



SHOAL™

DEVELOPING AUSTRALIA'S SPACE INDUSTRY

HOUSE OF REPRESENTATIVES INQUIRY

***SUBMISSION TO THE STANDING COMMITTEE ON
INDUSTRY, INNOVATION, SCIENCE AND RESOURCES***

PREPARED BY

Dr Derek Rogers, Roger Franzen and Shaun Wilson

SHOAL-REPORT-658-2020-S002

ISSUED 19 JANUARY 2021



SHOAL™

+61 2 6239 4288
shoalgroup.com

PO Box 7038 Hutt Street
SA 5000 AUSTRALIA

Shoal Group Pty Ltd
ABN 49 604 474 204





**ISO 9001 QUALITY
Certified System**

Provider of systems thinking, engineering, and research; complex systems design; asset management systems design; modelling, simulation, and analysis; strategic and operational analysis; tender support services; and related professional services.

COPYRIGHT NOTICE

This material has been copied and communicated to you by or on behalf of Shoal Group Pty Ltd pursuant to Part VB of the Commonwealth of Australia Copyright Act 1968 ('the Act'). The material in this communication may be subject to copyright under the Act. Any further reproduction or communication of this material to you may be the subject of copyright protection under the Act.

DO NOT REMOVE THIS NOTICE

PREFACE

The House of Representatives Standing Committee on Industry, Innovation, Science and Resources has invited interested persons and organisations to make a submission to their inquiry into developing Australia's space industry for which the Terms of Reference are:

"The House of Representatives Standing Committee on Industry, Innovation, Science and Resources 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." [1]

This report provides Shoal Group Pty Ltd's response to the inquiry as a highly-experienced member of the Australian space industry.

EXECUTIVE SUMMARY

Like many in Australia, Shoal has been energised by the approach of Government in the re-igniting the domestic Space Industry. The Australian Space Agency has made good progress and sought to collaborate, foster, and grow the industry. However, Australia is a relative newcomer in a global market that has been growing in sophistication for over 40 years. To achieve Australia's ambitions of \$12B in revenue and 20,000 jobs by 2030, we must be internationally competitive. The recommendations in this submission seek to support and encourage the space industry to achieve these objectives whilst preserving and protecting the environment.

The Government and Australian Space Agency rightly emphasises safety.

Recommendation 1: *That the Australian Space Agency actively support the development of sovereign capabilities in respect to facilities and range safety.*

The Government and Australian Space Agency also reduced a key barrier to participation in the Australian Space Industry whilst maintaining a safety focus, by addressing the level of insurance required as part of the Space (Launch and Returns) Act 2018. However, while this reduced barriers for those launching and returning space craft, for those in the wider Australian space industry, including organisations such as Shoal, Professional Indemnity Insurance remains prohibitively high. The general insurance industry in Australia does not understand the true risk of the involvement of different participants in the value chain.

Recommendation 2: *That the Government inquire into the barriers and potential remediations with respect to Professional Indemnity Insurance for participants in the Australian Space Industry.*

Growing space debris is a significant risk and Australia has emerging academic and industry capability in space monitoring.

Recommendation 3: *That the Government support the emerging development of sovereign capabilities for space debris observation and that the Space Agency work closely with Defence to develop an architectural framework for proper integration of space domain awareness capabilities and dissemination of unclassified information with civilian users.*

Recommendation 4: *That the Government encourage the expansion of industry technology demonstration activities such as SpaceFest, conducted by Defence.*

Australia's economy and environment can benefit from the greater use of space data.

Recommendation 5: *That the Government foster the growth of Earth observation from space and data processing capabilities that benefit Australia in respect to economic and environmental management including agricultural and land use, bushfire protection, flood and water management, air quality, and maritime and reef protection.*

Industry development is best accomplished by developing sovereign capability and instilling an export discipline cognisant of national interest.

Recommendation 6: *That any Government support of the Australian space industry be focussed on developing a sovereign capability and one that is internationally competitive by supporting those that have an export discipline that will upgrade Australian industry.*

To facilitate industry export, the Government must mandate international space engineering standards as a baseline compliance requirement for all Commonwealth space procurements, leading to two recommendations.

Recommendation 7: *That the Government seek advice from peak Engineering bodies and then mandate the use of recommended international standards such as of those of the European Cooperation for Space Standardization (ECSS), or the NASA Technical Standards, for all Commonwealth space procurements.*

Recommendation 8: *That Commonwealth space procurements seek to provide dual use functionality and to the maximum extent feasible, should host dual use payloads that are designed and manufactured within Australia.*

CONTENTS

PREFACE	3
EXECUTIVE SUMMARY	4
CONTENTS	6
1 INTRODUCTION	7
2 ABOUT SHOAL	7
2.1 A GROWING AUSTRALIAN COMPANY	7
2.2 SHOAL IN THE SPACE INDUSTRY	7
2.3 <i>SMARTSAT CRC</i> AND PROJECT CHORUS	8
2.4 <i>HAYABUSA2</i> RETURN PUBLIC SAFETY ANALYSIS	8
2.5 <i>ANTARCTIC BROADBAND</i>	9
3 INQUIRY RESPONSE AND RECOMMENDATIONS	9
3.1 THE NEW AUSTRALIAN SPACE AGENCY	9
3.2 FOCUS ON SAFETY	10
3.3 REDUCE BARRIERS TO INDUSTRY PARTICIPATION	10
3.4 IMPROVE USE OF SPACE-DERIVED INFORMATION	11
3.5 DEVELOP INDUSTRY IN THE NATIONAL INTEREST	12
3.6 ADOPT INTERNATIONAL STANDARDS	13
3.7 LEVERAGE DUAL CIVIL / MILITARY CAPABILITIES FOR NATIONAL BENEFIT	13
4 REFERENCES	14

1 INTRODUCTION

The Minister for Industry, Science and Technology, the Honourable Karen Andrews MP, asked the House of Representatives Standing Committee on Industry, Innovation, Science and Resources to inquire into and report on developing Australia's space industry.

The purpose of this submission is to respond to this inquiry with an emphasis on how the Australian Government can support and encourage the space industry while preserving and protecting the space environment.

2 ABOUT SHOAL

2.1 A growing Australian company

Shoal is a growing Australian company with a vision to become an iconic '*systems thinking*' institution that leads the solving of complex problems in the Defence, Space, Transport, and Infrastructure sectors.

The company began in 2001 as Aerospace Concepts Pty Ltd in Canberra providing design services in the Defence, aerospace, information technology and telecommunications sectors. Over the next decade, the company pioneered modern digital design engineering which led to involvement in some of Australia's most complex technology projects including the SEA 1000 new submarine project and the *Australian Space Research Program*.

In 2014, after a two-year collaborative research effort with Lockheed Martin Corporation of the United States, Shoal created one of the world's first quantum computing companies, *QxBranch*, with presence in Adelaide, Hong Kong, London, and in Washington, DC.

In 2015, to better reflect our expansion into new markets and services, the company rebranded as 'Shoal Group', a company of complex systems designers and engineers, focused on the early-stage design of large, complex systems and organisational capabilities.

Shoal has now grown to a team of almost 70 people based in Adelaide, Canberra, Melbourne, Sydney, and Auckland in New Zealand with a continued ambition to apply systems thinking using the latest in digital design engineering techniques.

2.2 Shoal in the space industry

Shoal has a long history in the Australian space industry and has a reputation for industry leadership in complex operational and technical analysis and design of modern space technology and systems in both commercial and defence sectors.

Our work has included work on military satellite communications projects with major companies and the Defence Department and, more recently, defining the major defence space-based surveillance and reconnaissance project, DEF799, for the Australian Geospatial-Intelligence Organisation (AGO).

We have also led development of a world-leading space safety capability for civil and defence use. As such, we are a major supplier of safety-related technical services to the Australian Space Agency.

2.3 SmartSat CRC and Project CHORUS

Shoal is a founding member of the Smart Satellite Cooperative Research Centre (*SmartSat CRC*) and collaborative partner on the first major design project, 'CHORUS', the *Compact Hybrid Optical-RF User Segment*, shown in Figure 1, which involves integrating both laser-based optical and radio frequency communications technologies into a satellite communications ground terminal.

Shoal is applying company-developed digital engineering methods and tools to help guide and expedite the CHORUS development effort. By developing and maintaining a 'digital twin' of the system being designed, optimisation and design trade studies can occur concurrently with research activities, whilst maintaining a 'single source of truth' accessible to all stakeholders and an audit trail of decision points and rationale.



Figure 1. CHORUS terminal rendition (Image credit EOS Space Systems)

This iterative approach allows faster development and enables a nuanced approach to risk management in what is acknowledged to be a high-risk activity. Use of a 'digital twin' should also reduce production and through-life costs.

2.4 Hayabusa2 return public safety analysis

In late 2020, a Shoal team worked with the Australian Space Agency to support key safety decisions during the return to Earth at Woomera of the Japanese *Hayabusa2* spacecraft. Our focus was prediction and independent analysis of the trajectory corrections needed to guide the return capsule safely to earth as shown in Figure 2.

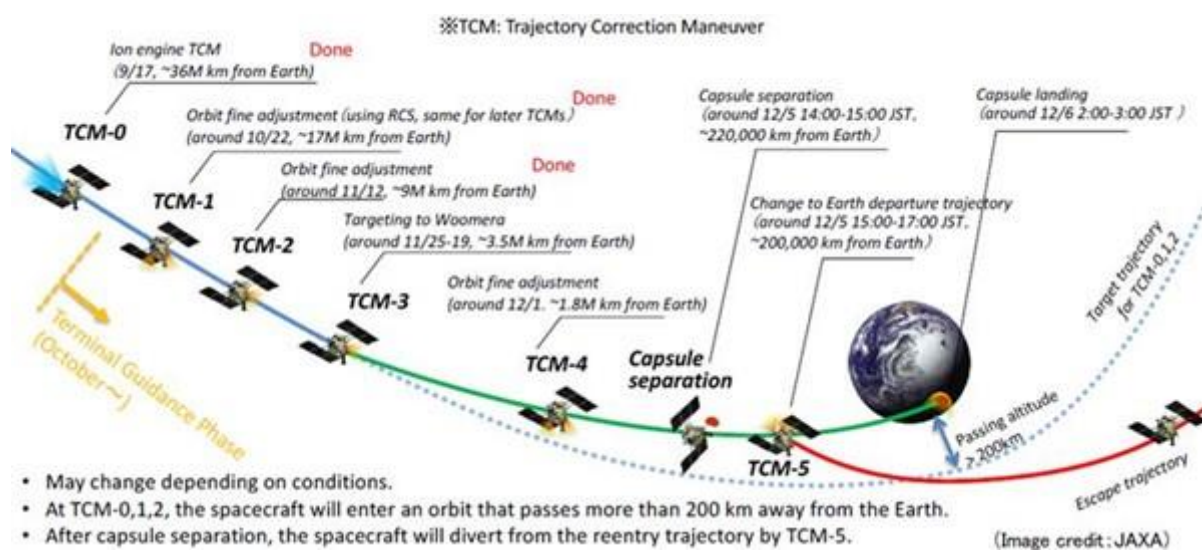


Figure 2. Illustration of trajectory modelling undertaken for the *Hayabusa2* return

Shoal was also heavily involved in the safety analysis for the return to Earth of the first *Hayabusa* mission in 2010.

2.5 *Antarctic Broadband*

In 2009, when Shoal was known as Aerospace Concepts, we led an Australian, Canadian and US consortium that was awarded a \$2.1M grant under the *Australian Space Research Program* to part-fund design of a satellite-based broadband communications service to service the Antarctic region.

This work resulted in development of a 10kg *Antarctic Broadband* nanosatellite, shown in Figure 3, to understand broadband communications over Antarctica; a nanosatellite payload integration and test facility and ground station at the Mt Stromlo Observatory in Canberra; and the only nanosatellite-class Ka-band broadband communications payload in the World at the time.

The work was awarded an 'Engineering Excellence Award' by Engineers Australia in 2011.

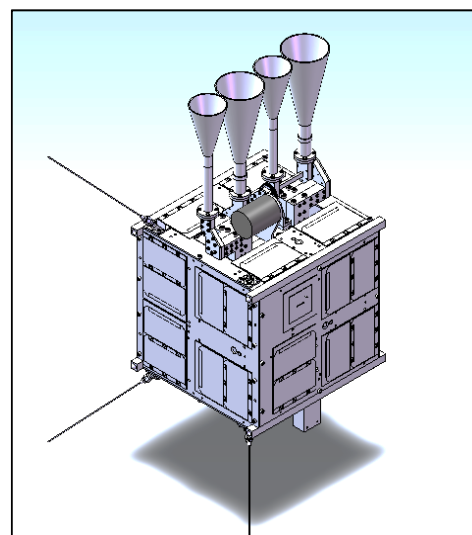


Figure 3. Shoal's Antarctic Broadband nanosat demonstrator

3 INQUIRY RESPONSE AND RECOMMENDATIONS

3.1 The new Australian Space Agency

The Australian Government initiative to establish a national space agency was widely applauded nationally and internationally when announced in 2017 at the International Astronautical Congress in Adelaide. The positive response was due to a broad recognition of the need for Australia to exploit emerging commercial opportunities and the criticality of space to our national security and prosperity.

Since commencement on 1 July 2018, the Australian Space Agency has worked to set out and execute a strategic vision for the Australian space sector that involves, [2]:

- Leveraging bilateral and multilateral partnerships;
- Increasing capability;
- Developing an appropriate safety and security regulatory framework; and
- Inspiring people to help build a future workforce.

The new Space Agency has had some notable accomplishments, for example signing eleven Memoranda of Understanding with other nations that encourage international collaboration and create opportunities for Australian companies, [3]. The government and the Space Agency have also fostered Australia's involvement in the significant *Moon to Mars* initiative. Many agreements have also been established between Australian and international companies leveraging the Agencies international efforts for collaboration.

Shoal applauds the work of the Agency in pursuing this agenda with vigour despite various challenges, including 'bedding down' the updated safety and security regulatory framework with the Australian space industry.

3.2 Focus on safety

The Government and the Space Agency rightly emphasises safety. The Agency has developed a *Flight Safety Code*, [4], and a *Maximum Probable Loss Methodology* for space and high-power rocket activities, [5]. These publications are important and utilise the experience of the USA, Europe, and other countries/regions. Australia should seek to leverage international experience when it comes to safety, but we should also develop sovereign capabilities in respect to our facilities and ranges for proper due diligence.

Recommendation 1: *That the Australian Space Agency actively support the development of sovereign capabilities in respect to facilities and range safety.*

3.3 Reduce barriers to industry participation

In seeking to understand and address barriers to industry participation, the Agency consulted widely on changes to space regulatory regime then enshrined in the *Space Activities Act 1998*. Improvements embodied in the replacement legislation, the *Space (Launches and Returns) Act 2018* [6], include arrangements for launches from aircraft in flight and launches of high-power rockets, both of which have encouraged international companies to explore launch opportunities in Australia in partnership with Australian companies.

One other matter remarked upon by industry during the consultations was the levels of insurance cover for launches and returns required by the original legislation and the barrier to industry activity that this presented. Happily, the new legislation significantly reduced the insurance burden for launches and returns thereby lowering barriers for small to medium companies and for Australian universities. These reductions have been widely applauded.

There is now an opportunity for Government to go further with respect to insurance being a barrier to space industry participation. Companies that offer space-related services in Australia currently significant costs for Professional Indemnity insurance. This is because:

- Australian insurance companies typically lack the relevant technical expertise to make sophisticated risk assessments, and
- There is an increasingly lower risk tolerance due the greater prevalence of bush fires and other natural disasters.

Consequently, premiums can sometimes be unreasonably high or much worse, coverage outright declined thus prohibiting companies from offering competitive services.

Whilst Government can do little to directly influence the risk appetite and pricing of insurers, it can indirectly encourage industry participation and vibrant competition by ensuring that insurance requirements in Government contracts are no higher than reasonably necessary given the nature of the risks encountered.

Recommendation 2: *That the Government inquire into the barriers and potential remediations with respect to Professional Indemnity Insurance for participants in the Australian space industry.*

3.4 Improve use of space-derived information

Space debris monitoring is important for global and national security given how reliant we are on space-based technologies such as the Global Positioning System (GPS) [7].

Space debris monitoring is an area where Australia can make a global contribution because of our location in the Southern Hemisphere. Australia will be involved through facilities such as the new Space Surveillance Telescope at Exmouth, Western Australia. The telescope, a C-band radar, has been relocated from New Mexico in the United States [8]. The telescope will enable the sharing of data with the US and other 'Five Eyes' partners as part of a Combined Space Operations initiative [9].

However, Australian industry, universities, and other publicly funded research organisations such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Defence Science and Technology (DST) Group have, and are, developing important sovereign capability; that is, our own sensors and data fusion systems.

Where the Australian Government can assist is not only in supporting the development of sovereign capability but doing so in a way that improves integration through establishing a suitable architectural framework, one driven by Digital Engineering and adopting the latest in open-innovation and agile software development methodologies. There are analogies here with the United States architectural approach for the latest iteration (unlike earlier iterations) of the enterprise-level space traffic management system that integrates many sensors, data processing, and response capabilities; see for example [10].

Recommendation 3: *That the Government support the emerging development of sovereign capabilities for space debris observation and that the Space Agency work closely with Defence to develop an architectural framework for proper integration of space domain awareness capabilities and dissemination of unclassified information with civilian users.*

Related to recommendation 3, for several years, Defence has sponsored an activity known as *SpaceFest* [11]. *SpaceFest* plays a critical role in helping Defence to become familiar with emerging space domain awareness technology and de-risking future acquisitions set out in the Defence White Paper. However, *SpaceFest* has also helped incubate Australian start-up companies and academic research in both sensors and data fusion; technology that has good export potential.

Recommendation 4: *That the Government encourage the expansion of industry technology demonstration activities such as SpaceFest, conducted by Defence.*

In the formation of the Space Agency, it was recognised that Australia's economy and environment can benefit from the greater use of space data. The use of satellites for remote sensing and the benefits to mining and agriculture is well known. In December 2020, the Space Agency published the *Bushfire Observation Taskforce Report* [12] and the SmartSat CRC is undertaking research into water management [13]. The work in bushfire monitoring was key to encouraging *Lux Aerobot*, a Canadian robotics company, to establish a presence in Australia, [14]. Funding research and development, and providing industry support and providing critical infrastructure, in areas where Australia faces important challenges and can economically benefit, will provide direction, and help stimulate the space sector.

Australia has several Ground Stations in radio quiet areas that support national and international space activities, facilities such as New Norcia in Western Australia, the Canberra Deep Space Communication Complex at Tidbinbilla, and the Parkes radio-telescope. The capabilities of these facilities should continue to be developed, expanded, and opened to greater industry and academic use where possible.

The Mission Control Centre (MCC) being developed at Lot Fourteen in Adelaide is another example of critical infrastructure that can be used to benefit the growth of the space industry, [15]. The MCC will be available for use by space start-ups and small-to-medium enterprise space businesses, as well as research and educational institutions from across Australia to control small satellite missions, provide access to observation data, and support testing of, for example, new algorithms. The MCC will not compete with existing facilities but rather complement them from a broader industry development perspective.

Adoption by the MCC of an open-architecture framework, and expanding access to Earth observation data, and provide greater research and development and testing capabilities would access and encourage innovation by academia and emerging industry.

Recommendation 5: *That the Government foster the growth of Earth observation from space, and data processing capabilities that benefit Australia in respect to economic and environmental management including agricultural and land use, bushfire protection, flood and water management, air quality, and maritime and reef protection.*

3.5 Develop industry in the national interest

The previous recommendations are aligned with the Terms of Reference in supporting and encouraging the Australian space industry while preserving and protecting the space environment. However, there is another recommendation that is needed, leveraging the experience of industry development globally throughout history. Industry development is best accomplished by developing sovereign capability and instilling an export discipline, [16]. Government's should try and avoid picking winners, but Government spending that is needed to encourage entrepreneurs, that is, developing sovereign capability, and must be directed to those that have an export discipline so that they are or become internationally competitive.

As the Space Agency has been doing as part of its focus on international collaboration, Government can facilitate access to export markets, supporting those that develop export discipline and foster the upgrade of Australian industry, and not supporting those that do not unless there are overriding national security reasons to do so As to what is exported requires consideration of what is in our national interest to export, particularly in defence many countries are careful on what can be exported but they still maintain an export focus.

Recommendation 6: *That any Government support of the Australian space industry be focussed on developing a sovereign capability and one that is internationally competitive by supporting those that have an export discipline that will upgrade Australian industry.*

3.6 Adopt international standards

To facilitate industry export, the Government must mandate international space engineering standards as a baseline compliance requirement for all Commonwealth space procurements. The mandate of standards gives industry certainty, and the mandate of recognised international standards supports improving industry's capability, leveraging the knowledge of the best, and facilitating Australian industry's ability to export products. Alternatives such as 'good practice' guides, are sometimes proposed by those unable or unwilling to meet standards but provide little in the way of certainty.

There are two major international standards approaches that could be adopted; those of the European Space Agency (ESA) known as the *European Cooperation for Space Standardization (ECSS)*, [17], and those of the US National Aeronautics and Space Administration (NASA), known as the *NASA Technical Standards* [18]. There is a high level of compatibility between the ESA and NASA standards however further study would be needed to identify which standards are most appropriate for facilitating the growth of the Australian space industry.

Recommendation 7: *That the Government investigate and then mandate the use of international standards such as of those of the European Cooperation for Space Standardization (ECSS), or the NASA Technical Standards, for all Commonwealth space procurements.*

3.7 Leverage dual civil / military capabilities for national benefit

Australia has considerable specialised design manufacturing capability that could be applied to development of space systems but is currently not considered. Australia has some of the world's most experienced astronomical sensor development capability, almost exactly that which is required to design and build the sensors needed for sophisticated Earth Observation. Over the coming years, Defence will be making space acquisitions that could host dual use payloads on platforms well suited to monitoring both our environment as well as the fires that plague our nation. Realistically, Australia cannot build all these acquisitions but could make significant contributions to them.

Recommendation 8: *That Commonwealth space procurements seek to provide dual use functionality and to the maximum extent feasible, should host dual use payloads that are designed and manufactured within Australia.*

4 REFERENCES

- [1] House of Representatives Standing Committee on Industry, Innovation, Science and Resources, "Inquiry into Developing Australia's Space Industry, Terms of Reference," 2020. [Online]. Available: https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Innovation_Science_and_Resources/SpaceIndustry/Terms_of_Reference.
- [2] Australian Space Agency, "Australian Civil Space Strategy 2019-2028," Australian Government, Department of Industry, Science, Energy and Resources, 4 2019. [Online]. Available: <https://www.industry.gov.au/data-and-publications/australian-civil-space-strategy-2019-2028>. [Accessed 7 12 2020].
- [3] Australian Space Agency, "International collaboration on space," Australian Government, Department of Industry, Science, Energy and Resources, [Online]. Available: <https://www.industry.gov.au/policies-and-initiatives/australian-space-agency/international-collaboration-on-space>. [Accessed 7 12 2020].
- [4] Australian Space Agency, "Flight Safety Code," Australian Government, Department of Industry, Science, Energy and Resources, 8 2019. [Online]. Available: <https://www.industry.gov.au/data-and-publications/flight-safety-code>. [Accessed 7 12 2020].
- [5] Australian Space Agency, "Maximum Probable Loss Methodology for space and high power rocket activities," Australian Government, Department of Industry, Science, Energy and Resources, 8 2019. [Online]. Available: <https://www.industry.gov.au/data-and-publications/maximum-probable-loss-methodology-for-space-and-high-power-rocket-activities>. [Accessed 7 12 2020].
- [6] Australian Space Agency, "Space (Launches and Returns) Act 2018: consultation on draft rules," Australian Government, Department of Industry, Science, Energy and Resources, [Online]. Available: <https://consult.industry.gov.au/space/space-launches-and-returns-act-2018-draft-rules/>. [Accessed 7 12 2020].
- [7] C. Agius, "Australia's reliance on US space capabilities could put security at risk, defence expert says," Australian Broadcasting Corporation, 23 2 2018. [Online]. Available: <https://www.abc.net.au/news/2018-02-23/australias-reliance-on-us-in-space-a-national-security-risk/9474122>. [Accessed 16 12 2020].
- [8] A. McLaughlin, "CASG takes over Space Surveillance Telescope building," Australian Defence Business Review, 23 5 2019. [Online]. Available: <https://adbr.com.au/casg-takes-over-space-surveillance-telescope-building/>. [Accessed 15 12 2020].
- [9] M. Davis, "Keeping watch on space," The Australian, 31 10 2020. [Online]. Available: <https://www.theaustralian.com.au/special-reports/defence/adf-to-begin-a-new-space-mission/news-story/058854620414ba0bea2bc5442ca48be1>. [Accessed 15 12 2020].
- [10] T. Hitchens, "New Space BMC2 System To Debut at Corona: Raymond," Breaking Defence, 30 9 2019. [Online]. Available: <https://breakingdefense.com/2019/09/new-space-bmc2-system-to-debut-at-corona-raymond/>. [Accessed 7 1 2021].
- [11] R. A. A. Force, "SpaceFest at the Edge," [Online]. Available: <https://www.airforce.gov.au/our-mission/spacifest-edge>. [Accessed 15 12 2020].

DEVELOPING AUSTRALIA'S SPACE INDUSTRY

SUBMISSION TO THE STANDING COMMITTEE ON INDUSTRY, INNOVATION, SCIENCE AND RESOURCES

- [12] A. S. Agency, "Bushfire Earth Observation Taskforce Report," [Online]. Available: <https://www.industry.gov.au/publications/bushfire-earth-observation-taskforce-report>. [Accessed 15 12 2020].
- [13] S. C. R. Centre, "SmartSat and CSIRO commence AquaWatch project to boost national water quality management with space technology," [Online]. Available: <https://smartsatcrc.com/smartsat-and-csiro-commence-aquawatch-project-to-boost-national-water-quality-management-with-space-technology/>. [Accessed 15 12 2020].
- [14] S. Bakan, "Canadian space robotics startup Lux Aerobot lands its HQ in Adelaide," startupdaily., 10 12 2020. [Online]. Available: <https://www.startupdaily.net/2020/12/canadian-space-robotics-startup-lux-aerobot-lands-its-hq-in-adelaide/>. [Accessed 16 12 2020].
- [15] A. Spence, "Mission control boost for Australian Space Agency," The Lead, 18 3 2019. [Online]. Available: <http://theleadsouthaustralia.com.au/industries/space/mission-control-for-australian-space-agency/>. [Accessed 16 12 2020].
- [16] J. Studwell, *How Asia Works: Success and Failure in the World's Most Dynamic Region*, London: Grove Press, 2014.
- [17] E. Secretariat, "European Cooperation for Space Standardization," European Space Agency, [Online]. Available: <https://ecss.nl/>. [Accessed 5 1 2021].
- [18] Office of the NASA Chief Engineer, "NASA Technical Standards System," NASA, [Online]. Available: <https://standards.nasa.gov/>. [Accessed 5 1 2021].