tamworth. The question I would have is: given that that facility is not being used, why not make the space park at Uralla?[61]

3.49 Similarly, regulation affecting infrastructure development was raised at the Committee's public hearing in Brisbane. Mr Blake Nikolic, Chief Executive Officer, Black Sky Aerospace shared his experience of trying to establish launch testing facilities in Quilpie. He explained to the Committee:

> We need enough infrastructure to be able to develop an industry, build an industry and build an ecosystem. Not only will we be creating jobs in these areas; when we talk about the space industry, it's not all about rocket scientists. We're talking about everything from security, catering and looking after the site right down to finding the local talent that can actually manufacture and put hard labour into the facility. Further, at the time, we were talking about a drought stricken area. We were hearing of suicide rates going through the roof in these areas, and here is a new, thriving industry that's going to be worth trillions in the not-too-distant future internationally, and we can deliver a small piece of the puzzle in these rural areas.[62]

3.50 For Black Sky Aerospace, its efforts to establish a launch testing facility were thwarted by changes to government regulation. Mr Nikolic further explained:

> The whole thing was lost because of a material change of use, and we didn't want to pay a third party to assess the road, and the entire thing fell apart again.
>
> There were two parts to change of use. One, the environmental: what were we changing on the site? At the time, with the mobile infrastructure, nothing. They actually took that away, because they said: 'We're not cutting down any trees. We're not actually cutting any roads. We're not doing anything.' For the road itself, which carries cattle trucks, road trains and that, they wanted us to do a full assessment about how small-scale vehicles would affect the road.

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61 Mr Rod Drury, Vice President International, Lockheed Martin Space, Lockheed Martin Australia, *Committee Hansard,* Armidale, 20 April 2021, p. 24.

62 Mr Blake Nikolic, Chief Executive Officer, Black Sky Aerospace, *Committee Hansard,* Brisbane, 6 May 2021, p. 13.

> Because we wouldn't actually do that, because we didn't have the funding to pay third parties for that, the whole thing was quashed.[63]

3.51 Space infrastructure is fundamental national infrastructure. To appreciate the national capability, there is a need to determine what Australia currently has, where it is located and what is needed. This will enable informed decisions to be made about future investment and coordination of infrastructure across the space industry.

3.52 The Queensland Government emphasized federal leadership and support for space infrastructure across the nation. It stated that states and territories would benefit from increased infrastructure collaboration and coordination to ensure that development efforts are complementary to other jurisdictions.[64]

3.53 Some stakeholders considered a role for Infrastructure Australia in this process. In its submission, Infrastructure Australia noted:

> Our current operating framework does not include any formal requirements to provide policy or investment advice specifically for the space industry. Notwithstanding this, we are generally supportive of investment to grow the space industry in Australia and consider that some components of our work-program could be leveraged by the space industry to guide investment or policy considerations.[65]

3.54 While Infrastructure Australia advised that it has 'no formal plans to play a more active role in Australia's space industry, including through the development of sector specific guidance' it did state that it is 'well positioned to support the space industry through the provision of strategic advice on the broader infrastructure sector'.[66]

3.55 SmartSatCRC set out the national space architecture it considers Australia needs over the next seven years. This is listed in Appendix D.

Industry data

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63 Mr Blake Nikolic, Chief Executive Officer, Black Sky Aerospace, *Committee Hansard*, Brisbane, 6 May 2021, p. 13.

64 Queensland Government, *Submission 60*, p. 3.

65 Infrastructure Australia, *Submission 88*, p. 1.

66 Infrastructure Australia, *Submission 88*, p. 3.

3.56 Measuring the Australian space industry with standard industry datasets is challenging.[67] Deloitte stated this presents a key challenge for understanding and estimating the value of the space industry in a way that can be benchmarked against other Australian industries and global space industries.[68]

3.57 The NSW Government identified a lack of specific data as 'one of the most challenging aspects' of measuring Australia's space industry.[69] It stated:

> Due to the lack of Australian and New Zealand Standard Industrial Classification (ANZSIC) codes specifically for the space industry, mapping and tracking the growth of the industry is difficult to plot and understand.[70]

3.58 In particular, the NSW Government highlighted the absence of substantial revisions to the ANZSIC since 2006. It asserts that the inclusion and measurement of the space sector in the ANZIC would support the tracking of the space industry's growth, which is expected to be exponential in decades to come.[71]

3.59 The SIAA also discussed industry data in its submission. It asserted that there is 'no single source of truth' on companies or individuals involved in the space industry, and noted that the Australian Bureau of Statistics (ABS) 'does not collect data for the space industry in the way it does for other more established industries'.[72]

3.60 Mr James Brown, Chief Executive Officer of SIAA told the Committee:

> It's very hard to track the industry when you don't have those codes and you can't say who's definitively in and who's definitively out.[73]

3.61 The SIAA recommended that a specific ABS classification be developed to help track Australia's space industry growth.[74]

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67 Deloitte, *Submission 53*, p. 12.

68 Deloitte, *Submission 53*, p. 12.

69 NSW Government, *Submission 75,* p. 16.

70 NSW Government, *Submission 75,* p. 16.

71 NSW Government, *Submission 75,* p. 16.

72 Space Industry Association of Australia (SIAA), S*ubmission 83,* p. 10.

73 Mr James Brown, Chief Executive Officer, SIAA, *Committee Hansard,* Sydney, 19 April 2021, p. 34.

74 SIAA, S*ubmission 83,* p. 11.

Strengths and opportunities

3.62 Stakeholders identified a range of opportunities for Australia to develop specific sovereign capacity. The Committee consistently heard that smallsats, data applications, ground stations and launch facilities are competitive strengths for Australia.[75] Furthermore, Australia's strengths in other sectors not traditionally associated with space – such as mining, medicine and advisory services – present real opportunities for the domestic space sector.

3.63 The Queensland Government underscored the importance of national direction in developing space capabilities :

> Australian industries collectively have all the elements to build sovereign national space capabilities. However, these capabilities are often pockets of niche expertise outside what is usually considered the core space industry. Compared to long established industries such as aerospace, the emerging Australian space industry is only now starting to connect across different disciplines and to seek national direction about the types of capabilities Australia would like to develop as a nation.[76]

3.64 Northrop Grumman argued that Australia must play to its strengths and focus on those areas where it enjoys a comparative advantage, avoiding ambitious or ambiguous programs that don't futureproof desired strategic outcomes.[77] It stated that this begins with the Federal Government focusing and prioritising its investments across the space capability spectrum by working with industry to define where the country has a comparative advantage and where sovereign capabilities should be a priority.[78]

3.65 Northrop Grumman identified three priority areas including transmission and exploitation of space-derived data, space control and operations, and space governance and regulatory standards.[79] By focusing effort and resources on these areas, Northrop Grumman argued it will help to avoid the risks associated with developing the industry too quickly, particularly

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75 For example, see Dr Dave Williams, Executive Director, Digital, National Facilities and Collections, Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Committee Hansard*, Canberra, 24 February 2021, pp. 2-3.

76 Queensland Government, *Submission 60*, p. 3.

77 Northrop Grumman Australia, *Submission 27*, p. 9.

78 Northrop Grumman Australia, *Submission 27*, p. 9.

79 Northrop Grumman Australia, *Submission 27*, p. 9.

where it has not met the required level of maturity and self-sufficiency. It will also allow for informed and targeted policy and investment decisions.[80]

3.66 Boeing Australia identified a similar set of areas as opportunities to grow and enhance Australia's space industry including advanced software development capabilities, artificial intelligence and machine learning, capabilities in niche emerging technologies, and establishing a contemporary regulatory framework.[81]

3.67 Shoal stressed the importance of developing capability that does not seek to replicate what has been achieved elsewhere. Rather, it argued Australia should identify areas where it can differentiate its space industry from others. This means identifying and building on Australia's strengths, as well as exploring emerging areas.[82]

3.68 Some selected strengths and opportunities are discussed below. Launch and space tracking, and the potential for Australia to leverage a contemporary and progressive regulatory framework are discussed in subsequent chapters.

Satellites and Earth observation

3.69 Earth observation (EO) involves using data from satellites to see and respond to what is happening on Earth. It is sometimes called remote sensing.[83] Examples of how EO is used in Australia are set out in Box 3.1.

3.70 Earth Observation Australia explained the relevance of EO:

> Australia has unique marine, coastal, terrestrial and atmospheric environments, and the monitoring, management and sustainable use of these are driven at all levels of government and industry by Earth observation satellite information. It is essential we significantly increase Australia's application and technological expertise in EO, and our ability to collect the data, through growth and development in Australia's EO (and space industry) capability, development, and skilled workforce.[84]

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80 Northrop Grumman Australia, *Submission 27*, pp. 9-10.

81 Boeing Australia, *Submission 80,* p. 9.

82 Shoal, *Submission 5.2*, p. 7.

83 Mr Enrico Palermo, Head of Agency, ASA, *Committee Hansard*, Canberra, 20 September 2021, p. 29.

84 Earth Observation Australia (EOA), *Submission 21*, p. 4.

Box 3.1 Satellite data applications[85]

- **Agriculture, Meteorology and the Environment:** EO data will continue to provide key inputs for monitoring soil, rainfall, snow cover, drought and crop development.
- **Transport, Logistics and Smart Cities:** EO offers the ability to analyse and monitor transport networks by detecting and counting vehicles on roads, freight vehicles, aircrafts and monitoring road structure and congestion management.
- **Defence, Security and Surveillance:** with space proficiency becoming more sophisticated, governments are strengthening intelligence, surveillance and reconnaissance capabilities.
- **Prevention, response and recovery:** the space sector is well positioned to support government to improve its capability in emergency management.
- **Mining and Exploration:** opportunities for the space sector to impact mining and energy are twofold – either improving existing Earth-based mining practices (e.g. global positioning and communications advances), or new resource exploration opportunities (such as asteroid mining).
- **Telecommunications and Connectivity:** the introduction of machine learning, AI, IoT and nanosatellite constellations has opened the doors to improved connectivity and lower latencies. This will touch many sectors and provide access to education and healthcare resources in remote regions.
- **Health and Pharmaceuticals:** satellite imagery allows us to monitor spread of diseases, vegetation health, climate changes, atmosphere changes and pollution concentration. In addition, the pharmaceuticals industry can benefit from manufacturing experiments off-Earth.
- **Travel and Tourism:** the tourism and leisure industries are using high resolution imagery and GPS data to evaluate and assess attractions such as resorts, cultural experiences, and sports arenas to provide travellers accurate up-to-date detailed mapping of their destinations.
- **Insurance, Finance and Retail:** Earth observation helps insurers and financial institutions to better understand and analyse the impact of natural disasters, identify infrastructure that has been damaged and estimate the overall financial damage cost.
- **Space Exploration and Operations:** upstream space capabilities such as launch, manufacturing, automation and robotics have a pivotal role in

[85] Deloitte, *Submission 53*, pp. 4-5.

enabling downstream capabilities supported by industry demand. Space companies around the world are developing sovereign capabilities to design, manufacture and test space systems for future space exploration and operations.

3.71 Australia does not currently own its own EO satellites.[86] Yet its use across Australia is extensive. As described by the CSIRO:

> …over 140 government programs, state and federal, and associated stakeholders, rely on unencumbered access to satellite-derived Earth observation data to address areas of national benefit including climate and disaster monitoring, managing our water and natural resources, and monitoring the environment.[87]

Box 3.2

CSIRO, Geoscience Australia and the National Computational Infrastructure (NCI) jointly developed the Open Data Cube platform technology. [88] Data Cube data analytics platforms support public access and use of petabyte-scale Earth observation datasets.[89]

Data Cubes provide the digital infrastructure to facilitate Earth observation data discovery and integration.[90] In addition, they enable governments and industry, including Small to Medium Sized Enterprises (SMEs), to undertake scalable and low start-up cost data analysis to develop new business products.[91]

The Open Data Cube allows data to be brought in from multiple sensors and different satellites into a single super computer or cloud based computer system.[92] As the Open Data Cube is written as an open source code, it is effectively owned by everyone who contributes to it.[93]

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86 CSIRO, *Submission 11*, p. 7.

87 CSIRO, *Submission 11*, p. 7.

88 Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission 11*, p. 5.

89 CSIRO, *Submission 11*, p. 5.

90 CSIRO, *Submission 11*, p. 5.

91 CSIRO, *Submission 11*, p. 5.

92 Dr Alex Held, Director, Centre for Earth Observation, CSIRO, *Committee Hansard*, Canberra, 24 February 2021, p. 7.

93 Dr Alex Held, CSIRO, *Committee Hansard*, Canberra, 24 February 2021, p. 8.

> Companies use the Open Data Cube as a platform to do their processing because it saves them effort in having to implement their own super-computers.[94] It is already loaded with data so private companies can put their own applications on top of it, value add to it and conduct business in this way.[95]

3.72 Stakeholders called for Australia to develop sovereign satellite capability. For example, the Bureau of Meteorology (BoM), a significant user of EO, noted that Australia is one of a small number of developed nations that has no sovereign satellite weather observing capability. Rather, Australia obtains its data free of charge under the World Meteorological Organisation (WMO) Resolution 40.[96]

3.73 The BoM highlighted that while access to data provided under the WMO Resolution has 'worked well', 'there is no guarantee that access to satellite data will continue in the long run'.[97] It stated:

> In recent years there has been an exponential growth in commercial satellite data providers offering new business models, resulting in potential threats and opportunities in the space industry. In the future, this may pose a risk to the volume of data the Bureau can access if current arrangements for the free and open exchange of international satellite data are reduced.[98]

3.74 The BoM recommended that Australia develop sovereign capability to meet national weather observation needs, address gaps in the global weather observation systems, and ensure continuity of data.[99] In addition to secure access to data, other benefits advocated by the BoM include:

- a strengthened relationship with key international partners

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94 Dr Alex Held, CSIRO, *Committee Hansard*, Canberra, 24 February 2021, p. 8.

95 Dr Alex Held, CSIRO, *Committee Hansard*, Canberra, 24 February 2021, p. 8.

96 The World Meteorological Organization Resolution 40 is a reciprocal agreement by which countries around the world agree to share meteorological observations and data – Dr Peter Stone, Group Executive, Business Solutions, Bureau of Meteorology (BoM), *Committee Hansard*, Canberra, 24 March 2021, p. 2.

97 BoM, *Submission 74*, p. 2.

98 BoM, *Submission 74*, p. 3.

99 BoM, *Submission 74*, p. 2; BoM, *Submission 74.1*, p. 5.

- an opportunity for the Australian space industry to develop technology to benefit the national and international meteorological community
- enhanced weather and climate services for Australia, and
- the development of expertise and capability in technology which could be exported.[100]

3.75 The Minderoo Foundation Fire and Flood Resilience Initiative also advocated for a sovereign owned satellite technology. It stated that:

> Unlike other countries, Australia has not historically had a dedicated satellite capability to assist with building resilience to fire and flood. There is an opportunity to implement solutions fit for purpose in Australia which will support mitigation of risk will provide improved monitoring of vulnerability and exposure and will detect early changes in hazards caused by climate change.[101]

3.76 The Minderoo Foundation argues that Australia can not only lead the world in disaster resilience, which is an exportable commodity, but with improved space based communications Australian communities will no longer be vulnerable to the effects of natural hazards.[102] The NSW Government advocated for Australian managed and owned satellites, particularly for bushfire management. [103]

3.77 From an agriculture perspective, Mr Tim Neale, Managing Director, Data Farming, told the Committee that other countries tend to know more about Australia's crops than it does. This can have commercial implications. Mr Neale said:

> … There's been this sort of rumour—it's a bit of a joke, I guess, but it's not a joke, really—that other countries like China and the US know more about our wheat than we do and that we should be doing the same to the other countries too. And why not? We need the intelligence, and they're gathering a lot of intelligence on our production system.[104]

3.78 A similar point was made by the NSW Government which noted that Australia is charged to access information after that information is seen by other nations. It stated:

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100 BoM, *Submission 74*, p. 5.

101 Minderoo Foundation Fire and Flood Resilience Initiative, *Submission 87*, p. 2.

102 Minderoo Foundation Fire and Flood Resilience Initiative, *Submission 87*, p. 4.

103 NSW Government, *Submission 75*, p. 13.

104 Mr Tim Neale, Managing Director, DataFarming, *Committee Hansard*, Brisbane, 6 May 2021, p. 38.

> An example of this is monitoring crop yield. We rely on other nations to provide us information on our crop yields, and so by the time we receive the data, they have already analysed it. This can have massive flow on impacts on trade and price negotiations as they will know more about our yields than our farmers.[105]

3.79 The Australian Strategic Policy Institute shared similar concerns noting that Australia needs to reduce its dependency on foreign providers of space capability. It stated:

> government should expand our ability for small satellite design, development, and manufacture, including establishing an ability to rapidly produce large numbers of small satellites for operationally responsive space requirements to augment existing space capability in a future crisis.[106]

3.80 Earth Observation Australia advanced that Australia already has the 'building blocks' to support a sovereign EO capability. It identified the following characteristics:

- well-established capabilities in transforming satellite imagery to information in all levels of government and small business
- world leading and recognised science and EO
- collaboration with international space science teams, including the European Space Agency, NASA, or Japan
- a focus on building and delivering services that decision-makers will need and use
- indigenous understanding and management of country based on Indigenous people being on the ground and seeing what is happening
- being well positioned as a good testing facility given our terrestrial, marine and atmospheric environments.[107]

3.81 Earth Observation Australia listed a series of current limitations and future needs to better support this industry. Primarily this includes certainty and sustained investment for the development of EO missions. It noted that 'without this, Australia is unable to move forward in the design, development and operation of space EO satellite missions'.

3.82 Swinburne University of Technology also recommended investment in sovereign satellite constellations to enhance Australia's EO. It stated that this

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105 NSW Government, *Submission 75*, p. 13.

106 Australian Strategic Policy Institute (ASPI), *Submission 79*, p. 1.

107 Professor Stuart Phinn, President, EOA, *Committee Hansard*, Brisbane, 6 May 2021, pp. 29-30.

would enable unencumbered access for Australian organisations to satellite data, increasing efficiency and productivity, a range of economic benefits, and increase the capacity of defence and emergency services.[108] Professor Alan Duffy, Director, Space Technology and Industry Institute, Swinburne University of Technology promoted Australia's potential:

> We can start afresh. In that way, we can leverage the new model where, rather than sending a single billion dollar satellite to some high orbit, latest technologies—in particular, microelectronics—allow you to have something much smaller but of equal power and, indeed, send up several of those as a constellation such that, as one flies overhead, the next satellite picks up the observation, and you can provide that constant monitoring. That's particularly critical for emergency services, where there may well be rapidly changing on-the-ground scenario situations, and you simply cannot wait 90 minutes for the next flyover; you really need to provide that constant monitoring capability.[109]

3.83 In its evidence to the inquiry, the ASA noted the potential of EO to be delivered as a mission set. Mr Enrico Palmero, Head of Agency, told the Committee:

> …probably earth observation would be at the top of the list from my perspective. What we can leverage there is some competitive strengths we have in Australia to develop payloads for these satellites. In a similar vein, we have the opportunity to uplift our capability to build those satellites and the supporting applications.[110]

3.84 The Committee notes that recently, the CSIRO acquired a '10 per cent tasking and downlink capacity share of the UK-operated NovaSAR-1 satellite' providing the 'first opportunity for Australian scientists to directly task and acquire imagery in near-real-time from an EO satellite, for applications ranging from disaster monitoring to land use and land cover mapping.'[111]

Data applications

3.85 Data derived from space underpins our daily lives. Its wide application and capacity to change the way we live presents a significant opportunity for

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108 Swinburne University of Technology, *Submission 63*, p. [3].

109 Professor Duffy, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, p. 17.

110 Mr Palermo, ASA, *Committee Hansard*, Canberra, 20 September 2021, p. 29.

111 CSIRO, *Submission 11*, p. 6.

Australia. Geoscience Australia advanced that the applications component of Australia's space industry can and will be a significant driver of industry growth and benefits to the economy:

> There are opportunities for new space applications in almost every sector of the economy, the variety of data that's available to power the applications is growing, and the barriers to entry for SMEs are actually lower than in many other parts of the space industry.[112]

Box 3.3

Through the Gravity Challenge, Deloitte Touche Tohmatsu (Deloitte) is actively supporting space innovators to navigate the innovation ecosystem.[113] The Gravity Challenge is a global technology innovation program for corporates, entrepreneurs and universities to design and build solutions to real industry, social and environmental problems using space data and capability.[114]

Over a period of nine months, the Gravity Challenge is divided into three phases.[115] The 'Recruitment' phase involves the recruitment of Challengers and Innovators, and the publishing of the Challenges.[116] The 'Innovate and Accelerate' phase consists of Innovators working to develop solutions, collaborating with Challengers and data and tech providers.[117] The 'Scale' phase involves the commercialisation of the solution, with ongoing support from Gravity and data and tech providers.[118] Each phase is 12 weeks long.[119]

Through the program, participants have privileged access to current and over 20 years of historic satellite data from AWS and other satellite data providers.[120] They receive mentorship and support from Deloitte and

112 Dr Martine Woolf, Branch Head, National Positioning Infrastructure, Geoscience Australia, *Committee Hansard*, Canberra, 17 March 2021, p. 1.

113 Deloitte Touche Tohmatsu, *Submission 53*, p. [5].

114 Deloitte Touche Tohmatsu, *Submission 53*, p. [5].

115 SmartSat CRC, *Submission 29.1*, Answer to Question on Notice, p. [10].

116 SmartSat CRC, *Submission 29.1*, p. [10].

117 SmartSat CRC, *Submission 29.1*, p. [10].

118 SmartSat CRC, *Submission 29.1*, p. [10].

119 SmartSat CRC, *Submission 29.1*, p. [10].

120 SmartSat CRC, *Submission 29.1*, p. [10].

AWS technology and venture building experts.[121] In addition, the winning teams have access to a commercialisation strategy and incubation support to help scale the offerings in market.[122]

3.86 Mr Rod Drury, Vice President International, Lockheed Martin Australia highlighted the significant opportunities from processing and using space derived data:

> … I also want to acknowledge that a lot of people think of space as being rockets and astronauts, and in fact a significant portion of the space business is all to do with the data that we collect in space. The amount of data that we collect versus what we process is amazing. We process a very small amount and we've got to make more use of that. That's really where a lot of it is—what we would refer to as downstream markets. I think Australia's got great opportunities there.[123]

121 SmartSat CRC, *Submission 29.1*, p. [10].

122 SmartSat CRC, *Submission 29.1*, p. [10].

123 Mr Rod Drury, Lockheed Martin Australia, *Committee Hansard,* Armidale, 20 April 2021, p. 24.

3.87 Dr Paul Scully-Power made the same point in his evidence to the inquiry:

> They are certainly going to be the wealth generators of the future and, just like Apple and Google, it will be the apps applied to those downlinks of data from smart sensors that are going to be where the money is.[124]

3.88 Similarly, Queensland University of Technology noted that space-based data promises to deliver substantial gains for key rural and remote industries, improve our responsiveness to natural disasters and enhance our environmental protection.[125]

3.89 One of the key benefits to developing the applications sector is that the market for space derived applications is 'global as well as local'. It is often easier to export space applications than some dual-use hardware.[126] In addition, supporting space application developers will drive the growth of the entire Australian space industry.[127] Geoscience Australia explained:

> Growth in this downstream component of the space industry will, in turn, drive demand for the products and services provided across the space value chain including the manufacture of satellite systems and the operation of satellite ground stations. The greater the customer demand for applications that use space data, the greater the demand will be for the space systems that generate that data.[128]

3.90 Swinburne University highlighted the value of space applications and recommended the Australian Government focus on 'encouraging research and enterprise that has terrestrial application'.[129] This includes earth and marine observation data. Professor Alan Duffy told the Committee:

> Roughly speaking, about nine-tenths of all of the value, the revenue, the profitability indeed, of the space sector is on that so-called downstream aspect—so where the data from space is used to aid sectors on the ground, and that includes agriculture, marine, fisheries, as well as any number of emergency services. So the intention there really is to ensure that government

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124 Dr Paul Scully-Power, *Committee Hansard*, Sydney, 19 April 2021, p. 3.

125 Queensland University of Technology, *Submission 7,* p. 2.

126 Dr Martine Woolf, Branch Head, National Positioning Infrastructure, Geoscience Australia, *Committee Hansard*, Canberra, 17 March 2021, p. 1.

127 Dr Martine Woolf, Branch Head, National Positioning Infrastructure, Geoscience Australia, *Committee Hansard*, Canberra, 17 March 2021, p. 2.

128 Geoscience Australia, *Submission 13*, p. 5.

129 Swinburne University of Technology, *Submission 63,* p. 5.

> drives and continues to drive national flagships. These are major game-changing levels of capability. … And I think government has that whole-of-ecosystem, whole-of-industry awareness that can support community involvement and industry engagement, as well as ensure the research organisations are delivering on translatable, commercialisation-ready technologies for those sectors.[130]

3.91 While downstream applications are considered to be the greatest growth area for the space industry, there are current barriers to this sector. This includes:

- risks to ongoing access to critical satellite data
- ability to assure customers of product quality
- support for export of space applications
- shortages of local skills in specialist areas
- access to innovative space data tailored to local and regional needs.[131]

3.92 A comprehensive list of ways to address these barriers is set out in Box 3.4. It includes developing a targeted suite of small satellites.

Box 3.4

Risks to ongoing access to critical satellite data:

- Maintain an open data policy for Australian–supported satellites using public funds, thus encouraging other countries to continue or adopt similar open data policies.
- Support and encourage the development of space applications that do not rely solely on data from a single foreign satellite system.
- Promote the interoperability of data from different satellite operators, including through ongoing engagement in the multilateral technical fora that establish standards.
- Strengthen key international partnerships, including by participating in collaborative satellite development projects that will generate data important for Australia.
- Develop a targeted collection of small satellites that help address important data supply vulnerabilities.
- **Ability to assure customers of product quality:**
- Establish an ongoing capability that coordinates and promotes the

130 Professor Alan Duffy, Director, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, pages 16 and 17.

131 Geoscience Australia, *Submission 13*, p. 5.

development of a national network of quality assurance facilities for space applications.

- Promote the capability to international satellite sensor manufacturers and space applications developers.
- **Support for export of space applications:**
- Establish an ongoing program that supports Australian innovators to tailor products and services developed for local markets to meet the needs of export markets.
- Establish an initiative to work with likeminded partner countries to ensure there are infrastructures for satellite applications available in priority target markets.
- **Shortages of local skills in specialist areas:**
- Explore opportunities to encourage those seeking a career in STEM to enter courses in areas including spatial sciences, geodesy, remote sensing and sensor engineering.
- Highlight that such skills will provide opportunities to establish new high-tech digital businesses.
- **Access to innovative space data tailored to local and regional needs:**
- Support the establishment of satellite ground stations in Australia's Antarctic territory, and promote the establishment of a network of 'space parks' on the Australian mainland.

Source: Geoscience Australia, Submission 13, pp. 5-6.

Calibration and validation

3.93 Australia has world leading expertise and reputation in the calibration and validation (cal/val) of space EO missions. Australian cal/val technology and equipment has played a vital role in securing EO data for the nation from international space agencies.[132]

3.94 FrontierSI identified cal/val as a particular strength and opportunity for Australia. It stated:

> Providing calibration and validation as a service offers a significant economic activity and builds on our internationally recognised capabilities. It can attract overseas companies to enter the Australian market and generate new business for those offering these services. Currently, these services are limited in offering within Australia to government and research organisations. Investment in additional calibration and validation research development with the private sector through existing entities such as the SmartSat CRC may

[132] EOA, *Submission 21*, p. 7.

> provide an opportunity to increase participation, and potentially borrowing from models used in the health sector in which the companies access infrastructure operated by public research institutes and/or government.[133]

3.95 Earth Observation Australia expressed the same view, noting that Australia is uniquely positioned to offer EO satellite cal/val as an essential national and international service due to its geography, landscapes and world-leading expertise.[134] It states that this opportunity is currently being missed due to the absence of support to:

- establish formal 'calibration infrastructure' sites with adequate facilities
- cohesively connect cal/val research, practices, and commercial applications in Australia.[135]

3.96 The availability of calibration infrastructure would support Australian research and business and lead to increased engagement of international partners. Professor Boyce, Director, UNSW Canberra Space commented on the lack of cal/val infrastructure and noted that it represents particular opportunities for people in rural and regional Australia:

> Australia has calibration and validation locations which are utilised by the rest of the world for calibrating the satellite sensors that deliver the data that we and the rest of the world need. I know that there is need within Australia to formalise the cal/val infrastructure. It's not in the cities.[136]

3.97 International partners have expressed interest in using Australian cal/val sites and experience to calibrate new and existing satellite missions.[137] In particular, the United States Geological Survey expressed its support noting that it sees 'significant value in Australia becoming a global resource for remote sensing cal/val advancements, including the collection of datasets to support those efforts'.[138] It stated:

> The concept of Australia leading an international effort to develop and promote Cal/Val best practices - with the potential inclusion of a satellite mission designed to support those efforts - would be quite favorably received

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133 FrontierSI, *Submission 38*, p. [3].

134 EOA, *Submission 21*, pp. 7-8.

135 EOA, *Submission 21*, pp. 7-8.

136 Professor Russell Boyce, Director, University of New South Wales (UNSW) Canberra Space, *Committee Hansard*, Canberra, 12 May 2021, p. 5.

137 EOA, *Submission 21*, pp. 7-8.

138 United States Geological Survey, *Submission 71*, p. 2.

> by those who currently collect, distribute, and utilize space-based remote sensing data. With the proliferation of government and commercial remote sensing capabilities, the need for clear and widely accepted radiometric, geometric, and format/metadata standards and processes are critical in enabling improved interoperability among various datasets.[139]

3.98 Symbiosis Communication suggested that Australian investment could target extending international capabilities (e.g. by contributing complementary instruments), and/or by enhancing utility for Australian users.[140] It highlighted the work of Geoscience Australia with the SBAS, improving the quality and utility of GNSS signals for Australian users. Symbiosis Communication suggested the streamlined provision of satellite cal/val via a government facility implemented by Australian industry.[141]

Off-Earth opportunities

3.99 Space is entering a new environment called the 'off-earth economy'. This includes people going back to the moon, to Mars, and undertaking in-situ resource utilitsation.[142] APAC explained:

> One of the emerging areas of space activities with the highest economic potential is the extraction and processing of minerals and resources from planetary bodies (Moon, Mars and asteroids). The extraction and processing of resources including carbon-rich minerals and rare earth minerals found in space will be an essential feature of long-term manned presence on the Moon, Mars and more remote space stations such as the Lunar Gateway and is the key to unlock the Off Earth economy around living, working and manufacturing in space.[143]

3.100 APAC argued that Australia should draw on its on-earth capability and skill base – particularly in mineral mining and extraction and remote operations – to maximise these new opportunities.[144]

3.101 Other submitters also drew attention to Australia's strengths in these areas and have started exploring opportunities. The NSW Government stated:

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139 United States Geological Survey, *Submission 71*, p. 2.

140 Symbios Communications, *Submission 30*, p. 3.

141 Symbios Communications, *Submission 30*, p. 3.

142 Mr Kirby Ikin, Managing Director, APAC, *Committee Hansard,* Sydney, 19 April 2021, p. 39.

143 APAC, *Submission 76*, p. 13.

144 APAC, *Submission 76*, p. 14.

> Current expertise in advanced mining and autonomous mine operations will be a natural fit for organisations undertaking in-situ resource utilisation on space missions, while capability in agriculture and construction in hostile environments have the potential to support future space settlements.[145]

3.102 The NSW Government has signed a memorandum-of-understanding with the Luxembourg Government to support collaboration on the exploration, exploitation and utilisation of space resources. It encourages greater international cooperation in this area.[146]

3.103 Professor Boswell similarly promoted Australia's expertise in mining, particularly smelting, and agriculture in difficult environments:

> There are many challenges in successfully creating and managing a space program, especially a manned mission to the Moon. Australia needs to find a niche where it can really contribute rather than be an "also ran" and a "me too". We are good with minerals and agriculture and should relish the chance to apply our experience to one of the most challenging environments known.[147]

3.104 Professor Boswell and his team are currently developing a road map to identify and develop on-earth activities that can be applied to a moon habitat.[148]

3.105 While recognising the off-earth potential for Australia, APAC identified the lack of international regulation as a key risk. It stated:

> One of the challenges with attracting the necessary investment to develop Off-Earth resource exploitation is that there is currently no agreed international regime for the possession and sale of Off-Earth resources that is essential to protect the investment of mining operators and enable profits. The language and interpretation of the UN Space Treaties are part of the challenge here.[149]

3.106 APAC recommended that Australia should use its position as a country with significant resource extraction expertise and as a signatory of the Moon

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145 NSW Government, *Submission 75,* p. 14.

146 NSW Government, *Submission 75,* pages 14 and 15.

147 Boswell Technologies, *Submission 31*, p. 6; Professor Rod Boswell, Chief Executive Officer, Boswell Technologies, *Committee Hansard*, Canberra, 26 February 2021, pp. 41-42.

148 Boswell Technologies, *Submission 31*, p. 6

149 APAC, *Submission 76*, p. 14.

Agreement to develop an internationally agreed regime to safeguard investments and activities in this area.[150]

3.107 Other opportunities raised in evidence include space tourism; in particular building on Virgin Galactic's spacecraft which can launch and land from a standard airport runway. The WA Government considers that Western Australia's proximity to Asia would make it an 'ideal place' to set up a southern hemisphere launch location for space tourism and position Australia more generally for sub-orbital flights.[151]

3.108 Shoal also commented on the opportunity presented by space tourism and the development of space ports in Australia. It suggested that Australia could consider the regulatory requirements to support an endeavour and possibly private-public partnerships to develop the necessary infrastructure.[152]

3.109 APAC identified suborbital space flights as a potential opportunity and recommended that the Australian Government position Australia to become an early participant in this future travel system.[153]

3.110 Space Solar Technologies provided information about its technology and investment opportunities. See Box 3.5. It is seeking initial funding from Government to develop this technology and area of investment.[154]

150 APAC, *Submission 76*, p. 15.

151 Western Australian Government, *Submission 61*, p. 7.

152 Shoal, *Submission 5.2*, p. 8.

153 APAC, *Submission 76*, p. 15.

154 Solar Space Technologies, *Submission 15*, p. 17.

Box 3.5

Solar Space Technologies is an Australian company, developing a space solar power project in Australia.[155] Space solar power involves the gathering of solar energy in space through the design, manufacture and deployment of large satellites.[156] This solar energy is then transferred to Earth.[157] Space solar power production levels are predictable and systems have the capability to supply large amounts of low cost baseload energy without producing carbon emissions.[158]

Solar Space Technologies is working with Mankins Space Technology, a USA based company, to generate base-load space solar power in Australia and to export the energy to the region and around the world.[159] Space solar power is produced through the use of a solar satellite in geostationary orbit over Australia.[160] The satellite collects the solar energy and transmits it as microwaves to a ground based rectenna where it is converted to electricity and transferred to the national electricity grid.[161] As the sun is always shining in space, space solar power produces renewable energy 99.8 percent of the time.[162]

3.111 Small World Communications promoted an astronaut program as a possibility for Australia, highlighting the experience of Canada as a potential model.[163] The Canadian Space Agency provided robotic arms to NASA's Space Shuttle and International Space Station and plans to provide an arm for the Lunar Gateway. In exchange, NASA provides seats on its spacecraft and space station for Canadian astronauts.[164] Small World Communications

155 Solar Space Technologies, *Submission 15*, p. 3.

156 Solar Space Technologies, *Submission 15*, p. 3.

157 Solar Space Technologies, *Submission 15*, p. 3.

158 Solar Space Technologies, *Submission 15*, p. 3.

159 Solar Space Technologies, *Submission 15*, p. 4.

160 Solar Space Technologies, *Submission 15*, p. 6.

161 Solar Space Technologies, *Submission 15*, p. 6.

162 Solar Space Technologies, *Submission 15*, p. 6.

163 Small World Communications, *Submission 4*, p. 3.

164 Small World Communications, *Submission 4*, p. 3.

contends that Australia can 'easily afford' to adopt a similar model by identifying something that a) can be built in Australia, and b) is required by NASA or another space agency for future plans.[165]

3.112 Dr Jason Held, Chief Executive, Saber Astronautics, similarly identified off-earth opportunities for Australia, including an astronaut program. Dr Held told the Committee:

> I would also set the conditions for an astronaut program for Australia. If you look 10 years out, and if look at what's happening today in markets that we're not yet playing in—the ability to do advanced manufacturing in space, the ability to do pharmaceuticals and quantum computing are all things we're doing quite nicely here on earth; But, if you do them in space, you get considerable competitive advantages in terms of the quality of product.[166]

3.113 In its submission, Saber Astronautics set out a plan for a public-private Australian astronaut program.[167]

Adjacent sectors

3.114 Multiple industries adjacent to the space sector have capabilities that are transferrable to space.[168] In addition to mining, remote operations and agriculture discussed above, other industries include next generation communications, manufacturing, space medicine and human life sciences, and digital mapping.[169]

3.115 Mr Anthony Murfett, Deputy Director of the ASA highlighted the potential of adjacent industries to space. He told the Committee:

> There are a whole range of companies out there that just aren't even thinking about space. The mining sector is a really good one. They've got capabilities, and NASA wants them, which is great. So that's one we can transition into. I think as we look at our manufacturing base there are a whole range of others. They're working in defence, they're working in medtech and they're working in agriculture, but those capabilities—if they harden them, they can survive radiation et cetera—could then be applied to space or help us here on the

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165 Small World Communications, *Submission 4*, pp. 2-3.

166 Dr Jason Held, Chief Executive Officer, Saber Astronautics, *Committee Hansard*, Sydney, 19 April 2021, p. 13.

167 Saber Astronautics, *Submission 84*, p. [5].

168 ASA, *Submission 55*, pp. 8-9.

169 ASA, *Submission 55*, pp. 8-9.

> ground. So there's a whole lot of work, and we've only scratched the surface on talking to those companies that aren't even thinking about space.[170]

3.116 The NSW Government noted that adjacent sectors are unaware that they can participate in the space industry and identified a role for government to make these connections: Mr Roland Stephens, Executive Director, Jobs and Industry Development, NSW Government said:

> A lot of companies don't know that they're space companies. There are a lot of companies out there that have interesting technologies and applications and they're not aware of the linkages into the space sector or the applications of those in the space sector. We do see part of our role as helping to bring those opportunities to the attention of firms, and that is both regional and metropolitan.[171]

3.117 Engaging adjacent industries is mutually beneficial. While adjacent sectors afford the space industry a source of skills and expertise, the space industry affords adjacent sectors the opportunity to participate in space supply chains, employ highly skilled and technical personnel, and attract new customers.[172] It also provides diversification avenues for sectors in decline.[173]

3.118 Saab Australia argued that the narrative around the space industry is dominated by the 'visible' elements of the domain; space vehicles and their launch systems.[174] To create a more robust space industry, a greater emphasis must be placed on broader systems, including the ground based elements, support systems and infrastructure.[175] This includes broader industry engagement to attract those in adjacent sectors. Saab Australia stated:

> There will be further opportunities for adjacent and supporting industries as the Australian space domain evolves. By acknowledging that not all contributors to the space capability will be traditional space companies, we will see technology companies diversify into the space domain. This diversification will not only benefit the outcomes for the space domain. It will also provide sustainability for the industry during times of reduced space

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170 Mr Anthony Murfett, Deputy Head, ASA, *Committee Hansard*, Canberra, 17 February 2021, p. 6.

171 Mr Roland Stephens, Executive Director, Jobs and Industry Development, NSW Government, *Committee Hansard*, Sydney, 19 April 2021, p. 50.

172 ASA, *Submission 55*, p. 5.

173 ASA, *Submission 55*, p. 8.

174 Saab Australia, *Submission 12*, p. [1].

175 Saab Australia, *Submission 12*, p. [1].

> related activity as these multidimensional companies will be able to better balance their workload across various domains and demand cycles.[176]

3.119 Saab Australia emphasized support for adjacent industries to identify the opportunities that space offers and to translate current capability into one suitable for space.[177] It also recommended that a research and development capability stream be established to identify sovereign innovation in adjacent industries, and broader industry engagement with technology and engineering companies, and adjacent industries, to highlight how industry capabilities can be applied more broadly across the space domain.[178]

3.120 Similar themes were raised by the SLCANZ. It argued the 'continuing need' to promote space industry related and space industry adjacent sectors.[179] These include sectors such as law, finance, insurance, economics and advisor services.

3.121 By focusing on these adjacent sectors, the SLCANZ considers that those businesses at the core of Australia's space industry – e.g. those engaging in international relationships, managing intellectual property ownership, managing compliances with export controls, manufacturing rockets or satellite components, those operating orbital space assets and ground-based space infrastructure – are protected from unnecessary legal, business and financial risks arising out of a lack of understanding or advice.[180]

3.122 Furthermore, a strong space adjacent business sector can play a substantial role in attracting international business, and increase the relevance of the Australian space industry to a broader range of sectors, as well as the current and future workforce.[181]

3.123 The Adelaide Law School expressed the same view. It identified the need to consider the contribution of non-STEM businesses to the Australian space industry, identifying the essential role that these professions play in developing and maintaining the industry. In particular, it noted that:

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176 Saab Australia, *Submission 12*, p. [3].

177 Saab Australia, *Submission 12*, p. [3].

178 Saab Australia, *Submission 12*, p. [2].

179 Space Law Council of Australia and New Zealand (SLCANZ), *Submission 14*, p. 4.

180 SLCANZ, *Submission 14*, p. 4.

181 SLCANZ, *Submission 14*, p. 4.

> …the non-STEM industry sectors play an essential role in enabling space-related operations through fundraising, legal and intellectual property advice, and facilitating day-to-day operations.
>
> Greater recognition of non-STEM sectors can also assist the Australian space industry in addressing issues before they arise to avoid small to medium enterprises only engaging with professional advisers when issues presents.[182]

3.124 It encouraged a greater focus on non-STEM industry government initiatives and strategies to support the development of niche specialist advisory capabilities that are capable of being internationally renowned.[183]

Aerospace medicine

3.125 While adjacent space related sectors can transfer capability into the sector, the space industry itself can spill-over into other sectors of the economy. For example, the ASA highlighted that new remote medicine techniques can assist rural medicine, new communication technologies can improve communications on Earth, and advancements in robotics can automate farming practices to help farmers manage their land.[184] These spill-over benefits have the potential to generate additional economic activity, productivity and jobs.

3.126 The Committee spoke to Dr John Cherry, Director, Australasian Society for Aerospace Medicine and Dr Rowena Christiansen, Founder and Chief Consultant, the Ad Astra Vita Project about aerospace medicine which refers to the application of medicines to support human space flight. Dr Cherry explained to the Committee:

> … as international space agencies look to develop longer-duration missions beyond low Earth orbit, the challenges of providing optimal medical care to astronauts increases dramatically. Many of these challenges are similar to the healthcare challenges faced by rural and remote communities across Australia. Access to resources, suitably trained medical staff, accessible and reliable telehealth facilities, and access to suitable medical technologies are common challenges.[185]

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182 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [8].

183 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [8].

184 ASA, *Submission 55*, p. 5.

185 Dr John Cherry, Company Director, Australasian Society for Aerospace Medicine, and Chair, Space Life Sciences Committee, Australasian Society for Aerospace Medicine, *Committee Hansard*, Canberra, 20 September 2021, p. 14.

3.127 The benefits of Australian expertise in aerospace medicine is two-fold: not only is there an opportunity to work with international partners to support long-duration space flight but these innovations can then be applied to rural and remote communities across Australia to improve their access to quality health care.[186]Furthermore, lessons learned from health related issues in space can be applied more generally on Earth. Dr Christiansen said:

> A lot of the physiological changes which occur in space—for instance, the changes in bone mineral density and muscle strength and bulk—have are a lot of parallels with ageing, and the knowledge that we get from that sort of research can be applied to populations on Earth.[187]

3.128 Dr Christiansen made a series of recommendations to improve the education and training opportunities for Australian doctors to specialise in aerospace medicine.[188] These include:

- a formal space medicine training pathway for Australian doctors and health professionals which includes access to international agencies and support to develop dedicated programs.
- financial support such as FEE-HELP or open scholarships to assist Australians to develop aerospace medicine skills and qualifications, and attend international conferences.
- small scale funding packages to support innovative local space health STEM initiatives.
- a national space sector opt-in database to showcase Australian capabilities.[189]

3.129 To better facilitate the translational benefits of aerospace medicine, the ASAM recommended the development of an Australian Clinical Research Institute for Space Health to help coordinate space medicine research, training and development.[190] Based on NASA's Translational Research Institute for Space Health, the Australian Institute would be a standalone

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186 Dr Cherry, Australasian Society for Aerospace Medicine, *Committee Hansard*, Canberra, 20 September 2021, p. 14. Also see the Australasian Society of Aerospace Medicine, *Submission 20*, pp. 2-3.

187 Dr Rowena Christiansen, Founder and Chief Consultant, The Ad Astra Vita Project, *Committee Hansard*, Canberra, 20 September 2021, pp. 19-20.

188 The Ad Astra Vita Project, *Submission 68*.

189 Dr Christiansen, The Ad Astra Vita Project, *Committee Hansard*, Canberra, 20 September 2021, pp. 14-15. Also see The Ad Astra Vita Project, *Submission 68*.

190 Australasian Society of Aerospace Medicine, *Submission 20*, p. 4.

organisation, funded by the ASA, and designed to promote Australian excellence in the field.[191]

Committee comment

3.130 Australia's reliance on space, and its reliance on other countries for space highlights the need for Australian to develop sovereign capability. Defining what this means, identifying priority areas for development, and providing the framework to facilitate the growth of Australian-owned and operated businesses will reduce Australia's vulnerability to loss or restricted access to space based technology and services.

3.131 Supporting and maintaining the domestic space industry alone will not be enough to sustain Australian businesses nor contribute to the broader growth of the industry. The Australian space industry will need to export its products and services and connect to global supply chains. Government has an important role to play here. This includes by facilitating partnerships with primes, advocating for Australian businesses in international markets, providing timely and tailored access to funding, and ensuring the policy settings provide confidence to stakeholders to invest.

3.132 Ensuring availability and access to necessary space infrastructure to support industry develop, design, test and manufacture technology is also fundamental to developing the domestic industry. There is a need to examine how Australia's space infrastructure can be incorporated into future national infrastructure plans. The Committee recommends that space be identified as a key infrastructure priority area and that a national audit be undertaken of current and future space infrastructure needs.

3.133 Australia can capitalise on its strengths, particularly in downstream activities. Earth observation, space based applications and expertise in calibration and validation present significant strengths that can be leveraged to position Australia in a global market. Opportunities also exist within supporting sectors as specialist space advisory services can be developed for an international market.

3.134 The Australian Government recently announced that an Australian made rover be included in a future NASA mission as part of NASA's Artemis program. This is an exciting and important opportunity for Australia to showcase its off-earth expertise in remote operations and mining.

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191 Australasian Society of Aerospace Medicine, *Submission 20*, p. 4.

Identifying further international partnership opportunities in the off-earth sector as well as emerging areas should be a focus of Government.

3.135 The parallels between rural and remote health care and aerospace medicine was a fascinating area briefly examined during this inquiry. Access to resources and reliable telehealth facilities, properly trained medical staff, and access to medical technologies are common challenges. The dual benefits afforded by aerospace medicine sector highlight the enormous potential of this niche area. The Committee supports efforts to foster its growth.

Recommendation 9

3.136 The Committee recommends that the Australian Government define Australian sovereignty as it relates to the development of Australian space capability to ensure that Australia's space related interests are promoted and protected.

Recommendation 10

3.137 The Committee recommends that the Australian Government identify in consultation with the Australian space industry particular national space capabilities that can be designed, built and delivered by industry.

Recommendation 11

3.138 The Committee recommends that the Australian Government consider ways to encourage stronger commercially attractive partnerships between global space primes and Australian businesses. These strategies should seek to engage and prioritise those companies that can demonstrate a commitment to growing the Australian space sector.

3.139 The Committee recommends that this includes establishing a program to assist SMEs connect with primes and navigate the broader global space industry more generally.

Recommendation 12

3.140 The Committee recommends that the Australian Government pursue policy settings that incentivise private sector investment in industry development including such things as matched funding or co-funding, taxation incentives, and public and private partnerships.

Recommendation 13

3.141 The Committee recommends that the Australian Government expand support to SMEs to improve connections in global supply chains.

3.142 The Committee recommends that the Australian Government streamline access to funding mechanisms and increase efficiency of investment by reducing complexity and enhancing transparency.

Recommendation 14

3.143 The Committee recommends that space be identified as a key infrastructure priority area. It recommends a national assessment of Australia's current and future space infrastructure requirements with particular emphasis on developing sovereign capability in identified areas.

3.144 This assessment should acknowledge the need for industry to access a range of infrastructure for research and development, and manufacture. It should build on the preliminary work set out by the SmartSat CRC.

3.145 The Committee recommends further consultation with Infrastructure Australia to establish whether it is best placed to undertake this work in consultation with industry.

Recommendation 15

3.146 The Committee recommends that the Australian Government, in consultation with industry, examine the requirement to use international standards such as those used by the European Space Agency and NASA for all Commonwealth space procurements.

Recommendation 16

3.147 The Committee recommends that the Australian Government develop a specific ABS classification to provide a more accurate picture of the size of the Australian space industry and to help track its value and growth.

Recommendation 17

3.148 The Committee recommends that the Australian Government foster the growth of Earth Observation from space and data processing capabilities that benefit Australia across ever sector of the economy.

Recommendation 18

3.149 The Committee recommends that the Australia Government identify other off-earth opportunities in partnership with international agencies.

3.150 The Committee recommends that consideration be given to developing a mechanism to identify and develop innovative space proposals such space solar power technology in Australia.

Recommendation 19

3.151 The Committee recommends that the Australian Government undertake broader industry engagement to:

- **create awareness in adjacent sectors of opportunities to participate in the Australian space industry**
- **identify relevant skills and expertise within adjacent industries that could be transferable to the Australian space industry**

3.152 The Committee recommends that the Australian Government better promote and engage non-STEM industries such as law, economics, finance, business and advisory services to ensure that these sectors are well equipped to support and maintain the operation of the Australian space industry and provide a specialist service in an international market.

Recommendation 20

3.153 The Committee recommends that the Australian Government examine ways to better support and coordinate space medicine research, training and development to ensure that the translational benefits of aerospace medicine can be applied on Earth.

4. Launch

4.1 Rocket launches are synonymous with space. Their imagery, wonder and excitement shape popular perception about the space industry. Australia launched its first satellite into space in 1967 from Woomera, South Australia.[1] In 2020, South Australia was home to Australia's first commercial launch of space-capable rockets by Southern Launch at the Koonibba Test Range.[2]

4.2 In Australia, it is estimated that launch service providers could contribute up to $2 billion of direct, indirect and induced value in the coming decade and beyond.[3] Growth in this part of the sector is considered likely to contribute to between 10 – 20 per cent of the Australian Government's goal to create 20,000 new jobs by 2030.[4]

Australian launch sector

4.3 Stakeholders to the inquiry advocated for Australia to develop its own launch capability. Australian 'launch leaders', Equatorial Launch Australia, Gilmour Space Technologies and Southern Launch set out the benefits of a domestic launch industry:

> Ultimately, the launch industry attracts and enables investment in, and development of, satellite manufacture, satellite mission control and other

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1 K Dougherty, Australia in Space: A History of a Nation's Involvement, Space Industry Association of Australia (SIAA), 2017, p. 29.

2 Southern Launch, *Submission 46*, p. 5.

3 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 2.

4 Southern Launch, *Submission 46*, p. 15.

space related downstream industries. This is due to modern satellite companies wanting to reduce their supply chain lengths and position their manufacturing hubs as close to the launch infrastructure as practical, to reduce overall logistics costs and transportation timelines.[5]

Box 4.1

Located in East Arnhem Land, Equatorial Launch Australia is developing a commercial spaceport.[6] The development of the spaceport has shown close working relationships with the rural community and traditional owners.[7] It has also brought about direct jobs in land clearing, safety and recovery.[8] The development has brought in 60,000 year old stories and landcare practices which have been melded with practices from NASA and other world leaders in the space community, to see that Australia has real and diverse space jobs.[9]

Carly Scott, Chief Executive Officer, Equatorial Launch Australia, states that "with this example, we've got direct employment already, from land clearing to landcare, and ongoing space capability at the Equatorial Launch site in a remote community where there has been significant change and transition as an industry seeking opportunities for Australia."[10]

5 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 3.

6 Ms Carly Scott, Chief Executive Officer, Equatorial Launch Australia (Equatorial Launch), *Committee Hansard*, Adelaide, 10 March 2021, p. 8.

7 Ms Carly Scott, Equatorial Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 8.

8 Ms Carly Scott, Equatorial Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 8.

9 Ms Carly Scott, Equatorial Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 8.

10 Ms Carly Scott, Equatorial Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 8.

4.4 Research cited by the launch leaders noted that an Australian launch industry could service as many as 2,500 satellites in the next five years providing a unique opportunity for Australia to attract foreign investment and create new jobs.[11]

4.5 Boeing Australia emphasized the dual application of an Australian sovereign launch sector, noting its potential to create an enduring national space capability with defence and commercial applications, and provide tangible business opportunities for Australia to be used as a launch location of choice for the region.[12]

4.6 Mr Lloyd Damp, Chief Executive Officer, Southern Launch made a similar point regarding civil and defence industries:

> Space technologies are also critical for national security, and a sustainable, industry-led sovereign launch capability for Australia will provide necessary support to the Australian Defence Force. In developing our sovereign capability, we harness Australian grown technologies, we create jobs and we support our service men and women on the front line.[13]

Box 4.2

The Koonibba Test Range (KTR) in the District Council of Ceduna, South Australia, is managed by Southern Launch Space Pty Ltd (Southern Launch).[14] As Australia's only rocket launch facility licensed by the Australian Space Agency, the KTR was developed by Southern Launch, with strong support and involvement from the Koonibba Community Aboriginal Corporation.[15] The KTR is the Southern Hemisphere's largest overland suborbital rocket testing facility.[16]

By August 2020, the Civil Aviation Safety Authority approved Southern Launch's maiden launch from the Koonibba Test Range.[17] Leading up to

11 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 3.

12 Boeing Australia, *Submission 80*, p. 9.

13 Mr Lloyd Damp, Chief Executive Officer, Southern Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 1.

14 SouthernLaunch.Space Pty Ltd, *Submission 46:1*, Answer to Question on Notice, p. [1].

15 SouthernLaunch.Space Pty Ltd, *Submission 46:1*, p. [1].

16 SouthernLaunch.Space Pty Ltd, *Submission 46:1*, p. [1].

17 SouthernLaunch.Space Pty Ltd, *Submission 46:1*, p. [1].

the launch in September 2020, adults and children in Koonibba actively participated in organisation efforts.[18] Southern Launch organised a Road Traffic Management course for Koonibba community members and hired 19 individuals to staff roadblocks during launch week.[19] The Koonibba school children proudly decorated the town with rocket themed motives, built 3D rocket models and announced their interest in studying STEM subjects.[20]

The broader community has identified that there are now a large cohort of individuals in the Aboriginal community who can perform these other economic activities.[21] The community is now outsourcing these staff to gain additional income for individuals.[22] Corey McLennan, Chief Executive Officer, Koonibba Community Aboriginal Corporation stated, 'our entire Aboriginal community is very proud to be directly involved in the development of the Konnibba Test Range and [the Koonibba Community Aboriginal Corporation] look[s] forward to a long and mutually beneficial relationship with Southern Launch.'[23]

4.7 Australia has a number of inherent advantages for space launch capability including its geography, environment and political stability, as well as potential interest from strategic partners. Southern Launch listed the advantages of its facilities in a global market:

- located in environments with suitable weather for launch to take place all year
- ease of access for equipment and personnel
- potential to rapidly launch space objects into relevant high-inclination orbits (e.g. polar and sun synchronous) using multi-user launch facility infrastructure

18 SouthernLaunch.Space Pty Ltd, *Submission 46:1*, p. [1].

19 SouthernLaunch.Space Pty Ltd, *Submission 46:1*, p. [1].

20 SouthernLaunch.Space Pty Ltd, *Submission 46:1*, p. [1].

21 Mr Lloyd Damp, Chief Executive Officer, SouthernLaunch.Space Pty Ltd, *Committee Hansard*, Adelaide, 10 March 2021, p. 7.

22 Mr Lloyd Damp, SouthernLaunch.Space Pty Ltd, *Committee Hansard*, Adelaide, 10 March 2021, p. 7.

23 Mr Lloyd Damp, SouthernLaunch.Space Pty Ltd, *Committee Hansard*, Adelaide, 10 March 2021, p. 7.

- limited interference with aviation and shipping routes and an absence of infrastructure, residences, or human activity downrange of flight paths; increasing launch safety, launch window availability and launch window flexibility
- Australia is a politically stable nation with supportive export control measures.[24]

4.8 Dr Carly Scott, Chief Executive Officer, Equatorial Launch also highlighted Australia's geography and proximity to the equator as a 'huge advantage' in the global space market.[25] Dr Scott explained to the Committee:

> …there are about 22 orbital launch sites around the world, but not all of those are accessible or able to do the launches that the market requires. Australia's unique geography and the fact that we have wide-open launch windows, and very-wide-open spaces with a very low risk profile, means we're a primary spot for launch both down south and up at the equator, where we're uniquely positioned globally to do GEO launches.
>
> These are launches that, in terms of market dollars, are the most dominant in the space market. Doing those close to the equator positions Australia uniquely to absorb a significant chunk of the international market in addition to the southern launches that we're doing. We're also able to cover using one tenth of the satellite.[26]

4.9 The ability to service both geostationary (equatorial) and high inclination (sun synchronous, polar orbits) satellite markets is a particular strength for Australia.[27] It builds on the opportunity to be a primary launch location for Asia and a preferred provider for launch activities globally.[28]

Challenges

4.10 Despite the benefits of developing a domestic launch industry, stakeholders identified current challenges inhibiting the sector's growth. These primarily

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24 Southern Launch, *Submission 46*, p. 6.

25 Ms Carly Scott, Chief Executive Officer, Equatorial Launch Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 2.

26 Ms Scott, Equatorial Launch Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 8.

27 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 2.

28 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 2.

relate to investment and infrastructure, and the current regulatory framework and administration.

4.11 The SIAA attributed the current lack of space launch capability in Australia to 'government ambivalence'.[29] It stated:

> government ambivalence on the requirement and appropriate technologies for an Australian domestic space-launch capability has potential impacts on wider industry development and second-order commercial opportunities. Australia should either commit to developing a domestic launch capability, as the United Kingdom has, or accept the strategic and commercial risk of being dependant on foreign launch partners.[30]

4.12 Mr Lloyd Damp called for national leadership on this issue noting that industry alone cannot position Australia as a global leader.[31] Mr Damp stated:

> …it is vital that policy and regulation on the national level aligns with the same vision. Matters such as strategic direction, funding priorities and regulatory frameworks are the factors which can make or break Australia's opportunity.[32]

Infrastructure and investment

4.13 Launch is a driver of upstream technology development and an enabler of downstream use of space services.[33] Stakeholders told the Committee that national coordination of this essential infrastructure is required.

4.14 Domestic launch capability is needed to build a domestic satellite industry. Otherwise, Australia needs to take its products to be launched from other countries. Mr Richard Price, Chief Executive Officer, South Australian Space Industry Centre, told the Committee:

> …if we don't have a solid launch base, we're not going to have any business case that makes sense to manufacture satellites in volume. Why would anybody manufacture satellites thousands of kilometres away from their launch site? It doesn't make any sense whatsoever. So, if we want to unlock a

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29 Space Industry Association of Australia (SIAA), *Submission 83*, p. 4.

30 SIAA, *Submission 83*, p. 4.

31 Mr Damp, Southern Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 2.

32 Mr Damp, Southern Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 2.

33 Queensland Government, *Submission 60*, p. 4.

> manufacturing base here for satellites, we naturally need to launch them here, if we want to do it in volume. That connection is critical.[34]

4.15 Mr Price said that investment in infrastructure should be concentrated on select launch facilities given that 'fragmentation will be unsustainable'.[35]

4.16 The Queensland Government called for a more coordinated approach to developing the nation's launch industry, including the development of a national launch strategy.[36] It stated that the broader economic value of launch rests in the potential for Australia to develop a world class launch supply chain. This could enhance the development of advanced manufacturing and produce spill over effects into other Australian industries such a mining and agriculture.[37]

4.17 The absence of a dedicated launch strategy may give rise to capability gaps and market loss. The Queensland Government identified the following risks:

- upstream technology value chains becoming fragmented
- the relocation overseas of Australian launch and satellite development and manufacturing
- even if manufacturing stays onshore, satellites and rockets are deployed overseas.[38]

4.18 Capability loss may also impact Australia's upstream supply chains and the ability to build sovereign capability.[39]

4.19 Nova Systems, a Technical Advisor for Space Launch for the ASA, and a Suitably Qualified Expert raised the lack of launch infrastructure as an issue, and suggested consideration be given to government 'taking a stake to aid in the development of strategically important infrastructure, which could be coordinated at a national level'.[40]

4.20 Similarly, the University of Southern Queensland noted that in order to build in launch and payload development, the Australian space industry

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34 Mr Richard Price, Chief Executive Officer, South Australian Space Industry Centre (SASIC), *Committee Hansard*, Adelaide, 10 March 2021, p. 21.

35 Mr Price, SASIC, *Committee Hansard*, Adelaide, 10 March 2021, p. 21.

36 Queensland Government, *Submission 60*, p. 4.

37 Queensland Government, *Submission 60*, p. 4.

38 Queensland Government, *Submission 60*, p. 4.

39 Queensland Government, *Submission 60*, p. 4.

40 Nova Systems, *Submission 39*, p. 2.

needs appropriate infrastructure for large scale propellant manufacture and rocket static testing that is available to the whole industry and embeds research capabilities.[41]

4.21 Boeing Australia stated that the challenge for sovereign launch in Australia is the investment in launch infrastructure.[42] It argued that:

> Taken on a program-by-program view, this investment will likely prove cost-prohibitive and of limited competitiveness in a market already well served by the established players. However, when viewed across the portfolio of programs and interests in both the defence and commercial sectors, and combined with other intangible benefits, the business case for a sovereign launch capability may well prove compelling.[43]

4.22 Issues related to the national coordination of infrastructure more generally across the Australian space industry were discussed in the previous chapter.

Regulatory framework

4.23 The regulatory framework for launch in Australia is governed by the *Space (Launches and Returns) Act 2018*.[44] Examples of regulated activities under the Act include:

- launching a space object from Australia
- returning a space object to Australia
- launching a space object overseas (for Australian nationals with an ownership interest)
- returning a space object overseas (for Australian nationals with an ownership interest)
- operating a launch facility in Australia.[45]

4.24 Australian laws regulating the space industry are primarily derived from international treaties governing the conduct of governments and private entities in outer space. Australian government agencies participate in a range of international organisations and forums that facilitate Australian

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41 University of Southern Queensland (USQ), *Submission 35*, p. [1].

42 Boeing Australia, *Submission 80*, p. 9.

43 Boeing Australia, *Submission 80*, p. 9.

44 Australian Space Agency (ASA), *Submission 55*, pp. 19-20.

45 Department of Industry, Science, Energy and Resources, 'Regulating Australian Space Activities', <https://www.industry.gov.au/regulations-and-standards/regulating-australian-space-activities>, accessed 26 October 2021.

space capability or provide other benefits to Australia. This is discussed further in Chapter 5.

4.25 In addition, there are non-treaty export control regimes in place to prevent the proliferation of sensitive technology or materiel with military applications. Australian space capability depends upon access to technology that may be owned by foreign companies or in some way regulated by foreign governments.

Box 4.3

The objects of the *Space (Launches and Returns) Act 2018* are:

(a) to establish a system for the regulation of space activities carried on either from Australia or by Australian nationals outside Australia; and

(aa) to establish a system for the regulation of the launch of high power rockets in Australia; and

(b) to ensure that a reasonable balance is achieved between:

- the removal of barriers to participation in space activities and the encouragement of innovation and entrepreneurship in the space industry; and
- the safety of space activities, and the risk of damage to persons or property as a result of space activities, regulated by this Act; and

(c) to implement certain of Australia's obligations under the UN Space Treaties.

4.26 The ASA outlined the background to the current regulations noting that it was updated in 2018 and 2019 to ensure it 'supports the growth of the space industry by removing unnecessary barriers to participation and encouraging entrepreneurship, as well as ensuring the safety of the activities and making sure our international obligations are met'.[46]

4.27 Stakeholders to the inquiry expressed their frustration with the current regulatory arrangements, particularly relating to launches. For example, the SLCANZ submitted that the recent reforms to the *Space Activities Act 1998*

46 ASA, *Submission 55*, p. 19.

fell short of the 'wholesale change the industry was seeking'.[47] It argued that the Australian Government should adopt a 'new, ambitious approach to regulating the space industry' to ensure that future operations are accommodated and the Australian legal framework is harmonised as much as possible with 'mature and upcoming markets' , including the United States, the United Kingdom and New Zealand.[48]

4.28 The Adelaide Law School made a similar point, and advocated for 'a purpose built and future looking legal regime'.[49] It stated:

> Despite the 2018 amendments…there appears to have been a substantial lack of appetite for the creation of legal regimes with a future looking space focus. The 2018 amendments to the *Space Activities Act 1998* were narrow and focused on selected issues, primarily the reduction in insurance obligations for operators, changes to titles, and minor variations responding to specific concerns during the review process.
>
> The *Space (Launches and Returns) Act 2018* (Cth) regime only regulates the operation of launching facilities, launch (in Australia and overseas) and returns of space objects. At present, this legislative framework fails to capture the full life of a space operation, especially the 'operational' phase of a space asset.

4.29 The Adelaide Law School further noted that the recent 'substantial reform processes undertaken by other western economics have left the Australian legal framework wanting'.[50] In evidence to the Committee, Professor Melissa De Zwart, Dean of Law, University of Adelaide said:

> …the regulation as it is currently drafted is too complex. …it is vastly expensive to comply with the requirements, such as the need for expert assessment. There are delays in getting launch licences, delays with the review process and loss of contracts offshore.[51]

4.30 Southern Launch recommended that the Australian Government commission a review of the *Space (Launches and Returns) (General) Rules 2019* in consultation with industry and stakeholders. It stated:

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47 Space Law Council of Australia and New Zealand (SLCANZ), *Submission 14*, p. 8.

48 SLCANZ, *Submission 14*, p. 8.

49 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [5].

50 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [5].

51 Professor Melissa de Zwart, Dean of Law, University of Adelaide, *Committee Hansard*, Adelaide, 10 March 2021, p. 29.

> Unfortunately… the Rules do not streamline the approvals process in any measurable manner since the prior 1998 Act. Neither have the Rules helped make Australia a more cost competitive launching state in the global launch market. … Sadly, minimal consideration was given to the comments, issues and concerns raised by industry, academia and associations during consultation on the draft delegate legislation prior to its adoption were implemented in the delegate legislation.[52]

4.31 Southern Launch recommended that the submissions and issues previously raised by industry be revisited.[53]

4.32 The SIAA commented on the 'regulatory overburden' in Australia' and supports a review of the regulatory process for launch to ensure there are no impediments to Australia developing launch activities and spaceflight heritage.[54] It advocated for a 'forward leaning, industry-friendly regulator willing to work actively and closely with space companies to evolve Australia's space capability'.[55]

Approval processes

4.33 Timeliness of processes and approvals was a key issue affecting the launch sector. Southern Launch explained that without timely approvals it cannot conduct or host space launches and therefore will be unable to meet its financial commitments.[56] Furthermore, there is a real risk that Australia will not develop a sovereign launch capability.[57]

4.34 Mr Blake Nikolic, Chief Executive Officer, Black Sky Aerospace, noted Australia's approvals are out of sync with other space countries. He told the Committee:

> …the time frames for approvals put Australia out of touch with international standards. Whilst increased launch complexity will require more scrutiny—

52 Southern Launch, *Submission 46*, p. 21.

53 Southern Launch, *Submission 46*, p. 25.

54 SIAA, *Submission 83*, p. 3.

55 SIAA, *Submission 83*, p. 7.

56 Southern Launch, *Submission 46*, p. 28.

57 Southern Launch, *Submission 46*, p. 28.

> even the simplest of launches can take up to six months to approve. Other countries do these in a matter of weeks.[58]

4.35 Deloitte submitted that regulatory differences between jurisdictions can also add to complexity. It noted that regulations seem to differ based on geographies, which inhibit start-ups wanting to launch outside of their country of origin.[59] It added that the multiple definitions of what a rocket or spacecraft is, and its changing propulsion mechanisms result in complications for permit applications.[60]

4.36 A similar point was made by Virgin Orbit when discussing partnerships between Australia and the United States:

> Given that both Australia and the United States will require separate licenses and regulatory approval to support a singular launch operation from Australia, there is risk of burden and duplication of effort… Steps should be taken between Australia and the United States to minimize the differences between their regulatory requirements, standardize methodologies to demonstrate regulatory compliance, or otherwise develop a framework of mutual approval of one country's launch license as demonstrative of regulatory compliance.[61]

4.37 The space industry's risk-adverse nature was identified as contributing to the time taken to process applications and licences. To address this, Nova Systems recommended a regulatory framework based on levels of risk.[62] It proposed:

> Activities with inherently low risk to public safety or the space environment undertaken with small investments need not be subjected to the same process as large commercial endeavours with higher levels of risk. If possible, tailoring of the process could apply to the level of independent assessment industry is required to obtain, the size, detail and type of documentation required and the processing timeframes.
>
> Moreover, Government could engage early as a matter of formal application planning process with industry entities, assess and advise them on suitable

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58 Mr Blake Nikolic, Chief Executive Officer, Black Sky Aerospace, *Committee Hansard*, Brisbane, 6 May 2021, p. 8.

59 Deloitte, *Submission 53*, p. 10.

60 Deloitte, *Submission 53*, p. 10.

61 Virgin Orbit, *Submission 33*, pp. 15-16.

62 Nova Systems, *Submission 39*, p. 2.

> limitations they should apply to their activities to ensure they remain within acceptable levels of risk, and undertake a suitably sized safety assessment process. This could be conceived as an Operating Permit Plan (Facility or Launch).[63]

4.38 Nova systems argued that 'right sizing' the level of oversight to the risk of the activity would facilitate a greater number of activities, encouraging growth of the industry.[64] It will also lead to more efficient use of Government resources as the Government increases ASA resources and those of space related institutions to provide oversight to a growing industry.[65]

4.39 Gilmore Space Technologies also commented on the risk adverse nature of industry, describing launch as an opportunity, not a risk.[66]

Suitably qualified expert provisions

4.40 Some stakeholders advocated for the removal of the 'suitably qualified expert' provisions in the Rules. Mr Adam Gilmour, Chief Executive Officer, Gilmour Space Technologies, explained to the Committee:

> There's a concept called a 'suitably qualified expert' that's in the legislation. That's a person who has technical expertise to evaluate the flight safety risk of a launch. In the regulations, in Australia, that has to be an independent expert, that's probably going to be another company that will do this on a commercial basis. One of the issues with that is there are not many of these companies that are suitably qualified. The second thing is that when we look into the other countries that launch rockets, this activity is done internally by either the space agency or the civil aviation authority.[67]

4.41 The launch leaders consider the 'suitably qualified expert' provision to be counterproductive and a risk to developing Australia's launch capability.[68] This is because:

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63 Nova Systems, *Submission 39*, p. 2.

64 Nova Systems, *Submission 39*, p. 2.

65 Nova Systems, *Submission 39*, p. 2.

66 Gilmour Space Technologies, *Submission 59*, p. 7.

67 Mr Adam Gilmour, Chief Executive Officer, Gilmour Space Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 2.

68 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, pp. 5-6.

- experienced international launch vehicle operators are not permitted to perform flight safety tasks on vehicles in Australia. Instead they must be undertaken by third parties. This increases the risk to safety where entities unfamiliar with the launch vehicle, its development history and technology inputs are performing risk hazard analyses.
- contracting risk hazard analyses to third parties raises commercial concerns for domestic and international launch vehicle operators.
- there are no equivalent requirements in other commercial launch legislation, including the United States and New Zealand.[69]

4.42 By amending Australia's launch application rules to be in line with comparable countries, the launch leaders submit that this will incentivise launch operators to launch from Australia and enable Australia to remain competitive in a global market.[70]

4.43 Mr Gilmour further suggested that the ASA could be equipped to conduct these activities in the future, and remove the need and commercial cost of a third party.[71] Similarly, Southern Launch suggested the ASA should assess the flight safety aspects of an application on 'their merit rather than on the basis that the flight safety matters are performed by an independent party'.[72] It further argued that should the applicant be competent to perform its own risk hazard analyses, the ASA should be resourced to assess those analyses, providing for increased safety and competitiveness within the global launch market.[73]

4.44 Professor Melissa de Zwart also noted the 'significant' costs and agreed that further expertise could be developed within the ASA:

> Certainly it would be preferable, more than preferable, to have that expertise in house at the Space Agency because that reduces the cost and, as you say, builds up expertise. That's why I feel that the Space Agency needs better funding, and it needs to really clarify what its role is as a regulator. Remembering that one of the objects of the act itself is to facilitate industry, that should be an object of the Space Agency, but its role as a regulator should

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69 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, pp. 5-6. Also see Southern Launch, *Submission 46*, pp. 22-23.

70 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 6.

71 Mr Gilmour, Gilmour Space Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 2.

72 Southern Launch, *Submission 46*, p. 24.

73 Southern Launch, *Submission 46*, p. 24.

> be properly resourced with people with expertise. I think it is fair to say that, because of the particular niche areas of expertise that people in the Australian space industry have, it's almost impossible for them to find someone outside of their own start-up who has expertise that's better than what they actually have in house anyway.[74]

4.45 King and Wood Mallesons (KWM) made a similar point about in-house expertise to assist industry. It stated:

> …navigating the regulatory landscape – both in Australia and abroad – remains a barrier to entry for some participants, particularly new entrants that are early stage companies without in-house expertise or existing relationships with legal providers.[75]

4.46 The SIAA recommended that the ASA absorb the costs of conducting risk hazard analysis for launch applications for at least two years in order to catalyse Australian access to space.[76]

Australian Government Cost Recovery Scheme

4.47 Stakeholders raised the Australian Government Cost Recovery Scheme as a particular issue for industry. For example, Southern Launch described an intention to charge 'approximately $189,894 per launch permit application assessment' as being 'uncompetitive'[77] and stated that the proposal should be abandoned.[78]

4.48 In its submission, Southern Launch explained:

> …investors are informing us that, notwithstanding the technical advantages… it may be less preferable to launch in Australia over the long term due to the existence of this Cost Recovery Scheme. … This Scheme is grossly disproportionate to other like-minded commercial space-faring nations.[79]

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74 Professor de Zwart, University of Adelaide, *Committee Hansard*, Adelaide, 10 March 2021, p. 33.

75 King and Wood Mallesons, *Submission 54*, p. 9.

76 SIAA, *Submission 83*, p. 3.

77 Southern Launch, *Submission 46*, p. 26.

78 Southern Launch, *Submission 46*, p. 28.

79 Southern Launch, *Submission 46*, p. 27.

4.49 Fellow launch leaders expressed the same view citing 'uncompetitive costs on launch vehicle operators and Australian launch facility providers'.[80] They noted that for small launch vehicle operators, the fees are as much as three times the value of rocket development and mission costs; severely limiting Australia's ability to gain investment from the global launch market.[81]

4.50 Furthermore, the Committee was told that the scheme is 'grossly disproportionate' to other like-minded space countries.[82] Mr Lloyd Damp, told the Committee:

> New Zealand charges a flat rate of $60 and America charges zero dollars. The Northern Territory government has, in its submission collated 11 countries, I believe, that do not charge a fee, or if they do, it's somewhat minor, like NZ$60. This is a very large impediment to Australia being competitive on a global scale, especially when the modern launch vehicles are far smaller, far less complex and far cheaper to operate.[83]

4.51 Mr Scott Schneider, Southern Launch, also noted that the purpose of the scheme is unclear:

> ..the purpose of cost recovery has not been made clear. It's to enhance the capabilities of the agency. It's to recover costs that are used in the assessment of the application, which could be staffing hours but also could be outsourcing those assessments to third parties—to contractors. That's the purpose of cost recovery under the current framework.[84]

4.52 The Queensland Government highlighted industry concerns about the user-pays and cost recovery models being placed on the emerging space industry, particularly the launch sector. This can lead to 'negative impacts on jobs and economic growth in a start-up industry which already faces high competition and legacy investment overseas'.[85] The Queensland

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80 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 6

81 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 6

82 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia, *Submission 50*, p. 6

83 Mr Damp, Southern Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 2.

84 Mr Scott Schneider, Regulatory Lead, Southern Launch, *Committee Hansard*, Adelaide, 10 March 2021, p. 3.

85 Queensland Government, *Submission 60*, p. 5.

Government further argued that the user-pays regulatory model makes it more expensive to launch in Australia than comparable countries like New Zealand, and the USA even accounting for freight costs. It called for consideration to be given to reduce or remove the regulatory fees for launch until the industry is more developed.[86]

4.53 The Australian Government recently announced that it will defer the introduction of partial cost recovery for applications submitted under the *Space (Launches and Returns) Act 2018* until 1 July 2022.[87] This decision to defer cost recovery fees follows a review, and is designed to encourage launch activity, continued investment, and growth in the broader space sector.

4.54 Southern Launch recommended the Australian Government abolish the Cost Recovery Scheme all together.[88] It argued that extending the moratorium 'does not go far enough', as it raises the possibility that the moratorium might be lifted, creating uncertainty for potential operators considering an Australian launch.[89] Furthermore the scheme unnecessarily impedes Australia's international competitiveness as a launch services provider because the scheme does not demonstrate how it enhances launch safety. Southern Launch concluded that fees should not be applied to the assessment of launch permit or facility applications.[90]

Technology Safeguards Agreement

4.55 Evidence to the Committee highlighted the particular importance of concluding a Technology Safeguards Agreement (TSA) with the United States (US). The US requires a TSA be signed with partner countries, prior to the export of specific space technologies, such as launch vehicles.[91] It requires foreign governments to ensure that US technology is properly

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86 Queensland Government, *Submission 60*, p. 5.

87 Department of Industry, Science, Energy and Resources, 'Regulating Australian Space Activities', <https://www.industry.gov.au/regulations-and-standards/regulating-australian-space-activities>, accessed 26 October 2021. Also see the Hon. Senator Marise Payne, Minister for Foreign Affairs and Women, 'New Measures to Help Grow Australia's Civil Space Sector', *Media Release*, 1 July 2021.

88 Southern Launch, *Submission 46*, p. 26.

89 Southern Launch, *Submission 46*, p. 28.

90 Southern Launch, *Submission 46*, p. 28.

91 Virgin Orbit, *Submission 33*, p. 14.

handled, consistent with US non-proliferation policy, the Missile Technology Control Regime (MTCR) and US export control laws and regulations.[92] It also provides for specific controls on access to, disclosure of and procedures for safeguarding US launch vehicles, spacecrafts, related equipment, technical data and other areas that contain these items during launch activity.[93]

4.56 The SIAA discussed the TSA in its submission:

> Australia has been carefully preparing the way for a Technical Safeguards Agreement with the United States for the past 18 months. This treaty would allow for the transfer of sensitive equipment between the United States and Australia, and make it easier for satellites and instrumentation to be launched in Australia.[94]
>
> …the lack of a TSA severely impedes the ability of Australian companies to develop partnerships with the world's largest space export market. The Missile Technology Control Regime and International Traffic in Arms Regulations can place limitations on the ability of Australian and allied personnel to work on space projects and can be a barrier to space technology development.[95]

4.57 Virgin Orbit expressed a similar view, submitting that the absence of a TSA is a significant barrier to initiating collaborative partnerships and missions between American commercial space companies and Australian entities.[96]

4.58 A number of countries, such as the United Kingdom, Russia, India, New Zealand and Brazil, have entered into a TSA with the US.[97] Australia does not currently have a TSA in place, and without such Australia is locked out of the US space market, which carries a significant portion of the global space market share.[98]

4.59 Australian based space operators are not able to access US technologies, experience, knowledge, space missions and development programs.[99] For

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92 Virgin Orbit, *Submission 33,* p. 14.

93 Southern Launch, *Submission 46*, p. 36.

94 SIAA, *Submission 83*, p. 10.

95 SIAA, *Submission 83*, p. 10.

96 Virgin Orbit, *Submission 33*, p. 14.

97 Virgin Orbit, *Submission 33,* p. 14.

98 Southern Launch, *Submission 46*, p. 36.

99 Southern Launch, *Submission 46*, p. 36.

example, Southern Launch stated that the company had a number of potential clients based in the US who have been prepared to invest millions of dollars in Australia, but have been prevented from doing so because of the lack of a TSA.[100]

4.60 On 1 July 2021, the Australian Government announced that it will be commencing negotiations on a TSA with the US.[101]

Australian Space Agency status and functions

4.61 Issues about space activity regulation raised a broader issue about the role and functions of the ASA more generally. The SIAA emphasised that the ASA 'must perform its regulatory function in a manner which is more permissive to industry growth in a safe and sustainable manner'.[102] In particular, the SIAA raised concerns with the administration of the Act and the development of regulatory guidance and processes.[103]

4.62 EOS submitted that critical to ASA's success will be its staffing. It argued that the agency would 'benefit from increasing the level of direct space industry experience in its workforce, providing it with further insights into the challenges being faced by Australian space businesses and industry perspectives on how to help resolve them'.[104]

4.63 Some stakeholders suggested that the industry and regulatory functions of the ASA be separated, describing the current dual roles of the agency as unique. For example, the SLCANZ submitted that the current co-location of industry promotion and advocacy, and industry regulation presents the potential for conflicts of interest or direction.[105] The University of Adelaide Law School recommended that these functions be separated:

100 Southern Launch, *Submission 46*, p. 36.

101 The Hon. Christian Porter MP, Minister for Industry, Science and Technology, 'New Measures to Help Grow Australia's Civil Space Sector', Media Release, 1 July 2021.

102 SIAA, *Submission 83*, p. 7.

103 SIAA, *Submission 83*, p. 7.

104 Electro Optic Systems (EOS), *Submission 47*, p. 14.

105 SLCANZ, *Submission 14*, p. 7.

> …formally separating industry promotion and regulatory functions of the agency into separate entities… or in the alternative introduce a reporting and management structure that separates oversight of agency functions…[106]

4.64 The Committee heard that the role of the ASA needs to be clarified. Furthermore, it must be better resourced to perform its regulatory function. Air Vice-Marshall Chris Deeble (Retired), Chief Executive, Northrop Grumman Australia stated:

> If you want them to be looking across space industry and harnessing those things, that's a very different skill set for the Australian Space Agency. When you're looking at a regulatory role and comparing that to a husbanding role, they are two extremes, conceivably, in the way in which you would expect them to do business. So I think it's really important that we define exactly what we expect them to do, make sure they are skilled in delivering those outcomes, and make sure they have a clear charter to be able to undertake that work.[107]

Regulatory guidance

4.65 Publicly available guidance was identified as an important means to assist industry navigate the regulatory process and reduce lengthy delays and costs. It can also reduce barriers to entry for SMEs, and reduce the legal costs by providing industry with support from legal specialists.[108] The Adelaide Law School explained:

> Regulator guidance plays a significant role in putting applicants under a legislative framework on notice as to the expectations of a regulator and insight into how they will exercise their discretion.
>
> …unlike …the US, UK, NZ, Japan and other jurisdictions, there is no publicly available guidance on how the Australian Space Agency intends on assessing applications it receives for licences under the *Space (Launches and Returns) Act 2018*.[109]

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106 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [6].

107 Air Vice-Marshal Chris Deeble, AO, CSC (Retired), Chief Executive, Australia, and Director, Strategy, Northrop Grumman Australia, *Committee Hansard*, Canberra, 20 September 2021, p. 24.

108 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [7].

109 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [7].

4.66 To assist in timely assessment and approval of applications under Australia's space legislation, Southern Launch recommended the Australian Government through the ASA:

- provide further clarity and detail, in publicly accessible documents and guidance material regarding the technical expectations under the Rules and the stylistic requirements of launch facility licence and Australian launch permit applications; and
- establish a dedicated branch or personnel, responsible for engaging with applicants under the space legislation.[110]

4.67 Southern Launch argued this will result in applicants satisfying the Commonwealth's requirements under the space legislation in a timelier and more direct manner.[111] This benefits the industry and government as less resources are required for staff to assess applications. Sufficient resourcing to prevent timely assessments and determinations of pending launch applications was also stressed.[112]

4.68 Nova Systems made a similar point, observing that consideration should be given to the user experience of industry and 'soft law' guidance:

> … Australia's legislation should be supported with tools and resources which enable industry to efficiently meet their legal obligations. Consideration should be given to the "user experience" of industry, particularly in sectors which have been underdeveloped in Australia. Nova has previously suggested 'soft-law' guidance, online tools and support, exemplars and templates, and suggested Acceptable Means of Compliance (AMC) as commonly used in modern global aviation regulatory frameworks including the Federal Aviation Administration (FAA) Office of Commercial Space Transportation(AST).[113]

4.69 Nova Systems advocated for legal compliance to be a 'standard to strive for rather than simply a barrier to overcome or boxes to be ticked'.[114] Mr BJ Martin, Nova Systems told the Committee:

> it would be advantageous to focus on getting regulatory certainty at the beginning of the process, having the discussions between the agency and the

110 Southern Launch, *Submission 46*, p. 29.

111 Southern Launch, *Submission 46*, p. 29.

112 Southern Launch, *Submission 46*, p. 29.

113 Nova Systems, *Submission 39*, p. 2.

114 Nova Systems, *Submission 39*, p. 2.

> applicant, working through education sessions—'This is what we expect'; 'We can't do that. We've got this alternative; 'We'll consider alternatives.' The consideration of alternatives is something that hasn't been given a lot of space, because, I guess, it's all new.[115]

4.70 The Adelaide Law School advanced that regulator guidance assists with managing expectations and reducing costs.[116] It stated:

> Producing guidance would be a simple, yet effective method of placating industry and reducing barriers to entry for small to medium enterprises. Further, regulatory guidance reduces legal spend by allowing industry participants to act without immediate and continuous input from legal specialists.[117]

4.71 Similarly, the Queensland Government noted that while the Act is a 'much needed framework for the regulation of launch activities' there is little to no precedent for industry to draw on when preparing applications for permits and licences.[118] It recommended additional support to industry, in the form of guidance and information sessions, and highlighted the information provided by New Zealand to its industry as a useful example.[119]

4.72 The SIAA observed that the ASA 'has recognised the need to better educate both agency staff and industry licence applicants on regulatory processes so that respective priorities and expectations can be managed'.[120] The ASA noted it plans to hold a roundtable with companies considering launch activities to identify areas where guidance would benefit industry.[121]

Committee comment

4.73 The Australian launch sector presents a significant opportunity for Australia to develop a sovereign space capability, and establish itself as a global launch destination. Investment and infrastructure will be fundamental to

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115 Mr Brett (BJ) Martin, Launch Support Services Business Lead, Space, Nova Systems, *Committee Hansard*, Canberra, 26 February 2021, p. 33.

116 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [7].

117 The Adelaide Law School (University of Adelaide), *Submission 16*, p. [7].

118 Queensland Government, *Submission 60*, p. 5.

119 Queensland Government, *Submission 60*, p. 5.

120 SIAA, *Submission 83*, p. 7.

121 ASA, *Submission 55*, p. 20.

grow this sector of the industry. As with other sectors, success will depend on the ability of launch providers to market themselves globally. This means that Australia's regulatory framework must facilitate easier collaboration with international stakeholders - helping rather than hindering space companies wanting to launch in Australia. Given Australia's proximity to other launch destinations in the region, it must establish itself as a competitive and comparable destination for launch.

4.74 The Committee heard the frustration of launch providers regarding the complexities of the regulatory system, the desire for better engagement between industry and government, and the need for regulatory guidance documents to help stakeholders navigate processes and manage expectations. While the Committee acknowledges work is underway in this area, more could be done to streamline processes and reduce regulatory burden.

4.75 At the request of the Committee, the Adelaide Law School set out suggested detailed amendments to the *Space (Launches and Returns) Act 2018* to improve Australia's space legal framework and provide benefits to the Australian space industry. These suggested changes are included in supplementary submission 16.1 for the consideration of Government.

4.76 The Committee makes the following four recommendations, which are designed to complement recommendations made in other sections of the report that are relevant to launch.

Recommendation 21

4.77 The Committee recommends that the Australian Government consider a national launch plan or strategy to support a sovereign capability in Australia including the investment, infrastructure and expertise required. This includes development of policies that preference Australian launch capability to support government space requirements.

Recommendation 22

4.78 The Committee recommends that the Australian Government give consideration to further reforms to the *Space (Launch and Returns) Act 2018* and Rules 2019, in consultation with industry to ensure that regulatory provisions:

- **support the growth and competitiveness of the Australian domestic industry**

- **ensure the safe and responsible management of the space environment**

- **are in line with the regulations used by similar space countries.**

It is recommended that further engagement be undertaken with government and industry to determine the most suitable regulatory changes to best benefit growth and investment. Consideration may be given to the Adelaide Law School supplementary submission given to the inquiry.

Recommendation 23

4.79 The Committee recommends that the Australian Government give consideration to further suspending or amending the Australian launch permit application fees to ensure that Australian businesses are not financially or commercially disadvantaged, and remain competitive with other space countries.

Recommendation 24

4.80 The Committee recommends that the Australian Government establish dedicated and effective industry engagement mechanisms to guide stakeholders through the application and regulatory processes. This includes designated staff within the Australian Space Agency to work with industry, and the development of publicly available guidance documents.

5. Space Environment

5.1 Access to space-based capabilities is critical to a broad range of Australian sectors including agriculture, telecommunications, financial services and meteorology. It also underpins the operational effectiveness of the Australian Defence Force.[1] A consequence of this dependency is that Australia has a strong interest in maintaining a stable, secure, resilient and safe space environment.[2]

5.2 The Committee explored three key themes related to the space environment – Australia's ability to access space and defend space assets, tracking and monitoring what is happening in space, and protecting the space environment more generally.

International regulation of the space environment

5.3 Exploration and use of the space environment is subject to a range of national and international regulations. As discussed in Chapter 4, launch and return activities are regulated under the *Space Activities Act 1998* and the *Space (Launches and Returns) Act 2018* and associated rules.[3]

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1 For example, see: Australian Space Agency (ASA), *Submission 55*, pp. 5-6, 36; Bureau of Meteorology (BoM), *Submission 74*, pp. 2-3; New South Wales (NSW) Government, *Submission 75*, p. 12; Australian Strategy Policy Institute (ASPI), *Submission 79*, p. 2; Air Vice-Marshal Catherine Roberts, Head of Air Force Capability, Department of Defence, *Committee Hansard*, Canberra, 23 June 2021, pp. 1-2.

2 ASA, *Submission 55*, p. 43.

3 ASA, *Submission 55*, pp. 19-20.

5.4 Australia is a party to five international treaties related to the exploration and use of outer space, which are administered by the United Nations (UN). These include the:

- *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (the 'Outer Space Treaty') (entered into force for Australia in 1967)
- *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space* (the 'Rescue Agreement') (entered into force for Australia in 1986)
- *Convention on International Liability for Damage Caused by Space Objects* (the 'Liability Convention') (entered into force for Australia in 1975)
- *Convention on Registration of Objects Launched into Outer Space* (the 'Registration Convention') (entered into force for Australia in 1986)
- *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (the 'Moon Agreement') (entered into force for Australia in 1986).[4]

5.5 The Outer Space Treaty is the key treaty that outlines the 'overarching conditions of how countries will operate in space'.[5] This includes the principles that the exploration and use of space 'shall be carried out for the benefit and in the interests of all countries' and that states 'shall be liable for damage caused by their space objects'. It also prohibits the placement of nuclear weapons or other weapons of mass destruction in orbit or on celestial bodies.[6]

5.6 Some evidence to the inquiry suggested that space is a relatively unregulated environment or that rules and regulations are not keeping pace with the reality that space is now accessible to more nations and, increasingly, private entities. For example, Air Vice-Marshal Catherine Roberts, Head of Air Force Capability at the Department of Defence, explained that:

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4 ASA, *Submission 55*, pp. 20-21.

5 Mr Anthony Murfett, Deputy Head, ASA, *Committee Hansard*, Canberra, 17 February 2021, p. 3.

6 United Nations Office for Outer Space Affairs, 'Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies', <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html>, accessed 22 July 2021.

> Space doesn't have the same regulation system that we have for international airspace or the law of the sea. It has some treaties but they are not in detail. So we need to do some more ... in defining what is right and wrong in space.[7]

5.7 Air Commodore Nicholas Hogan, Director General Space Domain Review at the Department of Defence suggested that a 'grey zone' was emerging regarding the responsible use of space as a result of space becoming more accessible due to new and cheaper technologies.[8]

5.8 The emerging distance between the legal framework and the modern space environment was also raised by other submitters. The ASA explained that the international legal framework for space activities, which was established between the 1960s and the 1980s, 'was built in a very different technological and strategic environment'.[9] Northrop Grumman made a similar point:

> A cooperative, rules-based international space governance regime is essential to realise all the benefits that space assets provide. However, the dated nature of existing treaties often leaves many new space activities unaccounted for or allows actors to operate under wide-ranging interpretations of existing agreements.[10]

5.9 International law plays an essential role in the regulation of outer space activities, placing downward pressure on nations to ensure their activities are conducted in a safe, responsible and lawful manner. [11] The SLCANZ argued that Australia should continue to participate in international forums to 'clarify how international law impacts private activities in outer space, while also seeking to develop enforceable and internationally agreed norms of behaviour'.[12] This theme resonates throughout the chapter.

Changing nature of the space environment

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7 Air Vice-Marshal Roberts, Department of Defence, *Committee Hansard*, Canberra, 23 June 2021, pp. 4-5.

8 Air Commodore Nicholas Hogan, Director General Space Domain Review, Department of Defence, *Committee Hansard*, Canberra, 23 June 2021, p. 5.

9 ASA, *Submission 55*, p. 43.

10 Northrop Grumman, *Submission 27*, p. 11.

11 Space Law Council Australia and New Zealand (SLCANZ), *Submission 14*, p. 9.

12 SLCANZ, *Submission 14*, p. 9.

5.10 The space environment was characterised as becoming increasingly congested, contested and competitive.[13] In this context, 'congested' refers to the amount of space infrastructure and debris orbiting the earth; 'contested' refers to the range of potential threats—including deliberate disruption to space infrastructure and services such as satellites—posed by adversaries; and 'competitive' refers to the number of countries and commercial entities vying for access to and control of space and its resources.

Congestion and space debris

5.11 The Committee heard that low-earth orbits (LEO), which are generally defined as Earth-centred orbits with an altitude of 2,000 kilometres or less, are becoming congested due to the growing accessibility of space and the rapid increase in satellite launches. The SIAA noted that 'ten per cent of the current 2,500 satellites in low earth orbit were launched in the past 12 months and there are plans to deploy more than 10,000 additional satellites in coming years'.[14]

5.12 Viasat, a communications company, said that over 1,000 satellites were launched into LEO in the past year and that this number was expected to increase in future years.[15] In particular, it highlighted proposals for 'mega-constellations consisting of many thousands of satellites' and suggested that these constellations 'threaten[ed] to preclude continued access to both finite orbits and spectrum for many types of satellite networks'.[16] Potential environmental harms caused by mega-constellations - such as ozone depletion, light pollution and collusions - were highlighted.[17]

5.13 Viasat argued for national regulators to define and enforce policies to secure safe space environments. It noted that unless policymakers hold operators accountable there is a serious risk that LEO will be unusable for decades. Mr Mark Dankberg, Executive Chairman, Viasat told the Committee:

> These problems can be avoided with licensing conditions for access to each individual country and ensure shared, fair, competitive access. We don't have to accept those consequences. Innovative new systems can deliver better service, ensure space sustainability and allow all nations to compete and fairly

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13 For example, see: Mr Murfett, ASA, *Committee Hansard*, Canberra, 17 February 2021, p. 3.

14 Space Industry Association of Australia (SIAA), *Submission 83*, p. 4.

15 Viasat, *Submission 64*, p. 2.

16 Viasat, *Submission 64*, p. 2.

17 Viasat, *Submission 64*, pp. 2-5.

> earn their place in the new economy. National regulators have the power to ensure the systems they allow to serve their countries are not a threat to their own national interests or to space safety and that multiple actors can share critical spaces.[18]

5.14 Increasingly congested and contested orbits was one of six strategic risks identified by the SIAA which could 'block or undermine' the growth of Australia's space industry. It explained that:

> Space domain awareness, space weather prediction, space traffic management, and international spectrum management and licensing are becoming more complex and critical for Australia's space industry.[19]

5.15 In addition to congestion due to satellites, the Committee heard about a significant increase in the amount of debris—sometimes referred to as 'space junk' or 'space pollution'—orbiting the earth. For example, Viasat said there are over 900,000 pieces of orbital debris greater than 1 centimetre in diameter in space.[20] Similarly, Dr Muhammad Akbar Hussain, Founder of the Southern Cross Outreach Observatory Project (SCOOP), told the Committee:

> As more and more countries and companies are getting into the space industry, with every launch and deployment of satellites there's going to be more junk in space, naturally, as part of the deployment. … It's estimated that the space debris of greater than 10 centimetres in size numbers over 50,000 or 60,000, maybe even more, and that space debris between one and 10 centimetres in size is close to a million.[21]

5.16 According to NASA, LEO is now viewed as the world's largest garbage dump. This is because the problem of space junk – which is close to 6,000 tons of materials - is so extensive and so expensive to remove.[22] Several submitters explained that space debris poses significant risks to the continued use of the space environment. Northrop Grumman observed that

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18 Mr Mark Dankberg, Chairman of the Board and Executive Chairman, Viasat, *Committee Hansard*, Canberra, 20 September 2021, p. 2.

19 SIAA, *Submission 83*, p. 4.

20 Viasat, *Submission 64*, pp. 2-3.

21 Dr Muhammad Akbar Hussain, Founder, Southern Cross Outreach Observatory Project (SCOOP), *Committee Hansard*, Adelaide, 10 March 2021, p. 52.

22 Northrop Grumman, *Submission 27*, p. 10.

most space debris 'moves fast and can reach speeds of over 25,000 kilometres per hour'.[23] It noted that:

> Due to the rate of speed and volume of debris in LEO, current and future space-based services, explorations and operations pose a safety risk to both people and important property and capabilities that we rely on in space and on Earth.[24]

5.17 While relatively small debris (1 to 10 centimetres in diameter) can not be detected or tracked easily, it can still 'destroy a functioning satellite or even a human space mission'.[25] The ASA noted that collisions between spacecraft and orbital debris could 'pose a risk to assets and life'.[26]

5.18 Some submitters referred to a theory known as the 'Kessler Syndrome' to describe the effects of space debris. This theory holds that collisions between objects in space generate debris that increases the likelihood of future collisions, leading to a cascading effect which could threaten the continued use of the space environment.[27] Viasat argued that:

> Much like the climate crisis today on Earth, we face a mounting level of space junk that, unlike pollution on land, could become all but impossible to repair resulting in dramatic consequences for all space-faring nations limiting continued access to space for government, commercial, and human exploration purposes.[28]

5.19 Given the volume and threat posed by space debris, there were calls to address this compounding issue domestically and internationally. For example, Mr Henry Strong argued the 'need for regulatory solutions to be adopted on the international level is mounting rapidly'.[29]

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23 Northrop Grumman, *Submission 27*, p. 10.

24 Northrop Grumman, *Submission 27*, p. 10.

25 Dr Hussain, SCOOP, *Committee Hansard*, Adelaide, 10 March 2021, p. 52.

26 ASA, *Submission 55*, p. 12. See also: Australian National University (ANU) Institute for Space (InSpace), *Submission 18*, p. 3; Air Vice-Marshal Roberts, Department of Defence, *Committee Hansard*, Canberra, 23 June 2021, pp. 5-6.

27 Northrop Grumman, *Submission 27*, p. 11; Viasat, *Submission 64*, pp. 2-3; Dr Hussain, SCOOP, *Committee Hansard*, Adelaide, 10 March 2021, p. 52.

28 Viasat, *Submission 64*, pp. 2-3.

29 Mr Henry Strong, *Submission 8*, p. 3.

Box 5.1

Boeing Australia provided a profile of one of its employees to showcase achievements within the industry:

Sarah Mecklem, Autonomous Systems Research Engineer

Sarah started her career in space with a Bachelor of Mechanical and Aerospace Engineering focused on space-related content.[30] She has been with Boeing since 2016, when she joined as an intern.[31] Currently studying a PhD in scramjet technology (a key enabler for reusable space platforms), Sarah truly is a rocket scientist.[32]

Sarah has always dreamt of engineering a system that exits our atmosphere, acknowledging that it is the challenge to design something that can operate without human intervention for years that motivates and excites her.[33] More broadly, Sarah is watching with interest as the Australian space industry starts to develop local low-earth orbit/small satellite capabilities.[34] Sarah states that 'Australia has a unique combination of innovative minds and geographic capability to catapult our domestic space capabilities, such as ground and LEO observation. [She] would love for Australia to be moving towards a domestic launch capacity.'[35]

Contest and competition in space

5.20 Australia's defence is reliant on space-based capabilities.[36] Northrop Grumman noted that the Australian Government's *2020 Force Structure Plan*

30 Boeing Australia, *Submission 80:1*, p. [6].

31 Boeing Australia, *Submission 80:1*, p. [6].

32 Boeing Australia, *Submission 80:1*, p. [6].

33 Boeing Australia, *Submission 80:1*, p. [6].

34 Boeing Australia, *Submission 80:1*, p. [6].

35 Boeing Australia, *Submission 80:1*, p. [6].

36 For example, see: ASA, *Submission 55*, p. 36; ASPI, *Submission 79*, p. 2; Air Vice-Marshal Roberts, Department of Defence, *Committee Hansard*, Canberra, 23 June 2021, pp. 1-2.

recognises space as 'a war-fighting domain in its own right, joining sea, land, air and cyber'.[37]

5.21 The Committee heard about the growing strategic contest between nations with space-based capabilities. In its submission, the Australian Strategic Policy Institute (ASPI) referred to space as a 'warfighting domain' and described the use of space by the military:

> Space is contested. Although it is a global common, it is not a sanctuary that sits serene, distant, and untouched by intensifying geopolitical rivalry below. Space has been militarised since the 1960s with the deployment of satellites to support nuclear command and control and missile early warning. The growing sophistication of space capabilities in orbit, together with more advanced information-enabled military forces on and over the Earth have seen the role of space capabilities in supporting military forces proliferate vertically, as space systems provide new types of support, and horizontally, as more and more states can 'plug and play' with space capabilities. In doing so, space has become a 'centre of gravity' for military forces, against which an opponent can direct his military effort to deny us a decisive advantage.[38]

5.22 ASPI highlighted the risk posed by the deliberate use of 'counter-space capabilities' (anti-satellite weapons), noting that the development of these capabilities could challenge Australia's ability to ensure access to vital space-based capabilities in a future crisis.[39] The SIAA also noted the risk of counter-space technologies and the persistent threat of cyber interference to the growth of the space industry.[40]

5.23 The ASA argued that geostrategic competition in space is 'intensifying', and noted the development of capabilities to disrupt, degrade and exploit satellites and other space-dependent systems.[41] Air Vice-Marshal Catherine Roberts, also indicated that defence has 'got to be very aware' of anti-satellite capabilities being developed by other nations and said that Australia has a role in calling out 'unacceptable behaviour':

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37 Northrop Grumman, *Submission 27*, p. 6.

38 ASPI, *Submission 79*, p. 2.

39 ASPI, *Submission 79*, p. 3.

40 SIAA, *Submission 83*, p. 4.

41 ASA, *Submission 55*, p. 43.

> We've got to call it out when [other nations] start doing things that we don't think are responsible in space. It's a bit like a global rules based order. That is our aim at the moment: to really call out any unacceptable behaviour.[42]

5.24 In light of the rapidly changing space environment, submitters and witnesses highlighted a range of opportunities for Australia to maintain and strengthen its access to important space-based capabilities. These included further developing Australia's space domain awareness and space tracking capabilities, and strengthening international engagement to promote the responsible use of space.

Space domain awareness

5.25 A strong theme in evidence to the inquiry related to the opportunity for Australia to build on its existing capabilities in Space Situational Awareness (SSA) and Space Domain Awareness (SDA).

5.26 Situational space awareness is one of the seven national civil space priorities identified in the Australian Government's *Advancing Space: Australian Civil Space Strategy 2019-2028*.[43] The ASA explained that SSA 'assists with the management of orbital resources, ensuring that orbits which are valuable for space-based services remain available for use'. Situational domain awareness was described as a 'broader concept' involving 'the ability to identify, characterise and understand factors that affect the space domain'.[44]

5.27 The SmartSat CRC submitted that SDA was one of four key space capabilities. It explained that while SDA 'has historically been the preserve of the military':

> ... with increasing commercial interest in space, an element of SDA, namely Space Traffic Management, is emerging as a national/international capability to ensure space remains a global commons capable of continuing to deliver benefit to all as it becomes increasingly congested.[45]

5.28 The University of Tasmania also noted the importance of SDA for both civil and defence purposes.[46]

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42 Air Vice-Marshal Roberts, Department of Defence, *Committee Hansard*, Canberra, 23 June 2021, pp. 5-6.

43 ASA, *Submission 55*, p. 12.

44 ASA, *Submission 55*, p. 38.

45 SmartSat Cooperative Research Centre (CRC), *Submission 29.1*, p. 7.

46 University of Tasmania, *Submission 52*, p. [3].

5.29 The Committee heard that Australia has a history and expertise in SDA, particularly space tracking. The Committee inspected some of these tracking facilities at its site visits throughout the inquiry and received evidence from station and program operators.

5.30 Australia hosts two deep-space tracking stations operated by the CSIRO on behalf of the European Space Agency and NASA, as well as other antennas capable of tracking space craft.[47] Similarly, Lockheed Martin operates the Uralla satellite ground station near Armidale in New South Wales, which provides telemetry and tracking to support satellite launches. It also operates the FireOPAL ground-based sensor system to track space debris.[48] Mr Rod Drury from Lockheed Martin explained that FireOPAL is:

> ... a sovereign space domain awareness technology that is Australian designed, built and operated. The system, jointly developed with Curtin University, cost-effectively tracks satellites and space debris, utilising a lot of commercial off-the-shelf hardware. We can observe and track satellites in all orbits, from low earth to geosynchronous.[49]

5.31 Other examples of Australia's SDA capability were highlighted by EOS and ANU InSpace. EOS explained that its 'autonomous space laser tracking system is the only one of its kind globally, providing 24/7 awareness and collision risk reduction.[50]

5.32 ANU InSpace hosts the Centre for Space Situational Awareness Research, which aims to incentivise responsible behaviour in space. It does this:

> ... through the establishment of the first open-source data system for tracking and identifying orbiting objects, tracking compliance with national and international space debris mitigation norms, freedom from interference, and sustainable space activities.[51]

5.33 The Committee was interested to hear about some local proposals related to space debris tracking including SCOOP and the Tamworth Regional Astronomy Club. The SCOOP is proposing to establish a network of

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47 Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission 11*, pp. 4-7; University of Tasmania, *Submission 52*, pp. [2-3].

48 Mr Rod Drury, Vice President International, Lockheed Martin Space, Lockheed Martin Australia, *Committee Hansard,* Armidale, 20 April 2021, pp. 22, 26-27.

49 Mr Drury, Lockheed Martin Australia, *Committee Hansard,* Armidale, 20 April 2021, pp. 22, 26-27.

50 Electro Optic Systems (EOS), *Submission 47*, p. 8.

51 ANU InSpace, *Submission 18*, p. 3.

mobile observatories for the purpose of detecting and tracking space debris. Dr Muhammad Akbar Hussain, Founder of SCOOP, explained that the network would be based on its existing mobile observatory:

> Nearly five years ago we designed, constructed and executed the operation of Australia's first purpose-built mobile astronomical observatory for astronomy outreach in remote communities. Today we see the immense potential of this concept ... not just as an educational tool but also in its application in space situational awareness for tracking and cataloguing space debris with high accuracy.[52]

5.34 The key advantage of this proposal is that in overcast conditions, mobile observatories could be rapidly redeployed to locations with clear skies, thereby maintaining seamless operation of the network. Dr Hussain told the Committee:

> Australia is perhaps the largest piece of land with flat topography, clear skies and low light pollution where such a network of mobile observatories could be established. That could make Australia a global leader in space situational awareness and in mitigating of the debris problem. ... These mobile observatories, of course, will be connected to each other in real time, actually turning the entire continent of Australia into a single giant instrument.[53]

5.35 Dr Hussain said his proposal aimed to detect and track space debris of between one and ten centimetres in size, which he described as 'a dark area' currently, and noted the potential for this information to assist space agencies and organisations with SDA more broadly.[54]

5.36 Dr Ray Hare from the Tamworth Regional Astronomy Club shared with the Committee the club's citizen science project that involves investigating the viability of tracking objects in orbit using commercially available cameras, with observers in both the United Kingdom and Australia:

> The experiment is designed to explore affordable options for space situational awareness, the process of tracking objects in orbit and predicting their future

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52 Dr Muhammad Akbar Hussain, *Submission 6*, p. [23]; Dr Hussain, SCOOP, *Committee Hansard*, Adelaide, 10 March 2021, p. 52.

53 Dr Hussain, SCOOP, *Committee Hansard*, Adelaide, 10 March 2021, pp. 53, 55-56.

54 Dr Hussain, SCOOP, *Committee Hansard*, Adelaide, 10 March 2021, pp. 53-54.

paths to mitigate the risks posed to UK and Australian satellites by collisions with debris.[55]

Box 5.2

The Tamworth Regional Astronomy Club (the Club) was formed in early 2016.[56] As an incorporated association with charitable status, the Club has over 100 members, covering a wide range of skills, ages and interests.[57] The Club aims to bring a greater appreciation of the sciences, in particular astronomy, to the community.[58]

The Club is working on a project which involves tracking both low-orbit satellites and geostationary satellites.[59] The experiment explores affordable options for space situational awareness, the process of tracking objects in orbit and predicting their future paths to mitigate the risks posed to the UK and Australian satellites by collisions with debris.[60]

The Club is also involved in science education.[61] Members have the opportunity to cooperate with other amateurs and professional astronomers, and school as well as university students can become involved in the Club's activities.[62]

5.37 The Club would welcome some direct funding of regional science clubs and science centres to further support its work which is generally supported

55 Dr Ray Hare, Committee Member, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 40.

56 Dr Ray Hare, Committee Member, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 39.

57 Dr Ray Hare, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 39.

58 Dr Ray Hare, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 39.

59 Dr Ray Hare, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 40.

60 Dr Ray Hare, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 40.

61 Dr Ray Hare, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 40.

62 Dr Ray Hare, Tamworth Regional Astronomy Club, *Committee Hansard*, Armidale, 20 April 2021, p. 39.

through donated or philanthropic means.

5.38 As noted above, stakeholders advocated for Australia to further develop its SDA capability as a priority. This follows the identified need to have sovereign capability in this area particularly to secure Australia's space assets. For example, EOS argued that:

> Developing a 24/7 tasking capability in this area ensures that Australia can directly monitor and protect the other crucial space facilities we rely on. Depending on foreign entities for these types of services poses the risk of limited or delayed access to SDA information, which can be highly damaging and costly in time-critical operations.[63]

5.39 Furthermore, EOS stated that SDA has the potential to be 'a national differentiator for the Australian space industry'.[64] Similarly, APSI stressed the need for Australia to have an effective 'ground segment', which would include 'facilities for space tracking and communications, space domain awareness and the management and processing of data from satellites'. Specifically, it argued:

> Greater attention needs to be given to ensuring the ground segment is secure and survivable in the face of adversary counterspace capabilities, which can be directed against the satellites in orbit, and against the ground facilities controlling those satellites, as well as against the data flowing to and from ground station to satellite.[65]

5.40 Several submitters suggested that Australia is well placed to build on its existing SDA capabilities, particularly given its unique geography and location compared to other nations. EOS stated that:

> Geographically, Australia's position in the southern and eastern hemispheres makes its SDA contribution highly valuable to its security partners in North America and Europe. Australia's size also presents the opportunity to establish multiple SDA facilities covering vastly different geographical locations. This presents both significant coverage and contingency for adverse weather conditions.[66]

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63 EOS, *Submission 47*, p. 6.

64 EOS, *Submission 47*, p. 9.

65 ASPI, *Submission 79*, p. 5.

66 EOS, *Submission 47*, p. 8.

5.41 A similar point was made by the ASA:

> Australia's geographic position and clear skies makes Australia an ideal location for space traffic management activities, tracking space debris, monitoring space weather, scanning for potentially dangerous Near Earth Asteroids and satellite laser ranging.[67]

5.42 Tasmania and Western Australia were both highlighted as logical places to host additional SDA infrastructure.[68]

5.43 The ASA advised that the Australian Government is continuing to invest in sovereign SSA and SDA capability, including sensors and tracking systems, to support the operations of the Australian Defence Force.[69] In particular, it noted that:

> Through Joint Project 9360, Australia is investing in a diverse multi-technology sensing and command and control system that will provide a sovereign SDA capability while allowing for flexibility to adapt to emerging threats. This allows an iterative approach to capability management with a strong focus on industry partnerships.[70]

5.44 The SASIC recommended that civilian SDA be promoted as an 'adjunct' to Defence capabilities.[71]

Sustainable space practices

5.45 Much like efforts to protect and care for the physical environment, the space environment is no different. Not contributing to the growing issue of space debris was a consistent theme in evidence. Furthermore, the Committee heard that Australia has an opportunity to take the lead globally on undertaking space activities in a responsible and sustainable way, particularly as a developing space industry. Mr Henry Strong explained:

> Australia should therefore seek to establish itself as a world-leader in space sustainability practices at all stages of the mission timeline and in all areas of law and policy. This will allow for longer-term economic growth trajectories, a

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67 ASA, *Submission 55*, p. 12. See also: ANU InSpace, *Submission 18*, p. 3.

68 University of Tasmania, *Submission 52*, p. [3]; Western Australian Government, *Submission 61*, pp. 1-2.

69 ASA, *Submission 55*, pp. 36, 38. See also: EOS, *Submission 47*, p. 17; Air Vice-Marshal Roberts, Department of Defence, *Committee Hansard*, Canberra, 23 June 2021, pp. 1-2.

70 ASA, *Submission 55*, p. 38.

71 South Australian Space Industry Centre (SASIC), *Submission 56*, p. 12.

> position of international leadership, and an attractive market for international operators while other space industries undergo lengthy fundamental changes to meet future sustainability requirements. This strategy would act to insulate Australia from the turbulence of the structural shift that will soon be required of the global space industry.[72]

5.46 There was strong support for Australia to consider its domestic space regulations and international agreements to support a sustainable space industry. ANU InSpace argued:

> Other governments with significantly more developed space programs have been allowed to evolve in unsustainable ways. They have proven unable to inject sustainable industry regulations or curb negative behaviours such as leaving defunct or aged satellites in orbit when their missions are complete.
>
> Australian regulations should be nimble .... Unlike other nations, we should commit to not becoming too lax and 'going backwards' in terms of sustainability goals.[73]

5.47 Similar views were expressed by other stakeholders. Northrop Grumman submitted that Australia should ensure that its regulations position it as a responsible global space actor.[74]

5.48 Dr Matthew Tetlow from Inovor Technologies said that while orbits below 600 kilometres were 'self-cleaning' - in other words, debris burns up upon re-entry - there should be 'strong international agreement' about the management of objects launched into higher orbits:

> When you start going into the higher orbits, that's when there really needs to be strong international agreement that these things can't be left up there because there will be a problem. … We don't want to be putting things up into orbit that never come back. That was the Wild West of the seventies and eighties. That's what was happening and we have to get away from that, in my opinion.[75]

5.49 Mr Mark Ramsey, General Manager, Sitael Australia, emphasized that space debris is an issue that 'everyone in the sector' is becoming conscious of:

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72 Mr Henry Strong, *Submission 8*, p. 3.

73 ANU InSpace, *Submission 18.1*, pp. 3-4. See also: Mr Henry Strong, *Submission 8*, pp. 2-4; Mr John Lee, *Submission 9*, p. 14.

74 Northrop Grumman, *Submission 27*, pp. 9-10.

75 Dr Matthew Tetlow, Chief Executive Officer, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 13.

> It's an international issue, so it's not something Australia can address by itself, but it is something Australia needs to be a part of diplomatically, legally and politically. We can choose to take a political position of leadership in the domain, or we can sit back and wait for the sector to evolve. But the next decade is the time to start getting this right; otherwise, in a few years' time, there will certainly be some orbits that become unusable to everyone... So it's a really hot topic that we need to get right in the next decade.[76]

5.50 To address the issue of space debris created by the domestic sector, Mr Henry Strong argued that 'there is a duty for the Australian Space Agency and others to establish regulatory frameworks that rule out unsustainable missions on Australian soil'. In advocating for 'debris-neutral' strategies, Mr Strong suggested that 'responsible disposal of space objects that either malfunction or reach the end of their operational lifetime should be a requirement of issuing a license to operators in Australia'.[77]

5.51 In his submission, Mr John Lee set out a proposal for the establishment of a specific body and program referred to as Care of the Outer Space Environment.[78] While not restricted to space debris, Mr Lee submitted, there is a need for the space industry 'to be seen by the general public to be exercising reasonable care of the outer space environment in all actions which contain elements of 'ethical, social or legal responsibility'.[79]

International engagement

5.52 Several submitters highlighted the opportunity for Australia to strengthen its international engagement in order to promote the responsible use of space. The SIAA said that while Australia has an 'excellent track record as a responsible citizen in the global space industry', there is a 'pressing need for more active diplomatic effort'.[80]

5.53 The Adelaide Law School encouraged the Australian Government to continue and enhance its participation in international forums to establish 'norms of law and behaviour compatible with the increasing prevalence of private space activities':

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76 Mr Mark Ramsey, General Manager, Sitael Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 13.

77 Mr Henry Strong, *Submission 8*, p. 4

78 Mr John Lee, *Submission 9*.

79 Mr John Lee, *Submission 9*, p. 7.

80 SIAA, *Submission 83*, p. 10.

> Continuing to work at the international level will provide the Australian space industry with a stable legal and political environment to invest and grow into.[81]

5.54 Northrop Grumman argued that Australia was well placed to have a 'leading role' in developing international regulatory and governance standards:

> Australia should leverage its bilateral partnerships and standing in multinational forums to lead the development of space governance policies that focus on creating functionally specific and agile bilateral agreements between like-minded allies and partners that can advance emerging commercial space activities and ensure the preservation of the LEO space environment.[82]

5.55 King and Wood Mallesons, an international law firm, also expressed support for Australia to continue its international engagement:

> While competition should continue to thrive, there should be a shared vision in relation to the ultimate aims of space exploration and activities.
>
> ... Australia has had a long track record in successful international policy engagement across multiple industries. Even where international treaties or regional agreements are not possible, there ... remains a strong opportunity to inform industry and regulatory development through thought leadership and collaboration via transnational fora.[83]

5.56 Similarly, Mr Henry Strong advocated for Australia to use clean space 'as an area of diplomatic cooperation to leverage positive working relationships with both regional and strategic partners'.[84]

5.57 Several submitters specifically called on Australia to clarify its position on the exploitation of space resources by private entities with respect to the Outer Space Treaty and the Moon Agreement in order to provide clarity to an emerging and potentially lucrative space resources industry.[85] For example, the SLCANZ stated:

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81 The Adelaide Law School (University of Adelaide), *Submission 16*, pp. [7-8]. See also: SASIC, *Submission 56*, p. 11.

82 Northrop Grumman, *Submission 27*, p. 11.

83 King and Wood Mallesons, *Submission 54*, p. 5.

84 Mr Henry Strong, *Submission 8*, p. 3.

85 SLCANZ, *Submission 14*, p. 9; The Adelaide Law School (University of Adelaide), *Submission 16*, p. [8]; Asia Pacific Aerospace Consultants (APAC), *Submission 76*, pp. 13-15.

> The Australian Government should also consider its position on space resource exploitation by private entities as a matter of urgency. Such an action would follow in the footsteps of nations such as the United States, Luxembourg and the United Arab Emirates who have confirmed the ability for private entities to exploit space resources. Specifically, the Australian Government should take steps to publicly clarify how it reconciles its obligations under Article II of the1969 Outer Space Treaty and Article 11 of the 1984 Moon Agreement and its adherence to the 2020 Artemis Accords.[86]

5.58 In its submission, the ASA said that the Australian Government is 'committed to strengthening international rules and laws that apply to space, including military uses of space', and that it is working with other nations to 'strengthen norms of responsible behaviour'.[87] Mr Anthony Murfett, Deputy Head of the ASA told the Committee that one of Australia's priorities is 'ensuring our values here on Earth are reflected in space'.[88]

Commercial opportunities

5.59 In addition to being a responsible global citizen, establishing sustainable space practices may also lead to commercial opportunities. The Committee heard about the potential for 'green' space technology designed to reduce the pollution and debris associated with rocket launches to be marketed overseas. Dr Michael Smart, Co-Founder and Head of Research and Development, Hypersonix Launch Systems, told the Committee that:

> ... Australian space technology needs to be green.... there's a lot of space junk up there, and there's also a lot of pollution created by rockets that are just one use—that is, a rocket system that's built and launched and then ends up in the ocean. We can't be seen to be adding to these problems. We need to be solving these problems, particularly when there are plans for launching constellations of tens of thousands of satellites.[89]

5.60 Dr Smart suggested that green technology could lead to significant opportunities in the international marketplace for Australian companies.[90]

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86 SLCANZ, *Submission 14*, p. 9.

87 ASA, *Submission 55*, p. 44.

88 Mr Murfett, ASA, *Committee Hansard*, Canberra, 17 February 2021, p. 3.

89 Dr Michael Smart, Co-Founder and Head of Research and Development, Hypersonix Launch Systems, *Committee Hansard*, Brisbane, 6 May 2021, p. 62.

90 Dr Smart, Hypersonix Launch Systems, *Committee Hansard*, Brisbane, 6 May 2021, p. 62.

Committee comment

5.61 Our use of space related technology and services on Earth is dependent on access to infrastructure in space. Traditionally, this access has involved regulation of government activity, here and internationally. Now, there is a need to consider regulation of private entities that are increasingly accessing the space environment, including to launch thousands of satellites that are contributing to the growing problem of space debris.

5.62 The responsible use of space means not leaving the space environment in a worse position than it was found. The Committee appreciates that many of the regulations and treaties that govern the use of space have failed to keep pace with a rapidly changing space environment. Many were also never designed to regulate the unexpected activities that are now occurring on the Moon and Mars and in low Earth orbits.

5.63 Australia has a real opportunity to be a global leader in space regulation and law to ensure that countries that engage with space do so in a safe, responsible and respectful way. The Committee supports Australia's participation in international forums to this end.

5.64 With threats to space assets having significant consequences for the way we live, strengthening capability across situational space awareness and situational domain awareness is important. Continued investment in these areas is recommended.

Recommendation 25

5.65 The Committee recommends that the Australian Government continue its investment in sovereign situational space awareness and situational domain awareness capability including the infrastructure to support it.

Recommendation 26

5.66 The Committee recommends that the Australia Government take a lead role internationally in implementing the Long Term Sustainability Guidelines for the United Nations Committee on the Peaceful Uses of Outer Space.

Recommendation 27

5.67 The Committee recommends that Australian regulators prioritise post-mission disposal, debris-neutral missions plans, and organisational capacity in identifying viable space projects.

Recommendation 28

5.68 The Committee recommends that the Australian Government continue to participate in international forums to:

- **clarify how international law impacts commercial activities in space**
- **lead the development of enforceable and internationally agreed norms of behaviour in outer space.**

Recommendation 29

5.69 The Committee recommends that the Australian Government examine the feasibility of more green technology in the Australian space sector, and ways to ensure that the industry is not contributing to an already congested environment.

6. Research and Development

The importance of space science

6.1 Most developments and innovation in the space sector can be attributed to discoveries grounded in scientific research.[1] Basic space science research is necessary for the development, long-term success, and competitiveness of the Australian space industry.[2]

6.2 The Committee heard that Australian space science needs to be 'reprioritised and funded'.[3] Stakeholders argued that if support for space science research is inadequate, goals for the Australian space industry will not be realised.[4]

6.3 Furthermore, framing Australia's space investment priorities around jobs and growth overlooks the opportunities generated by investments in science which includes social and economic benefits.[5] For example, several studies have shown that funding science (especially space science missions) generates a five to 10 times return on investment.[6]

Coordinating Australian space science

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1 The Australian Academy of Science, *Submission 70*, p. [2].

2 The Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission 11*, p. 10; Sitael Australia, *Submission 36*, p. [3]; The Australian Academy of Science, *Submission 70*, p. [1].

3 Sitael Australia, *Submission 36*, p. [3].

4 The Australian Academy of Science, *Submission 70*, p. [1].

5 Curtin University, *Submission 81*, p. 2.

6 Curtin University, *Submission 81*, p. 2.

6.4 Multiple organisations have varying roles in space science, including universities, the ASA, Geoscience Australia, the National Committee for Space Science, Defence Science and Technology (DST), and the CSIRO.[7] There are also several national and state and territory programs involved in space science technology development. [8]

6.5 For all of these programs, investments in space science are independently determined, although the Space Industry Leaders Forum provides the opportunity for a small amount of funding coordination.[9]

6.6 To help organisations better prioritise and coordinate space science research funding, SmartSat CRC recommended the development of 'Government endorsed national space research and innovation priorities aimed at driving societal, economic, environmental and national security outcomes for Australia'.[10] These national priorities should cover various space sector stakeholders and program delivery agencies to help inform their decision making.[11]

6.7 Other stakeholders also called for space science to be nationally coordinated, noting the absence of such in the ASA's strategy.[12] The Australian Academy of Science (the Academy) stated that:

> The single most significant support that the Australian Government could provide the Australian space sector is to provide national co-ordination in space science. There is no body with a mandated role of co-ordinating Australia's space science investments or actively supports the development of space science…
>
> Despite the Australian Space Agency's establishment, this is a critical gap that needs to be filled. The Agency's charter does not explicitly mention science. Nor is science mentioned in the Civil Space Strategy, although it underpins key objectives and challenges.[13]

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7 The Australian Academy of Science, *Submission 70*, p. [1].

8 SmartSat CRC, *Submission 29*, pages [1], [3].

9 SmartSat CRC, *Submission 29*, p. [3].

10 SmartSat CRC, *Submission 29*, p. [2].

11 SmartSat CRC, *Submission 29*, p. [3].

12 SmartSat Cooperative Research Centre (CRC), *Submission 29*, p. [3]; The Australian Academy of Science, *Submission 70*, p. [1].

13 The Australian Academy of Science, *Submission 70*, p. [1].

6.8 The CSIRO noted that the ASA 'does not currently have a science-specific program, although it has funded some science activities that are driven by industry growth'.[14] Stakeholders suggested the ASA take on the role of coordinating civil space science.[15] For example, to support international collaboration and industry growth, the Western Australian Government suggested that the ASA:

- appoint a science officer
- formalise partnerships with the CSIRO who have a long history in space research
- modify their funding criteria to include science
- recognise that science is a key enabler in the space economy, generating growth rather than limiting it.[16]

6.9 Earthspace suggested that the Australian Government challenge the SmartSat CRC with nationally beneficial priorities and 'encourage it to engage research Australia wide in all states and territories'.[17]

6.10 SmartSat CRC advocated for a 'sustained effort on investment with R&D'.[18] Dr Peter Woodgate, Chair of Board of SmarSat CRC told the Committee that its organisation has 'identified 27 key capabilities that will underpin a long-term national plan' and would like the capabilities incorporated into an overarching national plan – a 'national space mission of missions'.[19]

Universities

6.11 The importance of universities was repeatedly mentioned in evidence received by the Committee, with Australia Space Futures stating that the university sector is fundamental to driving growth in the Australian space sector.[20] In its submission, the Queensland University of Technology (QUT) stated:

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14 CSIRO, *Submission 11*, p. 10.

15 The Australian Academy of Science, *Submission 70*, p. [1].

16 The Western Australia Government, *Submission 61*, p. 6.

17 Earthspace, *Submission 23*, p. 6.

18 Dr Peter Woodgate, SmartSat CRC, *Committee Hansard*, Adelaide, 10 March 2021, p. 44.

19 Dr Peter Woodgate, SmartSat CRC, *Committee Hansard*, Adelaide, 10 March 2021, p. 44.

20 Australia Space Futures, *Submission 57*, p. 1.

> The higher education and research sector makes a vital contribution to Australia's national interest, fostering international collaborations and furthering the success of the Australian space industry.[21]

6.12 QUT submitted that there is a gap in Australia's space industry. This is because most Australian space firms are SMEs and start-ups which lack sufficient resources and experience to establish effective research programs and achieve adequate commercialisation outcomes.[22] This gap could be filled by Australia's universities given their extensive international partnerships, specialised commercialisation offices and large space R&D programs.[23]

6.13 Many universities highlighted their national and international partnerships within the global space industry and an impressive range of collaborations, programs and initiatives across government and commercial sectors.[24]

Box 6.1

The SHINE Program, now expanded into the Swinburne Youth Space Innovation Challenge, provides students with the opportunity to design and create experiments that are sent to the International Space Station.[25] The Program was initially undertaken in partnership with Haileybury College,[26] but now has expanded to six schools across Australia and is supported by SmartSat CRC.[27] The Australian Space Agency is also actively involved in the Program.[28]

Involving final year students, Master's students, PhD students and

21 Queensland University of Technology (QUT), *Submission 7*, p. 2.

22 QUT, *Submission 7*, p. 3.

23 QUT, *Submission 7*, p. 3.

24 For example see QUT, *Submission 7*; ANU InSpace, *Submission 18*; University of Western Australia (UWA) International Space Centre (ISC), *Submission 72*; University of New South Wales (UNSW) Canberra Space, *Submission 73*; Curtin University, *Submission 81*.

25 Professor Alan Duffy, Director, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, p. 18.

26 Swinburne University of Technology, *Submission 63*, p. [2].

27 Professor Alan Duffy, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, p. 18.

28 Professor Alan Duffy, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, p. 18.

professors, the Program has successfully seen a fifty-fifty split from the secondary school, in terms of male to female involvement.[29] Secondary school students participating in the Program are able to grow as STEM professionals, while university students have the opportunity to develop important leadership and mentoring skills.[30]

6.14 Despite being capable of developing commercial space services and products, several challenges facing universities were highlighted by stakeholders. For example, QUT stated that the Australian space industry is 'defined narrowly in a manner that privileges private investment, marginalises universities and places a hard cap on the fledgling sector's ability to grow'.[31]

6.15 Australia Space Futures, a consortium of Australian universities, identified some barriers to maximising the university sector's impact on space industry growth – including:

- ineffective translation of university research minimises the impact of economic growth.
- external stakeholders such as industry, often find it difficult to navigate the university sector.
- the Australian space industry is wide but thin and not in a position to fund research at scale. The sector therefore requires research funding from Government.
- space research is not concentrated in one area, and sits across many disciplines such as STEM, health, business, humanities, social sciences and the arts.
- while the sector has proven ability to manage long-term, major infrastructure for cutting edge research, without industry consultation at the beginning, it risks failure to reach its true potential.
- the competitive nature of student fees has damaged the powerful possibility of university collaboration to offer joint courses and initiatives to utilise each university's unique area of expertise.

29 Professor Alan Duffy, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, p. 18.

30 Professor Alan Duffy, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard*, Canberra, 16 September 2021, p. 18.

31 QUT, *Submission 7*, pages 1 and 3.

6.16 Australia Space Futures argued that the best way to drive space R&D is by creating specific space capability networks large enough to exert a commercial impact, after which other complimentary capabilities could be gradually developed.[32]

Industry and commercialisation

6.17 Commercialisation is the process that monetises R&D and grows the space industry.[33] The value of commercialising space research is amplified when it can also be applied to other sectors.[34] Barriers to commercialising space R&D therefore not only hinders space sector growth, but growth of other areas.[35]

6.18 EOS submitted that a 'sustained investment of resources and expertise' and a 'keen understanding of commercialisation' will be needed for Australian industry to be globally competitive. It stated:

> Developing a viable, sustainable and internationally competitive sovereign space industry will require an intense focus on both research and development (R&D) and the commercialisation of research outcomes. This will require a close, collaborative relationship between government and industry, where the goal of the R&D process is well-understood and the commitment from both sides is consistent. If this can be achieved, the intellectual property (IP) generation, export opportunities and economic outcomes already being realised by Australian companies can be expanded significantly. [36]

6.19 SmartSat CRC expressed similar sentiments to the Committee:

> …the extensive R&D streams that are coming out of the SmartSat research activities need to translate across to Australian companies. This will build our national capability. They're focused on solving national challenges and we need to seize the opportunity to build an internationally competitive industry. This means space is seen as a critical component of the national fabric of science and industry. An innovative nation sells to the world and that's particularly so in space.[37]

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32 Australia Space Futures, *Submission 57*, p. 1.

33 Gilmour Space Technologies, *Submission 59*, p. 4.

34 Saab Australia, *Submission 12*, p. [3].

35 Deloitte, *Submission 53*, p. [12].

36 Electro Optic Systems (EOS), *Submission 47*, p. 10.

37 Dr Peter Woodgate, SmartSat CRC, *Committee Hansard*, Adelaide, 10 March 2021, p. 44.

6.20 Converting R&D into commercially viable products is one of the challenges in innovation policy.[38] This holds true in Australia. While Australia has a strong history in space R&D and a significant research base, it struggles to commercialise its R&D. [39] Dr Jason Held, Chief Executive Officer, Saber Astronautics told the Committee:

> A lot of the funding mechanisms … focus very much on research. ARC linkages and CRCs are good programs that are very much focussed on research, and we, as a nation, need to leverage that research better. We're top 10 in the world for science output, but we're dead last for commercialisation…[40]

6.21 Deloitte made the same point and stated that the space industry will need government support 'to get the ball rolling':

> Australia in particular is renowned for struggling to convert ideas into opportunities. This is often due to a variety of factors that differ radically from industry to industry.
>
> …Australian policy makers need [to] learn the lessons from other sectors and innovation ecosystems, while also tailoring policies (such as grant funding) to ensure alignment with sector growth over the long-term.[41]

Funding challenges

6.22 In Australia, the space sector is 'a relatively new (commercial) industry', providing an opportunity to establish good funding program practices.[42] Deloitte submitted that the objectives of funding programs (such as increasing revenue, supporting researchers, creating jobs, increasing patents and increasing private investment) should be clearly defined as different objectives require different funding structures.[43] For example:

> … grants requiring matched funding support growth in incumbents; small grants support new entrants seeking seed capital; manufacturing-focused

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38 Deloitte, *Submission 53*, p. [13].

39 Dr Jason Held, Chief Executive Officer, Saber Astronautics, *Committee Hansard*, Sydney, 19 April 2021, p. 9 ; Deloitte, *Submission 53*, p. [13].

40 Dr Jason Held, Saber Astronautics, *Committee Hansard*, Sydney, 19 April 2021, p. 9.

41 Deloitte, *Submission 53*, p. [13].

42 Deloitte, *Submission 53*, p. [13].

43 Deloitte, *Submission 53*, p. [12].

> grants support launch activities while less specific grants can be used by earth observation value added resellers.[44]

6.23 Deloitte recommended that the experience and knowledge gained from funding the wider innovation sector should be leveraged when developing funding for the space sector.[45]

6.24 The SASIC argued that R&D should not be 'diluted' across a broad base but instead 'targeted and niche to lead to industry developments at scale'.[46] Currently, the ASA has a wide range of investments and grants allocated across Australia based on its articulated priorities for research.[47] R&D, however, should instead be focussed at a scale that maximises research excellence and impact, delivers high quality outcomes, optimises the potential of limited resources and sustains growth.[48]

6.25 Gilmour Space Technologies expressed a similar view, stating that concentrating space grant funds by distributing them between fewer companies would better enable Australia's space capabilities to increase, rather than dividing them between a large number of research entities.[49]

6.26 Given the limited space development funding available in Australia, Gilmour Space Technologies also argued that a) Australian private-sector companies (with Australian headquarters) developing sovereign capability should be prioritised for funding and b) Government contracts and grants should 'include funding for capital equipment and headcount, which can be tied to milestones for accountability'.[50]

6.27 Dr Mark Hodge, Chief Executive Officer, DMTC, also told the Committee that research and investment needs to be targeted:

> I think we have to be really strategic about how we establish our investment priorities and send a really clear signal to the research sector and the industrial sector that this is where the purchasing power of government procurement is likely to go. This is not about research for its own sake.

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44 Deloitte, *Submission 53*, p. [12].

45 Deloitte, *Submission 53*, p. [13].

46 South Australian Space Industry Centre (SASIC), *Submission 56*, p. 10.

47 SASIC, *Submission 56*, p. 10.

48 SASIC, *Submission 56*, p. 10.

49 Gilmour Space Technologies, *Submission 59*, p. 4.

50 Gilmour Space Technologies, *Submission 59*, p. 4.

> … I think the main thing is to not invest small amounts of money everywhere and let a thousand flowers bloom. It's about targeting, with that investment, and trying to understand, what capabilities are necessary for the national good and being clear eyed about where the credible pathways for developing that capability can come from.[51]

6.28 The Academy called for 'commitment and investment in a national capability for space science, which would enable the development of a sustainable and focused research and development program and support the space industry's development'.[52] This includes support for a research translation fund that mirrors the Medical Research Future Fund.[53]

6.29 QUT suggested a government fund similar to the Biomedical Translation Fund, properly linked to university commercialisation offices and focused on providing significant early-stage funding for space companies' to aid space development and commercialisation.[54]

6.30 In its submission, Deloitte set out policy options other than grants that could be examined to help grow Australia's space ecosystem.[55] These include:

- the tax system and if it works well for the space ecosystem
- the costs of starting a space business and if these are prohibitive
- regulatory duties and if these are proportionate to risks
- whether businesses can fail fast
- whether government procurement is a more sustainable funding mechanism than grants for certain areas of the space industry.[56]

6.31 Gilmour Space Technologies argued that the R&D tax grant should not be discontinued because it is one of the main and/or only sources of funding for commercial space companies.[57]

6.32 FrontierSI stated that increased awareness and targeted use of other government grant programs, such as the AusIndustry's Business Research and Innovation Initiative would be beneficial to the space industry.[58]

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51 Dr Mark Hodge, DMTC, *Committee Hansard*, Canberra, 16 September 2021, p. 11.

52 The Australian Academy of Science, *Submission 70*, pages [1]-[2].

53 The Australian Academy of Science, *Submission 70*, p. [2].

54 QUT, *Submission 7*, p. 3.

55 Deloitte, *Submission 53*, p. [13].

56 Deloitte, *Submission 53*, p. [13].

57 Gilmour Space Technologies, *Submission 59*, p. 4.

Other challenges

6.33 Other challenges facing the space industry regarding commercialisation include the space technology commercialisation pathway. This was described as being unclear, and should be defined.[59] The Committee heard that lessons could be learned from Defence, who have made investments into defining and building commercialisation pathways.[60] Australia's space technology roadmaps could also be more commercially oriented, aimed at increasing the Technology Readiness Level (TRL) of sovereign capabilities' like the Defence Innovation Hub (DIH).[61]

6.34 Australia's 'addressable' market is limited and companies will need help to address the current local markets with products and services to provide opportunities to scale up to global markets.[62] The DIH, Moon to Mars initiative and the CRC Program (such as SmartSat CRC) are crucial 'planks' for forming international collaborations to enable world-leading R&D outcomes.[63]

6.35 Saab Australia recommended the establishment of a 'Research and Development/Capability Development stream that looks for sovereign innovation in adjacent industries with transferability to space related systems and supports the sovereign commercialisation process'.[64]

6.36 Earth Observation Australia (EOA) asserted that government mechanisms that enable more business-to-business and research-to-business collaboration are needed to grow market demand and address capability gaps in the EO sector.[65] EOA also noted that a coordinated approach that brings research in to support the EO industry's capabilities would be beneficial.[66] A coordinated approach would also foster joint capability across the industry and enable it to develop new services and products for new

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58 FrontierSI, *Submission 38*, p. [5].

59 Saab Australia, *Submission 12*, pages [2]-[3].

60 Saab Australia, *Submission 12*, p. [3].

61 Gilmour Space Technologies, *Submission 59*, p. 4.

62 FrontierSI, *Submission 38*, p. [5].

63 FrontierSI, *Submission 38*, p. [5].

64 Saab Australia, *Submission 12*, p. [3].

65 EOA Inc., *Submission 21*, p. 9.

66 EOA Inc., *Submission 21*, p. 9.

markets, while helping research organisations achieve real-world impact for their research.[67]

Box 6.2

Myriota is an *Internet of Things* connectivity solution using a constellation of low Earth-orbit satellites.[68] It is an example of a commercially successful company 'spun out' of R&D.

Myriota identified two key factors that facilitated the company's commercial viability and success:

- The company is involved in a novel area of space ('deep tech') that is used in both Australia and the rest of the world.
- The company's co-founders discussed creating a commercial portfolio of IP and commercialising it when they started the research program from which Myriota was founded.[69]

Mr Tom Rayner, Vice President Sales, Satellite Communications told the Committee:

> It was clearly a research program that was aimed at making a commercial entity as an outcome of the research program. I think that has held us in pretty good stead, right from the way the cap table was structured to begin with, to enable further investment et cetera.[70]

For Myriota, this meant that when it was time for the company to be created, many problems had already been discussed and addressed.

Collaborative tensions

6.37 Productive research and industry collaboration can foster strong commercial outcomes. Sometimes however there can be tension and frustration within these relationships. The Committee heard that collaborative differences, competing products across sectors, funding restrictions, competing organisational priorities and security issues can all hinder effective partnerships between research and industry.

67 EOA Inc., *Submission 21*, p. 9.

68 Mr Tom Rayner, Myriota, *Committee Hansard*, Canberra, 26 May 2021, p. 1.

69 Mr Tom Rayner, Myriota, *Committee Hansard*, Canberra, 26 May 2021, p. 2.

70 Mr Tom Rayner, Myriota, *Committee Hansard*, Canberra, 26 May 2021, p. 2.

6.38 A lack of sufficient and genuine collaboration between research entities – such as universities, Commonwealth agencies, the CSIRO and CRCs – and the private sector, was identified as an issue.[71] Mr Tim Neale, Managing Director, DataFarming shared his experiences, describing the 'whole model' particularly around CRCs as 'broken'. Mr Neale told the Committee:

> It's probably no surprise to all of you to know that we are the worst OECD nation when it comes to commercialising research, and I can see that a lot of those problems are coming from this core problem. I think the whole model, particularly around CRCs, is broken. We're not seeing the flow of research into commercialisation.[72]

6.39 Mr Neale stated that his company felt they were being used by universities to obtain leverage funds with little in the way of commercial outcomes being achieved and attempts to collaborate with CRCs have resulted in requests for money rather than to genuinely collaborate.[73] Mr Neale emphasized that effective collaboration with industry needs to occur from the start.[74] He explained:

> I've been negotiating with a number of CRCs to try to get projects up, and all they really want out of us is money. It's not about a collaborative arrangement where we can work together to build a solution. A lot of the time we get, at the end of the process: "What can you commercial out of all this?" We've got to start at the beginning as a commercial partner and work our way through; otherwise we should just call it a university, because what it does is research. This is a cooperative research centre, which supposedly turns the R&D into commercial outcomes. That's what it's specifically designed to do, and I don't think it's working.[75]

6.40 Another stakeholder also submitted that insufficient collaboration is reducing the impact of space R&D and frequently leads to 'failure to realise operational industry benefits'.[76]

6.41 The release of market products in competition with industry was identified as inhibiting industry growth. In particular, there was concern that public

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71 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021, p. 37; Name withheld, *Submission 17*, p. [1].

72 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021, p. 37.

73 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021, p. 40.

74 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021, p. 40.

75 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021, p. 40.

76 Name withheld, *Submission 17*, p. [1].

resources and publicly funded IP is 'locked up' and used to compete with the private sector. [77] As described by one submitter:

> CSIRO's approach to industry collaboration seems to be spinning off a company and then providing exclusive rights to publicly funded IP to a company owned or partly owned by CSIRO. Then providing access to public sector scientists to support the business – directly against SME's who actually have "skin in the game".[78]

6.42 Similar sentiments were echoed by Mr Neale, who said this was leading to market failures:

> We are continually finding that universities are bringing new competitive products to market. When we've spent money on products, they bring out competing products and that's creating market failures. CSIRO are also doing a lot of bringing out products to market in competition with private enterprise, and I think that's some of the problem.[79]

6.43 Various products released across the agriculture sector were used as examples to illustrate this point.[80]

6.44 Tensions around funding related mainly to access and perceived inequity. Stakeholders advocated for these funding opportunities to be more open and competitive. For example, one submitter argued that the government preferences university research institutions while under-recognising private sector contributions and opportunities in collaborative space R&D.[81] Similarly, Mr Neale stated that universities receive most CRC research funds however the private sector could undertake some of this R&D particularly those that employ researchers.[82]

6.45 EOS recommended that industry success in commercialising R&D should be acknowledged by the Government.[83]

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77 Name withheld, *Submission 17*, p. [1].

78 Name withheld, *Submission 17*, p. [2].

79 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021, p. 37.

80 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021; Name withheld, *Submission 17*.

81 Name withheld, *Submission 17*, p. [1].

82 Mr Tim Neale, DataFarming, *Committee Hansard,* Brisbane, 6 May 2021, pages 37, 40.

83 EOS, *Submission 47*, p. 10.

6.46 QUT stated that despite university research focussing on industry outcomes (including collaborating with large international space primes, licensing research results and establishing space companies), Australian universities are currently not allowed to compete for the same amount of funding as Australian companies.[84] The ASA's Moon to Mars program was cited as an example of this issue.[85] QUT proposed that the Australian Government ensure universities are eligible for all competitive space funding programs.[86]

6.47 Mrs Ali Buchberger, Director, Industry Engagement (Science and Engineering), QUT, discussed the different funding rounds for the Trailblazer program, suggesting that universities be allowed to apply for more funding rounds:[87]

> Our view is that this program is set up to build a pipeline into an Australian moon mission, into the Trailblazer program, and we think that universities play a really valuable role as institutions that develop and commercialise enabling technology for that potential mission. But, obviously, we need to be funded to do that and, given that the commercial potential for these technologies is 10 years from now, when there is a demonstrated lunar economy, in the interim we are really reliant on government funding for that early development work. So I guess it's the observation that, if not the supply chain round of funding, that at least the demonstrator round provide an opportunity for universities to lead applications to demonstrate key component technologies that could contribute to a Trailblazer mission.[88]

6.48 Mrs Buchberger further argued that opening funding rounds to universities would create 'a level playing field' that allows for a greater range of applications from which demonstrator projects and technologies could be developed and then incorporated into a trailblazer mission.[89] Universities are well-placed to develop and commercialise technologies in partnership with international space primes, not just SMEs.[90]

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84 QUT, *Submission 7*, p. 3.

85 QUT, *Submission 7*, p. 3.

86 QUT, *Submission 7*, p. 3.

87 Mrs Ali Buchberger, Director, Industry Engagement (Science and Engineering), Queensland University of Technology (QUT), *Committee Hansard,* Brisbane, 6 May 2021, p. 24.

88 Mrs Ali Buchberger, QUT, *Committee Hansard,* Brisbane, 6 May 2021, p. 24.

89 Mrs Ali Buchberger, QUT, *Committee Hansard,* Brisbane, 6 May 2021, p. 24.

90 Mrs Ali Buchberger, QUT, *Committee Hansard,* Brisbane, 6 May 2021, p. 25.

6.49 Collaboration between government, industry and universities is essential to grow the space industry, domestically and internationally. According to Australia Space Futures:

> The Australian space sector combined with the tertiary sector in Australia is in the 'goldilocks' zone; small enough to collaborate in key areas and large enough to deliver world class research. now is the time to take advantage of this. …
>
> Without collaboration between universities, industry and Government, we miss out on opportunities to create national level initiatives that will help Australia globally.[91]

6.50 Mr Matthew Opie, Director, Defence and Space, University of South Australia, also told the Committee that the ideal 'dream team' for R&D collaboration consists of a university, SME and prime due to their different capabilities:

> We need research, but we also need the small, smart ideas from small to medium companies. But then you also need the capacity from the primes in order to be able to produce something or commercialise it or understand a bit better how Defence is going to use it. So the dream team on a research project, if you like, is often a prime, a university and an SME – to bring those three capabilities to the team.[92]

6.51 Collaborations between commercial companies and universities (or other research organisations) can sometimes be challenging because of differing R&D strengths, key objectives and financial time frames.[93] Gilmour Space Technologies suggested that these collaborations could be made more realistic, by letting companies lead projects when funding is being used to commercialise technology between TRLs 4 and 9.[94]

6.52 In its submission, Gilmour Space Technologies explained:

> The Government has historically mandated that commercial companies partner with universities/research organisations to be eligible for R&D grants. This model has its challenges as both parties have their different strengths (companies are committed to achieving higher TRLs), key objectives

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91 Australia Space Futures, *Submission 57*, pages 2-3.

92 Mr Matthew Opie, Director, Defence and Space, University of South Australia, *Committee Hansard*, Adelaide, 10 March 2021, p. 23.

93 Gilmour Space Technologies, *Submission 59*, p. 5.

94 Gilmour Space Technologies, *Submission 59*, p. 5.

(companies are driven by commercial outcomes), and financial time frames (companies are more time constrained).[95]

6.53 Gilmour Space Technologies emphasised that 'supporting research is not the same as supporting companies' because discovery-related R&D (generally at TRLs 0-3) is often undertaken by universities and research organisations, while companies are better at innovation, which is the conversion of a discovery into a commercial product (at TRLs 7-9).[96]

6.54 FrontierSI argued that government-based incentives for collaboration between the research and private sectors are needed to promote and increase the commercialisation of research outcomes.[97] The company also suggested that a national business agenda program containing specific priorities could be developed to promote collaborative partnerships.[98] This model would have the advantage of promoting long-term partnerships and increasing the movement of university research into the private sector, thereby increasing the development of business opportunities.[99] Similar sentiments regarding government mechanisms to facilitate collaboration and coordinating collaboration were echoed by EOA in its submission.[100]

6.55 The success of Australia's space sector depends upon the participation and collaboration of academic institutions and SMEs with 'higher classified organisations in Australia and internationally'.[101] Penten argued that academic institutions and SMEs, however, are commonly 'the weak link in supply chains' as they are often the target of foreign cyber interference and typically lack necessary resources to protect themselves.[102] This vulnerability poses a risk to the successful growth of the space sector and Australia's security.[103]

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95 Gilmour Space Technologies, *Submission 59*, p. 5.

96 Gilmour Space Technologies, *Submission 59*, p. 5.

97 FrontierSI, *Submission 38*, p. [5].

98 FrontierSI, *Submission 38*, p. [5].

99 FrontierSI, *Submission 38*, p. [5].

100 EOA Inc., *Submission 21*, p. 9.

101 Penten, *Submission 37*, p. [3].

102 Penten, *Submission 37*, p. [3].

103 Penten, *Submission 37*, p. [3].

6.56 Penten suggested that the C4 EDGE (Evolutionary Digital Ground Environment) communications program could be used as a 'template for industry-wide collaboration in the space industry'.[104]

6.57 Dr Mark Hodge also raised security as a problem affecting R&D, including within the university sector. Dr Hodge explained that 'the ability to hold a national security clearance is becoming more and more important', with this clearance not just including the individuals conducting sensitive research in partnership with companies such as DMTC, but also the university 'infrastructure' surrounding them, including PhD supervisors.[105] These security concerns extend to the way research has traditionally been performed, as explained by Dr Hodge:

> You've also got those cultural elements from universities. Research is peer reviewed. The idea is, 'I'm having trouble with this concept, and who's got a better idea than I have?' That's how research has been done for dozens of generations. It can't always work like that. If you go to a technical conference and you've given your presentation and you're meeting somebody in the hall afterwards, and some stranger comes up to you and says, 'I'm really interested in your research. Can you tell me more?' the first instinct of an academic is to say: 'I'd love to. Let's get together for a beer, and I'll talk about it.' You can't do that, of course. So, there are going to be some serious decisions that are going to have to be made.[106]

Intellectual property

6.58 Fundamental to the commercialisation of R&D is intellectual property. Mr Ian McLeod, Vice President, International, MDA, told the Committee that there are two areas of interest regarding IP: protecting it, and regulating its use and commercialisation.[107] These issues are not confined to the space sector.[108]

6.59 The importance of regulating the use of IP, examples of how IP is currently regulated, and the current challenges in regulating IP were all raised with

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104 Penten, *Submission 37*, p. [3].

105 Dr Mark Hodge, Chief Executive Officer, DMTC, *Committee Hansard*, Canberra, 16 September 2021, pages 13-14.

106 Dr Mark Hodge, DMTC, *Committee Hansard*, Canberra, 16 September 2021, p. 14.

107 Mr Ian McLeod, Vice President, International, MDA, *Committee Hansard*, Canberra, 28 May 2021, p. 13.

108 Mr Ian McLeod, International, MDA, *Committee Hansard*, Canberra, 28 May 2021, p. 13.

the Committee. Dr Matthew Tetlow, Chief Executive Officer, Inovor Technologies, explained that ensuring IP is owned by Australians and within Australia is important, because 'it provides unhindered access to global opportunities without parent companies or foreign government agendas getting in the way'.[109] Dr Tetlow stated that currently Australia does not have policies to maintain local ownership and control of IP, unlike other countries:

> Most other countries have specific policies to ensure that space technology and know-how is locally owned and controlled, as they understand the commercial value of the space industry to their economies, not to mention the issue of sovereign priority access to technology when they need it. Australia, by comparison, does not mandate this federally or at the state level to support the Australian commercial space sector.[110]

6.60 Instead, as mentioned by Mr Anthony Murfett, Deputy Head of ASA, the commercial aspects of IP are currently managed by companies, who 'have their own arrangements to meet their commercial needs'.[111] Mr Murfett stated that issues regarding IP will need to be monitored and explored with regards to the aim of tripling the space economy and creating jobs.[112]

6.61 Australia's domestic market is unlikely to be big enough to support the entire Australian space industry, meaning that exports will be crucial for long-term growth.[113] MDA argued this means that flexible IP and export control regulations that encourage technology development and exportation by allowing the use of government program developed IP for other international opportunities should be created.[114]

6.62 Boswell Technologies expressed similar sentiments stating that licensing or collaboration is needed to commercialise technology, but argued that 'controlling the use of the technology and obtaining a return relies on strong IP protection'.[115]

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109 Dr Matthew Tetlow, Chief Executive Officer, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 9.

110 Dr Matthew Tetlow, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 9.

111 Mr Anthony Murfett, Deputy Head, ASA, *Committee Hansard*, Canberra, 17 February 2021, p. 4.

112 Mr Anthony Murfett, ASA, *Committee Hansard*, Canberra, 17 February 2021, p. 5

113 MDA, *Submission 40*, p. 7.

114 MDA, *Submission 40*, p. 7.

115 Boswell Technologies, *Submission 31*, p. 7.

6.63 When asked by the Committee about whether a TSA would facilitate or hinder the development of local Australian companies, Dr Tetlow acknowledged that the ability to export is important for Australia's space sector, but stated that owning IP in Australia is also important:[116]

> But you have to be careful: if you don't structure it [the TSA] properly, it can basically limit the ability of whatever Australian technology is developed to be exported out of Australia. Say company X comes in from the United States [US] and sets up here to meet a capability need. If they've set up a manufacturing or R&D facility or whatever, that's all fine and it works in the Australian context. But if an opportunity comes in, say, from Vietnam or something like that, that export opportunity comes out of the parent company, out of the US or wherever the company comes from. So you have to be careful. You're bringing them in, which upskills us quickly, but then it chops your head off because you then can't export. The reality is we have to export, because we can't rely on the Australian government to fund all our missions going forward. So we're very focused on the export market. That's why we want to own the technology, the IP, in Australia, and have only Australia's agenda in mind when we basically go after a foreign opportunity.[117]

6.64 Examples of how IP is regulated by some organisations within the space sector were shared with the Committee. Mrs Buchberger from QUT described the university's approach to IP as follows:

> The university has an IP policy and protocols which guide us as to how we negotiate with partners, and we're quite flexible. The position that we've determined as probably the easiest to negotiate and the most beneficial for the growth of our sector is an inventor ownership position, which basically says we plus an industry partner work together on component technologies that, for example, make up a lunar rover, and we own the parts we contribute.[118]

6.65 Mrs Buchberger told the Committee that QUT has not experienced any particular issues with their industry partners regarding IP, and that its inventor ownership model 'works because there are so many component technologies in most space products'.[119]

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116 Dr Matthew Tetlow, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 11.

117 Dr Matthew Tetlow, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 11.

118 Mrs Ali Buchberger, Director, Industry Engagement (Science and Engineering), QUT, *Committee Hansard*, Brisbane, 6 May 2021, p. 25.

119 Mrs Ali Buchberger, Industry Engagement (Science and Engineering), QUT, *Committee Hansard*, Brisbane, 6 May 2021, p. 25.

6.66 The CSIRO's approach to IP was discussed by Dr Dave Williams, Executive Director, Digital, National Facilities and Collections who noted that the CSIRO uses a couple of different 'pathways' for commercialising technology:[120]

> In terms of how CSIRO takes things forward commercially, it has three or four paths. Companies will come to us and pay us to do things for them, and they get the IP if it's fully paid for. Sometimes when we have our own science work and we retain the IP, companies will come and licence the IP and we let them work with it. We also create companies, taking an equity stake, which is usually quite a small equity stake. Small companies have difficulty with cash flow so getting a bit of equity is a better way of service.[121]

6.67 Dr Williams stated that each company working with the CSIRO follows the pathway that is most 'natural' for them, and that companies are not told they have to follow a certain route.[122]

Challenges

6.68 The Committee heard about several challenges concerning space-related IP regulation including that used by primes, universities and the SmartSat CRC. Boeing Australia submitted that the end-ownership of IP is 'often a major concern of larger primes when considering collaborating with Australian companies or government agencies'.[123] It argued that IP ownership needs to be managed carefully to 'avoid restrictive or onerous ownership and/or licensing arrangements' that could be viewed as a disincentive for international collaboration.[124]

6.69 According to Boeing, 'when core IP is held at risk, it is a strong disincentive for its inclusion in a proposal by the Prime'.[125] Boeing also noted that the current speed of technology development and innovation means that space-related IP needs to be commercialised quickly as it is 'relatively perishable in

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120 Dr Dave Williams, Executive Director, Digital, National Facilities and Collections, CSIRO, *Committee Hansard*, Canberra, 24 February 2021, p. 8.

121 Dr Dave Williams, Digital, National Facilities and Collections, CSIRO, *Committee Hansard*, Canberra, 24 February 2021, p. 8.

122 Dr Dave Williams, Digital, National Facilities and Collections, CSIRO, *Committee Hansard*, Canberra, 24 February 2021, p. 8.

123 Boeing, *Submission 80*, p. 10.

124 Boeing, *Submission 80*, p. 10.

125 Boeing, *Submission 80*, p. 10.

the marketplace'.[126] The company recommended that 'Government should recognise the need for industry to better exploit IP generated as a result of Government-funded space collaborations', including 'consideration of a model where IP defaults to those industry partners best placed to deliver long-term value to the Australian space industry'.[127]

6.70 Mr McLeod from MDA shared a similar view:

> I'm a proponent that if you want to develop your industry and you're a government, when you're funding R&D you need to get the IP into the hands of the companies. They're the ones who are going to commercialise it, and they need to be able to take advantage of it and use it for things like exporting.
>
> Having said that, there are export control rules in place for a reason, which is to control where some of that IP goes…[128]

6.71 Dr Michael Smart, Co-Founder and Head of Research and Development, Hypersonix Launch Systems called for more flexibility regarding IP used by universities.[129] Dr Smart told the Committee that 'if some intellectual property gets used by a company and then that company makes a hell of a lot of money, it should go back to the university'.[130] If, however, a university decides to charge a company a lot of money upfront for using their IP, this then becomes a barrier.[131]

6.72 Mr William Barrett, Senior Vice-President, APAC highlighted another problem stating that IP has been 'harvested' from Australian universities by many big multinational companies for years.[132] As stated by Mr Barrett:

> That is great at one level for the universities, because they get a little something for it, but it ties it [the IP] up in these big multinationals overseas

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126 Boeing, *Submission 80*, p. 10.

127 Boeing, *Submission 80*, p. 11.

128 Mr Ian McLeod, Vice President, International, MDA, *Committee Hansard*, Canberra, 28 May 2021, p. 13.

129 Dr Michael Smart, Co-Founder and Head of Research and Development, Hypersonix Launch Systems, *Committee Hansard*, Brisbane, 6 May 2021, p. 64.

130 Dr Michael Smart, Hypersonix Launch Systems, *Committee Hansard*, Brisbane, 6 May 2021, p. 64.

131 Dr Michael Smart, Hypersonix Launch Systems, *Committee Hansard*, Brisbane, 6 May 2021, p. 64.

132 Mr William Barrett, Senior Vice-President, Asia Pacific Aerospace Consultants, *Committee Hansard*, Sydney, 19 April 2021, p. 40.

> and is not actually able to be used here. Australia's been a very fertile hunting ground for a lot of those big companies.[133]

6.73 Mr Barrett also stated that consideration needs to be given to whether this IP can be built upon:

> The question is: can we actually build on that IP ourselves? That really gets into what we've loosely described, or more broadly described, as an ecosystem here. We need all the pieces to really build a strong space economy here. We have many of those. A few of them are less robust than others. But, as much as anything, it needs a mindset. We have this capability. There are some extremely good companies out there and some very clever ways of doing things.[134]

6.74 Professor Michael Milford, Acting Director, Centre for Robotics, QUT told the Committee that 'one of the biggest threats is not the IP specifically but the many talented people who would have generated that IP leaving the country'.[135] Professor Milford acknowledged that although this is an indirect problem concerning IP, it is particularly relevant at the moment.[136]

SmartSat Cooperative Research Centre

6.75 Currently the ASA, SmartSat CRC and DST's *Resilient Multi-Mission Space* Science, Technology and Research (STaR Shot) comprise a large portion of current space industry development funding.[137] Curtin University stated that if a couple of adjustments were made to this model concerning IP governance there would likely be a larger return on investments made into developing Australia's space industry.[138] In particular, it was mentioned that:

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133 Mr William Barrett, Asia Pacific Aerospace Consultants, *Committee Hansard*, Sydney, 19 April 2021, p. 40.

134 Mr William Barrett, Asia Pacific Aerospace Consultants, *Committee Hansard*, Sydney, 19 April 2021, p. 40.

135 Professor Michael Milford, Acting Director, Centre for Robotics, QUT, *Committee Hansard*, Brisbane, 6 May 2021, p. 26.

136 Professor Michael Milford, Centre for Robotics, QUT, *Committee Hansard*, Brisbane, 6 May 2021, p. 26.

137 Curtin University, *Submission 81*, p. 2.

138 Curtin University, *Submission 81*, p. 3.

> …our best researchers, who are foundational drivers of science and innovation, are reticent to bring forward proposals to the SmartSat CRC under the present format.[139]

6.76 Curtin University noted that one of their industry partners, who is a core member of SmartSat CRC, 'recommended not using the SmartSat CRC funding model due to the IP terms and conditions'.[140] The university stated that 'a refined funding model, addressing both science, and enhancing both the inputs to, and outputs from, SmartSat CRC, will help accelerate and grow Australia's sovereign space industry'.[141]

6.77 Skycraft raised a similar problem, stating that 'whilst some incentives such as the SmartSat CRC may appear appealing, some of their organisational features, in particular the IP terms, hinder cash injection by investors into the space ecosystem thus limiting the opportunities for small space companies to leverage their smart ideas into the market place'.[142]

6.78 EOA also stated that IP and funding constraints for research programs focused on industry – such as the CSIRO and CRCs – are 'not enabling the diverse, flexible, agile, and high level of activities that Australia needs' with the space sector having 'progressed significantly beyond the conditions in which these programs were established'.[143]

Intellectual property laws

6.79 Various factors have caused complexity within the space sector's IP 'landscape'.[144] These factors include technology complexities, multiple ownership of assets, and tensions between IP laws (which protect private entities) and space law (which has traditionally been government-based).[145] Deloitte stated that an 'IP protection strategy should be created in parallel with the company's commercial strategy' and noted that the Australian Government could identify important areas to harmonise IP regulation.[146]

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139 Curtin University, *Submission 81*, p. 3.

140 Curtin University, *Submission 81*, p. 3.

141 Curtin University, *Submission 81*, p. 3.

142 Skycraft, *Submission 10*, p. [2].

143 EOA, *Submission 21*, p. 2.

144 Deloitte, *Submission 53*, p. [10].

145 Deloitte, *Submission 53*, p. [10].

146 Deloitte, *Submission 53*, p. [10].

6.80 King & Wood Mallesons (KWM) also stated that the development of IP laws will need to be considered.[147] By providing protections and rights for the commercialisation of technological 'know-how' and innovations, KWM argued that IP laws will have an important role in promoting investment in the space sector.[148] Like Deloitte, KWM acknowledged 'an inherent challenge in reconciling IP laws, which aims to protect private property and secure benefits for the rights holder, with the fundamental space law principles. This includes that the exploration and use of outer space be for the benefit of all and the non-appropriation of outer space by any nation'.[149]

Protecting intellectual property

6.81 The Committee heard about the importance of protecting space-related IP and its associated challenges. Mr McLeod from MDA told the Committee that IP protection is 'extremely important' but also an ongoing challenge that 'dovetails with cyber protection, because if people can get into your computer systems then they're directly accessing your IP'.[150]

6.82 Mr Barrett from APAC explained that space-related IP protection is an 'interesting realm…because the information in space is considered a secure product as much as anything else'.[151] Like Mr McLeod, Mr Barrett told the Committee there is an element of cyber security in protecting IP by ensuring that it does not 'end up in the wrong hands' and that companies in the space domain do not get hacked.[152] Mr Barrett also noted that 'the government has, in its IT security site, put forward a methodology of how it covers essential Australian businesses in space, and rightly so, as part of that'.[153]

6.83 Mr Joshua Bolton, Director, Defence and Intelligence, Penten, further advocated for the protection of Australian IP stating that:

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147 King & Wood Mallesons, *Submission 54*, p. 10.

148 KWM, *Submission 54*, pages 10-11.

149 KWM, *Submission 54*, p. 11.

150 Mr Ian McLeod, Vice President, International, MDA, *Committee Hansard*, Canberra, 28 May 2021, p. 13.

151 Mr William Barrett, Senior Vice-President, Asia Pacific Aerospace Consultants, *Committee Hansard*, Sydney, 19 April 2021, p. 40.

152 Mr William Barrett, Asia Pacific Aerospace Consultants, *Committee Hansard*, Sydney, 19 April 2021, p. 40.

153 Mr William Barrett, Asia Pacific Aerospace Consultants, *Committee Hansard*, Sydney, 19 April 2021, p. 40.

> Australia's innovation rooms—the small and medium enterprises and the academic institutions—are creating incredible intellectual value, which is vulnerable to deliberate, malicious activity. If Australia wants to establish a true sovereign space industry and one that is globally competitive, we need to look at ways in which we can foster this growth as well as protect the industry from being compromised. This requires us to work with our allies, particularly the Five Eyes partners, to coordinate and align our priorities. This will give the government and industry the necessary confidence that our emerging technologies are being protected.[154]

6.84 Australia's sovereign intellectual advantage needs to be maintained and protected through the cyber environment. [155] Mr Bolton stated that 'for individual companies, such as SMEs, and academia, providing them with a framework to actually secure their intellectual property is fundamental'. [156] It was recommended that SMEs and academia need to be able to coordinate and communicate with each other and the Government in a secure environment to maintain Australia's intellectual advantage and develop new capabilities.[157]

Committee comment

6.85 Australian space science underpins innovation and discovery within the space industry. It provides opportunities for international engagement, development of technology and industry growth. Closer to home, the application of space science innovation can fundamentally change the way we manage and interact with a range of sectors across the economy.

6.86 The Committee supports the greater promotion of space science as the foundation upon which the space industry evolves. National coordination of space science across government agencies, and a defined set of national space science priorities are welcomed by industry. This will help to inform decision making around investment and space science research programs.

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154 Mr Joshua Bolton, Defence and Intelligence, Penten, *Committee Hansard*, Canberra, 26 February 2021, p. 18.

155 Mr Joshua Bolton, Defence and Intelligence, Penten, *Committee Hansard*, Canberra, 26 February 2021, p. 22.

156 Mr Joshua Bolton, Defence and Intelligence, Penten, *Committee Hansard*, Canberra, 26 February 2021, p. 20.

157 Mr Joshua Bolton, Defence and Intelligence, Penten, *Committee Hansard*, Canberra, 26 February 2021, p. 22.

6.87 Successful collaboration between sectors across the space industry has the potential to translate into national and international benefits. These partnerships must be properly supported and fostered. The Committee appreciates the challenges that stakeholders shared regarding perceived inequity in access to funding, competing priorities in collaborative partnerships, or competition more generally across sectors. Stakeholders have expressed their desire for a more level playing field for collaboration and investment between industry and academia. Some stakeholders have also called for a repositioning of these relationships to acknowledge respective strengths and commercial partnerships.

6.88 The Committee recognises that Australia is in its infancy of research commercialisation. There is a need to protect Australian space related IP, ensure fair access to it, and that collaborating efforts involving transfer of IP or discussion of ideas between stakeholders can occur in a secure environment. To that end, the Committee makes the following recommendations.

Recommendation 30

6.89 The Committee recommends that the Australia Government prioritise and promote the importance of space science as fundamental to innovation and growth of the Australian space sector. This includes:

- **specific reference to space science in the Australian Space Agency's Charter and Australia's Civil Space Strategy;**
- **examining options for better coordination of space science across Commonwealth and state and territory agencies; and**
- **identifying a set of national space science research and innovation priorities to enable stakeholders to make informed decisions regarding investment and research and development.**

Recommendation 31

6.90 The Committee recommends that the Australia government review the model for research and industry collaboration to ensure that it fosters the best outcomes to support innovation, development of space capability, and industry growth.

6.91 This includes access by academia and industry to cross sector research funding streams and programs.

Recommendation 32

6.92 The Committee recommends that the Australian Government examine options to protect the intellectual property security of stakeholders within the Australian space industry to ensure that collaboration between academics, industry and government can occur in a secure environment.

6.93 The Committee recommends that the Australian Government consider options for industry to commercialise publicly funded research and development and intellectual property creation in a competitive environment.

7. Future Workforce

7.1 The Australian Government has set a goal to grow the space industry by another 20,000 jobs by 2030. Traditionally, those interested in pursuing a career in the space industry would leave Australia to do it. Now people are not only finding employment opportunities in Australia, there are early signs that people are coming back from overseas to continue their careers. While much of this is due to a growing national industry, it is also due to the changing nature of work within space more generally and the opportunity to work in a broader range of space related fields, particularly those associated with 'downstream' or 'from space' activities.

Space 2.0

7.2 The space sector is transitioning from a focus of going into space and space exploration to developing technology for use on Earth. Dr Paul Scully-Power AM described this industry shift as moving from Space 1.0 to Space 2.0:[1]

> Few realise today that space is about to change every industry in Australia. I've named it 'space 2.0'. The old space industry, space 1.0, was all about launching into space. The new space industry, space 2.0, is all about what space can do for us down here. Put another way, space 1.0 is all about exploration and space 2.0 is all about exploitation.[2]

7.3 Space 2.0 includes a range of new technologies such as artificial intelligence, remote sensing, smart sensors, nanotechnology, microelectronics, big data, robotics, drones, autonomous systems, quantum computing and the internet

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1 Dr Paul Scully-Power AM, Space 2.0 – The Next World Revolution, *Journal and Proceedings of the Royal Society of New South Wales,* vol. 153, part 1, 2020, pages 104-107.

2 Dr Paul Scully-Power, *Committee Hansard,* Sydney, 19 April 2021, p. 2.

of things. The significance of Space 2.0 is that it will create the jobs of the future. According to Dr Scully-Power AM, Space 2.0 should be Australia's focus for growing the space industry:

> It's this litany that most people have not realised feeds the space industry today, and that's what we have to focus on to feed the space industry in Australia. In fact, I would say that that is the foundation for the jobs of the future in Australia.[3]

7.4 The University of New South Wales (UNSW) Canberra expressed the same view:

> The future space workforce will have some focus on manufacturing and operating space hardware, but that part of the industry will be exotic and boutique. The number of satellites that Australian organisations are likely to build will represent a niche market only. The majority of the workforce will be where the money is: the downstream analytics, the application of artificial intelligence, turning space-derived data into decision-ready information for a wide range of sectors and users on the ground.[4]

7.5 The ASA described Space 2.0 as 'an enabler and part of the 'fourth industrial revolution', often called Industry 4.0'.[5]

Skills for the future

7.6 A recent study by SmartSat CRC examined the skills needed for a future Australian space workforce.[6] It established a space-related skills 'taxonomy' specific to Australia, comprising 319 individual skills, and found that while Australia possesses 'nearly every skill type with very minimal gaps', there are 'pervasive current shortages and future requirements' across the required skills.[7] These include technical skills, technology specific skills, business, management, and governance skills, and soft skills relevant to the higher education, professional development, workforce development and

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3 Dr Paul Scully-Power, *Committee Hansard,* Sydney, 19 April 2021, p. 3.

4 UNSW Canberra, *Submission 73*, p. 8.

5 Australian Space Agency, *Submission 55,* p. 7.

6 SmartSat, 'Technical Report No. 5 – Space Industry Skills Gap Analysis,' March 2021, https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf.

7 SmartSat, 'Technical Report No. 5 – Space Industry Skills Gap Analysis,' March 2021, https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf.

vocational education sectors.[8] Furthermore, the study found potential gaps in training providers for these skills.

7.7 Evidence to the Committee was consistent with these findings. It found while Australia has good skill sets in some areas – for example graduate engineers, scientists and technicians – it is lacking in others.

7.8 The Queensland Government differentiated between gaps in 'general' and 'highly specialised' space skills.[9] It noted general skills are those which underpin most of a business' activities. Shortages in this skill set are often between the level of graduate and highly experienced – that is mid-career. While space companies can find suitably skilled graduates, they usually require upskilling and training. This is because graduates have 'academic prowess' but limited practical on-the-job experience.[10]

7.9 On the other hand, highly specialised skills refer to those which require 'very precise experience not often found straight out of Australian universities', for example launch vehicle developers, and are usually sourced from overseas.[11]

7.10 Witnesses to the inquiry offered some practical insights. Dr Matthew Tetlow, Chief Executive Officer, Inovor Technologies told the Committee:

> If you start with entry-level or early-career engineers and scientists, I think we have an incredible talent pool and we are second to none in the world. It is the same with the technicians. The skilled technicians that we have have everything that we could possibly need. When you get up to the more senior management level or systems engineers that have worked on spacecraft for long periods of time, we're lacking that, and we're lacking the very senior people who have been in it for decades and have all the war wounds to basically educate the younger team members.
>
> So I guess there's a mix. The vast majority of our team are Australian, and we've had a couple of people come in from overseas to bring skills. We've also been lucky enough to work with a couple of returned space systems engineering experts who basically support our team, one of whom is sitting next to us. I guess that sort of enables us to go forward just with the skill base that we have.

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8 SmartSat, 'Technical Report No. 5 – Space Industry Skills Gap Analysis,' March 2021, https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf.

9 Queensland Government, *Submission 60*, p. 6.

10 Queensland Government, *Submission 60*, p. 6.

11 Queensland Government, *Submission 60*, p. 6.

> If you then look down at the manufacturing industry that we use, which sits underneath us—including machinists, metal machinists, electronic manufacturing capabilities and all those sorts of things—they're also available in Australia at a very high level. There is some upskilling that needs to be done or that is being done, I guess.[12]

7.11 Dr Jason Held, Chief Executive Officer, Saber Astronautics supported the view that Australia produces good entry level space engineers:

> I firmly believe that we do not need to invite people from overseas…to build our country. We do not need to invite people from overseas to fill a gap in our skill set. We produce 800 space engineers a year out of all the universities. The juniors—associate engineers, graduate engineers—are sorted up to mid-career. That's what I've seen over the last 16 years in this country. The universities produce very good engineers that maybe need a little bit of tweaking here and there, in training and certain techniques. But it is not any better or worse than what you're finding out of the United States.[13]

Box 7.1

Boeing Australia provided a profile of one of its employees to showcase achievements within the industry:

David Corporal, Graduate Mechanical Engineer

David Corporal, an Indigenous Australian engineer, started working for Boeing as an intern in late 2016.[14] David is working on a number of space initiatives including the International Space Station (ISS) test of the Boeing-developed antimicrobial surface coating, human factors on the Lunar Terrain Vehicle and Boeing's solution for the Australian Defence Satellite Communications System.[15]

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12 Dr Matthew Tetlow, Chief Executive Officer, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 10.

13 Dr Jason Held, Chief Executive Officer, Saber Astronautics, *Committee Hansard*, Sydney, 19 April 2021, p. 11.

14 Boeing Australia Holdings Pty Ltd (Boeing Australia), *Submission 80:1,* Answer to Question on Notice, p. [5].

15 Boeing Australia, *Submission 80:1,* p. [5].

David was inspired to seek a career in space after watching videos of then-commander of the ISS, Chris Hadfield.[16] He continues to be inspired by the all that is yet to be discovered in space and human spaceflight.[17]

David notes that the growth in the Australian space sector means he can achieve some of his space-related goals without leaving Australia.[18] David states that 'when [he] started university the space industry was a lot smaller and didn't have the scope to help [him] achieve [his] career goals. Now [he's] able to be in Australia but work with the Boeing team in Houston on the ISS program, which gives [him] experience in their processes and how ISS works.'[19]

7.12 Mr Mark Ramsey, General Manager, Sitael Australia, identified the lack of skilled people with longevity in the industry as a workforce challenge:

> We've had a period of five or six decades of the space sector globally and Australia has really been hands off and out of the loop. The challenging area in expertise that we find is finding people with five, 10, 15 or 20 years of experience. That's probably a difficult workforce. There are a lot of Australians who've gone overseas. A lot of Australians are coming back at the moment.[20]

7.13 While some witnesses considered the space industry to have sufficient numbers of graduates – albeit in need of some upskilling or tweaking of skills – others identified a lack of graduates in specialist technical fields. The Committee was encouraged to consider how to increase the numbers of people with technical expertise to help establish a more extensive workforce.

7.14 FronterSI stated that remote sensing scientists, application developers, space engineers, data scientists and positioning experts will all be required to underpin future industry growth.[21] Similarly, Boeing Australia urged the Australian Government to encourage education and training in advanced

16 Boeing Australia, *Submission 80:1,* p. [5].

17 Boeing Australia, *Submission 80:1*, p. [5].

18 Boeing Australia, *Submission 80:1,* p. [5].

19 Boeing Australia, *Submission 80:1*, p. [5].

20 Mr Mark Ramsey, General Manager, Sitael, *Committee Hansard,* Adelaide, 10 March 2021, p. 10.

21 FrontierSI, *Submission 38*, p. 2.

software development, artificial intelligence, and machine learning as critical skill areas for the high value jobs of the future.[22]

7.15 Geoscience Australia highlighted a 'substantial deficiency' of skills related to space application development.[23] It listed gaps in the following areas:

- global navigation systems experts
- geodesists
- remote sensing scientists
- sensor designers and engineers
- big space data skills (including artificial intelligence, machine learning, data analytics and automation).[24]

7.16 Geoscience Australia stated that the proportion of Australian graduates in some of these areas is very low with little sign of increasing. As such, it recommended strategies to encourage more people to undertake stand-alone degrees in spatial science related fields and to consider opportunities to build these skill sets into other degrees such as agronomy or agriculture.[25]

7.17 EOA also commented on the 'skilled technical workforce shortage in EO and the wider spatial community' including a lack of graduates with technical skills in earth observation. It noted that while most Australian tertiary education institutions include EO subjects in degrees in geographic information and technology, surveying, and spatial science, few institutions offer comprehensive EO courses along with the data analysis and specialised expertise required in other applications.[26] Furthermore, few secondary education institutions teach EO subjects in any of their science, technology, or other courses.

Box 7.2

Boeing Australia provided a profile of one of its employees to showcase

22 Boeing Australia, *Submission 80*, p. 7.

23 Geoscience Australia, *Submission 13*, p. 8.

24 Geoscience Australia, *Submission 13*, pages 8 and 9.

25 Dr Martine Woolf, Branch Head, National Positioning Infrastructure, Geoscience Australia, *Committee Hansard*, Canberra, 17 March 2021, pages 3 and 4.

26 Earth Observation Australia, *Submission 21*, p. 6.

achievements within the industry:

Kathryn Burr, Program Manager JP9012 (Australian Defence SATCOM System) Program and Space & SATCOM Market Lead

Kathryn brings her extensive experience in defence, industry and government to her current role leading Boeing's bid for JP9102 for the Australian Defence SATCOM System.[27] After a career of delivering large scale complex acquisition projects, one of Kathryn's strengths is her ability to unite large and diverse teams to work together to solve complex problems.[28]

On JP9012, her focus has been on engaging with Australian industry across all the domains that are required to develop sovereign space capability.[29] Kathryn is highly mindful that JP9102 represents a significant investment by the Australian Government, and presents a massive opportunity for the Australian space industry to invest in the development of skills and capabilities that will enable to nation to compete on the world stage.[30] To date, under Kathryn's leadership, Boeing has engaged more than 200 Australian small-to-medium enterprises (SMEs) and is taking a long-term approach with a view to up-skilling and growing the local industry.[31]

Growing the workforce

7.18 The skills and expertise needed to support Australia's future space workforce will need to be drawn from three key areas – within the domestic education and training sector, other Australian industries and sectors, and internationally. Mr Matt Dawson, Director, Space Business, Thales Australia said:

27 Boeing Australia, *Submission 80:1,* p. [5].

28 Boeing Australia, *Submission 80:1,* p. [5].

29 Boeing Australia, *Submission 80:1,* p. [5].

30 Boeing Australia, *Submission 80:1,* p. [6].

31 Boeing Australia, *Submission 80:1,* p. [6].

> It is very much a mix of the space industry actually drawing skilled resources in from across sectors—reskilling but being drawn into the space sector from other sectors—and also drawing skilled resources up through our education institutions, through the STEM fields, and all of that mixed in with moving expertise around the world globally and drawing on experts as we need them to supplement various endeavours. I think those three elements are the mix that we need to focus on to be able to build enough critical mass with the Australian industry.[32]

7.19 The Australian space industry will need to be supported by people with the right skills, and comprise a diverse and inclusive workforce. Several stakeholders advocated for increasing the numbers of women, indigenous Australians and those from underrepresented groups. Smartsat CRC stated:

> Such efforts should pay close attention to and provide support for diversity and inclusion initiatives. This will overcome a long history of male dominated STEM workforce, and retention, ensuring our best students and workers stay in the industry and preferably stay in Australia thus reaping the benefits from the capitalisation of the whole Australian workforce.[33]

7.20 Submitters to the inquiry made a number of interrelated suggestions to build Australia's space workforce:

- increase awareness of space-related job opportunities
- improve uptake of STEM related courses across education sectors
- strengthen skill capacity in technical areas
- develop pathways from education to industry
- improve transition of skilled workers between industries
- facilitate easier engagement and migration of international workers

7.21 Perhaps the strongest message conveyed to the Committee is that a future workforce needs to know that Australia's space industry is not just for astronauts and rocket engineers. Rather, there are a range of professions – not generally associated with space - such as law, medicine, project management, communications and business that will all be required to support Australia's space industry. It is this message that should be communicated and facilitated to grow an internationally competitive sector.

Space careers

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32 Mr Matt Dawson, Director, Space Business, Thales Australia, *Committee Hansard,* Canberra, 16 September 2021, p. 3.

33 SmartSat CRC, *Submission 29,* p. 5.

7.22 There is no problem attracting people to space. It fascinates and excites people. It is engaging and inspiring. From a workforce perspective, however, there is a need to address the perception that space is not an industry accessible to all. To encourage people to choose space as an employment option, prospective employees should be able to see and know how they can be part of the industry. As Mr Martin Rowse, Airbus, explained:

> I don't think there's necessarily a problem with space being sexy as such. I think space is seen as cool. It's seen as something to be involved in. I think the problem is that people don't necessarily know how to get into it. I think there's a problem of space being inaccessible, both in terms of actual space and space as an industry, where it tends to be seen that the scientists are the ones that are needed. They obviously are, but then you need mathematicians. You also need business people. You need people with strategy backgrounds. You need people with accountancy background. You need a whole range of people to make space work, to make it a commercial enterprise.[34]

7.23 The Committee was encouraged to consider how to make space relevant to people. Specifically, how to 'make it a commercial enterprise so that people can see their way in'. Mr Rowse further explained:

> If you try to make space sexy by looking at astronauts and by looking at very capable individuals, that makes it quite inaccessible for the majority of people. What I would focus on is how you commercialise the industry so that a career in space is accessible and is realistic, so that people can understand that you don't have to be the top physicist in the world to have a career in space, and that you can be a very good accountant to go into space, or you can be a very good configuration manager and have a career in space. It's about widening the view of space rather than rather than narrowing it.[35]

Box 7.3

The Airbus Faces Campaign showcases the achievements of employees throughout their career path at Airbus.[36]

Cameron Cooke, Artificial Intelligence Specialist Originally from

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34 Mr Martin Rowse, Key Account Manager, Airbus, *Committee Hansard*, Canberra, 26 February 2021, p. 11.

35 Mr Martin Rowse, Airbus, *Committee Hansard*, Canberra, 26 February 2021, p. 11.

36 Airbus, *Airbus Faces* <https://www.airbus.com/careers/airbus-faces.html> accessed 24 August 2021.

Sydney, Cameron Cooke moved to Toulouse, France to work as an Artificial Intelligence Specialist for Airbus.[37] As an Artificial Intelligence Specialist, Cameron and his team are studying the use of cameras in Final Assembly Lines workstations to better understand what happens during the manufacturing process.[38] The project aims to optimise the layout of the shop floor and make people's jobs easier and safer.[39]

Wensy, Intern Wensy joined Airbus Asia Pacific as an intern working in the C-130J Hercules Through Life Support Program at the Royal Australian Air Force Base in Richmond.[40] As an intern at Airbus, Wensy was exposed to real life engineering challenges, which 'help[ed] [her] grow as an engineer.'[41] As an active member in Sydney University Women in Engineering, Wensy is passionate about motivating and empowering young girls to study STEM.[42] Upon completion of her internship, Wensy received a full time offer as an Avionics Graduate Engineer.[43]

7.24 It was a view shared by other stakeholders. ANU InSpace argued that the growing space industry will require people from a range of disciplines and fields including law, marketing, business, science and humanities.[44] It asserted the importance of focusing on expanding awareness of job diversity in the space industry. Similarly, Saab Australia stressed 'importantly,

37 LinkedIn, *Cameron Cook* <https://www.linkedin.com/posts/camerongcooke_airbusfamily-airbusfaces-airbustoulouse-activity-6710157397379301376-Y4Vk> accessed 24 August 2021.

38 LinkedIn, *Cameron Cook* <https://www.linkedin.com/posts/camerongcooke_airbusfamily-airbusfaces-airbustoulouse-activity-6710157397379301376-Y4Vk> accessed 24 August 2021.

39 LinkedIn, *Cameron Cook* <https://www.linkedin.com/posts/camerongcooke_airbusfamily-airbusfaces-airbustoulouse-activity-6710157397379301376-Y4Vk> accessed 24 August 2021.

40 LinkedIn, *Airbus* < https://www.linkedin.com/posts/airbusgroup_stem-airbusfaces-airbusaustralia-activity-6704205730435633154-2xG6> accessed 24 August 2021.

41 LinkedIn, *Airbus* < https://www.linkedin.com/posts/airbusgroup_stem-airbusfaces-airbusaustralia-activity-6704205730435633154-2xG6> accessed 24 August 2021.

42 LinkedIn, *Airbus* < https://www.linkedin.com/posts/airbusgroup_stem-airbusfaces-airbusaustralia-activity-6704205730435633154-2xG6> accessed 24 August 2021.

43 LinkedIn, *Airbus* < https://www.linkedin.com/posts/airbusgroup_stem-airbusfaces-airbusaustralia-activity-6704205730435633154-2xG6> accessed 24 August 2021.

44 ANU Inspace, *Supplementary submission 18.1*, p. 3.

informing students that not all future space sector jobs will involve building, launching or operating satellites must be part of this conversation'.[45]

7.25 Prospective students and employees need to see a pathway to real jobs and careers in space. In other words, how their skills and expertise can be applied. The Committee heard that people seem to struggle to make that connection between studying something like engineering and the vast range of careers that are linked to it. Specifically Dr Mary McMillan, University of New England said:

> I think we do have that problem where we talk to students at schools, even, and we say, 'You could be a scientist or a computer scientist,' or whatever it is. I don't think we are yet doing a very good job of actually showing young people what those careers look like. And that's what I think we need to do better right from the beginning of education. Rather than talking about learning mathematics or engineering or chemistry, we need to be actually making those connections with the skills that they're learning through these things, which is often problem solving and how to do experiments and solve problems, rather than just working in a lab.[46]

7.26 The Victorian Space Science Education Centre (VSSEC) emphasized that in its experience, students do not avoid STEM related subjects because they are difficult. Rather, these subjects are avoided because of career expectations. Director of the VSSEC, Mr Michael Pakakis said:

> Young men and women do not really understand what a career in science and engineering means. Scientists and engineers do not do a very good job at explaining just what they do from day to day. This absence of understanding is the single most important factor that leads students to studies and career areas with which they are more familiar.[47]

7.27 Saab Australia shared the same view, it emphasized that 'demonstrating the pathway to real careers within the space industry will be imperative'.[48] It suggested that defining the space specific education pathways that lead to

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45 Saab Australia, *Submission 12*, p. 3.

46 Dr Mary McMillan, School of Science and Technology, University of New England, *Committee Hansard*, Armidale, 20 April 2021, p. 12.

47 Mr Michael Pakakis, Director, Victorian Space Science Education Centre, *Committee Hansard*, Canberra, 20 September 2021, p. 6.

48 Saab Australia, *Submission 12*, p. 3.

real jobs should therefore be a focus, along with articulating the broad range of skills and roles within the sector.[49]

Science Technology Engineering and Mathematics education

7.28 While acknowledging the diversity of skills and expertise required within the new space industry, a recurring theme in evidence was addressing issues associated with the uptake of science, technology, engineering and mathematics (STEM) courses as a means of future proofing Australia's space workforce. The University of Tasmania stated:

> All aspects of the space industry depend on appropriately trained graduates and those with skills in engineering, mathematics and physics will be in high demand nationally and internationally in a range of sectors. Providing appropriate support to raise the general level of STEM education from primary through to tertiary levels will be critical, as will policy settings and communication which encourage more students into STEM course at Universities. [50]

7.29 Penten, an Australian based cyber technology company that employs over 100 people across Australia also expressed its support for greater tertiary training opportunities in STEM, noting that 'if the space industry in Australia is to grow and diversify, its highly-specialised workforce will need a steady stream of appropriately-qualified STEM graduates'.[51]

7.30 The VSSEC stated that the number of students currently studying STEM at the secondary level, and continue at university and TAFE, is insufficient to meet the forecast demands of industry.[52] It observed that this will place 'in question' the Government's 2030 targets as well as its ambition to establish sovereign manufacturing capability, including for space.

7.31 In addition to increasing the numbers of students studying STEM, the VSSEC advocated for properly resourced and structured primary and secondary STEM programs with teachers who are qualified, competent, and confident to teach the STEM disciplines. It also advocated for engaging students earlier.[53] Mr Michael Pakakis told the Committee:

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49 Saab Australia, *Submission 12*, p. 3.

50 University of Tasmania, *Submission 52*, p. 4.

51 Penten, *Submission 37*, p.1.

52 Victorian Space Science Education Centre, *Submission 1*, p. 3.

53 Victorian Space Science Education Centre, *Submission 1*, p. 3.

> If we're going to create pathways and create areas that we want to get students engaged and enthused about, we have to start at that lower level. We can't be expecting them to go to the tertiary level and be interested in something in a particular area of STEM they've never heard about.[54]

7.32 Several submitters called for greater promotion of space and its relevance to people, to help encourage the uptake of STEM education, including for women and underrepresented groups. For example, Dr McMillian told the Committee:

> I'm particularly interested in women in STEM. When we're talking about the space industry, we're talking a lot about IT, mathematics, engineering—areas where we have traditionally had very low representation of women. In creating a sustainable space industry, as with any STEM industry, we need to consider how we're going to make that an exciting career for young people, how we're going to get them into that education pathway and, in particular, how we're going to encourage girls and women to also be involved in studying those subjects and following those career paths.[55]

7.33 At the Committee's site visit to ANU InSpace, Director Professor Anne Moore shared her own experience of being inspired as a four-year-old to be become an astronomer by watching NASA missions. In its submission, ANU Inspace advanced that developing and funding similar 'grand science missions' in Australia will help to create a national interest in space, help people to understand the relevance of space to their lives, and motivate children to pursue education and training in the space industry.[56]

7.34 ANU InSpace suggested the funding of joint academic and industry space science missions as the most effective way to inspire the next generation of Australia's space workforce and to reliably bring more women and minorities into the space industry.[57]

7.35 Earthspace also advocated for space missions to help inspire people. It noted that encouraging students to undertake STEM courses remains a 'perpetual challenge' but space has the ability to inspire students to aspire to the harder STEM courses. It suggested that Australia engage in highly visible and well

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54 Mr Michael Pakakis, VSSEC, *Committee Hansard*, Canberra, 20 September 2021, p. 8.

55 Dr Mary McMillan, University of New England, *Committee Hansard,* Armidale, 20 April 2021, p. 10.

56 ANU InSpace, *Submission 18.1*, p. 1.

57 ANU InSpace, *Submission 18*, pages 3 and 4.

promoted but achievable space missions that show students that there is a future in the space sector.[58]

7.36 Alternatively, Mr Rob Hunt, Managing Director of start-up Scubayorp STEM Outreach, advocated for changing mindsets about space not just providing education. In particular, Mr Hunt called for 'much greater grass-roots exposure' so that people have a positive attitude towards the space industry as a whole, and are not dismissive of its existence:

> A proud, interested and aware general public will have huge economic flow-on advantages for development of hardware, international collaborations, commercialisation of R&D and overall workforce capacity.[59]

7.37 Mr Hunt encouraged a 'sustained visible presence in all forms of media' and stated that this general public outreach will require long term government commitment and funding.[60]

Training and pathways to industry

7.38 Like other industries across the Australian economy, education and training relevant to the space sector is provided through a number of formal and informal means. Universities and TAFEs offer courses in general and specialist areas, the private sector has introduced various in-house mentoring, graduate and training programs for employees as well as university scholarships, and industry more generally provides opportunities to bridge the gap between formal education and being job-ready.

7.39 While opportunities to train through education institutions and on-the-job are improving, the Committee heard that more needs to be done to develop and train a future space workforce. Submitters advocated for:

- specialised space training and education centres
- more space focused tertiary and education courses
- better education to industry pathways

Box 7.4

The University of Southern Queensland (USQ) is working on a program

58 Earthspace, *Submission 23*, p. 6.

59 Scubayorp STEM Outreach, *Submission 2*, p. 2.

60 Scubayorp STEM Outreach, *Submission 2*, pages 2 and 3.

with PFi Aerospace, a company based in Darra, which provides machine automation systems for industrial operations.[61] PFi Aerospace is one of the first to utilise the Helidon Rocket Test Site, which is owned by Rocket Technologies International and will be used to complete static rocket engine tests.[62]

PFi Aerospace has developed a fully functioning rocket motor, sponsored by the University of Queensland,[63] for its Hybrid All Inclusive Learning Instrument (HAILI) Rocket STEM in Schools Program.[64] HAILI has been developed in collaboration with TAFE Queensland as part of their initiative to encourage more students to undertake STEM.[65] Dr Fabian Zander, Senior Research Fellow, University of Southern Queensland highlights that the Helidon Rocket Test Site has the opportunity to provide practical experience.[66] Dr Zander states that 'internationally the space industry is booming,' and 'a large part of that is propulsion, including rocketry and high-speed flight.'[67] The program therefore aims to '[construct] capability within Australia and [educate] a new generation of people to work in that field.'[68]

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61 Professor Peter Schubel, Executive Director, Institute for Advanced Engineering and Space Sciences, University of Southern Queensland (USQ), *Committee Hansard*, Brisbane, 6 May 2021, p. 15.

62 Space Australia, *Australia's First Commercial Rocket Testing Facility Announced* < https://spaceaustralia.com/index.php/news/australias-first-commercial-rocket-testing-facility-announced> accessed 10 August 2021.

63 Professor Peter Schubel, USQ, *Committee* Hansard, 6 May 2021, p. 15.

64 Space Australia, *Australia's First Commercial Rocket Testing Facility Announced* < https://spaceaustralia.com/index.php/news/australias-first-commercial-rocket-testing-facility-announced> accessed 10 August 2021.

65 Space Australia, *Australia's First Commercial Rocket Testing Facility Announced* < https://spaceaustralia.com/index.php/news/australias-first-commercial-rocket-testing-facility-announced> accessed 10 August 2021.

66 Space Australia, *Australia's First Commercial Rocket Testing Facility Announced* < https://spaceaustralia.com/index.php/news/australias-first-commercial-rocket-testing-facility-announced> accessed 10 August 2021.

67 Space Australia, *Australia's First Commercial Rocket Testing Facility Announced* < https://spaceaustralia.com/index.php/news/australias-first-commercial-rocket-testing-facility-announced> accessed 10 August 2021.

68 Space Australia, *Australia's First Commercial Rocket Testing Facility Announced* < https://spaceaustralia.com/index.php/news/australias-first-commercial-rocket-testing-facility-announced> accessed 10 August 2021.

7.40 Smallworld Communications recommended the Australian Government provide funding for an Australian Space Centre program based on a collaborative university/industry model focussing initially on satellite communications, remote sensing and geospatial positioning.[69] It noted that although the SmartSat CRC already exists, space centres would provide a long-term but low-cost option compared to SmartSat CRC, which currently receives $55 million in funding and has a seven year term.[70] Smallworld Communications referred to the former Australian Space Industry Development Centre as a useful model.[71]

7.41 Similarly Earthspace recommended that the Australian Government establish 'TAFE-like' education facilities to train students in the 'hands-on' skills required to build space systems. [72] Mr Roger Franzen stated:

> we need to have a training program that's established in maybe one or two key centres within Australia that are empowered and informed with that know-how knowledge of how to screw things together so that they work reliably once they get into space. It is not trivial.
>
> … The education part is about assembly, integration and test, and it must comply with international standards that have been set by other experienced nations with which all reliable space missions need to comply.[73]

7.42 Collaboration and connection between academic institutions and industry will be vital in developing a future space industry workforce.[74] It was a strong theme in evidence to the inquiry. Northrop Grumman recommended strengthening academic and industry partnerships as a means to develop tailored training and skilling packages for the space sector, and engage and future proof Australia's next generation space workforce.[75]

7.43 The Melbourne Space Program (MSP) is an example of an organisation that bridges the gap between universities and being industry ready. It creates

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69 Small World Communications, *Submission 4*, p. 2.

70 Small World Communications, *Submission 4*, p. 2.

71 Smallworld Communications, *Submission 4*, p. 2.

72 Earthspace, *Submission 23*, p. 6.

73 Mr Roger Franzen, Director, Earthspace, *Committee Hansard*, Canberra, 26 February 2021, p. 36.

74 Boeing Australia, *Submission 80*, p. 3.

75 Northrop Grumman, *Submission 27*, p. 13

pathways for university students interested in the space sector by providing an opportunity to work on projects in collaboration with industry.

7.44 The MSP argued that for the Australian Government to realise its 2030 goal, it needs to 'grow organically'.[76] This means the private sector hiring local graduates, and local graduates being internationally competitive. The Australian Government can support both objectives:

> Government support for space related tertiary training organisations may come in the form of official partnerships or endorsements, thus facilitating and encouraging the recruitment of Australian space graduates directly. Alternatively, support could be in the form of funding to allow such organisations to support larger and more sophisticated programs, thus providing even higher quality training to a greater number of students.[77]

7.45 The University of Western Australia (UWA) International Space Centre discussed training and development in its submission. It identified two factors central to workforce development:

1 Having opportunities for students throughout their studies will provide benefits for industry with access to the developing talent pool and benefits to students with career options.

2 Providing training to industry enables re-skilling and up-skilling opportunities for current and future skilled workforce.[78]

7.46 The UWA recommended that the Australian Government provide funding for universities to offer a) students placement opportunities with industry, and b) industry training to up-skill the workforce.[79]

Apprenticeships

7.47 The Committee explored opportunities to value-add to the vocational education and training or higher education sectors to support the space industry. Under this model, those undertaking trades or courses work more closely with industry to understand the specific skills and technical abilities needed for particular roles.

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[76] Melbourne Space Program, *Submission 22*, p. 3.

[77] Melbourne Space Program, *Submission 22*, p. 5.

[78] University of Western Australia, *Submission 72*, p. 4.

[79] University of Western Australia, *Submission 72*, p. 6.

7.48 It was suggested that more apprenticeships would be useful to help train people with space specific skills. Mr Nick Leake, Head of Satellite and Space Systems, Optus told the Committee:

> I think it's about communicating more to year 11 and year 12, because I think it starts there… it's the grassroots where we need the apprenticeships. If you join the armed forces as a technician, they train you in an apprenticeship and then you can go to fix things on aircraft or tanks. That's what we seem to be missing. If we get that coming through, we will start to get more people entering the industry, because once you get into satellites there's a love of satellites. You never leave.[80]

7.49 The German model of masters and apprentices was identified as a good example of a training program. This model involves people undertaking a base-level apprenticeship and then specialising in particular areas. Dr Tetlow told the Committee that Inovor Technologies uses a similar informal model where younger technicians learn from more experienced staff.[81]

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80 Mr Nick Leake, Head of Satellite and Space Systems, Optus, *Committee Hansard*, Sydney, 19 April 2021, p. 30.

81 Dr Matthew Tetlow, Inovor Technologies, *Committee Hansard*, Adelaide, 10 March 2021, p. 10.

Adjacent sectors

7.50 As discussed in Chapter 3, many of the skills and expertise required in the space industry can be found in other Australian sectors. Opportunities to grow the space workforce can therefore be found by tapping into relevant industries with transferrable skills as well as tapping into tertiary and training courses that may not have considered space as a path.

7.51 EOS said that the surge of new space sector jobs will require a concerted effort from government, industry and academia to train and attract highly skilled workers to space-related positions.[82] It identified encouraging mobility between the space sector and adjacent industries, particularly defence, as one aspect of this skilling effort. EOS stated:

> The defence sector is currently engaging in its own drive to develop the skills required to meet future workforce requirements, with Defence releasing the Defence Industry Skilling and STEM Strategy in 2019. By engaging with Defence and defence industry, the ASA can draw on the methods and lessons that emerge the defence skilling endeavour, while establishing pathways for workers to move between the space and defence sectors.[83]

7.52 To support future workforce development and job creation, EOS made two recommendations designed to enhance collaboration, foster career pathways in space, and enable greater workforce mobility.[84]

7.53 FrontierSI identified significant opportunities to grow the number of graduates available to the space sector by introducing a 'cross-disciplinary approach' to university education and training.[85] For example, it stated that industry ready data science graduates could be developed through relatively minimal training in earth observation and satellite data. This could be achieved by encouraging university students to undertake one or two subjects as part of their degree that focused explicitly on space priorities.[86]

7.54 Furthermore, FrontierSI argued that universities should be encouraged to add computer science and engineering courses as official elective units to promote cross-disciplinary skill exchange. Additional PhD Masters

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82 Electro Optic Systems, *Submission 47*, p. 15.

83 Electro Optic Systems, *Submission 47*, p. 15.

84 Electro Optic Systems, *Submission 47*, p. 15.

85 FrontierSI, *Submission 38*, p. 2.

86 FrontierSI, *Submission 38*, p. 2.

Coursework and undergraduate scholarships could also be used to target graduate development.[87]

International skilled workers

7.55 To support a future space workforce, Australia will still require access to experienced skilled workers. As noted earlier in the chapter, one of the workforce challenges in Australia is mid-to-senior level expertise.

7.56 QUT stated that its space industry partners 'frequently cite access to talent as one of their key business challenges'.[88] It noted that with the upturn in talent wishing to return to Australia and the downturn in key space-related industries such as the automated vehicle industry in the USA, there is a window of opportunity for Australia to facilitate entry for highly skilled space workers to Australia.[89]

7.57 Specifically, QUT proposed that Australia implement visa program policies that facilitate Australia's ability to attract international talent, including:

- expedited visa processes to minimise barriers to talent mobility
- supportive spouse/partner and dependent policies to assist in attracting talent
- international recruitment strategies targeting those with priority skillsets
- funding and scholarships for space-related higher degree research
- incentive for Australian companies to offer work experience or internship opportunities to high-potential students studying in Australia or on a post-study work visa
- mutual recognition of qualifications between relevant partner institutions
- increased access to research infrastructure for international talent
- talent exchange with international partners.[90]

7.58 The University of South Australia also advocated for a visa program to assist international start-ups in Australia. Specifically it recommended 'support for international start-up founders to set up operations in Australia by enabling high potential space start-ups with access to a visa that leads to residency.[91]

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87 FrontierSI, *Submission 38*, p. 2.

88 Queensland University of Technology, *Submission 7*, p. 4.

89 Queensland University of Technology, *Submission 7*, p. 4.

90 Queensland University of Technology, *Submission 7*, p. 4.

91 University of South Australia, *Submission 19*, p. 3.

7.59 Similarly, Southern Launch called for incentives to attract overseas talent. It said that 'for Australia's space industry to grow and remain internationally competitive, it must attract experienced skills and experts from overseas markets. Providing financial incentives to foreign nationals with certain experience or technical competencies, to relocate to Australia for the purpose of mentoring or assisting space industry in Australia, would be extremely beneficial in advancing Australian technical expertise'.[92]

7.60 Moonshot expressed a similar view noting the value of attracting international talent. It stated that by 'importing talented people, promising entrepreneurs, and their businesses - especially those with deep connections with the global space sector - Australia can create an easy way to keep pace with the space sectors of other nations'.[93]

Regional Australia

7.61 Rural and regional Australia offers significant opportunity for the Australian space sector, particularly given existing space infrastructure, regional educational and training opportunities and a skilled workforce. Regional Australia also presents an opportunity to decentralise the space sector and spread the benefits of a growing sector across the country.

7.62 The Northern Territory Government identified 'significant synergies' between the space industry and the Australian Government's decentralisation plan noting the space industry as an enabler of regional growth and development.[94] It stated:

> In many cases the industry depends upon remoteness and isolation to operate effectively due to the need for radio silence, uninterrupted views of the horizon, or a low population in the case of launch. In the NT for example, Alice Springs and Nhulunbuy are both emerging as regional hubs for space industry activity due to these factors.[95]

7.63 It also noted that the benefits of earth observation and industry specific data applications are largely unrealised in regional Australia.[96] The NT Government asserted that decentralising Commonwealth research agencies

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92 Southern Launch Australia, *Submission 46*, p. 37.

93 Moonshot, *Submission 58*, p. 4.

94 Northern Territory Government, *Submission 67*, p. 8.

95 Northern Territory Government, *Submission 67*, p. 8.

96 Northern Territory Government, *Submission 67*, p. 8.

to the regions would assist in developing research capacity, workforce development and job creation for the space industry. It would also contribute to a better understanding of local policy settings, challenges and opportunities.[97]

7.64 For some businesses, while they are able to offer opportunities in the regions, attracting skilled workers out of the cities was as a key problem. ICT International said that this was preventing the company starting a $5 million job. Dr Peter Cull, Director, ICT International told the Committee:

> It's got nothing to do with space; it's got to do with the ability to get skilled people to our region. I spoke to a parliamentary inquiry several weeks ago about skilled migration. I've put off a project of over $5 million that would employ 10 more people. I cannot get the people. The minute I get them, I'll start that project in Armidale. It is to manufacture sensors that we got an inquiry about from Riyadh the other day—180 of these sensors for one park, a central park in Riyadh. So there are enormous opportunities, for manufacturing reasons, if we can get the skills there. We know what we want to do. We have the export markets. We know that we have the customers. We can't get the people we need to work in our town. But the spouse is the problem. We can get one or two there, but the spouse can't get a job. It doesn't matter what the government subsidises, whether it's 20 grand, 30 grand or 40 grand. It will not get them there, because the spouse doesn't have a job.[98]

7.65 Similarly, Mr Raymond McLaren from Andromeda Industries told the Committee his company set up a division to manufacture aerospace componentry but that opportunity closed after five years due to a lack of skilled people and a lack of demand. Mr McLaren said:

> Well, we ran it for about five years, but there were two problems. One is to get sufficiently skilled people. That's probably the main problem. The other one is that we had difficulty with getting ongoing business. We did a lot of work developing components for people. Developing one or two parts takes a lot of time and effort, but there was always the promise that it would be 100 or 200 of these in due course. So we spent thousands of dollars developing the parts, getting them right and then that's it. We'd never see the order. That happened over and over again.[99]

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97 Northern Territory Government, *Submission 67*, p. 8.

98 Dr Peter Cull, Director, ICT International Pty Ltd, *Committee Hansard,* Armidale, 20 April 2021, p. 17.

99 Mr Raymond McLaren, Owner-Manager, Andromeda Industries, *Committee Hansard,* Armidale, 20 April 2021, p. 28.

7.66 Boeing Australia identified some ways to increase the benefits of the space industry flowing to rural and regional Australia. This includes:

- Regional university and training courses: many school leavers train and study in their local areas. Some may move away and return later. By focusing heavily on STEM training opportunities in space and allied industries, regional training institutions can encourage more of their young people into the industry and this in turn could spur the development of enterprises encouraged by the availability of a workforce. This would be reinforced by basing Government space infrastructure or ongoing space endeavours in the same location.
- Further refinement and promotion of a database such as the ICN Gateway: the ICN Gateway is a not for profit organisation with offices in each state and territory that aims to connect those seeking products and services with small and medium-sized providers. Its primary remit is to provide local content to projects large and small. With refinements to its taxonomy, this service can be improved to capture a wider base, including the space industry, and with search criteria to include regional and remote suppliers. Work has already commenced on these improvements.
- Space infrastructure in regional areas: much of the required infrastructure for launching into space, for communicating via space, and for observing to or from space requires regional infrastructure. Careful planning of proximity of future infrastructure to human resources such as regional populations, training institutions and employment opportunities for families can further encourage the growth of the industry outside the capital cities.[100]

Role for Government

7.67 Submissions to the inquiry identified a more strategic role for government in developing education and training to support the Australian space industry. This includes articulating a space strategy to provide certainty to education providers. The Committee was told that this direction greatly assists universities to determine what courses would be needed in the future and where demand might be. Dr Brett Carter, Former Chair of the Solar-Terrestrial and Space Physics Group, Australian Institute of Physics, said:

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100 Boeing Australia, *Submission 80.1*, Answer to Question on Notice, pages. 3 and 4.

> From an academic's perspective, in order for us to be able to design and offer these types of degree programs, whether they be undergraduate, postgraduate or whatever, we need support from our vice-chancellors, who are looking at things like national government priorities in order to make their decisions. When it came to the Space Agency being announced we were able to internally highlight: 'Look, no-one is offering this, and this is actually what we need now, as a very industry focused, skills focused and broad-level focused bachelor program that no-one else is offering at the moment.' Again, universities are doing their bit to try and mobilise there, but it has been in response to announcements of national priorities from the government.[101]

7.68 Dr Carter highlighted that the absence of a long-term space strategy has resulted in Australia losing highly trained PhD graduates, post docs and researchers overseas and hindered the ability to bring people back.[102] He told the Committee:

> A long-term strategy that supports university led space R&D will also encourage Australian expats, particularly Australian space expats, to return home, bringing with them their experience and expertise, which will further boost the Australian space sector.[103]

7.69 Swinburne University of Technology also supported national direction to inform capability development and recommended long term research funding to fill capability gaps.[104] Professor Alan Duffy told the Committee:

> I think government has the broader overview of the nation's needs. It can identify what the national need is five years hence, for example. They can determine what capability gaps—perhaps in consultation with the Australian Space Agency—and what kinds of requirements there are, and then that can be fed through via these PhDs, which themselves last three- to four-year time frame such that you can actually deliver on those needs as they are occurring throughout that PhD program. It's a long-term research commitment and engagement.[105]

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101 Dr Brett Carter, Former Chair of Solar-Terrestrial and Space Physics Group, Australian Institute of Physics, *Committee Hansard*, Canberra, 16 September 2021, p. 24.

102 Dr Brett Carter, Australian Institute of Physics, *Committee Hansard*, Canberra, 16 September 2021, p. 23.

103 Dr Brett Carter, Australian Institute of Physics, *Committee Hansard*, Canberra, 16 September 2021, p. 22.

104 Swinburne University of Technology, *Submission 63*, p. 5.

105 Professor Alan Duffy, Director, Space Technology and Industry Institute, Swinburne University of Technology, *Committee Hansard,* Canberra, 16 September 2021, p. 20.

7.70 The absence of education in the ASA's charter was cited by the VSSEC as an important issue for consideration as part of the ASA's upcoming review.[106] In evidence to the Committee, Dr Brett Biddington, External Relations, VSSEC suggested a Chief Scientist and an Education Directorate within the ASA would also be necessary to better foster space education.[107]

7.71 Stakeholders suggested that a national space education and training plan or roadmap be developed. The Australian Academy of Science advanced that realising Australia's space industry's opportunities requires a national innovation and education strategy spanning the primary, secondary, tertiary, VET and industry sectors.[108] It notes that this strategy could use space science to grow participation in STEM, the STEM workforce, and the space sector as well as increase diversity and inclusion, improving career pathways and opportunities for underrepresented groups.[109]

7.72 Similarly, the University of South Australia recommended that an Australian Space Sector Strategy include a training, education and skills plan.[110] It advanced that the Australian space sector has an opportunity to draw on less traditional resources and skills to grow the space sector and consideration be given to training and skilling scholarships to broaden diversity.[111]

7.73 The Western Australian Government suggested that the Australian Government could engage with industry, training, education and universities sector to develop an Australian space workforce development roadmap focused on building, attracting and retaining a skilled workforce to meet the current and future needs of the national space sector.[112]

Committee comment

7.74 There are many opportunities for Australians within the space industry. While it is clear that space fascinates and excites people, the challenge is to

106 Victorian Space Science Education Centre, *Submission 1*, pages 3 and 4.

107 Mr Brett Biddington, Victorian Space Science Education Centre, *Committee Hansard*, Canberra, 20 September 2021, p. 9.

108 The Australian Academy of Science, *Submission 70*, p. 3.

109 The Australian Academy of Science, *Submission 70*, p. 3.

110 The University of South Australia, *Submission 19*, p. 3.

111 The University of South Australia, *Submission 19*, p. 2-3.

112 Western Australian Government, *Submission 61*, p. 6.

convince people that they can be part of a global industry that is much more than rockets and astronauts.

7.75 Anyone wanting to pursue a career in space is likely to find a part of the industry to do it. Generalist and specialist expertise will be required as will skills from adjacent sectors.

7.76 The Australian space sector is likely to offer long-term job opportunities, which requires access to the nation's full workforce. This includes groups generally underrepresented across the space sector such as women and Indigenous Australians. Creating awareness of the connection between education and training and particular space sector roles as well as demonstrating employment pathways to accessible jobs will be central to encouraging people to pursue space related education and training. This includes in fields outside traditional STEM fields.

7.77 Many of the issues and recommendations raised throughout this report will go a long way to shape and develop a future workforce. Strengthening the Australian Space Agency, defining a set of long term space missions and space capability priorities, fostering greater collaboration nationally and internationally as well as articulating a regulatory framework within which the sector can safely and responsibly operate will all help to inform the education and training needs to support a future space workforce.

7.78 While Australia has access to a skilled workforce, and work is underway to address skills and training shortages, Australia will still require and benefit from the expertise of skilled international workers and commercial enterprise. Efforts to more readily engage international expertise would be welcome by industry.

7.79 The Committee fully supports initiatives that promote and build on the strengths of rural and regional Australia. Regional geography, existing infrastructure, and a strong education sector offer strategic opportunities for growth of the Australian space industry as well as regional areas.

Recommendation 33

7.80 The Committee recommends that the Australian Government develop a community education and outreach program to promote the diversity of employment, careers and opportunities within the space sector.

7.81 This campaign should also target underrepresented groups within the space industry to help increase diversity across the sector.

Recommendation 34

7.82 The Committee recommends that the Australian Government promote the value of STEM through primary, secondary and tertiary years to ensure a continued pipeline of specialist and technical expertise is available to support and sustain the Australian space sector.

Recommendation 35

7.83 The Committee recommends that the Australian Government examines options to improve education to industry pathways within the sector.

Recommendation 36

7.84 The Committee recommends that the Australian Government introduce a program to better connect adjacent industries with transferrable skills to the space industry.

Recommendation 37

7.85 The Committee recommends that the Australian Government examine ways to maximise the benefits of rural and regional Australia to foster the growth of the Australian space industry.

Recommendation 38

7.86 The Committee recommends that the Australian Government examine options to improve engagement and relocation of international workers and commercial enterprise to the space industry.

Mr Pat Conaghan MP

Chair

24 November 2021

A. Submissions

1 Victorian Space Science Education Centre

2 Scubayorp STEM Outreach

3 Footstool Earthmoving Pty Ltd

4 Small World Communications

5 Shoal

- 5.1 Supplementary to submission 5
- 5.2 Supplementary to submission 5

6 Dr Muhammad Akbar Hussain

7 Queensland University of Technology

8 Mr Henry Strong

9 Mr John Lee

10 Skykraft Pty Ltd

- 10.1 Supplementary to submission 10

11 CSIRO

- 11.1 Supplementary to submission 11

12 Saab Australia Pty Ltd

13 Geoscience Australia

- 13.1 Supplementary to submission 13

14 Space Law Council of Australia and New Zealand Ltd

15 Solar Space Technologies

16 Adelaide Law School, The University of Adelaide

- 16.1 Supplementary to submission 16

17 *Name Withheld*

18 Australian National University - Institute for Space (ANU InSpace)

- 18.1 Supplementary to submission 18

19 University of South Australia

20 Australasian Society of Aerospace Medicine

21 Earth Observation Australia Inc.

22 Melbourne Space Program Ltd.

23 Earthspace

24 *Confidential*

25 Airbus

26 *Confidential*

27 Northrop Grumman Australia

28 Australian Institute of Physics

29 SmartSat CRC

- 29.1 Supplementary to submission 29
- 29.2 Confidential

30 Symbios Communications

31 Professor Rod Boswell

32 ANSTO

- 32.1 Supplementary to submission 32

33 Virgin Orbit

34 SSSI and SIBA|GITA

35 University of Southern Queensland

36 Sitael Australia

37 Penten

38 FrontierSi

39 Nova Systems

40 MDA

41 *Confidential*

- 41.1 Confidential

42 DMTC Ltd

43 Space Pioneers Foundation

44 EI Australia

45 Vocus

46 Southern Launch

- 46.1 Supplementary to submission 46

47 Electro Optic Systems (EOS)

48 Communications Alliance

49 Mr Scott Schneider

50 Southern Launch, Gilmour Space Technologies and Equatorial Launch Australia

51 *Confidential*

- 51.1 Confidential

52 University of Tasmania

53 Deloitte Touche Tohmatsu

- 53.1 Supplementary to submission 53
- Attachment 1

54 King & Wood Mallesons

55 Australian Space Agency

- 55.1 Supplementary to submission 55

56 South Australian Space Industry Centre (SASIC)

57 Australia Space Futures

58 Moonshot

59 Gilmour Space Technologies

60 Queensland Government

- 60.1 Supplementary to submission 60
- Attachment 1

61 Western Australian Government

62 SpaceBase Limited

63 Swinburne University of Technology

64 Viasat

65 Optus

- 65.1 Supplementary to submission 65

66 *Confidential*

67 Northern Territory Government

68 The Ad Astra Vita Project

69 AMWU NSW & ACT

70 Australian Academy of Science

- 70.1 Supplementary to submission 70

71 US Geological Survey

72 University of Western Australia International Space Centre

73 UNSW Canberra

- 73.1 Supplementary to submission 73

74 Bureau of Meteorology

- 74.1 Supplementary to submission 74

75 NSW Government

76 Asia Pacific Aerospace Consultants

77 *Confidential*

78 *Confidential*

79 Australian Strategic Policy Institute

80 Boeing Australia

- 80.1 Supplementary to submission 80

81 Curtin University

82 ACT Government

83 Space Industry Association of Australia

84 Saber Astronautics

85 Applied Agriculture Remote Sensing Centre (AARSC)

86 Thales Australia

87 Minderoo Foundation Fire and Flood Resilience Initiative

88 Infrastructure Australia

89 Dr William Billingsley

B. Public hearings

Wednesday, 17 February 2021

Committee Room 1R1, Parliament House, Canberra

Department of Industry, Science, Energy and Resources

- Ms Donna Looney, General Manager, Industry Capability & Participation Branch, Industry Growth Division
- Mr Nick Purtell, General Manager, Industry Engagement Branch, Manufacturing Division
- Mr Michael Bryson, Executive Manager, Science and Commercialisation Division

Australian Space Agency

- Mr Anthony Murfett, Deputy Head

Wednesday, 24 February 2021

Committee Room 1R1, Parliament House, Canberra

Commonwealth Scientific and Industrial Research Organisation

- Dr Kimberley Clayfield, Director, Space Technology Future Science Program
- Dr Alex Held, Director, Centre for Earth Observation
- Dr Dave Williams, Executive Director, Digital, National Facilities and Collections

Friday, 26 February 2021

Committee Room 1R1, Parliament House, Canberra

Electro Optic Systems Pty Ltd

- Professor Craig Smith, Chief Executive Officer, Space Systems
- Mr Glen Tindall, Chief Executive Officer, Communications Systems

Airbus Defence and Space

- Mr Martin Rowse, Key Account Manager, Space

Penten

- Mr Joshua Bolton, Director, Defence and Intelligence

Break

Skykraft

- Mr Mark Skidmore, Executive Chair

Nova Systems

- Mr Phil Krix, Program Manager, Critical Communications and Space
- Mr Bret (BJ) Martin, Launch Support Services Business Lead

Earthspace

- Mr Roger Franzen, Director

Boswell Technologies

- Professor Rod Boswell, Chief Executive Officer

Wednesday, 10 March 2021

Victoria Room, Hilton Adelaide, 233 Victoria Square, Adelaide

Southern Launch, Gilmour Space and Equatorial Launch

Southern Launch

- Mr Lloyd Damp, Chief Executive Officer
  Mr Scott Schneider, Regulatory Lead

Gilmore Space Technologies

- Mr Adam Gilmore, Chief Executive Officer

Equatorial Launch

- Ms Carly Scott, Chief Executive Officer

Sitael Australia

- Mr Mark Ramsey, General Manager

Inovor Technologies

- Dr Matthew Tetlow, Chief Executive Officer

South Australian Space Industry Centre

- Mr Richard Price, Chief Executive Officer

University of South Australia

- Mr Matthew Opie, Director, Defence and Space

Adelaide Law School (University of Adelaide)

- Professor Melissa de Zwart, Dean of Law

Space Law Council of Australia and New Zealand Limited

- Mr Joel Lisk, Director

Shoal Group Pty Ltd

- Mr Graeme Dunk, Head of Strategy
- Dr Derek Rogers, Engineering Lead, Defence and Space

SmartSat CRC Ltd

- Mr Peter Kerr, Coordinator Defence and National Security
- Professor Andy Koronios, Chief Executive Officer
- Dr Peter Woodgate, Chair of Board

Southern Cross Outreach Observatory Project

- Dr Muhammad Akbar Hussain, Founder

Wednesday, 17 March 2021

Committee Room 1R1, Parliament House, Canberra

Geoscience Australia

- Dr John Dawson, Adviser, National Positioning Infrastructure Branch
- Mr Jonathon Ross, Director, National Planning and International Relations, Earth and Marine Observations
- Dr Martine Woolf, Branch Head, National Positioning Infrastructure

Wednesday, 24 March 2021

Committee Room 2R2, Parliament House, Canberra

Bureau of Meteorology

- Dr Boris Kelly-Gerreyn, General Manager, Data Program, and Chief Officer
- Dr Peter Stone, Group Executive, Business Solutions

Monday, 19 April 2021

Corinthian Room, SMC Conference & Function Centre, 66 Goulburn Street, Sydney

Dr Paul Scully-Power, Private capacity

Saber Astronautics Pty Ltd

- Dr Jason Held, Chief Executive Officer

Solar Space Technologies

- Mr Serdar Baycan, Founder and Director
- Mr John Mankins, Director

Moonshot

- Mr Troy McCann, Chief Executive Officer

Optus

- Mr Nick Leake, Head of Satellite and Space Systems
- Mr Andrew Sheridan, Vice President, Regulatory and Public Affairs

Space Industry Association of Australia

- Mr James Brown, Chief Executive Officer

Asia Pacific Aerospace Consultants Pty Ltd

- Mr William (Bill) Barrett, Senior Vice-President
- Mr Kirby Ikin, Managing Director

Australian Nuclear Science and Technology Organisation (ANSTO)

- Dr Miles Apperley, Head, Research Infrastructure
- Dr Ceri Brenner, Leader, Centre for Accelerator Science

NSW Government

- Mr Roland Stephens, Executive Director, Jobs and Industry Development

Tuesday, 20 April 2021

Education Room 224, Arts Road (off Clarks Road), University of New England, Armidale

University of New England SMART Farms - via teleconference

- Professor David Lamb, Chief Scientist, Food Agility Cooperative Research Centre; and Researcher
- Professor Andrew Robson, Director, Applied Agricultural Remote Sensing Centre

University of New England

- Dr Mary McMillan, School of Science and Technology

Dr William Billingsley, Private capacity

ICT International - via teleconference

- Dr Peter Cull, Director
- Mr Sam Fisher, Scientist and Technologist

Lockheed Martin Australia

- Mr Rod Drury, Vice President International, Lockheed Martin Space

Andromeda Industries

- Mr Raymond McLaren, Owner-Manager

Cotton Research and Development Corporation

- Dr Ian Taylor, Executive Director
- Mr Allan Williams, General Manager, Research and Development Investment

Tamworth Regional Astronomy Club

- Dr Ray Hare, Committee Member
- Mr Raymond McLaren, Committee Member
- Mr Geoff Tall, Secretary

Thursday, 6 May 2021

Kennedy Room, Pullman & Mercure Brisbane King George Square, Cnr of Ann & Roma Streets, Brisbane

Boeing Research and Technology Australia

- Dr Jason Armstrong, Senior Manager, Anti-Microbials

Boeing Defence Australia

- Mr Matthew Buckle, Emerging Markets
- Ms Kathryn Burr, Space and SATCOM Market Lead

Boeing Australia, New Zealand and South Pacific

- Dr Brendan Nelson, President

Black Sky Aerospace

- Mr Blake Nikolic, Chief Executive Officer

University of Southern Queensland

- Professor Peter Schubel, Executive Director, Institute for Advanced Engineering and Space Science

Queensland University of Technology

- Mrs Ali Buchberger, Director, Industry Engagement (Science and Engineering)
- Professor Michael Milford, Acting Director, Centre for Robotics

Earth Observation Australia Inc.

- Professor Stuart Phinn, President

DataFarming

- Mr Tim Neale, Managing Director

Fireball International

- Mr Christopher Tylor, Co-founder, Managing Director and Chief Executive Officer

Queensland Government

- Air Vice-Marshal Neil Hart AM (Retired), Queensland Defence Adviser for Aerospace
- Ms Denise Johnston, Executive Director, Department of State Development, Infrastructure, Local Government and Planning

Deloitte Australia

- Dr Geraldine Baca Triveno, Senior Consultant
- Mr Jason Bender, Partner, Head of Innovation
- Mrs Kelly Heaton, Director, Access Economics

Hypersonix Launch Systems

- Dr Michael Smart, Co-Founder and Head of Research Development

Wednesday, 12 May 2021

Committee Room 1R1, Parliament House, Canberra

University of New South Wales Canberra

- Professor Russell Boyce, Director, University of New South Wales Canberra Space

Wednesday, 26 May 2021

Committee Room 1R1, Parliament House, Canberra

Australian National University

- Professor Paul Tregoning, Head, Geodesy Group, Research School of Earth Sciences

Myriota - via teleconference

- Mr Tom Rayner, Vice President Sales, Satellite Communications

Friday, 28 May 2021

Committee Room 1R3, Parliament House, Canberra

Virgin Orbit - via video conference

- Mr Jim Simpson, Chief Strategy Officer

MDA - via video conference

- Mr Ian McLeod, Vice President, International

Wednesday, 23 June 2021

Committee Room 1R1, Parliament House, Canberra

Department of Defence

- Air Commodore Nicholas Hogan, Director General Space Domain Review
- Air Vice-Marshal Catherine Roberts, Head of Air Force Capability

Thursday, 16 September 2021

Committee Room 1R3 (via video conference), Parliament House, Canberra

Thales Australia - via video conference

- Mr Gary Dawson, Vice President, Strategy and Communications
- Mr Matt Dawson, Director, Space Business

FrontierSI - via video conference

- Dr Graeme Kernich, Chief Executive Officer
- Dr Jasmine Muir, Earth Observation Technical Lead and Industry Innovation Team Manager
- Ms Eva Rodriguez Rodriguez, Space Lead

DMTC Limited - via video conference

- Dr Mark Hodge, Chief Executive Officer

Swinburne University of Technology - via video conference

- Professor Alan Duffy, Director, Space Technology and Industry Institute

Australian Institute of Physics - via video conference

- Dr Brett Carter, Former Chair of Solar-Terrestrial and Space Physics Group
- Dr Kirrily Rule, National Honorary Secretary

Monday, 20 September 2021

Committee Room 1R3 (via video conference), Parliament House, Canberra

Viasat - via video conference

- Mr Mark Dankberg, Chairman of the Board and Executive Chairman
- Ms Amy Mehlman, Vice President US Government Affairs and Public Policy

Victorian Space Science Education Centre - via video conference

- Dr Brett Biddington, External Relations
- Mr Michael Pakakis, Director

Melbourne Space Program - via video conference

- Ms Vivienne Bear, Business Sustainability Manager
- Ms Laura Breckon, Project Co-Lead and Regulatory Officer
- Mr Andrew Wetherell, Managing Director

Australasian Society of Aerospace Medicine - via video conference

- Dr John Cherry, Company Director, Australasian Society of Aerospace Medicine, and Chair, Space Life Sciences Committee

The Ad Astra Vita Project - via video conference

- Dr Rowena Christiansen, Found and Chief Consultant

Northrop Grumman Australia - via video conference

- Air Vice-Marshal Chris Deeble, AO, CSC (Retired), Chief Executive, Australia and Director, Strategy

Australian Space Agency - via video conference

- Mr Anthony Murfett, Deputy Head of Agency
- Mr Enrico Palermo, Head of Agency

C. Site visits

Friday, 19 February 2021

- Canberra Deep Space Communication Complex, Tidbinbilla, ACT

Australian National University Research School of Astronomy and Astrophysics, Mount Stromlo, ACT

Wednesday, 10 March 2021

Southern Launch, Adelaide, SA

Thursday, 11 March 2021

Royal Australian Air Force No. 1 Remote Sensor Unit, Edinburgh, SA

Lot Fourteen, Adelaide, SA

- Australian Space Agency
- Australian Space Discovery Centre
- Mission Control Centre
- SmartSat CRC
- Myriota
- Inovor Techologies

Tuesday, 20 April 2021

University of New England SMART Farms Innovation Centre, Armidale, NSW

Friday, 7 May 2021

Gilmour Space Technologies, Gold Coast, Qld

University of Queensland Centre for Hypersonics, Brisbane, Qld

Friday, 28 May 2021

Geoscience Australia, ACT

D. SmartSat CRC supplementary submission

The following is an extract from a supplementary submission provided by SmarSatCRC.[1]

Building the Space Architecture to Realise the Vision

At the heart of a fully functioning space ecosystem for Australia are the triple capabilities of earth observation, satellite telecommunications and PNT, supported by advanced analytics, and space systems providing coverage to every part of Australia and its off-shore territories including the Indian and Pacific Oceans and Antarctica.

Set out below is a first cut of the detailed components of the national space architecture for Australia which in our view are needed over the next seven years, comprising a mix of government and commercial ownership, operating from a variety of orbits:

ORBIT TYPE	SATELLITE ORBITAL ALTITUDE	ESTIMATED NUMBER OF SATELLITES FOR PERSISTANT COVERAGE	TYPICAL APPLICATION
LEO	800km	50-60	Communications, High-resolution Earth Observation
MEO	10,000 – 20,000 km	6-9	PNT, Communications
GEO	35,768 km	1-2	Communications, Low-resolution Earth Observation

[1] SmartSat CRC, Supplementary Submission 29.1, pages 4-6 and 7-9.

In order to achieve persistent coverage of Australia from non-geostationary orbits it is necessary to provide global coverage. This creates opportunities from these orbits to offer regional services around the globe and further foster critical international partnerships.

Implementation will also require development of the additional components as outlined below. Again these will comprise a mix of government and commercial owned assets, many of which will become critical infrastructure or contribute to systems of national importance.

Element	Description
LEO Satellites	Constellation of low earth orbit satellites providing continuous coverage of Australia for low-latency communications and sensor data download
MEO Satellites	Provides wider field of view than LEO resulting is lower number of satellites. These can provide PNT signals and communications relay functions for LEO satellites.
GEO Satellites	Provide persistant coverage from a single satellite but the orbital location results in high cost launch and long signal propagation delays that result in low quality voice services as well as hampering the development of low latency-dependent applications.
Space Based Sensors	Satellites will carry Earth Observation sensors that offer less than one metre pixel resolutions at least six hourly with passive optical and NIR sensors. Larger satellites in LEO and MEO orbits will carry shortwave imaging and low cost hyperspectral. The MEO satellites will be configured to offer persistent coverage, approaching 24 hourly. Satellites with electro-optical and RF imaging capabilities to provide 24/7, 365 day coverage of Australia
Access to space	Launch capabilities onshore for small satellites

Mission Control	To monitor and safely operate national space infrastructure
System Design and Integration	Capabilities for ideation, design, build and space hardening of sensors and satellite buses across the private and publicly funded research sectors
Space Manufacturing	Manufacturing of specialised componentry for domestic and international markets
Intelligent Spacecraft	Artificial intelligence processing capabilities on-board select satellites
Space and Spatial Digital Twins	Digital twin analytics systems that operate off a common backbone of space-related infrastructure.
Data Analytics and Decision Support and in particular spatial capabilities	Analytics which power information product generation using multiple data sources from real-time sensor acquisitions combined with existing data from the vast existing data stores producing customised outputs, fit for purpose, timely and available where and when required (cover AquaWatch, Eye in the Sky, the Indo-Pacific Connector and others)
Data Stores	Located within Australian territory for enhanced cyber resilience
SBAS (Space Based Augmentation System)	Fully integrated with PNT (GNSS) at all key stages of the information supply chain. Currently under acquisition by Geoscience Australia
Whole-of-Government Coordination	Favourable and coordinated policies and programs for tendering, procurement and R&D to build national capability that has specifically been identified as a needed sovereign capability, and critical mass for capturing and growing domestic and international markets
Planning	Stage gated development over the next seven years which sees capability development managed to this nationally conceived design

These capabilities are the equivalent today of Australia's telecommunications copper wires and their supporting infrastructure from early to the middle of last century - a national sovereign capability that was critical to building our nation.

Space Infrastructure

There are four key space capabilities that are needed to serve every nation on earth:

1 Communications;

2 Earth observation;

3 Positioning, navigation and timing; and

4 Space Domain Awareness (SDA), including Space Traffic Management.

It is the first two that are the focus of this submission. The third, positioning, navigation and timing is being very effectively advanced by Geoscience Australia's 'Positioning Australia' program with $224.9M from the 2018 Federal budget.

The final capability has historically been the preserve of the military but with increasing commercial interest in space, an element of SDA, namely Space Traffic Management, is emerging as a national/international capability to ensure space remains a global commons capable of continuing to deliver benefit to all as it becomes increasingly congested.

Communications

Satellite communications are needed to provide reliable, high bandwidth and high speed to all areas of the continent, our offshore territories and our territorial waters. The absence of this capability is widely recognised as impeding growth in regional, rural and remote areas.

Moreover the benefits of the sensor revolution (the Internet of Things) cannot be realised without access to constellations of low earth orbit cube satellites (cubesats) that prioritise coverage of the nation, nor can other technological advances such as autonomous vehicles (e.g. driverless cars). The hopeful plans of a number of Australian start-ups will see dozens of these cubesats appearing over our skies in the coming years, but without a national plan to construct the infrastructural backbone for their use, they face significant risk of failure.

Earth Observation

Australia relies on about 25 earth observing remote sensing satellites for operational applications across much of the economy. None of these satellites systems are owned by Australian companies, nor have any Australian industrial

content. These satellites serve every jurisdiction, across many government agencies and Australian enterprises, across much of the economy for commerce and for disaster and emergency management.

Space Capability Applications

The following is a list of current applications and those needed in the future. This is a preliminary set of application areas for space systems based on work conducted within SmartSat CRC during our bid development phase and first year of operation. This is provided with the view of highlighting to the reader that a broad range of opportunities exist. This is not claimed to be an exhaustive list and work being undertaken by other organisations, including the Australian Space Agency, will no doubt identify other potential national application areas.

Communications (LEO/MEO – orbital choice based on cost/latency trade-off)

- National emergency response communications network including safety of life (AMSA) function
- Universal Service Guarantee voice/data (low latency, high availability)
- Telemedicine for remote/rural/regional communities
  - An overlaid applications that could be delivered through a combination of the NBN/Commercial broadband networks and the USG network listed above

Environmental sensing (LEO/GEO – spatial/temporal resolutions trade)

- Meteorology
  - Alternate/augmented sensor to complement data accessed under existing international agreements. Would require consultation with the Bureau of Meteorology.
- Water resources
  - Extension of Aquawatch to improve national management of fresh water resources.
- Carbon monitoring
  - Includes sensors to assess effectiveness of carbon reduction measures including soil management.
- Land use (e.g. fire fuel loads)
  - Advanced hyperspectral sensors to improve understanding of land use for agriculture, mining, environmental.
- Civil maritime security threats

  - Quarantine and Inspection
  - Biosecurity/environmental management such as marine transport sector oversight
  - Fisheries management, including detecting and policing illegal exploitation of fish-stocks in partnership with pacific partners.

Position, Navigation and Timing (PNT) (LEO/MEO)

- Additional Satellite Based Augmentation Systems (SBAS)/Regional Navigation Satellite Services
  - Including a stronger focus on PNT service resilience to supplement current SBAS approaches targeting accuracy.
- High precision timing signal
  - Provided independently from position and navigation capabilities. Many commercial applications, e.g. finance, are highly reliant on timing information and there are many well documented vulnerabilities related to relying on global GNSS systems for this signal. Advanced, compact atomic clocks currently under development within Australia, could form the basis of a high precision, resilience timing service from LEO, MEO or GEO to reduce reliance on foreign controlled satellite networks.

Space Domain Awareness (Earth/LEO/MEO/GEO)

- Space weather observation and forecasting
- Orbital re-entry monitoring (could be Defence function)

Space Service Delivery Enablement (MEO/GEO)

- MEO relay capability (LEO service extension)
- Ground station networks
- Commercial space traffic management
  - Includes conjunction analysis and warning for commercial operators