



SIAA WHITE PAPER:

ADVANCING AUSTRALIA IN SPACE

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Executive Summary

At a time when Australia faces rapid social, economic and geo-political change, the space industry has emerged as one of the most dynamic and fastest growing sectors of the world economy. Space is critical to the operations of government and the private sector and Australia has developed a range of space-related capabilities and space-related assets are recognised as central to Australia's critical infrastructure.

The Australian space sector currently produces annual revenues of \$3-4 billion and employs between 9,500 and 11,500 people from its 0.8% share of the global space economy. The SIAA believes there is an opportunity to double this within five years - if the Australian Government is prepared to commit to the establishment of an Australian Space Agency to lead a cohesive national space strategy. Further, the agency should have an aim of capturing 4% of the world market for Australian industry within 20 years, a five-fold increase in the industry's current global market share.

This White Paper argues that the development of a mature and innovative Australian space sector and a level of sovereign space capability underpinned by world class space science and technology should become an urgent national priority for the following reasons:

1. The Australian Government is committed to taking advantage of innovation in science and technology to transform the national economy and strengthen security¹
2. Australia is missing out on opportunities enjoyed by other advanced economies in an industry sector that currently enjoys growth rates of 10.7% per annum², considerably higher than most other industries³
3. Australia can no longer assume that its vital security interests in space will continue to be maintained at virtually no cost to the Australian Government.

A long term National Space Program will:

- ensure the long term sustainability of the sector and its industry participants
- build on Australia's substantive previous investments and expertise in the sector
- provide additional employment opportunities for thousands of Australians, and
- result in a greater national contribution to the protection of our own national security.

Australia will have the attention of the world's space leaders for an entire week when it hosts the International Astronautical Congress in Adelaide in September 2017 – the world's largest and most prestigious space meeting. This is an ideal opportunity to announce and highlight Australia's renewed commitment as a global player in the space industry.

¹ See National Innovation and Science Agenda <http://www.innovation.gov.au/page/agenda>

² Compound global growth rate between 1998 and 2013. See *A Selective Review of Australian Space Capabilities*, APAC 2016, p 23

<http://www.spaceindustry.com.au/Documents/APAC%20Report%20on%20Australian%20Space%20Capabilities%20Revised.pdf>.

³ Compare this with other industry sectors at <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/8155.0Main+Features12014-15?OpenDocument>

Introduction - Australia's Dependence on Space

For over 60 years space has played an important role in national affairs and our international relations. The Australian economy and the lives of every day Australians are underpinned by space-based technologies. Space derived data and services provided by a combination of government and privately owned systems have increasingly become embedded into the fabric of modern life providing the communications, geolocation and timing services upon which millions of individuals and businesses rely each day. These data and services are parts of the critical infrastructure which enables our modern society to function. They include satellite positioning and communication services, as well as satellite earth-observation and astronomy capabilities. A recent study found that every industry segment in Australia uses space derived services and data in some form in their business activities.⁴

Without space technologies:

- Our ability to forecast weather and extreme weather events is immediately compromised, reducing the capacity to respond to emergencies such as bushfires and floods
- Satellite communications, including Foxtel, Imparja, the National Broadband Network and general telephony, would be significantly affected, leaving Australia reliant on a very small number of undersea cables for connection to the outside world
- Smartphones would not be smart anymore, with Google Maps, Uber and any other GPS based apps immediately useless
- Telecommunications, critical in providing health and education support in remote communities would suffer
- Farmers would no longer be able to use precision agriculture and the supply and delivery of food could no longer be co-ordinated through space-based navigation
- Mining companies would lose a valuable exploration method
- Air traffic would be disrupted
- Financial transactions which rely on GPS satellites would slowly degrade and
- Defence would lose satellite communications, intelligence satellites and GPS, critically affecting their ability to protect and defend Australia and its borders.

The relationship with Australia's national science and research priorities - food, soil and water, transport, cybersecurity, resources, environmental change, and health - is clear and yet, of all OECD countries, Australia is among the lowest investors in publicly-funded space-related research and development.⁵

Australia has benefited greatly from access provided by partner nations such as the United States, Japan and Europe for much of its satellite data, and traditionally this has been at very little cost to the Australian Government. There are numerous examples of the economic and societal benefits generated from earth observation (EO) data in Australia, across areas such as weather forecasting, onshore and offshore mining, mitigation and management of natural disasters like bushfires and floods, water resource management, design and assessment of conservation areas, insurance assessment, and land use planning

Our public and private sectors are fundamentally dependent on EO which is entirely provided by other countries. These data and services are recognised as essential to our public and private infrastructure with numerous national reviews showing that Australian governments and industry

⁴ Ibid pp 38-39

⁵ See SIAA Green Paper *The 2016/17 Commonwealth Budget and the Civil Space Sector*
<http://www.spaceindustry.com.au/Documents/2017%20Budget%20Green%20Paper%20v1.pdf>

are critically dependent on EO to maintain our economy and societal wellbeing.⁶ There is a vital national interest in maintaining the infrastructure, capabilities and international relationships necessary to secure access to satellite data sources.

A key issue in the development of our national space policy should therefore be the securing of long term access, for strategic purposes, preferably from Australian territory, to foreign owned space-segment capabilities, both military and civil. Furthermore, as the geo-political environment changes, Australia needs to become a technology contributor to those partnerships, or it risks significantly rising costs or, even, loss of access. Australia would also be well-advised to consider ways to reduce its dependence on the traditional data sources, and consider its own national priorities in the development of new systems.⁷

The commercial space industry in Australia today is primarily concerned with upstream development and downstream use of applications of space technologies such as satellite communications, earth observation and positioning navigation and timing (PNT).⁸ These industrial activities now represent 76% of global space expenditure.⁹

It is estimated that the Australian Government spends well in excess of A\$1 billion per year on space services and related activities. This includes satellite communications, space science and technology research, earth observation, satellite broadcast and the use of global navigation satellite services (GNSS). The main purposes of government space activity are national security, national and international telecommunications and broadcasting, international development assistance, environmental monitoring, and space scientific and industrial research and development.¹⁰

In this White Paper, we argue the case for the establishment of an Australian Space Agency, and examine some of the associated issues, and make recommendations on the way forward, as a means of promoting innovation, jobs and economic growth in the Australian space sector.

The Size of the Australian Space Sector

The size of the space sector in Australia today is imperfectly understood. A recent study of Australian space capabilities found that the space sector in Australia produces annual revenue of A\$3-\$4 billion and has an estimated workforce of between 9,500 and 11,500 full time equivalents.¹¹ This represents approximately 0.8% of the global space economy which was estimated to be worth US\$330 billion in 2014.¹² However Australia has a 1.8% share of the world's total economy¹³. This

⁶ See for example ACIL Allen Consulting, *The Value of Earth Observations from Space to Australia: Report to the CRC for Spatial Information* (2015) <http://www.crcsi.com.au/assets/Program-2/The-Value-of-Earth-Observations-from-Space-to-Australia-ACIL-Allen-FINAL-20151207.pdf>. See also *Risks of Data Supply of Earth Observations from Space for Australia*, Symbios (2015) <http://www.crcsi.com.au/assets/Program-2/Risks-of-Data-Supply-of-Earth-Observations-from-Space-for-Australia-Symbios-Communications-Final.pdf>

⁷ See Biddington, *Security and space: Australia's free ride is coming to an end*

<https://theconversation.com/security-and-space-australias-free-ride-is-coming-to-an-end-9918>

⁸ Satellite manufacture and launch services are not excluded; however the SIAA believes that while a future Australian commercial launch activity could be commercially feasible, it is unlikely to be the focus of Australian space industry policy in the short term.

⁹ *A Selective review of Australian Space Capabilities*, ibid, p 26

¹⁰ *The State of Space Report 2015*

<https://industry.gov.au/industry/IndustrySectors/space/Publications/Pages/The-State-of-Space-Report.aspx>

¹¹ *A Selective review of Australian Space Capabilities*, ibid, pp 11 and 40

¹² *The Space Report 2015 Overview*, p 2

¹³ Based on 2015 World Bank GDP data for Australia (US\$1.34T) and Global GDP (US\$73.5T)

suggests that the Australian space sector is under-performing. Furthermore, only 8% of Australia's space revenue is generated from exports.¹⁴

This under-performance is not due to a lack of opportunities, nor a lack of demand. Given our large continent and small population, few countries are better suited to exploiting space technologies. Yet, despite world-class space infrastructure such as the Woomera test range, deep space tracking stations and vibrant space science and technology communities linked to a broad base of users and consumers of these technologies, Australia is not fulfilling its potential in the global space economy and is vulnerable to sudden geo-political changes which threaten national security.

Key to our underperformance is a widely held perception, both within Australia and internationally, that Australia's general approach to space activities is that of a passive consumer purchasing satellite data and using satellites from other nations while generating few resources ourselves. In the earth observation sector, activities of our state and national governments are underpinned through 'free' access to billions of dollars' worth of foreign owned and operated satellite environmental monitoring and positioning systems.

An impediment to space exports cited by companies is 'that Australia is generally not perceived as being active in space hence Australian space companies suffer from a credibility gap when competing in international markets'.¹⁵ To help counter this view, greater whole-of-Government support and leadership is required.

The Industry Growth Opportunities for Australia

Australia also faces significant opportunity, with the current paradigm shift in space technology to a domain that now includes small satellite systems¹⁶ – a domain in which it makes sense for Australia to play niche lead roles and benefit from the innovation spin-offs and the export dollars that come with it.

This opportunity arises in the context of an exponentially growing international commercial investment in space, with almost 50% of non-US world expenditure in 2015 being in the Asia-Pacific region.¹⁷

The development of a mature Australian space industry, underpinned by world-class R&D translating to high technology innovation, powered by a skilled, space-educated work force, and providing a level of national sovereignty and self-reliance where appropriate, will assist our nation in responding to national needs and capitalising on emerging opportunities. The skilled work force will include diplomats, policy makers, lawyers and business experts, as well as scientists, engineers, computing specialists and social scientists.¹⁸

Critically, a mature space industry will interact with multiple points within government and support whole-of-government efforts. For example, it will provide for the identified needs of the Australian Defence Force for a level of sovereign space capability, provided at least in part by domestic

¹⁴ A *Selective Review of Australian Space Capabilities*, *ibid*, p 41

¹⁵ *Ibid*

¹⁶ Small satellite systems take advantage of miniaturization of electronic components and the development of off-the-shelf components. This allows technologies previously limited to large satellites to be flown on small satellites for a fraction of the cost. See Facchinetti, *Small Satellites Economic Trends* (2016) <http://www.defencesa.com/upload/Facchinetti%20G.%20Small%20Satellites%20Economic%20Trends%20Dec%202016-FINAL.pdf>

¹⁷ See https://space.taurigroup.com/reports/Start_Up_Space.pdf

¹⁸ See submission by Prof Russell Boyce, 'Walk and then run - a strategic coordination framework to nurture and grow a mature, self-reliant Australian space industry to meet national need', 17 November 2016

innovation.¹⁹ It will also address civilian needs, contributing to the work of agencies such as Bureau of Meteorology, CSIRO and Geoscience Australia.

The outcome will be a more resilient Australia, from economic, social and strategic perspectives. The result will also be a stronger Australia, in terms of export dollars, highly skilled employment opportunities, and greater influence internationally.

Many of the ingredients are already in place in Australia, in varying degrees of heritage and quality. These include expertise and capabilities in:

- space surveillance
- space weather monitoring and prediction
- analysing foreign Earth observation and remote sensing data
- applications of Position, Navigation & Timing and Satellite Communications data
- space education
- preliminary space technology developments based on small satellites²⁰ and
- designing and building sophisticated satellite sensors, platforms and missions.²¹

In addition, Australia's contribution to astronomy and astrophysics has historically been at the forefront of research leading to game-changing spin-off innovations (e.g. Wifi). As a host nation for the international Square Kilometre Array radio-telescope currently being developed, Government has a rare opportunity to leverage industrial returns from the Australian investment.

Current Government Space Arrangements in Australia

The Australian Government recognises our reliance on satellite-delivered services, with over 11 different departments or government agencies currently involved in an inter-departmental committee that was intended to facilitate coordination of these activities.²² However, there is no single agency that is responsible for setting priorities for spending on space hardware or services, or driving growth in the Australian space industry.²³

This has led to confusion amongst international space agencies and contractors, who are unsure as to who to contact within the Australian government, and who contact a variety of government agencies or industry bodies, such as the SIAA, to obtain information about business opportunities and collaboration. While responsibility for international space relations remains fragmented across a range of agencies and offices there is little accountability for lack of progress and little incentive for success.

¹⁹ As outlined in the *Defence White Paper 2016* and supporting documents <http://www.defence.gov.au/WhitePaper/Docs/2016-Defence-White-Paper.pdf>

²⁰ An example of these are the tiny satellites the size of shoe-boxes, known as cubesats – an excellent and affordable education mechanism, able to provide handy space-derived data for certain applications, but best utilised as a stepping stone in the maturation of Australian design and manufacturing, to somewhat larger, more sophisticated spacecraft capabilities provided by clothes-dryer-sized microsats.

²¹ In part, building on the expertise of Australians returning from the European and North American space sectors.

²² See <https://industry.gov.au/industry/IndustrySectors/space/Civil-space-coordination/Pages/default.aspx> Currently the co-ordination of government civil space activities including the regulatory function under the Space Activities Act is provided by the Civil Space and Cyber Security section, Industry Transition Branch, Industry Growth Division of the Commonwealth Department of Industry, Innovation and Science. It operates with a handful of dedicated staff.

²³ Although some sectors, such as earth observation, have organised consistent national plans, and others have developed research-focussed activities, such as Astronomy Australia Ltd, there has not been a cross-sectoral approach to Australia's space interests that has been effective.

Although its current status is unclear, *Australia's Satellite Utilisation Policy*, approved by Federal Cabinet in 2013, outlines seven Principles for a National Space Industry Policy:²⁴

1. Focus on space applications of national significance
2. Assure access to space capability
3. Strengthen and increase international cooperation
4. Contribute to a stable space environment
5. Improve domestic coordination
6. Support innovation, science and skills development
7. Enhance and protect national security and economic wellbeing

Furthermore, it outlines the goal to 'achieve on-going, cost-effective access to the space capabilities on which we rely', which will deliver the following benefits:²⁵

1. Improved Productivity: space capabilities such as satellite imagery and high accuracy positioning deliver information that brings about greater efficiencies and encourages innovation.
2. Better Environmental Management: satellite information enables effective environmental management across Australia's extensive and often inaccessible land and ocean territory.
3. A Safe and Secure Australia: space capabilities are important contributors to national security, law enforcement and to the safety of all Australians in disasters.
4. A Smarter Workforce: space capabilities help transform existing industries and build new ones that provide quality jobs.
5. Equity of Access to Information and Services: satellite communications enable high-speed, universal access to TV broadcasting, internet and telephone services.

The SIAA supports these principles, goals and benefits, but notes that the policy fails significantly in the following areas:

- There is no clear, ambitious and measurable strategy for growing the industry, with a proportionate increase in economic activity and jobs
- National oversight and program management is not provided by any government agency
- There is no unified approach to a national strategy for capability development, including promoting STEM studies at school level and education, training and professional development at post-school levels
- There is no strategy or follow through to promote the commercialisation of technology and knowledge gained from programs such as the Australian Space Research Program.²⁶

There is no shortage of evidence that government funding can play a critical role in space industry development. The Australian Space Research Program (ASRP) which ran from 2010 to 2014 is an example of an A\$40 million program that achieved direct co-investment from industry of \$39.1 million.²⁷

Examples of lasting benefits from this program include:

1. *The Space-based National Wireless Sensor Network Project*
Leader: University of South Australia

²⁴ See <http://www.spaceindustry.com.au/Documents/Australia's%20satellite%20utilisation%20policy%20-%20version%201.1p%20-%202016%20April%202013.pdf>

²⁵ Ibid, p 6

²⁶ These points are also supported by the findings of an industry wide survey conducted in 2016 that formed the basis of the five priorities identified in the Australian Earth Observation Community Plan – 2026.

²⁷ *Final Evaluation of the Australian Space Research Program*, p 52
http://www.spaceindustry.com.au/Documents/Final_evaluation.pdf

Outcomes: Start-up company Myriota. This company has since gone on to raise \$2.5M capital, and has commenced employing highly skilled staff. Its customer base is global, and likely to deliver significant export opportunities.

2. *The Automated Laser Tracking of Space Debris Project*

Leader: EOS

Outcomes: Significant development of Australian capabilities in civilian and Defence space surveillance. EOS has signed a Strategic Agreement with Lockheed Martin to build a new space object tracking telescope in Western Australia, leveraging more direct industry funding, delivering high technology jobs, and export opportunities well after the ASRP concluded.

3. *The Southern Hemisphere Summer Space Program (SHSSP)*

Leader: University of South Australia.

Outcomes: As an offering of the International Space University (ISU) based in Strasbourg, France, the SHSSP each year provides world-leading space education to Australian participants and participants from throughout the world. The program is now financially self-sustaining, delivering a small export income for Australia and inter-disciplinary and research skills for professionals and advanced university students. The success of the program has led to discussions about a permanent ISU presence in Adelaide. It also led to the decision to propose Adelaide as the host city of the International Astronautical Congress in 2017.

These outcomes demonstrate how strategic government engagement can lead to sustained benefits. The ASRP was independently assessed by Ernst & Young in 2015. It concluded that the program represented value for money, was delivered efficiently, and achieved its objectives whilst continuing to realise benefits to the space sector.²⁸

The Australian Government approach to the space sector, which will soon be unique amongst all developed countries, has led to Australia ‘punching well below its weight’ in terms of jobs and economic growth, driving both innovation and driving highly skilled Australians offshore.²⁹

The need for renewed vision and leadership from the Australian government in the Australian Space sector is highlighted by the opportunities arising from the recent significant influx of venture capital in the space sector globally, with more venture capital (US\$1.8 billion) invested internationally in space ventures in 2015 than in all the previous 15 years combined.³⁰

Much of this venture capital will be invested in start-up ventures seeking to take advantage of the reducing cost of small satellite construction and operations. The review of the Space Activities Act commenced in 2016³¹ will hopefully result in an improvement in the licensing process for these players in Australia, but the amended legislation is unlikely to have any marked effect on broader space industry development, unless the regulatory environment becomes attractive to satellite companies wishing to transfer their operations to Australia.

²⁸ Ibid, p 7

²⁹ There are over 90 Australians working at other space agencies in Europe and the US; and anecdotal evidence suggests that within Australia, many with specific space expertise are currently contributing to Australian space from outside the sector.

³⁰ See *Start Up Space: Rising Investment in Commercial Space Ventures*, p 12
<http://arc.aiaa.org/doi/abs/10.2514/6.2016-5233>

³¹ See <https://industry.gov.au/industry/IndustrySectors/space/Pages/Review-of-the-Space-Activities-Act-1998.aspx#header>

The Role of Government and the Economic and Social Benefits

Governments have a critical role in ensuring that citizens and businesses are able to access the broader benefits of space. Research has been done on the economic and social benefits of government engagement in the space sector. In the United Kingdom these benefits were outlined cogently in *The Case for Space 2015* by London Economics.³²

As outlined in the **Appendix**, there is abundant evidence that the governments of comparable countries such as the UK and Canada are driving space industry growth, and realising the broader economic benefits.

Similar evidence was examined in an Inquiry by the Australian Senate Economics Committee in 2008. In its unanimous report entitled '*Lost in Space? Setting a new direction for Australia's space science and industry sector*', the committee concluded:

'The committee believes it is not good enough for Australia to be lost in space. It is time to set some clear directions. The Australian government should have a space policy and, like most other comparable countries, an agency to implement it. The global space industry generates global revenues of around US\$250 billion per annum, and Australia should be playing a larger role.'³³

A National Space Program for Australia

The SIAA's vision is for a permanent and sustainable national civil space program that has the following goals and objectives:

1. Addressing Australian priorities and driving industry growth

The new Australian Space Agency would be responsible for formulating a detailed national strategy, setting growth targets, and implementing action and assistance plans to achieve these targets in consultation with industry and established space sector coordinating groups.³⁴ This planning would include existing and future Government-funded research and development projects to address Australian national priorities, and would set priorities and provide orderly management and funding of existing and future projects in space science, astronomy, earth observation, position, navigation and timing, telecommunications and other applications as determined from time to time. These plans would address technology development and innovation, support for technology commercialisation, niche capability development and enhancement, and export strategies.

In addition, where national priorities and international partner priorities align, Australia should participate in joint projects with international partners, for the benefit of Australian industry and research organisations.

It is important that the new body is technically competent and has international credibility. This means that it has the skill and competence to be an informed buyer of systems and services, and is able to establish and monitor standards and oversee projects and programs. This would involve prioritising capability areas and strategically spending funds on projects

³² *The Case for Space 2015*, pp 31-33 <http://www.ukspace.org/wp-content/uploads/2015/07/LE-Case-for-Space-2015-Full-Report.pdf>

³³ http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Completed_inquiries/2008-10/space_08/report/index at p 1.

³⁴ See for example the Australian Earth Observation Community Coordination Group, *Australian Earth Observation Community Plan 2026* (2016) <http://www.aeoccg.org.au/aeocp-the-plan/>

in those areas bringing together the necessary human capital and building experience over time.

In relation to growth targets, the SIAA believes that in developing its strategy, the new agency should aim for the following minimum results:

- the doubling of the size of our space industry sector within five years of its establishment and
- the longer term goal of capturing 4% of the world market for Australian industry within 20 years.

2. Policy, Law and International Relations

The Agency would be responsible for developing and administering Australian civil space legislation and regulations, and for implementing the licensing of space activities covered by the legislation. In addition, the Agency would advise the government on domestic policy and international policy, law and relations with other governments and international organisations. The policy development and oversight role would include:

- National policies dealing with security of Australia's access to space, and resilience and contingency plans in the event of disruption
- A smarter space initiative – in which the Agency has a mandate to monitor and coordinate cross-agency government (including Federal, State and local) civil space spending with the objective of saving money, enhancing capability and maximising the commercial opportunities for the Australian space industry sector.³⁵
- Regulation – being aware of and monitoring international regulation and advising government where reform, changes or new regulation may be required
- Compliance – oversight of Australia's obligations under key international space treaties.
- Playing an active role in shaping international space policy, for example through organisations such as the United Nations Committee on the Peaceful Uses of Outer Space, and the Inter-Agency Space Debris Coordination Committee.³⁶
- Ensuring equity of access to space-based services according to the principles of the UN Vienna Declaration, with particular regard to those usually excluded from space including minorities, women and Indigenous people.

3. Capability Development, STEM and Outreach

A space agency has an important role in inspiring and guiding young people to pursue studies leading to careers in science, technology, engineering and mathematics (STEM). This would include an active curriculum development program on space-related topics in schools and universities throughout Australia. In addition the Agency would have an essential communication and outreach role in informing and improving the community's understanding about space and its importance in our daily lives, as well as highlighting the achievements of Australia's national space program. It would be responsible for a dedicated Australian space capability development plan addressing skills planning, workforce

³⁵ This should be done in association with the Attorney General Department's Critical Infrastructure Resilience Strategy and Centre

³⁶ Australia's space policies should not be devised to fill the gaps in the current distribution of space responsibility between diverse government departments, but should articulate a willingness to take our place as a distinct voice in the international arena.

requirements and further development of our space education export activities.³⁷

Advancing to an Australian Space Agency

The SIAA calls upon the Australian Government to establish an Australian Space Agency, reporting direct to the responsible Minister.

Implementing that decision will involve considerable planning and coordination but the first step would be the appointment of an Interim Board of Management charged with the task of conducting a global search for a suitably qualified Space Agency Head and overseeing the transfer of current departmental staff. The Interim Board of Management should be selected from the key stakeholders including industry representatives.

It would also be the urgent priority of the Interim Board to oversee the preparation of a foundation strategic plan that should address the following questions:

- How best to manage the whole of government coordination of the space sector, taking into account commercial, civil and defence and national security requirements and the current functions of the various government departments and agencies
- Strategic priorities for the Agency with industry growth targets along the lines suggested in this White Paper
- An investment and operational plan for the three objectives of the Agency set out above i.e.
 - (1) addressing Australian priorities and driving industry growth
 - (2) managing policy initiatives, regulation and international relations and
 - (3) actively supporting capability development, STEM and outreach activities.

The SIAA would be pleased to offer its views on the issues to be addressed in the foundation Strategic Plan.

Conclusion

The essential theme of this White Paper is that a National Space Program, implemented by an internationally recognised space agency, is a critical element of any national strategy for the transition of the Australian economy. It is impossible to imagine a prosperous high-tech future for Australia that does not include a government plan for the accelerated development of our space industry.

This White Paper has provided the outline of such a plan with an essential first step – the establishment of an Australian Space Agency with the mandate to achieve an ambitious set of industry growth targets. The success of this policy will be measured in many ways:

- the number and type of jobs created
- the spill-over effects and benefits for the general economy
- the number of young people inspired to pursue STEM careers
- the recognition and support of our international partners and
- the confidence that as a nation we have a greater control over the infrastructure and systems upon which we rely for our national security.

³⁷ It should be noted that the space industry has one of the highest educated workforces, with surveys in the UK showing that three out of every four employees hold a higher education qualification, which exceeded all other reported industries in England and Wales

The need for this reform is urgent. We cannot be left behind while the rest of the world reaches for space. It's time to stop being a mere consumer of space services and to actively shape the future of our space sector. A National Space Program administered by an Australian Space Agency will play a key role in innovation, inspiration and imagination and advance Australia into a new Space Age.

Appendix - The UK and Canadian Precedents

Prior to 2010 the UK space sector was managed through the British National Space Centre. In 2010, realising that a lack of vision and coordination was undermining British participation in the global space industry, the UK Government, in consultation with British industry, established the UK Space Agency founded on principles of:

- industry growth
- smarter and more effective government spending and
- addressing national priorities through space.³⁸

The economic and social benefits of government engagement in the space sector set out in the Case for Space Report³⁹ include:

- Providing a link between R&D intensive upstream segments and commercially lucrative downstream segments
- Bridging gaps in the private capital market due to high uncertainty or risk, large fixed costs and long lead times for project development or long payback periods
- Preventing science and innovation market failures where the private payoff is not sufficiently certain and substantial to outweigh the costs of the research and development required
- Ensuring that space applications are deployed as public goods - because technological difficulties or social undesirability of charging users and preventing access for non-payers may impede incentives to invest in the systems and result in undersupply of infrastructure and/or services
- Ensuring government prominence – because government intervention is not limited to the achievement of economic objectives but is further influenced by ‘adjacent objectives of national strategic interest, defence (dual use nature of space technologies), political prestige, technological leadership and international competitiveness’
- Maintaining access to space as a global commons – because outer space is defined in international law (The Outer Space Treaty of 1967) as a ‘commons’, characterised by the principle of non-appropriation of property in space, and its availability for joint use by all States through their governmental and non-governmental organisations.
- Externalities – there is an important role for Government to control or restrict the negative externalities, such as space debris and to promote activities yielding positive spill over effects.
- Supporting a level playing field in space enterprises which could include intervening in relation to of trade and customs barriers, subsidies and/or duties.

The UK Government provided the space industry with a clear statement of its intentions, and increased public investment in space. This helped to drive increased private sector investment and investment by the European Space Agency in facilities in the UK.

In a recent assessment of the return from public space investments, London Economics found that at a conservative lower bound estimate, typical returns were estimated as:

- ESA membership: £3-£4 (direct) plus £6-£12 (spill over) per £1 of public investment
- Space science and innovation:
 - Earth Observation: £2-£4 (direct) plus £4-£12 (spill over) per £1 of public investment

³⁸ Osborne, Dempster and Aboutanios, Investing in space: what the UK Space Agency can teach Australia, 2014 <https://theconversation.com/investing-in-space-what-the-uk-space-agency-can-teach-australia-28559>

³⁹ The Case for Space 2015, pp 31-33 <http://www.ukspace.org/wp-content/uploads/2015/07/LE-Case-for-Space-2015-Full-Report.pdf>

- Telecoms: £6-£7 (direct) plus £6-£14 (spill over, lower as commercial) per £1 of public investment
- Navigation: £4-£5 (direct plus partial spill over) plus £4-£10 (spill over) per £1 of public investment.⁴⁰

This compares well with an OECD study that found 'that revenues generated by institutional investments in space over a decade have led to a multiplier effect of between 4.5 and 6.2 when considering the value chain and indirect effects only, and between 8.5 and 9.7 including the societal effects.'⁴¹

The Canadian Space Agency was established in 1990 and with around 1.5 times Australia's population Canada has captured approximately 2% of the global space market compared to Australia's 0.8%. The Canadian space sector contributes around 24,300 jobs to the economy, and has delivered over C\$750 million in tax revenue. It achieved a 5-year compound growth rate of 3.6% in 2015, which was twice that of the general economy; it has a high proportion (53%) of personnel who have tertiary qualifications and delivers six times the national job growth rate.⁴²

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⁴⁰ Return from Public Space Investments, p ii <http://londoneconomics.co.uk/wp-content/uploads/2015/11/LE-UKSA-Return-from-Public-Space-Investments-FINAL-PUBLIC.pdf>

⁴¹ Ex ante Assessment of Economic and Societal Effects induced by Space Investments in a Small Emerging Space Country, p 1 <http://www.spaceindustry.com.au/project/documents/IAC-13,E3,3,5,x16998.pdf>

⁴² Comprehensive Socio-Economic Impact Assessment of the Canadian Space Sector, p vii <http://www.asc-csa.gc.ca/eng/publications/2015-assessment-canadian-space-sector.asp>