gap
A Vision for Australia

The Australian Space Initiative

GAP TASKFORCE ON SPACE INDUSTRY REPORT

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ABSTRACT

Commercial space services have become major global industries, spearheading technological advance, social change and economic growth. In the absence of a national space agency or government support, Australia trails in the wake of its peers, but with modest support could develop a globally competitive domestic space industry worth up to AU$3 billion a year in export revenue and creating 5,000 new high-tech jobs by 2027. This document offers a realistic set of strategic goals, potential projects and practical steps to help the nation's engineers and entrepreneurs turn this vision into reality. The novel concept of a 'Commercial Space Agency' would allow operating higher value projects in Australia via commercially funded ventures – backed, however, with the authority that only a space agency can provide.

DISCLAIMER

This document summarises the deliberations of the *GAP Taskforce on Space Industry* - a cross-jurisdictional, multidisciplinary group of stakeholders brought together in 2017 by the institute for active policy Global Access Partners (GAP) under the banner of the *Australian Space Initiative*.

The report reflects the diverse range of views and interests expressed by the individuals involved and it should not be assumed that every member would agree with every point in full.

The report has been prepared in good faith from the information available at the time of writing and sources believed to be reliable. However, evaluation of the material remains the reader's sole responsibility and it should not be used as a substitute for independent professional advice.

TERMS AND ABBREVIATIONS

ACT	Australian Capital Territory
ANU	Australian National University
APAC	Asia Pacific Aerospace Consultants
ATM	Asynchronous Transfer Mode
CA	Canadian dollar
CASIS	Center for the Advancement of Science in Space
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DLR	Deutsches Zentrum für Luft und Raumfahrt (German Aerospace Centre)
EOS	Earth Observation from Space
ESA	European Space Agency
EU	European Union
GAP	Global Access Partners
GDP	Gross Domestic Product
GPS	Global Positioning System
HAP	High Altitude Platform
IAC	International Astronautical Congress
IDEA	Interactive Digital Earth for Australia
ISO	International Organization for Standardization
ISS	International Space Station
IT	Information technologies
JAXA	Japan Aerospace Exploration Agency
NASA	National Aeronautics and Space Administration, USA
NBN	National Broadband Network
NISA	National Innovation and Science Agenda
NSW	New South Wales
PIGI	Predictive Ground Station
R&D	Research and development
SATCOM	Satellite-based communications
SBAS	Satellite-based augmentation system
SMEs	Small to medium-sized enterprises
STEM	Science, technology, engineering and mathematics
TRL	Technology readiness levels
UAV	Unmanned aerial vehicle
UNSW	University of New South Wales
US	United States of America
VC	Venture capital

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EXECUTIVE SUMMARY

This report was prepared by the GAP Taskforce on Space Industry, an international multidisciplinary group of astronauts, entrepreneurs, engineers and policy experts. It offers a visionary, but realistic set of near and mid-term goals to create a vibrant space industry in Australia, rich in export, technology and employment opportunities.

Australia is now the only nation in world's top 50 economies to have no space programme of its own. Australia's failure to compete in the US$350 billion global space sector[1] impoverishes the nation to the advantage of other nations, while our reliance on foreign suppliers risks our national security. Australia cannot afford to lag behind its international competitors in this fast-growing sphere of economic and technological endeavour, nor should it cede the new marketplace to foreign firms when its own entrepreneurs and engineers are eager to play a greater part.

The traditional model of monolithic national agencies funding huge science projects is being replaced by smaller, cheaper and more commercial approaches, which Australia can adopt to its advantage. The nation can use its proven strengths in image processing, IT and communications to profit from the space industry's current commercial disruption and growth, rather than fund the success of other nations through buying their hardware and data.

The Australian Government has a golden opportunity to prove its commitments to innovation, technology and economic diversification by encouraging the growth of independent, internationally competitive domestic space capability. This demonstration of faith in the future would not only generate revenue and jobs, but would inspire a new generation of engineering and science students and stem the 'brain drain' of high-tech talent abroad.

As part of a planned series of financially modest steps to this end, the GAP Taskforce recommends the creation of a national space agency funded by public-private partnership, and co-funded associate membership of the European Space Agency to offer opportunities to Australian space entrepreneurs. A host of research, ground-based, flight-testing and space-based projects could then be pursued, including the creation of domestic launch sites.

The Commercial Space Agency would be a public-private partnership, supporting projects funded through private venture capital and investment banking, but with strategic backing by State and Federal Governments. This novel approach would allow Australia to join its peers in the OECD in having a dedicated Space Agency without implying extra costs to the public purse.

The Agency would allow Australia to manage strategic space sector needs and facilitate growth in a targeted fashion. It would maintain national authority and leadership in the sector while reaping all the benefits of free market growth. It would allow Australia to take the lead in the Space 2.0 era by offering domestic and international firms the services of the world's first "nationally led, but commercially driven" Space Agency.

While the recent call for submissions by the Minister for Industry, Innovation and Science[2] may bear fruit, the nascent Australian space sector needs action, and announcements of government intent would garner strong support at the 68th International Astronautical Congress (IAC) in Adelaide this September. [3]

The Australian Space Initiative

GAP established a *Space Tiger Team* in October 2016 to build on the momentum of a stirring address[4] by Andrea Boyd, an Australian International Space Station (ISS) controller, at the *'Spaces of Australian Innovation'* Summit on 16 September 2016 at NSW Parliament House.[5] Ms Boyd urged Australia to grasp the lucrative commercial opportunities of the new space market and protect its national sovereignty by establishing a space agency and becoming an associate member of the European Space Agency (ESA).

The *Space Tiger Team* included Ms Boyd, Dr Andrew Thomas AO, the Australian-born four-time shuttle astronaut, and Prof Gregory Chamitoff, who spent 199 days aboard the ISS. Other participants included Australian and international scientists, entrepreneurs, innovators, financial analysts and legal experts. Members were selected for their subject expertise and willingness to pool diverse interests in pursuit of a common framework for commercial space development.

The *Space Tiger Team* met six times between October 2016 and January 2017 and delivered three policy submissions to the Australian Government. With the support of the Department of Industry, Innovation and Science, GAP subsequently launched its *Australian Space Initiative* in April 2017 and established a new *Taskforce on Space Industry* to build on the *Space Tiger Team*'s recommendations.

The *GAP Taskforce on Space Industry* was asked to identify projects, products and services with employment and export potential and engage providers and customers with an interest in supporting domestic space capability. The Taskforce met from May to August 2017 to produce proposals ahead of the 68th IAC in Adelaide in September 2017.

THE CASE FOR SPACE

Global Context

The global space economy reached US$323 billion in 2015[6]. Commercial operations accounted for US$246 billion, over three quarters of the total. While space activities are still associated in the public mind with moon landings and Mars probes, space-reliant products and services are used by every sector of the economy. Australia spends up to AU$4 billion on space-dependent services every year, and the industry employs up to 11,500 people[7]. Prof Russell Boyce, the Chairman of UNSW Space Engineering, notes that *"it's reached a point where Australia and the rest of the developed world are critically dependent on space technology for the way we do everything"*.[8]

A 2015 report by ACIL Allen Consulting for the Cooperative Research Centre for Spatial Information calculates that the social and environmental benefits of Earth Observation from Space (EOS) for agriculture, aviation, tourism and recreation, petroleum, mining, water, property, and insurance topped AU$860 million in 2015, a sum expected to rise to AU$1,329 million by 2025[9]. The use of position navigation and timing solutions may increase GDP by up to AU$134 billion by 2030 from productivity gains in the agriculture, construction and mining sectors alone.[10]

Space is no longer the province of the US and Russian governments, as European nations, India, China, Japan and South Korea are increasingly active in the field, and every national actor now faces competition from new commercial companies. Unfortunately, Australia's domestic space hardware industry remains miniscule by comparison to its international peers, and although we import vast quantities of data and space-derived services, we export little of our own[11]. While our peers profit from launch and ground services, satellite manufacturing and operations, satellite television and communications, GPS services and defence applications, Australia's reliance on foreign nations and companies drains our resources abroad.

Commercial space revenues have grown by an average compound rate of 13.7% in the 21st century, exceeding China's GDP expansion of 9.7%.[12] The new space sector is set to grow even faster, as commercial launch systems operated by SpaceX, Blue Origin and other private firms come on stream and nanosats open space to new start-ups and tech companies. Just as the internet revolution democratised media by making everyone a producer as well as a consumer, so space is set to for its own transformation. However, despite the policies pursued by successive Australian governments to encourage start-ups and innovation to compete with low-cost Asian manufacturers and diversify the economy from agriculture and mining, the potential of space is yet to be fully realised.

Domestic Opportunities

The Space Industry Association of Australia estimates that the nation's space sector, currently worth about AU$4 billion a year, could double over the next five years[13]. Earth observation data used in federal and state government programs alone is worth almost AU$950 million, and includes two programs greater than AU$100 million and one worth more than a billion[14]. However, although Australia has relied on its international partners, notably the US, for satellite-derived data for over five decades, the need for domestic capability is increasing, as other countries look to sell value-added services derived from their satellite data, rather than supply raw information for domestically sourced analysis.

While Australia could not possibly compete with established behemoths, such as the US, in terms of global market share, there is no need to cede domestic markets to American firms. Australia has proven strengths in several niche areas that, with a modicum of support, could be significantly developed. Some proponents believe Australia could capture 3% of the world space market by 2026, up from the fraction under 1% of the present day[15], but the GAP Taskforce believes a worthwhile but achievable goal would be AU$3 billion in space export revenue.

Canada, a nation of comparable size, population and technological sophistication, generates CA$5.3 billion in annual space revenue, of which CA$1.6 billion come from exports – thanks, in part, to its associate membership of ESA. Overall, the space sector contributes CA$2.7 billion to Canada's GDP and supports over 24,000 jobs in the greater national economy. [16]

Although Australia would start well behind Canada and other space active nations, the dawn of 'Space 2.0' offers an opportunity to leapfrog competitors burdened by legacy approaches at a time of market disruption.

Leveraging Existing Assets

The GAP Taskforce proposal looks to leverage Australia's existing assets in the development of a new and highly productive space industry, guided by a commercially oriented space agency of modest size. Australia enjoys a range of competitive advantages which leave it ideally placed to take its place in the international space market, but these require a public vision and administrative support to have their potential realised.

- **Location**

Australia's position as a politically stable, democratic ally in the Southern Hemisphere has made it a preferred location for international satellite ground stations since the start of the space age. These stations offer command and control services for spacefaring infrastructure, as well as providing vital satellite-based communications connectivity.

Australia is also a popular partner for calibration and validation activities for Earth observation satellites, and this core competency offers a platform to develop other aspects of the industry. Australia's size and position leave it responsible for a sizeable fraction of the Earth's surface, and a domestic satellite capacity to monitor the region properly is increasingly important.

Australia could also build on its established reputation and alliances by hosting launch sites in its far north, near the equator, funded and used by less well-situated allied nations and emerging commercial entities from home and abroad. This would provide a major boost for Northern Australia, which has struggled to attract viable investment, despite the government's interest in developing the region.[17]

- **Wide Range of Willing Partners**

Four approaches from ESA, current requests from DLR (the German Aerospace Agency), and a long history of cooperation with NASA show that Australia would have no difficulty finding suitable partners in the future. A politically stable, English-speaking country adjoining Southern Asia offers advantages to partners which would, in turn, ensure our access to their world-class laboratories, facilities and expertise without having to build them ourselves. There is also increasing interest from the investment community, both locally and internationally, in Australian technology, which a more positive attitude to the space sector could unleash.

- **A Disrupted Market Favours New Entrants**

In common with other areas of commerce and technology, the space sector is undergoing an unprecedented period of disruption. Launch and operational services are no longer the preserve of heavily funded national agencies. Satellites are becoming smaller and cheaper to launch, while their data is increasingly available in real time via the internet, reducing capital requirements and the barriers for start-up entry. New companies, such as New Zealand-based Rocket Lab, are emerging in countries beyond the traditional strongholds of aerospace, proving that any developed country can compete. Much of the market growth in small satellites may occur in Southeast Asia, underlining the need to include space technology and services in the overall drive to increase Australian exports to the region.

Australian engineers and entrepreneurs are responding enthusiastically to the opportunity to leapfrog legacy competitors by reacting more quickly to technological change, unencumbered by outdated attitudes and infrastructure. More space start-ups were formed in Australia in 2015-2016 than in the last 20 years combined (see Attachments). These fledgling firms cover every segment required for a successful domestic space supply channel, including satellite manufacture, operations, software, launch systems and downstream customer services to mining and agricultural customers. These include 44 new exciting tech firms such as Hypercubes, Geoplex, Heliaq, Hexegeo, NodeSat, OtusIntel, Ubiquitous Solutions, Weebil and AU Launch Services, as well as accelerators such as the Melbourne Space Programme and the Delta-V SpaceHub.

Nearly a third of Australia's space start-ups have already secured a measure of venture capital funding, an unusual rate of success reflecting both the draw of the market and talent they offer investors. Vibrant small companies, such as FluroSat, HEO Robotics, Gilmour Space Technologies, Inover Technologies, Launchbox, Moonshot and Saber Astronautics, have secured seed funding, for example, while Fleet Space, Gilmour Space Technologies, Myriota, and Neumann Space have received Series A support.

Fleet, based in Adelaide, has raised AU$5 million in pursuit of its plan to put 100 nanosatellites in an orbital constellation to connect technology devices on Earth. The start-up's chief executive, Flavia Tata Nardini, began her career at ESA and argues that the lower costs, quicker development times and terrestrial applications of the 'space revolution' will allow Australian companies to flourish and prove their worth to government.[18] Other firms, such as OrbitAustralia and Shoal, are now established in the market, while Sky and Space Global has offered a reverse IPO and McGlaughlin Travel is Virgin Galactic's first international reseller.

The GAP Taskforce estimates that these companies have already created over 100 new jobs and generated up to AU$20 million in total revenue since 2015. They now look to grow into healthy mid-sized companies with 50 to 100 employees, generating AU$10-20 million in revenue per company per year. However, to survive and thrive they must fight off aggressive incursions from foreign competition and the conservative contracting approach of university, commercial and government customers. These companies would also have to be very savvy in attempting to enter and compete in foreign markets, given the lack of domestic infrastructure support.

An Australian space agency would offer the legitimacy and coordination they need to potentially generate AU$600 million and create 3,000 new jobs over the next five years, as they grow to mid-sized businesses.

- **Education and Research**

Australia's well-regarded education and research sectors will be critical components to success in the space sector. Australia has underutilised space, instrumentation and manufacturing facilities across the nation, including a 'cleanroom' for space hardware at the Australian National University (ANU), and many of its scientists and engineers are eager to pursue space-related R&D. The value of these existing physical and human assets would be maximised by a more concerted and coordinated space effort through the auspices of a space agency.

The Economic Potential

- **Foreign Income and Exports**

A domestic space industry will be able to sell or exchange satellite systems, imagery, analysis and related services to other nations, as well as meet a greater fraction of domestic demand. 'In-house' capability will allow Australian firms to build parts of large satellite orders for Australian customers placed abroad through contractual offsets. No Australian company was offered the opportunity to contribute to the NBN satellites, for example, meaning the whole of that considerable investment was lost to the nation.

Foreign firms with proven flight records in foreign markets dominate our domestic needs because Australia has no domestic supply channel, but this dominance makes it hard for home-grown start-ups to compete. New space companies in Australia, as well as academic institutions, must rely on US suppliers, but encouragement for a domestic supply channel would soon begin to recapture funds that would have been lost overseas, while building the flight 'heritage' required for Australian firms to compete for contracts overseas.

Once Australia establishes a sound track record with locally produced small satellites and components, it will be in a better position to create significant export opportunities with foreign customers. Australian suppliers will then need to differentiate themselves through technology as well as key relationships to succeed, but by leveraging the nation's recognised capabilities in robotics, intelligent systems, data, and operations, Australia can compete in other nations. Australia can reap particular export advantages in Southeast Asia where other regional powers tend to be less commercially focused. Australian firms can therefore dominate the small satellite market in Southeast Asia and enter the EU market through a relationship with ESA, as well as begin to balance American dominance in the domestic arena.

- **Government Spending on Space Services will be retained in Australia**

The Australian Government spends significant funds on space infrastructure, data and services. A 2010 report estimated that AU$100 million is spent offshore on space imagery to meet Australia's needs for Earth Observation[19], while significant one-off items in recent years includes the AU$2 billion spent on the NBN satellite system (see Appendix *"Australian Government expenditure on space-related activities and data"*).

Developing domestic capabilities will ensure an increasing fraction of this spending is retained within our borders. The use of Australian technology to tackle maritime piracy or increase agricultural production could recoup its costs within five years. The value of commercial applications, such as civil engineering, forestry, agriculture, energy and insurance, is expected to grow at a compound annual growth rate of 11.6% to reach US$6.5 billion by 2023.[20]

- **Australian companies will access a US$350 bn space market**

The global space market is already worth US$350 billion per year and has grown by US$100 billion in the last decade alone.[21] Ten years ago, an Australian Senate inquiry[22] assessed the global space industry and urged Australian participation as a national priority; however, Australian firms have secured only a small fraction of the market since then. Canada, a country of similar size and capability, developed a CA$5.3 billion space industry after creating their space agency and achieving associate membership of ESA.[23] There is no reason why Australia cannot follow suit.

As in many other industries, disruptive entrants enjoy a disproportionate impact through cheaper technology, leaner approaches and lower-capital start-ups. This proven approach offers a model for Australian success in space. Over 44 new Australian businesses entered the space sector in 2015-16 (see Attachments), showing the depth and breadth of interest and ambition in this country.

However, in contrast to their international competitors, these innovative Australian firms lack the legitimacy and contacts delivered by a national space agency and so cannot reach their full potential. Our most talented engineers are therefore attracted overseas by greater opportunities, wasting the public investment in their education. Australia's aerospace primes are owned by European or American companies and merely sustain an Australian fleet, and so although the Australian Government invests billions to acquire and sustain their platforms, their profits are pocketed abroad, rather than invested into Australian R&D.

A more vibrant domestic environment could see these Australian firms create 3,000 new jobs over the next five years as they scale into mid-sized businesses.

- **Smart use of space assets will deliver government savings**

Australia's national security responsibilities range across the Australian Antarctic Territory and the vast Southern Ocean, as well as the nation itself. Making the best use of satellite data across different government agencies is therefore critical to efficient, effective monitoring and control. From recording the agricultural runoff damaging the Great Barrier Reef to emergency and disaster planning, a technically savvy oversight organisation in the form of a space agency would deliver significant savings and improve the return on public investment by informing decision making, reducing duplication and maintaining a centralised repository of imagery.

National Defence and Cyber Security and Innovation

Space plays a critical role in Australia's national security. In addition to satellite imaging for defence purposes, satellites pass significant amounts of sensitive information including GPS signals, Asynchronous Transfer Mode (ATM) data and telemetry from critical infrastructure. Ensuring that a greater proportion of space hardware and data is Australian-built and owned will improve the nation's cyber security at a time of increasing cyber-espionage and attack from hostile nations.

The new space companies springing up in Australia can produce datasets for defence that are independent of foreign influence. Programs such as Defence Innovation Hub are already starting to use new domestic capabilities to benefit military assets and account for requirements specific to Australian needs.

New satellites are also a potential vector of attack for Australia's adversaries. This means that Australian Defence will need to protect new data channels to ensure national data supply is maintained under threat or enemy action. A recent report by the Center for Strategic and International Studies[24] on the implications of ultra-low-cost access to space argues that it will allow hostile nations to deploy space-based weapons and counter-weapons systems on a massive scale, threatening the communications infrastructure the free world depends upon.

The knowledge economy depends on fast and reliable internet and telecommunications, but Australia's links with the rest of the world hang by a literal thread, as the fibre cables which connect our major cities of the world also lie at the mercy of the fast-expanding submarine fleets of China and other regional powers. If these cables were deliberately compromised during times of international tension or hostility, Australia would have to rely on satellites vulnerable to attack themselves, without the ability to build or launch any of its own.

- **Innovation in the Wider Economy**

Just as the railways and roads of the 19th and 20th century drove the nation's economic and social development, so space infrastructure, linked to smart mobile devices and the 'Internet of Things' will drive growth in the 21st. Best-practice precision agriculture, for example, increasingly depends on space-based monitoring to increase crop yields and minimise mechanised soil compression, while the orbital detection of terrain faults is already saving lives in Australia's mines.

Above all, a successful innovation economy needs a smart and inspired workforce. Just as the 'Space Race' of the 1960s inspired a generation of American engineers and scientists and laid the foundations for Silicon Valley's success, so a vibrant Australian space sector, organised around a proper vision and theme, would galvanise student interest in STEM education and long-term careers in technology. Turning our back on the future will only ensure our best and brightest leave our shores, never to return. PlanetLabs and Rocket Labs, founded by Australian talent, attracted US$500 million of investment in 2015-2016 and created 300 high tech jobs in the US and New Zealand, after they were forced to leave Australia due to lack of opportunities and support.

LAYING THE FOUNDATION

The vision of a thriving Australian space sector will be realised through the accretion of practical projects on top of a strong foundation of institutional support and international links. Commercial, profit-making projects of direct and demonstrable financial benefit to the nation are the key to securing support. However, these projects can only attract private investment and paying customers if they are based on the strong, but relatively inexpensive, foundations of a space agency and ESA membership, funded in partnership with the private sector.

A Commercially Driven National Space Agency

A federally mandated space agency, funded through industry and venture capital contributions, would offer a focal point for entrepreneurs, engineers, academics, agencies and foreign entities to share knowledge and capital.

The agency would not fund major projects from the public purse. Instead, it would streamline existing spending and engage the dynamism of the domestic space market. It would be funded through partnerships with private industry, reflecting its role as an enabler of private enterprise for nationally beneficial ends.

Several factors led to the creation of the Commercial Space Agency concept:

1. **Balancing Political Will and Perceived Cost**. Despite many calls by space industry experts for an Australian Space Agency[25] in the past, there remains hesitation by political actors to mitigate the high costs spent by larger nations. The Commercial concept delivers the benefits of an official agency without risking further costs.

2. **The Need to Facilitate International Cooperation.** Australia must partner with other nations to progress, given its relatively small size, but such cooperation depends on the creation of a Space Agency. The Agency would leverage and centralise opportunities with other national space agencies, offer legitimacy and support to Australian firms competing in global markets and allow domestic manufacturers to tender for major international projects.

3. **The Reality of Current Market Disruption.** The Space 2.0 era of commercial exploitation by private sector firms will happen with or without Australian involvement. The only choice is whether Australia profits from this fast-growing sector as a supplier or pays as a dependent customer. Fast-growing companies such as RocketLabs and Planet.com are examples of Australian innovators who were forced to leave the country to find funding. Meanwhile, American suppliers of small satellites have risen from start-ups to achieve market dominance, and many Australian companies are now reliant on them. Australian firms will be locked out of competition as the market matures, if action is not taken now.

4. **The Opportunity to 'Jump Start' a Small Satellite Manufacturing Sector** to achieve a more balanced relationship with US suppliers and generate export opportunities in the EU. Creating a space agency would allow Australia to reap the benefits of a disrupted market, and the creation of a domestic small satellite sector would also support larger missions such as the next NBN Co, Optus, or national satellite of the future.

5. **The Potential to Unlock Investment Interest in Australian Space.** The mere existence of the Agency would unlock significant investment opportunities from State Governments and private sources to support high value projects outside of conventional tax channels. Several State Governments, including South Australia and the ACT, have clearly expressed their willingness to invest[26], and private investors have privately assured GAP of their willingness to match funding from states.

As researcher Haimin Huang noted in a recent article[27] for the Australian Strategic Policy Institute, *"a space agency isn't about making a decision — it's about giving decision-makers options*". A Commercial Space Agency would reflect political will and offer public presence in a similar manner to traditional agencies, but would offer greater flexibility in a fast-changing market. New teams making small commercial satellites can now produce their product within two years, while experienced commercial teams with heritage hardware and LEAN practices can typically manufacture missions in six months. These short cycles naturally facilitate innovation in contrast to the longer-term programmes of larger organisations.

The focus on small satellites would not rule out engagement with larger missions, but would facilitate participation in projects normally sent overseas due to a lack of local suppliers.

The commercial focus of the Space Agency would ensure projects were both market driven and sustainable by meeting the needs of the Australian population. This would ensure electoral support of the concept and tighten links between Australian consumers and the nascent space industry. Future administrations would of course retain the flexibility to fund large infrastructure or pure research projects if deemed to be in Australia's interest, but commercially driven projects supported by industry partnership will remain the norm.

Further consultation would be required to determine the merit, scope and functions of a new agency, and stakeholder expectations would have to be managed to ensure budgetary restraint, but states such as South Australia are already developing a space action plan and could contribute to hosting such a facility. The government's contribution – if one were required - would have to be gleaned from existing state and federal budgets to top up private sector sponsorship and support.

Fiscal reality means that staffing would also have to come from existing government agencies, but the member stressed the importance of an independent, standalone body, rather than an office sequestered away in some existing branch of the government. Legislation might therefore be required to enshrine its independence from both political and commercial influence and assign public servants to ensure continuity of service. The only staffing exception might be the appointment of an agency head through an international search to ensure the most qualified and experienced person is given the job, but such candidates can also be found in Australia.

Associate Membership of ESA

International cooperation helps share the benefits and costs of space activity. The establishment of a federal space agency is required to allow the oft-mooted partnership with ESA to become a reality. Such international partnerships have long been suggested as a way to encourage Australian space development. In 1985, the Madigan Report[28] urged Australia to consider negotiations with other West Pacific nations to create a regional body to generate the synergy which ESA has brought so beneficially to its members, while ESA itself has offered associate membership to Australia on at least four separate occasions.

ESA now requires associate members to have their own national space agency, but still guarantees that its membership costs would be reimbursed by contracts for Australian companies while giving access to a wealth of space data and engineering expertise. Canada, a country analogous to Australia with a thriving and lucrative space industry, based on an active national agency and the international partnerships this affords, has reaped hundreds of millions of dollars of business from its participation in ESA. ESA annual reports show that for the last 20 years, 98% of Canada's financial contributions to particular projects have resulted in industrial contracts directly back to Canada.

ESA is apparently willing to grant Australia associate membership for US$5 million a year for five years, a cost of $25 million in total. Money raised from the private sector could be used to pay in full or in part for associate membership for this initial term, with the arrangement extended, if it proved beneficial to its stakeholders.

While the start-ups which would benefit from such an agency may not be in a position to financially support it, several large defence suppliers vying for part of the Commonwealth's AU$190 billion defence programme are looking for opportunities to demonstrate their willingness to work in Australia, and could be approached to provide perhaps AU$1 million a year each in funding.

For a modest investment, Australia's nascent space industries would then have access to a large new market and more than four decades of engineering know-how. As the Labor party has already backed the creation of an agency, bipartisan support could allow a long-term plan to be maintained across political administrations.

PRACTICAL PROJECTS

Once the twin foundations of a domestic agency and an international collaboration have been laid, numerous projects proposed by a range of groups and entities will become more feasible. Such ideas include building on Australia's world-class expertise in spatial data collection analysis, dissemination and application through the Interactive Digital Earth for Australia (IDEA) project. Upgrading the nation's positioning infrastructure to establish highly accurate, openly accessible position data across its land mass and maritime jurisdictions would also be of great benefit. Other ideas include improving the analytical capacity of the Bureau of Meteorology and supporting the micro-satellite programmes of NSW and other leading universities.

Any proposals in this arena should be well-developed, with a clear purpose and an awareness of the context in which they would fit. Potential projects must be specific about their intent and resource implications and align with existing government priorities. Projects aiming to fill an identifiable gap must specify how they will achieve this and their benefit to Australian industry.

In the light of these guidelines, Taskforce members offered a raft of schemes of their own, ranging from research and ground and flight services to new launch sites, vehicles and satellite systems. These schemes offered graduated steps in cost and ambition, allowing capability to grow over time. Taskforce members have already held exploratory conversations with prospective suppliers, investors and customers, and these stakeholders underlined that official backing by a dedicated space agency would unlock funding opportunities and larger markets.

A VISION FOR AUSTRALIA'S SPACE INDUSTRY

The Taskforce's positive and productive vision of Australia's future in space is shared by thousands of other entrepreneurs, engineers and STEM students. SpaceX is already launching more rockets than any nation state, including the US, China, Russia, or the EU. The success of SpaceX and other commercial space companies, coupled with the reliance of everyday life on satellites and space-based technology, proves the future is happening today. Australia must take the opportunity to catch up in the current disruption of the industry, or be left behind for good. The nation can indeed develop an internationally competitive, export-oriented domestic space industry worth AU$3 billion a year over the next decade, creating thousands of high-technology jobs, inspiring a new generation of STEM students, and delivering innovation to all corners of Australian life, and the government can help its development.

A thriving domestic space sector could take the lead in under-developed areas such as space traffic control, leverage Australia's expertise in spatial data, foster links with international agencies and projects, and transfer powerful space technology to other industries. As well as designing, building and launching satellites ranging in size from nanosats to major platforms, Australian space services could optimise mining operations, create smarter cities, enable precision agriculture, improve transport logistics, ease insurance planning, upgrade telecommunications and support emergency services. A growing Australian space sector would generate a host of direct and indirect economic benefits, benefitting rather than draining the public purse.

A domestic space effort would also demonstrate the government's commitment to innovation, exports and STEM education. The industry-driven development of a vibrant and internationally competitive space sector would generate technological advance and export revenue and inspire a new generation of engineering and science students and stem the 'brain drain' of technology talent abroad.

The current review of the 1998 Space Activities Act should remove some regulatory barriers to private sector progress, but the government could also take action to integrate a new push for space utilisation as part of its own major commitments in the realms of defence procurement and NISA 2.0 and NISA 3.0. Cooperation with the states should also be pursued, given the interest of the ACT and South Australia in the space industry. South Australia has a space action plan, for example, and looks to host any proposed space agency, opening co-funding options to achieve it. On 21 August 2017, South Australia and ACT have already signed a five-year Memorandum of Understanding to work together towards the creation of a Canberra-based agency with an engineering centre in Adelaide.[29]

A long-term bi-partisan vision and relatively minor financial support would encourage activity and investment in a nascent space sector. There is no shortage of government agencies[30] covering every aspect of business, the arts, the professions, the environment and other spheres of worthy endeavour, but many of these cover sectors with far less commercial, social and technological impact than space.

The vision outlined in this report is ambitious but eminently attainable, given Australia's existing expenditure and resources, if the necessary organisation and commitment is put in place. The talent, energy and drive of Australia's space entrepreneurs and engineers will take the industry forward at a dizzying pace, if the basic requirements of an agency and ESA membership are delivered.

The space industry is more than just another economic sector. It will define our species' future on this planet and beyond. If Australia wishes to become a nation of the first rank, it must grasp this opportunity before the rest of the world leaves it behind. Practical steps towards this vision over a five and ten-year time frame could still be announced at the IAC, followed by a five to ten-year plan completed in the New Year.

Australia has long lamented its failure to produce its own Steve Jobs or Mark Zuckerberg. It still has a chance to find its Elon Musk.

Recommendations

To achieve this long-term vision of a vibrant and exciting Australian space industry, a series of near and mid-term goals must be set and achieved.

Over the next five years Australia should:

- Establish a modest Australian Space Agency, funded by public-private partnership, to coordinate existing and emerging civilian efforts and leverage current public spending. This would not remove funding from other agencies, but would maximise value for money and develop opportunities for the domestic industry to grow.
- Develop public and private partnerships in Australia and with international partners to nurture start-ups in small satellite research, development and manufacturing to attract AU$600 million in commercial investment and create 3,000 new jobs.
- Seek similar partnerships to facilitate R&D in remote sensing and the utilisation of satellite data to meet Australia's unique needs in terms of size, distance and low population density.
- Link new Australian firms to Australian Government tenders to maximise the amount which stays within the country, rather than being spent abroad. Fifteen percent of the Government's space expenditure could be captured in the first five years through meeting low fidelity requirements.
- Pursue the international corporate and government collaborations required to secure Australia's role as a space technology provider.
- Encourage the growth of domestic, independent capability to deliver subsystems and components for large Australian satellite orders and deliver small commercial satellites complete.

Building on this foundation, over ten years we should:

- Seek export opportunities in Southeast Asia and Europe for Australian subsystems, small satellites, and data products.
- Select and pursue a larger infrastructure project, such as a small satellite launch site, to meet Australian needs and international demand.
- Partner with commercial space tourism companies to use Australia as a base for Southeast Asian operations.
- Use the significant space-related investments we have accumulated to market domestic satellite systems and data analysis to customers at home and abroad.
- Capture 50% of Government purchasing by targeting higher fidelity contracts as domestic capacity increases, further reducing the need for foreign imports.
- Begin the domestic manufacture of large satellites capable of handling Australian national data needs on the scale of the AU$2 billion NBN Co satellite.

APPENDICES

Background Reading

GAP Summit Speeches*: http://www.openforum.com.au/forums/spaces-of-australian-innovation/*, particularly "Innovation in outer space and opportunities for Australia" by Andrea Boyd

Australia's Satellite Utilisation Policy: *http://www.industry.gov.au/industry/IndustrySectors/space/Publications/Pages/Australias-Satellite-Utilisation-Policy.aspx*

Space Activities Act 1998 Review: *https://www.industry.gov.au/industry/IndustrySectors/space/Pages/Review-of-the-Space-Activities-Act-1998.aspx*, particularly the "Issues Paper"

Australia's Civil Space Coordination: *http://www.industry.gov.au/industry/IndustrySectors/space/Civil-space-coordination/Pages/default.aspx*

Advanced Instrumentation Technology Centre: *http://rsaa.anu.edu.au/technology/advanced-instrumentation-technology-centre*

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DefenceSA portfolio: *http://www.defencesa.com/capabilities/space*

ACT Government: *http://www.investcanberra.com/opportunities/space,-satellite-and-spatial-science.aspx*

NSW Government: *http://www.industry.nsw.gov.au/business-and-industry-in-nsw/key-industry-sectors/defence-and-aerospace*

(Informal) History of Space in Australia: *https://quokkaspace.wordpress.com/the-full-history-of-space-in-australia/*

Australian space start-ups and notable SMEs

Below is a partial list of notable Australian SMEs, many of which formed in 2015-2017.

1. AU Launch Services
2. Av-Comm
3. (Seed) CubeRider
4. Curiosat
5. Delta-V SpaceHub
6. EoVision
7. Equatorial Launch Australia
8. (Series A) Fleet Space
9. (Seed) FluroSat
10. (Seed) HEO Robotics
11. (Series A) Hypercubes
12. Geoplex
13. (Series A) Gilmour Space Technologies
14. Hexegeo
15. (Seed) Inover Technologies
16. Irriscan
17. (Seed) Launchbox
18. Luna Letter
19. Melbourne Space Program
20. (Seed) Moonshot-X (Accelerator program)
21. (Established) McGlaughlin Travel (Virgin Galactic's first international reseller)
22. (Series A) Myriota
23. NearSat
24. (Series A) Neumann Space
25. NodeSat
26. (Seed) Obelisk Systems
27. OtusIntel
28. (Established) OrbitAustralia
29. Outora
30. Ovass
31. Ozius Spatial
32. Oz-Cube1
33. Project Thunderstruck
34. Rupples Griffin
35. (Seed) Saber Astronautics
36. (Established) Shoal
37. Singulan Space
38. (Reverse IPO) Sky and Space Global
39. Small World Communications
40. Space Ops
41. Station Innovation

42. Takor Group
43. Ubiquitus Solutions
44. Weebil

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12 APAC 2015 Report

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