Senate Standing Committee on Economics

Inquiry into the Current State of Australia's Space Science and Industry Sector

Submission

April 2008

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1 INTRODUCTION

In the 50 years since the launch of the first satellite, the importance of space to humankind has fundamentally changed. What started as a Cold War military race between superpowers has been transformed into a rapidly growing industry with revenues exceeding USD $120 billion worldwide[1].

At the beginning of the 21st century products and services that depend upon space are deeply embedded in our modern way of life. Although often unrecognized by the general public, space derived data is an essential element of our modern economy.

Dependence on space derived data is profound. It has become an essential utility. For example:

1. Space derived data forms the backbone of our modern weather forecasting and storm prediction services.

2. Satellites provide critical communications links, particularly to the many areas worldwide which do not have access to other forms of communications. Satellites are often the only means of communication in disaster areas and constitute an essential element of disaster response and relief operations[2].

3. Timing signals from Global Positioning Satellites (GPS) are used to coordinate transactions in the global finance industry such as ATM withdrawals, credit card transactions and stock exchange transactions and are used by the mobile phone networks to provide reference timing to coordinate mobile phone calls.

4. Navigation signals from GPS satellites provide essential positioning data for ships and aircraft and, increasingly, the trucking industry and recreational users. Flight navigation and air safety systems increasingly rely on satellite signals to maintain proper altitude, heading and separation for approach and landing.

5. Modern agriculture increasingly relies on satellite derived data for long term weather forecasts and navigation data for precision farming practices[3].

6. In the critical realm of climate change, the majority (25 out of 44) of the Essential Climate Variables needed to monitor the global picture of change can only be measured from space.[4]

As with other essential utilities, our modern economy would be seriously affected if these services were to cease or if access to them is, for any reason, denied. Nations are recognising the critical importance of these services and are taking steps to ensure their supply.

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[1] The Space Economy at a Glance, OECD 2007. Another private survey estimates global space revenue from government and private sources at US$251 billion in 2007 - see The Space Report 2008 http://www.thespacereport.org/

[2] The rescue of yachtsman Tony Bullimore in the Southern Ocean in 1997 would not have been possible without the activation of a satellite rescue beacon

[3] At a more basic level, the CSIRO is developing "virtual paddocks" for cattle using GPS units in collars worn by each animal. The boundaries of their permitted grazing area are set and the cattle are prevented by mild electric shocks from going outside those areas.

[4] Systematic Observation Requirements for Satellite-Based Products for Climate, Global Climate Observing System, World Meteorological Organization, GCOS-107, WMO/TD No. 1338, September 2006

Space is no longer only about the rockets and satellites that go into the sky. Nations are now aware that space is a portal into high technology, a catalyst or an enabler for a wide range of technologies and disciplines.

The challenges involved in getting into space and deriving data from that vantage point requires the participation of many industries. Manufacturing, high temperature materials, advanced chemistry, information processing, telecommunications, computing, data processing, project management, finance and legal are examples. Future space ventures will rely heavily on new and emerging technologies such as nanotechnology, robotics and biotechnology and health technologies. Nations are recognising that an investment in space can be a catalyst to stimulating innovation across the spectrum of existing and emerging high technology industries.

Space still fascinates the general public. It is one of the most reported on areas of science and one of the most popular topics for schoolchildren the world over. Australian astronauts, Paul Scully Power and Andrew Thomas, have achieved marvellous feats in space and have inspired Australians, young and old. Space attracts students in increasing numbers to tertiary studies in engineering and the sciences. It helps to enhance the technically trained workforce that is essential to the modern world. It attracts high calibre researchers and boosts scientific work in fields such as environmental research, astronomy, human sciences, telecommunications and other technical areas where space technologies are key enablers.

The critical importance of space derived data in modern society, the utility of space projects as a focal point for innovation and in the generation of a technically trained workforce and the growing economic importance of space have been the drivers of a rapid expansion in the number of space capable nations. Nearly 50 nations now have active government supported programs. The most rapid expansion has occurred in the Asian region where 11 countries have active programs, including the emerging space superpowers, China, India and Japan.

The contrast between Australia's focus and investment in space and the commitment of other countries raises serious questions for this country.

Therefore the key themes of this submission are that:

- Australia can no longer afford to ignore the risks of dependence on foreign space systems for critical services and

- As a modern, technologically advanced nation with ambitions to increase productivity and improve the lives of our citizens, Australia must increase its contribution to the global space effort.

The Inquiry by the Senate Economics Committee into the Current State of the Australian Space Science and Industry Sector is both timely and welcome.

2 ABOUT ASICC

The Australian Space Industry Chamber of Commerce (ASICC) was formed in 1992 as a national organisation to promote the Australian Space Industry. Its charter is to:

1. Create a forum for interchange of ideas about space projects and ventures

2. Provide a point of contact for organisations seeking information on Australian companies involved in space

3. Provide the mechanism by which the Australian Space Industry can formulate an industry view on matters affecting Australian space activities and

4. Foster public awareness of the space industry in general.

ASICC takes a leading role in advising government on behalf of the Australian space industry. ASICC consults with its members to devise policies to support the development of the Australian Space Industry and is active in promoting and facilitating commercial, industrial and research opportunities for its members nationally and internationally.

ASICC provides a forum to focus the individual interests of its members into a collective industry-based voice. Through harnessing the skills and expertise of its members, ASICC addresses issues of common concern to individuals and businesses involved in or seeking the benefits of the space environment.

ASICC's membership represents the diverse character of the Australian Space Industry including satellite operators, telecommunications companies, IT companies, satellite manufacturers, engineers, scientists, researchers, legal firms and consultants.

ASICC plays an active role in presenting industry views on space matters to Federal and State governments. Major undertakings have included:

1. Key contributions to Space Policy Advisory Group to assist Senator Chapman's Space Policy Submission in 2005[5]

2. Analysis of Australian space capabilities in response to a NASA call for 15 key technologies for future spaceflight

3. Representation and liaison with satellite operators for ACMA's newly formed Radio Communications Council

4. Contributions to the International Space Advisory Group Report to PMSEIC in 2002

5. Industry submissions that lead to the Space Activities Act 1998 and regulations under that Act

[5] Space A Priority for Australia, Submission to the Australian Government, December 2005

6. Efforts to obtain GST exemption for the import of launch vehicles and satellites for subsequent launch from Australia

7. Lobbying on behalf of Australian organisations for relief under the US arms control restrictions for commercial satellites

8. A submission to a Senate Committee on the required level of insurance for satellite and launch operators

The ASICC website http://www.asicc.com.au provides additional information about ASICC and the Australian Space Industry.

3 TERMS OF REFERENCE

Australia's capabilities in space science, industry and education

Australia has consistently demonstrated that it has the technical and intellectual capacity to be a major force in space science, industry and education.

Australia became the seventh nation to build its own satellite and the fourth nation to launch an indigenously built satellite from its own territory when it launched WRESAT from Woomera in 1967. The WRESAT satellite was designed and built in less than one year and its ozone experiment was a precursor of the intense interest in this field today.

Since its initial achievements and with varying levels of government support and under changing government space policies, Australia has developed significant space capability in a number of areas:

1. Satellite tracking stations – Australia has been a major base for tracking stations for both space agencies and companies since the beginning of the space age. Australian staff operate major tracking stations for NASA, the European Space Agency, the Japanese Space Agency, previous treaty organisations Intelsat and Inmarsat, the US Government and a wide range of private companies.

2. Satellite operations and services – A number of satellite operators have operations in Australia and provide services into Australia. Australia is home to a large number of teleports serving the satellite industry and most satellite communications services are marketed in Australia.

3. Ground Station design – CSIRO Radiophysics is world renowned for its expertise in antenna design. The six Optus A and B series satellites all carried antennas which benefited from this expertise.

4. Communications to remote areas – The School of the Air in New South Wales and the Northern Territory is now delivered entirely by Optus satellites to some 700 remote properties. Satellite is the only logical communications medium for isolated properties as it is ubiquitous and, unlike a terrestrial based system, the cost does not depend on the distance between the communicating parties.

5. Radioastronomy - The Australian radio-astronomers have a world class reputation and operate world class radio-telescopes at Parkes and the Australian National Telescope Facility. Australia has been shortlisted as one of the two sites identified as potential locations for the Square Kilometre Array, one of the largest and most ambitious international science projects ever devised[6].

6. Optical Astronomy - Australia also has significant capability in large telescope optical instrument design and construction, as was demonstrated with the Near-infrared Integral-Field Spectrograph (NIFS) at the Mount Stromlo Observatory in collaboration with Australian company, Auspace, when the latter still had facilities and capabilities in space borne instrument construction. The NIFS

[6] See http://www.ska.gov.au/default.htm

instrument is located at Hawaii's Gemini North telescope[7].

7. Signal and Data Processing – Australian organisations such as the Institute of Telecommunications Research of the University of South Australia (ITR), Optus8 and DSpace have world class expertise in signal processing and/or modem design for satellite systems. Free space optical communications is a recent area of potential research interest in Australia.

8. Satellite Laser Ranging and Space Debris Tracking – Electro-Optical Systems (EOS) is a world leader in Satellite Laser Ranging and laser tracking systems and works with major space agencies in space debris detection, mapping and tracking.

9. Processing and Interpretation of Earth Observation Data – Australia has a highly developed spatial information Industry and is particularly good at the provision of geospatial data, imagery and imaging software for user applications.

10. Propulsion – The Australian National University has made a significant breakthrough in plasma thrusters and is now working with ESA to develop this technology for long life space missions. The University of Queensland's Hyshot scramjet project achieved the world's first flight test of supersonic combustion in a scramjet engine and is a world leader in scramjet engine research with the current HyFire program.

11. Robotics – Australia is developing significant space robotics capability particularly at the University of Sydney that has drawn the attention of NASA.

12. Health Sciences – Australia has a number of medical research areas that have attracted the attention of NASA to assist in research on bone density and blood issues which are critical to long duration spaceflight including the Garvan Institute in Sydney and the Baker Medical Research Institute in Melbourne.

13. Support & Service Industries – Australia has significant legal and consulting expertise in the space field that are more often employed by foreign firms than Australian companies.

14. Education – Australia is a leading provider of undergraduate education in Aerospace Engineering and other space-related science and technical disciplines, and has also achieved success and recognition in graduate level professional level programs.

Australia currently has a wide range of capabilities that are directly relevant to the technologies necessary for the next generation of space missions for international space programs. This was borne out by the findings of an ASICC study into Australian capabilities to support NASA's Exploration Vision - The Return to the Moon and then to Mars in 2004. This study found that Australia had capabilities in all 15 critical

[7] This instrument design and construction capability evolved from a long relationship between the Mt Stromlo Observatory (MSO) and the Australian company, Auspace. Space instruments like the Along Track Scanning Radiometers orbiting on ESA satellites ERS-2 and ENVISAT were built in Canberra by Auspace in its early days. Much of Auspace's capability has been lost but the MSO has preserved the ability to continue with instrumentation work.

[8] Over the last 12 years Optus engineers have developed digital signal processing tools for our satellite communications system monitors. This was because there was no applicable equipment available overseas. The same technology has now been used in a patented Common Path Distortion Analyser used to detect faults in fibre optic cable lines.

technology categories identified by NASA as essential to future space exploration (see **Appendix 1**). The results of our study are further evidence that Australia clearly has the technical skill and intellectual capacity to play a major role in the global space industry and in the space research sector.

Over the years Australia has consistently shown that, when given the funding, it can produce space hardware that is internationally competitive. Australia has produced several world class space instruments including the Endeavour Ultraviolet space telescope which has been used to measure the ultraviolet signature of stars and celestial bodies from the Space Shuttle.

Australian companies built two significant instruments which are currently flying on European Space Agency (ESA) environmental monitoring satellites: 1) the Along Track Scanning Radiometer (ATSR-2) on ERS-2, and 2) the Advanced Along Track Scanning Radiometer (AATSR) on Envisat. These Australian built instruments measure sea surface temperatures and are critical in providing advanced warning of the El Nino and La Nina effects in the Pacific Ocean which have such a significant impact on Australia's weather and drought forecasts.

Australia also designed, developed and successfully operated Fedsat, the most complex microsatellite yet built when it was launched in 2002.

While these projects demonstrate the technical skill and capacity of Australian science and engineering there has been a notable lack of a policy to sustain this capability for the long term. As a result, most of these projects have been ad-hoc and singular events. Since the completion of the Fedsat project and the closure of the CRC for Satellite Systems the satellite development expertise assembled for Fedsat has been dispersed in the absence of a follow on project.

Arguments for and against expanded Australian activity in space science and industry

i. Risks to Australia's national interest of Australia's dependence on foreign-owned and operated satellites

Australia's Current Exposure

Against the background of expanding global space activity, at the beginning of the 21st century Australia's position is quite striking.

1. Australia is heavily dependent on space derived services yet it has no coordinated approach to obtaining and maintaining access to these services.

2. In contrast to the increase in the number of national space organisations globally, Australia is unique as the only country to have disbanded its national space coordinating body in 1996 and is one of the few countries in the Asian region not to have a nationally coordinated space program.

3. In an era of increasing importance of space to national security and increasing diplomatic tensions in space, Australia's lack of a government body to coordinate its national strategic interests in space places Australia in a position of diminishing influence and increasing isolation, both regionally and globally, and raises significant questions about Australia's ability to respond effectively to these challenges.

4. In a world where there is an increase in international collaborative space projects, Australia's passive ad-hoc approach results in missed opportunities for Australian companies and researchers.

5. In a time of growth in the global space industry the Australian space industry is barely surviving. Australia built one of the world's most sophisticated small experimental satellites, Fedsat 1, but the lack of any further funding and the consistent lack of support over the last decade has lead a number of space capable companies to cease their activities in space. Later in this submission we quote some specific examples.

National Security Risks

More specifically, dependence on the space systems of other countries or other service providers exposes Australia to a variety of national risks. This issue was a central theme of Senator Grant Chapman's space policy submission to the Australian Government 'Space – A Priority for Australia' (December 2005).

As pointed out in that submission, dependence on space assets and space systems that we do not own or control:

- exposes us to serious harm in the event of disruption to services and data
- leaves us open to political pressure from the nations that control the services
- opens us to the possibility of using degraded, outdated or misleading data
- places us at risk of being excluded from participation in the benefit of future global systems, involving international cooperation and the combining of resources and expertise
- puts us at the mercy of commercial forces that may result in services being restricted or discontinued

- means that we are unable to detect unfriendly incursions from space by other countries and
- prevents us from strengthening international and regional relationships through collaborations and exchanges in space missions.

With the rise of new space-faring powers, access to space and the use of space resources is not free from international contention[9]. The US, Russia, China and India have all announced Moon missions. Space spectrum and orbital positions are finite resources that require international coordination. Asteroids are already being targeted for mineral exploitation. The exploitation of space resources and combating space debris are among the issues that the international community will continue to address in international space forums.

Space derived data is already a major component of modern warfare and the major military nations are rapidly moving to network centric warfare where the command, control and communications for the individual soldier on the battlefield is almost completely derived from space systems. This makes these systems a potential target in the event of a major war and denial of space derived data is a real possibility. In the past year both China and the US have demonstrated their capability to destroy an orbiting satellite with an earth based missile. With the militarisation of space and the increasing competition for access to key space resources such as orbits and celestial bodies, the high ground of space is becoming an increasingly important international strategic issue.

Astronomy, space science and some high end Defence applications have strong synergies at industry level. Considered together, they provide a basis for a sustainable industry sector, vital to the national interest. The skills, competencies, laboratories etc. which are necessary for astronomy are similar to those needed to support satellite design, construction and operations and are similar to those needed to support electronic warfare in the defence/national security domain.[10]

Skills, Productivity and Innovation Risks

In addition, dependence on the space systems of other countries or other service providers severely limits opportunities and incentives that we could otherwise provide for young citizens who have chosen careers not only in engineering and the sciences but also in an array of other disciplines such as business, finance, marketing, accounting and law. The recent Australia 2020 Summit recognised that there is a global 'war for talent' and the national importance of retaining 'talented, creative and highly skilled people (including researchers and scientists, entrepreneurs and professional skilled workers)'[11].

Ironically, the number of space qualified graduates in Australia is on the increase, due to the recent popularity of undergraduate degrees in aerospace engineering[12]. The problem is that there are few

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[9] In a new statement of its national space policy dated 31 August 2006, the United States asserts a right to preserve its rights, capability and freedom of action in space including taking those actions necessary to preserve its space capabilities and denying adversaries the use of space capabilities hostile to US national interests – see http://www.fas.org/irp/offdocs/nspd/space.html

[10] National capability in electronic warfare is of particular importance to Australia, in the context of global supply chains, and in maintaining expertise in universities, Government laboratories and in industry

[11] Australia 2020 Summit - Initial Summit Report 20th April 2008 p 9

[12] The University of Adelaide, Royal Melbourne Institute of Technology, The University of Queensland, The University of New South Wales, The University of Sydney and Monash University all offer undergraduate degrees in Aerospace Engineering. The scores of entrants to these courses indicate that they are among the most sought after university programs in Australia

employment opportunities for engineering and science graduates in the space sector in Australia and these graduates are being snapped up in other sectors. Engineers and scientists with experience in space projects have been forced to move overseas or are unable to return to Australia because of the lack of employment opportunities in their chosen field. The lack of space-related career opportunities in Australia is likely to be more pronounced when the current group of aerospace engineering undergraduates come on stream.

Dependence on other countries' space assets and space systems also deprives Australian scientists and researchers of opportunities to do applied research and assist in the development for the national benefit of improved applications in fields such as environmental research, astronomy, human sciences, telecommunications and other fields in which space technologies are key enablers.

ii. *The potential benefits that could accrue to Australia through further development of our space capability*

Societal Benefits

The most important justification for devoting national resources to the development of space capabilities is the benefit that accrues to the nation as a whole. **As a responsible member of the world community with ambitions to increase productivity growth and to have a world leading education and innovation system[13], it is our key submission that Australia can no longer, as a matter of international strategic policy, leave it to other countries to develop the assets and infrastructure necessary for essential public services.**

The development of national space capability requires government action and government policy leadership. More precisely, as highlighted by a recent OECD study, an overall socio-economic strategy for the space sector involves three key steps[14]:

1 Implementation of a sustainable space infrastructure

Just as the world depends on infrastructure such as ubiquitous communications transport and electricity networks, the world needs infrastructure in the form of space systems (satellites, ground segments, launchers etc) to deliver space-based services. To minimise the risks enumerated above, Australia's national interest requires an investment in some of this infrastructure as a complement to the infrastructure provided by other nations. This not an argument in favour of self-sufficiency but, rather, in favour of international collaboration.

2 Encouraging public use

Space infrastructure should be used by governments to provide solutions for long term societal needs such as environmental monitoring, disaster relief and remedying the digital divide. At a national level this includes strengthening cooperation between government agencies to encourage the use of space-based data and to facilitate transactions between suppliers and public users of space-based services.

3 Encouraging private sector participation

The end of the Cold War has created opportunities for the commercial exploitation of space, including the opening of markets and the formation of international alliances. It has lead to the development of more cost effective telecommunications networks and high resolution Earth observation data. However the 'upstream' segment (space hardware manufacturing and launch services) faces high costs and excessive supply capacity and the 'downstream' segment (space applications such as satellite communications services, Earth observation services and satellite navigation services) have an uneven record of sustainability.

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[13] Australia 2020 Summit - Initial Summit Report, ibid p 6
[14] OECD Report 'Space 2030 – Tackling Society's Challenges' (2005) p 16

To overcome the weaknesses and risks of private sector participation, governments have an important role in:

- creating a supportive legal and regulatory environment
- strengthening the market for private space goods and services and
- fostering a supportive international business environment

These should be the guiding principles of a fresh space policy for this country.

In its study, the OECD identified five major societal challenges that space has the potential, globally, to assist with[15]:

- The environment
- The use of natural resources
- The increasing mobility of people and goods and its consequences
- Growing security threats and
- The move towards the information society.

The societal challenges identified by the OECD in relation to which space systems can make useful contributions, can be summarised as follows:

1 Environmental Challenges

Earth observation and navigation systems provide data for weather forecasting, assessing greenhouse gas emissions, monitoring air pollution, detecting potential anthropogenic change, validating climate models and predicting future change.

2 Managing Natural Resources and Agriculture

Space-based data can be used for controlling power and pipeline distribution systems, hydropower dam operation and wind power generation.

Earth observation data facilitate the management of water resources through better understanding of the water cycle, by providing information on atmospheric temperature and water vapour, sea surface temperatures, ocean winds, 3-D information on rainfall structure and characteristics, soil moisture and ocean salinity.

Space technology is useful for managing forest resources more effectively and combating deforestation. Remote sensing data also provide useful information about the aerial extent, conditions and boundaries of mangrove forests and have proved extremely useful for wetlands mapping and for determining high and low water lines.

Space systems have also important application in agriculture when combined with other technologies. Global navigation space systems (GNSS) and spaced-based augmentation systems (SBAS), geographic

[15] OECD Report ibid p 207

information systems, miniaturised computer components, automatic control and in-field and remote sensing can be used to appraise the state of crops, identify areas requiring attention and target treatment automatically.

3 Security Challenges

The capacity of space-based systems to see, locate and communicate over broad areas finds a growing range of applications. Space systems can provide useful input to disaster management information systems throughout the disaster management cycle. The Global Navigation Satellite System (GNSS) allows first responders to quickly pinpoint the scene of an accident, thereby reducing response time for emergency services, while space-based telemedicine applications can enhance the ability of emergency personnel to treat victims quickly and effectively. GNSS can also be used for tracking and controlling the transport of illegal and hazardous goods. Moreover, space- based systems can be used for monitoring compliance with international treaties and for the surveillance of international borders.

4 Mobility Challenges

Space-based systems can be used for a broad range of traffic management applications, including route guidance (selection of optimum route in real time), the management of traffic flows (monitoring of traffic flows in real time, anticipation of traffic jams and implementation of remedial action in real time), fleet management, advanced driving assistance systems and road-charging schemes. Air traffic control is a major area of application of space-based augmentation systems.

5 The Knowledge Society

The R&D efforts of space agencies and other space actors create new knowledge that can be applied both in the space sector and in other sectors of the economy. Moreover, Earth observation and deep space missions generate an unprecedented wealth of data and information on the state of our planet and of the Universe.

Space also facilitates the distribution of knowledge: satellite communication is an essential element of the communications infrastructure. Satellites have specific advantages in terms of international coverage, broadcasting, flexibility and rapid deployment of service. They have been very successful in some market segments, such as direct broadcasting satellites (DBS) and help foster competition and innovation in those markets. They also provide the technical means for the delivery of some public services (e.g. in rural and remote areas, for emergency services). The role of space for the distribution of knowledge – and more generally for communication – is particularly important in developing countries, where, typically, the ground-based infrastructure is limited or non existent.

There is good reason to believe that each of the societal challenges listed above will increase in importance over time and the potential for space systems to help mitigate the adverse consequences will also increase with the expected advances in space technologies.

Economic Benefits

The potential economic benefits of further development of our space capability can to some extent be predicted by looking at recent trends in the global space industry, by comparing Australia's investment with the investment of other countries and by analysing the economic impact on the economies of other countries of those investments.

1. The size of the market

According to a recently published OECD statistical survey[16], in 2006 global manufacturing revenues (e.g. satellites, rockets) were estimated at around US$12 billion and space-related services revenues (e.g. direct to home satellite television, GPS) were estimated at more than US$100 billion.

2. National Space Budgets

Space is no longer the domain of few wealthy countries. The dominance of the US and the Soviet Union during the Cold War has been replaced by active government supported programs in 41 of the top 49 largest economies[17]. Details of national space budgets for OECD countries obtained from a recent OECD study are set out in **Appendix 2**.

More than fifty nations have procured satellites in orbit, mostly for communications purposes.

The most recent figure we have been able to locate for Australian expenditure on space-related R&D is for 2003. In that year Australia spent 0.2% of its Government Budget Appropriations or Outlays for R&D (GBAORD) on space R&D, compared in the following year with an average of 9.2% for all OECD countries, 2.2% in Norway, 2.3% in the UK, 3.8% in Korea, 4.7% in Canada and 7.1% in Japan.[18]

The rapid expansion of the space capable club has been most pronounced in Asia. China, Japan and India are now high level space powers. In 2003 China became the third nation to launch astronauts into space and India is well advanced with its plans for manned space flight. Both these nations also have advanced plans to send exploration spacecraft and ultimately men to the Moon. Japan, China and India are now major launching states and satellite manufacturers. South Korea is rapidly developing its own launch capability and satellite manufacturing industry. China, Japan, South Korea and Malaysia have active astronaut programs with both South Korea and Malaysia recently having placed their first astronauts in space. South Korea, North Korea, Malaysia, Indonesia, Thailand, Taiwan, Singapore and Vietnam all have growing space programs.

While the strong focus and expanding capabilities have been very noticeable in Asia the expansion of space capabilities is occurring all over the world. Israel is a world leader in satellite and earth observation technologies. Algeria, Nigeria and Turkey are examples of countries with developing economies which recognise the important advantages of space and the need to secure their space derived data.

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[16] The Space Economy at a Glance, OECD, 2007
[17] See Appendix B of Space A Priority for Australia, Submission to the Australian Government, December 2005
[18] The Space Economy at a Glance, ibid, p 31

3. Revenues

Worldwide estimates of space-related services revenues (the downstream segment) range from some US$52.2 billion to US$77.2 billion in revenues in 2005[19].

These figures have increased each year and revenues from the world satellite services industry (mainly telecommunications and Earth observation services) were 83% higher in 2005 than five years earlier[20].

Telecommunications services represent the bulk of commercial revenues[21]. GPS navigation is another rapidly growing ground segment commercial activity[22]. This revenue relates to ground based equipment and chipsets. Governments, particularly defence departments, increasingly use satellite capacities, as demonstrated by their use of commercial satellite bandwidth for communications as well as commercially sourced remote sensing imagery.

4. Economic impacts

According to the recent OECD study, space activities can have significant economic impacts on other sectors, although the revenue multiplier effect often takes place only after years of R&D have led to operational space systems. **In 2005 Norway found that for each million Norwegian kroner (NOK) of governmental support through the European Space Agency or national support programmes, the Norwegian space sector companies have on the average attained an additional turnover of NOK 4.4 million. This spin-off effect factor of 4.4 is expected to climb further in future years.[23]**

In the telecommunications sector, the ability to transfer and broadcast information worldwide almost instantaneously has been a revenue multiplier effect since the 1980s for telecoms and television companies and more recently Internet providers. Another study shows that the EUR 5 billion (A$8.5 billion) invested in the manufacturing and launch of telecom satellites in 2002 generated revenues of around EUR 100 billion in the largest telecommunications sector[24].

According to the British National Space Centre[25], the UK space industry is growing strongly with an increase in real turnover of 17% in 2005 and 2006. A recent study highlighted that the UK space industry:

- contributes around GBP 6.8 billion (A$14.3 billion) a year to UK GDP including indirect, induced and spill-over effects
- employs directly more than 16,000 people
- invests 12% of revenue on R&D (including external sources).

Canada is particularly active in some space-related activities and because of its similar population and economy, is a useful country for Australia to compare itself with. Public funds on space expenditure in 2005

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[19] The Space Economy at a Glance, ibid, p 50
[20] The Space Economy at a Glance, ibid, p 50
[21] The Space Economy at a Glance, ibid, p 50
[22] The Space Report 2008, Executive Summary p 6 http://www.thespacereport.org/
[23] The Space Economy at a Glance, ibid, p 72
[24] The Space Economy at a Glance, ibid, p 67
[25] BNSC Publication: A Consultation on the UK Civil Space Strategy 2007 – 2010

of CAD 236 million ($A248 million) were almost exactly the same as in 1996, while private sources more than doubled to over CAD 1 billion.

Exports matched domestic revenue in Canada by accounting for 50% of the total in 2005. Most export revenue continued to come from the US from 1996 to 2004. However, this amount has fallen to less than 50% in recent years as Europe and other countries (Oceania, South America and Africa, etc) account for greater amounts. The biggest sources of revenue were applications and services (i.e. development and provision of services/products derived from space systems).

These examples provide an indication of the significant societal and economic benefits that could flow to Australia through further development of our space capability.

iii. Economic, social, environmental, national security and other needs that are not being met or are in danger of not being met by Australia's existing space resources or access to foreign resources

While the international space industry has expanded, Australia's space capability has contracted.

In the past 10 years several Australian organisations with space expertise have simply exited the field. Companies have closed their space divisions and their staff and expertise have been dispersed. Some of their personnel have left Australia in search of employment in space programs overseas.

For example:

- Fedsat1 has reached its end of life and has been decommissioned.
- A bid for a new round of funding by the CRC for Satellite Systems was unsuccessful and the CRC for Satellite Systems has been wound up.
- The ARIES low earth orbiting satellite project, designed to carry advanced remote sensing technologies to identify surface biophysical properties and geological composition, was abandoned.[26]
- British Aerospace Australia, Hawker de Havilland and Phillips have closed their space divisions.
- Auspace, the company that played an important role in the development of three generations of radiometers for European remote sensing missions and the primary builder of Fedsat, has ceased its space-related engineering work and sold its space test facilities overseas.[27]

This reduction of resources compromises Australia's ability to meet its critical space infrastructure requirements in fields such as environmental monitoring and national security. We also forego any potential economic benefit.

The reduction in critical skills and resources also impacts Australia's ability to make intelligent purchasing decisions. In the absence of space skillsets and expertise Australia has a diminished capability to make informed purchasing decisions or engagement decisions for complex space systems from foreign sources. The ability to critically evaluate an Australian position in the space context, the knowledge to understand the implications of a proposed system or solution and the know-how to drive for a particular outcome to meet the Australian national interest is absolutely critical in this field. Without this expertise Australia is subject to the commercial and policy drivers of others for space systems and space derived data that are critical to the national infrastructure, services and the Australian economy.

Australia's needs are often not adequately met via foreign owned remote sensing satellites. Instruments for environmental monitoring, earth observation and reconnaissance are highly sensitive and are usually calibrated for a specific set of parameters. Most of these satellites are built and operated by organisations in

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[26] Australia was perhaps ahead of its time for this key environmental management and mineral mapping tool and a satellite based on the Aries specification is now being built in Germany.

[27] The Auspace name and Satellite Tool Kit franchise were purchased by Nova Aerospace but it no longer has satellite construction capability.

the Northern Hemisphere and are not always well suited for Australian needs. Some may not even have orbital characteristics to cover all parts of Australia. In the absence of Australian specified satellites or Australian participation in such programs Australia may have little choice but to source data which is less than optimum in relation to Australia's critical needs.

Reliance on foreign based satellite systems makes Australia dependent upon the political and commercial considerations of other nations for areas of critical importance to its well-being, security and economy. National systems and even commercial systems are subject to political influence and at times political control. This may not be an issue in normal times but Australia's critical needs for space derived data may be restricted or denied in times of political strife. This may be simply because the host nation needs all its satellite resources for its own purposes in such times rather than any breach with Australia but the impact on Australia could be severe nonetheless.

The legal and collaborative framework for international space activities remains largely on a government to government basis. Access to foreign resources often requires a government commitment to the program in some form. The lack of a recognised Australian Government space body not only potentially excludes Australia from the benefits of such programs but also excludes Australian industry and researchers, which usually only gain access via government involvement, from participation in these programs as well. In the absence of a strong Australian commitment to space Australia is increasingly marginalised in international space forums and collaborative programs, thus increasingly denying Australia effective options to meet its economic, social, environmental and national security needs from space based resources.

iv. *Impediments to strengthening and expanding space science and industry in Australia, including limiting factors relating to spatial information and global positioning systems, including but not limited to ground infrastructures, intergovernmental arrangements, legislative arrangements and government/industry coordination*

The most recent expression of the Government's space policy is set out in a document entitled 'Australian Government Space Engagement – Policy Framework and Overview' (November 2006).

In April 2007 the response of the then Minister of Industry, Tourism and Resources to Senator Grant Chapman's space policy submission 'Space – A Priority for Australia' was that Australia had 'adequate access to space capabilities through inter-governmental and commercial arrangements' and that 'reliance on foreign owned facilities is not unique to space technologies'. He also said that the Government believed that responsibility for civil space activities across a wide range of government agencies is appropriate 'given the wide range of matters affected by space.'

Our submission is that the intergovernmental arrangements set out in the Space Engagement Statement are only satisfactory if the Government persists in the belief that:

1. Australia has adequate access to space capabilities through inter-governmental and commercial arrangements
2. There are insufficient social, economic, national productivity or strategic reasons why Australia needs greater inter-governmental and industry/government coordination and policy direction
3. The reasons for government intervention in the space sector are the same as for most other high technology industries, and
4. Australia does not suffer social, economic, national productivity or strategic disadvantages under its current space policy.

We do not believe that the current arrangements are satisfactory and that a far more proactive approach by government is necessary to underpin and sustain Australia's capability in this increasingly vital sector.

In relation to government/industry coordination, the opinion of this industry representative body is that the effect of the Space Engagement document, while recognising the need for coordination between government agencies, is that there is little or no need for space industry/government coordination. According to the logic of the document, there are no particular coordination requirements with the space sector because space projects that deserve funding will, in competition with other science and technology projects, win funding and the needs of companies in the space sector are no different from the needs of most other high technology industries.

It is a key message in this submission that companies and research organisations in the space sector are convinced that government has a critical role in industry coordination and policy leadership, in consultation with industry. Among other things:

- Only governments can set priorities and targets for national civil space infrastructure, such as satellite systems, environmental monitoring, remote communications and Earth observation.

- Only governments can ensure continued funding for long term programs and for infrastructure that extends beyond the scope and duration of ad hoc and generic science and technology funding programs.

- Only governments can formulate policy positions and represent a country internationally in issues such as the future of international law in space, non-proliferation, orbital debris and the exploitation of resources in space.

- Only governments can enter inter-governmental agreements for cooperation and collaboration with other countries.

- Only government agencies with appropriate skills and charters can represent a country's national interests (including the interests of industry) in international space-related deliberations and forums.

The lack of a clear and focussed Australian government space policy designed to leverage Australian capabilities for the good of the nation and underpinned by sufficient funding and commitment, is a significant limiting factor in the advancement of Australian space science and industry.

v. The goals of any strengthening and expansion of Australia's space capability both in the private sector and across government

In our view the dichotomy between private sector space capability and government space capability is not important in this context and we would prefer to think in terms of national space capability.

The goals of strengthening and expanding national space capability should include:

- contributing to innovation, productivity, environmental challenges and improving the quality of life of our citizens

- reducing our dependence on critical space derived data controlled by foreign players

- enhancing our ability to address national environmental and resource issues such as water planning and conservation, climate change, mineral exploitation, agriculture and remote communications

- contributing appropriate levels of skills and resources to the global and regional space missions of importance to our future well-being

- upholding Australia's reputation for scientific excellence, creativity and technological innovation

- assisting to solve international issues and tensions related to the use of and access to space and

- benefitting economically and diplomatically from improved cooperation in space programs, particularly with countries in our region.

Realistic policy options that facilitate effective solutions to cross-sector technological and organisational challenges, opportunity capture and development imperatives that align with national need and in consideration of existing world-class capability

Background

Experience throughout the world is that a sustainable space industry cannot exist without government support. This involves national policy, national infrastructure and national finance, through direct investment and with governments as a major customer for space derived services. Vital programs such as remote communications, earth observation, navigation and meteorology rely on this support.

Enabling participation and obtaining access for their researchers and companies in international space programs is a key function of most national space programs. New consortia are being formed for disaster monitoring systems, global navigation systems, earth observation and climate change monitoring. Countries without strong national space programs are increasingly marginalized as these programs are developed.

The legal and collaborative framework for international space activities requires government involvement and support and access to most programs and space forums for industry and researchers can best be facilitated by government.

Not all meaningful space projects have a large price tag. The past two decades have seen an evolution in technology which has enabled significant results to be achieved at modest cost. Organisations such as Surrey Satellite Technologies Limited have transformed the industry by focusing on producing low cost satellites by rethinking the engineering and using commercial-off-the-shelf components. They have succeeded in producing highly capable microsatellites which can be produced and launched for $10 to $50 million and their success has led other organisations to attempt the same, thus creating a new low cost satellite industry. The evolution of low-weight, low-cost satellites enables virtually any nation to readily acquire a satellite and this has been a key driver in the expansion of national satellite acquisition.

National governments are recognising the need to be well informed on modern space developments in order to understand the national security threats and to chart their diplomatic policies. They are increasingly relying on their national space agencies to advise them in these fields.

The overwhelming majority of nations (41 of the top 49 nations based on GDP) have chosen to create some form of space agency or space coordinating body to implement national space policy. **The ad hoc role that the Commonwealth industry departments, the CSIRO and the CRC for Satellite Systems have variously played as Australia's international space representative has caused confusion and misunderstanding.** None of these organisations have had the mandate or the resources to perform effectively the tasks outlined above.

We believe that Australia needs a national coordinating body for space to chart a course in the 21st century. In **Appendix 3** we have included some international research on various models for national space coordinating bodies. Based on this research and international experience we believe that a government agency with a statutory mandate is best suited to address the challenges outlined in this submission.

We are aware that an Australian Space Council and Australian Space Office were tried and disbanded in the 1990's. Without debating the merits of those decisions, we believe that the economic, environmental and social considerations outlined in this submission present new opportunities and challenges for this country and are ample justification for a new start.

Our priority is to ensure that the body chosen or formed has the authority and ability to perform the key functions of strategic policy coordination across the whole of government, the ability to act as Australia's voice in global and regional space discussions and that it has the political support, authority and resources to implement the national space policy proposals set out in this submission.

We are at an exciting point in our space history. We have an opportunity to design and create a national space program with a clean slate, learning from past setbacks and benefitting from the experience of other countries.

ASICC's Specific Policy Proposals

1. The Australian Government should adopt and commit to national space activity goals similar to those set out above under the heading '*The goals of any strengthening and expansion of Australia's space capability both in the private sector and across government*' which are as follows:

    1.1. contributing to innovation, productivity, environmental challenges and improving the quality of life of our citizens

    1.2. reducing our dependence on critical space derived data controlled by foreign players

    1.3. enhancing our ability to address national environmental and resource issues such as water planning and conservation, climate change, mineral exploitation, agriculture and remote communications

    1.4. contributing appropriate levels of skills and resources to the global and regional space missions of importance to our future well-being

    1.5. upholding Australia's reputation for scientific excellence, creativity and technological innovation

    1.6. assisting to solve international issues and tensions related to the use of and access to space and

    1.7. benefitting economically and diplomatically from improved cooperation in space programs, particularly with countries in our region.

2. The Australian Government should establish a coordinating body for Australian space activities. This body should vested with authority and provided with sufficient human and financial resources to:

    2.1. develop and coordinate a national space policy framework for the nation in consultation with government agencies, industry and other interested organisations

    2.2. coordinate, in cooperation with relevant agencies, government space activities (including the activities of Australian States with space interests)

    2.3. represent Australia's interests in global and regional space forums and in its relationships with foreign space agencies and organisations

    2.4. coordinate and/or support an appropriate level of Australian participation in space projects that are critical to Australia's national interests such as global and regional climate change, environmental monitoring projects and projects of importance to our national security

    2.5. provide and manage funding for projects in the national interest (including space science projects)

    2.6. promote and support the development of a vibrant Australian space industry and space science sector

    2.7. ensure that space is promoted to the community as a means of improving knowledge, encouraging creativity and innovation and attracting high-calibre students to careers in science, engineering and other space disciplines.

3. In the implementation the recommendations set out above, the Australian Government should conduct a national audit of Commonwealth funds (and if feasible State funds) spent on space or space derived data (including geospatial information) with the purpose of:

   3.1. understanding and benchmarking the national expenditure on space services

   3.2. determining the proportion of this funding that flows to Australian companies and

   3.3. determining whether more of this funding could be directed to Australian companies and universities to help support the Australian space industry.

4 APPENDIX 1

NASA CAPABILITY STUDY[28]

In November 2004 NASA identified 15 critical technology categories that are essential to space exploration but require significant additional development and innovation to meet the far-reaching Exploration Vision goals (the return of men to the Moon, establishing a Lunar base and then manned flight to Mars). NASA was interested in any related technology capability even if it was not presently space qualified. The 15 critical technology categories identified by NASA are:

1. High-Energy Power and Propulsion
2. In-Space Transportation
3. Advanced Telescopes and Observatories
4. Communication and Navigation
5. Robotic Access to Planetary Surfaces
6. Human Planetary Landing Systems
7. Human Health and Support Systems
8. Human Exploration Systems and Mobility
9. Autonomous Systems and Robotics
10. Transformational Spaceport/Range
11. Scientific Instruments/Sensors
12. In Situ Resource Utilization (Living off the land at Moon/Mars - Mining)
13. Advanced Modelling, Simulation, Analysis
14. Systems Engineering Cost/Risk Analysis
15. Nanotechnology

It is interesting to note that several of the categories are not traditionally associated with space, notably long term Human Health, Autonomous Systems and Robotics, Mining, Advanced Modelling, Simulation and Analysis, Nanotechnology. This is strong evidence of how space can act as a catalyst or an enabler for a wide range of technical disciplines.

ASICC conducted a survey of Australian capability in these 15 categories in November/December 2004 with additional follow up in early 2005. The responses revealed that Australia has capabilities in all 15 of the technology categories identified by NASA, a very interesting and significant result. Each of the 15 technology categories had at least two or more Australian organisations expressing capability. Overall, 75 Australian organisations expressed capability in at least one of the technology categories. These capabilities are spread all over the country with each Australian state and territory represented in the list of 75

[28] Fifteen Emerging NASA Opportunities for Australian Space Organisations, W. E. Barrett, Proceedings of the 5th Australian Space Science Conference, 2005

organisations.

Advanced Modelling, Simulation and Analysis was the technology category with the highest level of Australian capability. Nearly half of the 75 Australian organisations expressed capability in this category. Seven of the NASA technology categories had 10 or more Australian organisations indicating capability. The following table indicates the number of Australian organisations asserting capability in each of the 15 NASA technology categories.

Australian Capability in the 15 NASA Technology Categories

NASA Technology Category	Number of Australian Organisations
1. High-Energy Power and Propulsion	5
2. In-Space Transportation	8
3. Advanced Telescopes and Observatories	13
4. Communication and Navigation	19
5. Robotic Access to Planetary Surfaces	5
6. Human Planetary Landing Systems	2
7. Human Health and Support Systems	18
8. Human Exploration Systems and Mobility	3
9. Autonomous Systems and Robotics	25
10. Transformational Spaceport/Range	3
11. Scientific Instruments/Sensors	18
12. In Situ Resource Utilization (Living off the land at Moon/Mars)	2
13. Advanced Modelling, Simulation, Analysis	37
14. Systems Engineering Cost/Risk Analysis	10
15. Nanotechnology	9

This list is not comprehensive and represents only a sample of Australian capabilities. The results are further evidence that Australia clearly has the technical skill and intellectual capacity to play a major role in the global space industry.

5 APPENDIX 2

NATIONAL SPACE BUDGETS AND R&D EXPENDITURE

According to the recent study 'The Space Economy at a Glance, OECD 2007' the following OECD countries had the following space budgets in 2005:

Country	USD Millions
US	$36,635.00
France	$2,072.33
Japan	$2,036.87
Germany	$1,381.33
Italy	$1,077.95
United Kingdom	$312.06
Canada	$281.89
Belgium	$216.50
Spain	$211.04
Netherlands	$141.92
Switzerland	$122.44
South Korea	$120.00
Sweden	$115.13
Norway	$81.83
Austria	$61.36
Denmark	$49.62
Finland	$42.94
Portugal	$20.61
Ireland	$17.32
Greece	$14.55
Poland	$9.33
Luxembourg	$5.70
Hungary	$4.64
Czech republic	$2.98

The following countries spent a total of US$18.2 billion on space-related R&D in a 12 month period:

Country	USD Millions
Portugal (2006)	3.4
Romania (2006)	10
Czech Republic (2005)	10.2
Ireland (2005)	11.5
Austria (2006)	14.6
Greece (2005)	16.4
Hungary (2005)	16.7
Sweden (2006)	24.9
Denmark (2006)	27.5
Finland (2006)	30.7
Norway (2005)	31.8
Argentina (2005)	60.4
Switzerland (2004)	78.6
Netherlands (2006)	97.7
Chinese Taipei (2005)	165
Belgium (2005)	171.9
United Kingdom (2004)	205.7
Korea (2005)	260.3
Canada (2005)	280.4
Spain (2005)	322.1
Russian Federation (2003)	506
Italy (2005)	901.9
Germany (2005)	923.9
France 2004)	1,567.1
Japan (2004)	1,812.7
United States (2006)	10,645.1
Total	**18,197**

6 APPENDIX 3

OPTIONS FOR NATIONAL SPACE SECTOR COORDINATION[29]

The options considered are:

- a decentralised structure
- a coordinating body (e.g. a space council) or
- an independent space agency

1. Decentralised Management of Space Policy

The limitations of decentralised management of space policy include the fact that on the international stage, this structure compromises the ability of the government to provide a single point of contact for inquiries and for management of industrial and international space related programs. The benefit of this structure relates to the fact that the government can limit its costs and does not need to allocate money to a national space budget.

A variation on the decentralised option is the creation of a forum in which various representative government agencies meet regularly for the purpose of exchanging information about space activities within their portfolios. This system has been implemented in Australia (the Australian Government Space Forum). One perceived problem is that a government agency forum is unlikely to formulate unified space policies because of the differing interests of the agencies represented and the lack of a mandate for the forum.

2. Coordinating Body

Another option is to establish a coordinating body.

The British National Space Council is a good example of a space coordination body. The BNSC co-ordinates the civil space activities of its funding partners. The partners retain responsibility for their own budgets. In the year 2005/2006, BNSC's partners spent GBP 207 million (A$ 435 million) on space programs. The partners of the BNSC are:

- Department for Innovation, Universities and Skills (DIUS)
- Department for Business, Enterprise and Regulatory Reform (BERR)
- Department for Children, Schools and Families (DCSF)
- Department for Transport (DFT)
- Ministry of Defence (MoD)
- Foreign and Commonwealth Office (FCO)
- Department for Environment, Food and Rural Affairs (DEFRA)
- Natural Environment Research Council (NERC)

[29] Based on research performed by the International Space University SSP Program Policy and Law Department, July - August 2006

- Science and Technology Facilities Council (STFC)
- The Met Office

The BNSC receives advice on policy and co-ordination from the UK Space Board, which comprises those BNSC partners who provide the main funding for UK space activities – STFC, NERC, DIUS, the Met Office and the MoD.

One perceived advantage is that the costs can be found from the individual agencies that are members of the coordination body. A potential disadvantage is that the sustainability of the body depends upon each contributor being willing and able to renew their financial contributions from their own budgets.

3. National Space Agency

The establishment of a national space agency is the most centralised structure for managing national space activities. At the national level, the primary benefit of creating a national space agency is that a centralised body could coordinate activities between government, industry and the science community.

This is not to say that another type of coordinating body could not accomplish this goal; however, a permanent centralised structure can be highly effective at facilitating activities that fit a long term national vision (i.e. space program sustainability). An added benefit of establishing a space agency is the improved ability to obtain long term budgetary support for space activities. Moreover, an independent government space agency could be more efficient at assessing financial requirements of space projects and of allocating financial resources.

In addition to coordinating domestic activities, a national space agency facilitates interaction with the international space community. For example, a space agency would provide a point of contact for international agencies looking for cooperative space activities, as well as helping to secure a country's interests within international space organisations.

A national space agency would also assist to promote a country abroad in relation to its expertise and competencies in space systems and technologies. Furthermore, it would provide a platform for stimulating public interest in space and promoting space education and research opportunities.

A national space agency requires significant funding and involves specific government outlays. Space agencies can sometimes prove politically problematic due to occasional failures to achieve project or other outcomes that they have set for themselves or that have been set for them. The table on the following page summarises the advantages and disadvantages identified in the research.

	Performance		Sustainability			International representation	Impact on industry	
	Operational costs	Efficiency in coordinating space activities	Policy development	Securing a budget for space activities	Public awareness of space activities		Attraction of industry	Industry promotion
Option 1 Decentralized management	Reduces governmental costs	Structural inefficiencies	Difficult to develop and update a coherent policy for space activities	Budget secured only for specific activities	Difficult to raise public awareness	No representation or only for government space activities	Difficult to attract new aerospace companies and investments	No promotion of industry inside of the country
Option 2 Coordinating body	Minimal governmental costs	Efficient structure	Can develop a coherent policy	Difficult to secure a budget	Can raise public awareness	National representation	Limited industry attraction	Promotion of industry inside of the country
Option 3 National Space Agency	Involves separate budget	Efficient structure	Can develop a coherent and easily updated space policy	Specific and coherent budget	Can more readily raise public awareness	National representation	Maximises industry attraction	Promotion of industry inside and outside of the country

Table: Summary of Advantages and Disadvantages of Options for National Space Sector Coordination