



Australian Government
Department of Industry,
Innovation and Science



2016 STATE OF SPACE REPORT



A report by the Australian Government Space Coordination Committee

space.gov.au

© Commonwealth of Australia 2016

Ownership of intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Commonwealth of Australia.



Creative Commons licence
Attribution CC BY

All material in this publication is licensed under a Creative Commons Attribution 3.0 Australia Licence, save for content supplied by third parties, logos, any material protected by trademark or otherwise noted in this publication, and the Commonwealth Coat of Arms.

Creative Commons Attribution 3.0 Australia Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available from <http://creativecommons.org/licenses/by/3.0/au/>. The full licence terms are available from <http://creativecommons.org/licenses/by/3.0/au/legalcode>.

Content contained herein should be attributed as *The Australian Government State of Space Report 2016*.

This notice excludes the Commonwealth Coat of Arms, any logos and any material protected by trade mark or otherwise noted in the publication, from the application of the Creative Commons licence. These are all forms of property which the Commonwealth cannot or usually would not licence others to use.

Disclaimer:

The Australian Government as represented by the Department of Industry, Innovation and Science has exercised due care and skill in the preparation and compilation of the information and data in this publication. Notwithstanding, the Commonwealth of Australia, its officers, employees, or agents disclaim any liability, including liability for negligence, loss howsoever caused, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying upon any of the information or data in this publication to the maximum extent permitted by law. No representation expressed or implied is made as to the currency, accuracy, reliability or completeness of the information contained in this publication. The reader should rely on their own inquiries to independently confirm the information and comment on which they intend to act. This publication does not indicate commitment by the Australian Government to a particular course of action.

Inquiries

Email: space@industry.gov.au

Web: space.gov.au

Contents

Abbreviations	iv
Executive summary.....	vii
1 Introduction	1
2 Australian Government responsibilities and activities in civil space.....	2
2.1 Policy and regulation	2
2.1.1 Policy.....	2
Civil space coordination	2
Understanding Australian industry capabilities in civil space	3
2.1.2 Space regulation.....	4
Space regulation and licensing activities	4
Review of the Space Activities Act 1998.....	5
Management of access to spectrum for space services	5
Pricing of access to radiofrequency spectrum for satellite and space-based services.....	7
Coordination of Australian satellite filings.....	7
Access to radiofrequency spectrum for Earth observations from space.....	8
2.1.3 Other relevant regulation	9
Reform of the Radiocommunications Act 1992	9
Aviation safety: administration and regulation of Australian airspace.....	9
Air safety: rocket regulations	9
2.2 Space capability	10
2.2.1 Infrastructure	11
National Positioning Infrastructure.....	11
National Earth observations from space infrastructure planning and operation.....	11
Viewer Access Satellite Television	13
Australian Geoscience Data Cube.....	14
Radio-astronomy and spacecraft tracking and communications.....	15
Advanced Train Management System	16
2.2.2 Research and development	16
Satellite based data and products.....	16
Research and development on space systems.....	17
Buccaneer small satellite mission	18
National products from satellite data.....	18
Cooperative Research Centres Program	18
2.2.3 Skills development.....	19
PhD support in satellite data assimilation.....	19
2.3 National interest	19
2.3.1 National security	20
Space situational awareness.....	20
Radiofrequency spectrum management for defence-related satellite networks.....	20
Enhanced Commercial Access Capability.....	21
Combined Communications Gateway Geraldton.....	21
Understanding risks associated with Australia’s reliance on space-enabled services	22

2.3.2	Economic and social wellbeing	22
	Environmental intelligence for safety, sustainability, security, well-being and prosperity	22
	Reissue of 15-year spectrum licences	23
	Launch of the second nbn satellite	23
	Aircraft navigation and positioning	24
	Maritime safety: detection of Cospas-Sarsat distress beacons	25
	Satellite based air traffic management	25
	Investigating options for enhanced positioning information to the land transport sector	26
	Space Concession	26
2.4	International engagement	27
2.4.1	International agreements and partnerships	27
	Supporting international deep space missions	27
	Engagement with Combined Space Operations partnership	28
	Sustained access to PNT and Satellite Laser Ranging (SLR) capabilities	28
	Sustained access to Earth Observation capabilities	28
	Manage Australia's relations with bilateral and regional partners on space issues	30
2.4.2	International forums	30
	Advocate Australia's space interests in United Nations fora	30
	Promote Australian space expertise and experience internationally	31
	Engagement on international space spectrum activities	31
	International GNSS Service	32
	Global Geodetic Reference Frame Working Group	32
	International Committee on Earth Observation Satellite	32
	Asia-Pacific Regional Space Agency Forum	33
	International Astronautical Congress	33
3	Commonwealth agency functions	35
3.1	Attorney-General's Department	35
3.2	Australian Communications and Media Authority	36
3.3	Bureau of Meteorology	37
3.4	Commonwealth Scientific and Industrial Research Organisation	37
3.5	Department of Communications and the Arts	38
3.6	Department of Defence	38
3.7	Department of Foreign Affairs and Trade	40
3.8	Geoscience Australia	40
3.9	Department of Industry, Innovation and Science	41
3.10	Department of Infrastructure and Regional Development	42
3.10.1	The Australian Maritime Safety Authority	42
3.10.2	Civil Aviation Safety Authority	43
3.10.3	Airservices Australia	43

Abbreviations

Abbreviation	Description
ACMA	The Australian Communications and Media Authority
ADS-B	Automatic Dependent Surveillance – Broadcast
AGD	The Attorney-General’s Department
AGDC	Australian Geoscience Data Cube
AGO	Australian Geospatial-Intelligence Organisation
Airservices	Airservices Australia
ARSP	Australian Radiofrequency Spectrum Plan
ARTC	Australian Rail Track Corporation
ASKAP	Australian Square Kilometre Array Pathfinder
ATM	Air traffic management
ATMS	Advanced Train Management System
Beidou	GNSS being developed by China
C2G2	Combined Communications Gateway Geraldton
CASA	The Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CEOS	International Committee on Earth Observation Satellite
CI	Critical Infrastructure
CIR	Critical infrastructure resilience
CMA	China Meteorological Agency
CRC	Cooperative Research Centres Programme
CSIG	Cross Sectoral Interest Group
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCA	The Department of Communications and the Arts
DFAT	The Department of Foreign Affairs and Trade
DIIS	The Department of Industry, Innovation and Science
DIRD	Department of Infrastructure and Regional Development
EO	Earth observation
EOI	Earth Observation and Informatics
EOS	Earth observation from space
ESA	The European Space Agency
ESIMS	Earth stations in motion
FSP	Future Science Platform
GA	Geoscience Australia

Abbreviation	Description
Galileo	GNSS being developed by the European Commission through ESA
GGRF	Global Geodetic Reference Frame
GLONASS	GNSS owned and operated by Russia
GPS	Global Positioning System – GNSS owned and operated by the USA
IAC	International Astronautical Congress
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ISRO	Indian Space Research Organisation
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union Radiocommunication Sector
JAXA	Japanese Aerospace Exploration Agency
LEOSAR	Low-altitude Earth Orbit Search and Rescue
MEOSAR	Medium-altitude Earth Orbit Search and Rescue
MWA	Murchison Widefield Array
nbn	NBN Co Ltd
NWP	Numerical Weather Prediction
OAR	The Office of Airspace Regulation
PBN	Performance Based Navigation
PNT	Positioning, navigation and timing
R&D	Research and development
RNP	Required Navigation Performance
SARP	Standards and Recommended Practices
SBAS	Satellite-based augmentation system
SCC	Australian Government Space Coordination Committee
SKA	Square Kilometre Array
TARS	Turn Around Ranging Station
The Bureau	The Bureau of Meteorology
TISN	Trusted Information Sharing Network for Critical Infrastructure Resilience
UN	United Nations
UN-GGIM	The UN Committee of Experts on Global Geospatial Information Management
UNSW	University of New South Wales
USA	United States of America
VAST	Viewer Access Satellite Television
WMO	World Meteorological Organization
WRC	World Radiocommunication Conference

Executive summary

Like other developed economies, Australia is increasingly reliant on space-enabled services, in particular those that use satellite information in applications that protect and advance national interests. Key benefits derived from Australia's use of space applications include:

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

However, the ability to capitalise on the benefits that satellite data provides to the Australian community is at risk due firstly to Australia being reliant on satellites systems that are owned and operated by foreign entities, from both public and private domains and secondly due to less than optimum ground infrastructure.

Accordingly, the Australian Government places a high priority on achieving on-going and cost-effective access to space applications of national significance that underpin critical national capabilities. The government meets this objective through coordinated actions undertaken by agencies with interests in civil space.

This report documents the government's activities in civil space for the 2016 calendar year. These activities are grouped across four broad themes of activity, which are central to ensuring that Australia has the space capabilities it requires, now and into the future:

- **Policy and regulation:** coordinated activities undertaken by government agencies to facilitate innovation in the space sector while ensuring Australia's space-related activities do not jeopardise national interests and Australia's international obligations in space.
- **Space capability:** support for the provision of the physical infrastructure, research and development activity, and human capital required to leverage opportunities and benefits derived from space systems.
- **National interest:** addressing space-related issues that ensure Australia's national security, economic, and social objectives are appropriately achieved.
- **International engagement:** building on Australia's engagement as a global citizen by participating and collaborating in international space initiatives and agreements.

1 Introduction

The world is witnessing rapid growth in space-based applications that underpin a wide range of civilian and national security capabilities.¹

Protecting and advancing Australia's national interests is contingent on the continued access to space-based applications of national significance:

- **Positioning, navigation and timing (PNT)** is critical to Australia's smart infrastructure and ongoing social, economic and national security. PNT enables efficient logistics for mobile transport fleets on our roads, air, and sea. PNT services also provide time-stamping for financial transactions, and precision measurements for civil engineering, agriculture, and personal location based services.
- **Earth observation from space (EOS)** delivers crucial data that underpins national capabilities, such as weather and warning services, disaster mitigation and monitoring our changing climate. EOS also helps protect and manage our natural and built environments for sustainable development and the future health and prosperity of Australia.
- **Satellite communication** continues to provide a number of specialised functions, including supporting Australia's defence commitments around the world, and providing broadcast, broadband internet and telephony services. Importantly, communication satellites will help bridge Australia's digital divide for more than 200,000 homes and businesses in regional and remote areas that do not have access to terrestrial based broadband internet services.

Apart from corporately owned communication satellites, Australia is completely reliant on foreign owned satellites systems for access to critical PNT and EOS data. Australia's ability to capitalise on the benefits of satellite applications are therefore at risk to disruptions caused by satellite system failures and the changing priorities of nation states that have sovereign ownership and control of satellite systems.

Accordingly, the Australian Government places a high priority on achieving on-going and cost-effective access to space capabilities on which the nation relies. To support this priority, the government invests in a wide range of activities administered by a number of agencies. The Department of Industry, Innovation and Science (DIIS) is the central point of contact and coordination for the government's involvement in domestic and international civil space activities.

Together these undertakings can be grouped across four broad themes of activity, which are key to ensuring that Australia has the space capabilities it requires, now and into the future:

- **Policy and regulation:** coordinated activities undertaken by government agencies to facilitate innovation in the space sector while ensuring Australia's space-related activities do not jeopardise national interests and Australia's international obligations in space.
- **Space capability:** support for the provision of the physical infrastructure, research and development activity, and human capital required to leverage opportunities and benefits derived from space systems.
- **National interest:** addressing space-related issues that ensure Australia's national security, economic, and social objectives are appropriately achieved.
- **International engagement:** building on Australia's engagement as a global citizen by participating and collaborating in international space initiatives and agreements.

¹ European Global Navigation Satellite Systems Agency, 'Market Report', accessed April 16, 2014, <http://www.gsa.europa.eu/market/market-report>

2 Australian Government responsibilities and activities in civil space

2.1 Policy and regulation

The government undertakes policy and regulatory activities that seek to promote innovation and industry advancement in a way that is appropriate to national needs and circumstances. For example, the government established the National Innovation and Science Agenda to address both our immediate and future needs and inspire young Australians to pursue careers in innovative fields, such as space.²

In addition to setting broad framework conditions that aim to facilitate innovation and productivity across the economy, the government also sets space-specific policy frameworks and administers regulations that aim to provide the right conditions for researchers, entrepreneurs and businesses to develop capabilities, innovate, and capitalise on their space-related activities, while ensuring these activities do not jeopardise national interests and Australia's international obligations in space.

2.1.1 Policy

Civil space coordination

A number of government agencies engage in a variety of space-related activities to support Australia's strategic, economic and social objectives. Ensuring that the operating environment for these activities is conducive to innovation, combined with coordination and international cooperation are the key factors to maintaining and strengthening the space capabilities on which Australia relies.

DIIS is the central point of contact and coordination for the government's involvement in civil space and also chairs the Australian Government Space Coordination Committee (SCC), a forum for information sharing and coordinating the government's activities and priorities in civil space activities. The SCC membership is comprised of government agencies with an interest in civil space (see 1. Introduction):

- **Department of Industry, Innovation and Science (DIIS):** policy, regulation, and central point of contact and coordination for civil space activities.
- **Department of Defence:** civil space activities that overlap with defence-related issues in space.
- **Geoscience Australia (GA):** position, navigation and timing, and Earth observation (EO).
- **Bureau of Meteorology (the Bureau):** space weather and EO science.
- **Commonwealth Scientific and Industrial Research Organisation (CSIRO):** space science and EO science. CSIRO manage and run critical international space-related infrastructure.
- **Department of Communications and the Arts (DCA):** policy oversight of radiocommunications services and spectrum management (including satellite communication) in Australia.
- **Australian Communications and Media Authority (ACMA):** regulation of radiocommunications services, including radiocommunications licencing of space based communications systems in Australia. And ITU satellite filing coordination.

² www.innovation.gov.au

- **Department of Foreign Affairs and Trade (DFAT):** engagement on space-related international security issues.
- **Attorney-General's Department (AGD):** critical infrastructure policy.
- **Department of Infrastructure and Regional Development (DIRD):** positioning, navigation and timing as it relates to the transport sector.
- **Department of the Environment and Energy:** Earth observation as it relates to environmental management.
- **Department of Agriculture and Water Resources:** Positioning, navigation and timing, and Earth observation as it relates to agricultural production systems.

The **Department of Prime Minister and Cabinet**, and the **Treasury** have observer status on the committee.

Three working groups report to the SCC:

1. EOS Working Group
2. PNT Working Group
3. Inter-Departmental Working Group on Space Law.

These working groups promote national coordination and planning and report to the SCC on relevant strategic priorities including coordinated advice on domestic and international policy, standards, and research.

Key activities and developments

- The SCC convened three times in the 2016 calendar year.
- SCC members were briefed on activities undertaken by government and industry including progress updates on:
 - preparations for the 2017 International Astronautical Congress (IAC) in Adelaide
 - preparations for the 2016 International Committee on Earth Observation Satellites (CEOS) Plenary
 - the review of the *Space Activities Act 1998*
 - activities of the SCC sub-groups.

Future activities

- DIIS will actively contribute to IAC 2017; other SCC members are considering options for whole-of-government presence at IAC 2017.

Understanding Australian industry capabilities in civil space

In 2015, DIIS engaged the services of Asia Pacific Aerospace Consultants to undertake in-depth interviews with Australian space sector companies to provide an evidence-base of current Australian industry capability in civil space; domestic and global supply chain opportunities; growth opportunities in civil space applications for domestic and international markets; and case studies of Australian organisations that have found success in commercial civil space activities.

Key activities and developments

- The service providers presented their findings to the SCC's first meeting in 2016; and in a report released by DIIS in 2016: *A selective review of Australian space capabilities: growth opportunities in global supply chains and space enabled services*.³
- The study confirmed that Australian companies have the relevant capabilities and world class skills to participate in the rapidly growing global space economy; and that a number of Australian firms are already actively involved in international markets.

2.1.2 Space regulation

Space regulation and licensing activities

The Minister for Industry, Innovation and Science has responsibility for civil space and the *Space Activities Act 1998*. DIIS administers the Space Activities Act on behalf of the Minister. The Space Activities Act provides for the regulation of space activities carried on either from Australia or outside Australia where an Australian national is a responsible party for the launch.

The Space Activities Act, the *Space Activities Regulations 2001*, and the *Space Activities (Scientific or Educational Organisations) Guidelines 2015* create a regulatory framework for civilian space activities in Australia, as well as for those conducted overseas but involving Australian interests. The Space Activities Act and Regulations deal primarily with the launching of space objects and the return of space objects to Australia.

Key activities and developments

- The Minister for Industry, Innovation and Science provided the first authorisation for an Australian experiment for the International Space Station in May 2016. Quberider was granted approval in relation to its 'Create for Space' program, which will transport a circuit board to the International Space Station to conduct student experiments for high schools in New South Wales.
- In August 2016, the Minister approved the launch of three CubeSat satellites under the QB50 project. The project is coordinated through Belgium's von Karman Institute for Fluid Dynamics. The CubeSats, built by the Universities of Sydney, New South Wales (UNSW) and Adelaide will carry out research on the thermosphere. The QB50 project will also demonstrate a model for small scale research missions.
- The satellites are scheduled to be launched in December 2016 from Wallops Island, Virginia, United States of America (USA); however confirmation of this date is subject to a number of contingent factors.
- QB50 satellites will be deployed from the International Space Station and will be operating in an orbit approximately 400km above Earth. The satellites will remain in orbit for approximately one to two years before burning up in the Earth's atmosphere.
- In September 2015, the Minister approved revised guidelines for 'Approved Scientific and Educational Organisations'. These replaced the previous guidelines that were passed in 2004 and were due to sunset in October 2015.
- The second communications satellite in the nbn 'SkyMuster' series was launched in October 2016 from the Guiana Space Centre in French Guiana. NBNC0-1A and NBNC0-1B satellites have

³ The report is available for download at <http://space.gov.au>

been authorised under the Act and will provide high-speed broadband service to 400,000 Australian homes and businesses in rural and remote Australia.

Future activities

- **Buccaneer:** UNSW Canberra has been granted an Overseas Launch Certificate and status as an ‘approved scientific and education organisation’ under the Space Activities Act for two planned CubeSat flights to be conducted in collaboration with the Defence Science and Technology Group. The first mission, ‘the Buccaneer Risk Mitigation Mission (BRMM)’ will check the deployment and stability of an innovative large flexible antenna as well as the performance of various electronic subsystems required for detecting signals from the Jindalee Operational Radar Network. The BRMM is scheduled to launch in March 2017 from the USA. The second mission, ‘the Buccaneer Main Mission’ is anticipated to launch a year or two later than the BRMM.

Review of the Space Activities Act 1998

The government is conducting a review of the Act to examine whether it remains relevant to advances in technology and to ensure that it does not inhibit innovation or opportunities for Australians to participate in the changing global market for space.⁴

Key activities and developments

- The Review commenced in August 2015 and DIIS engaged international space law expert, Professor Steven Freeland, to provide independent input and analysis.
- At a stakeholder forum at Parliament House in February 2016, the then Minister for Industry, Innovation and Science, the Hon Christopher Pyne MP, made a statement on the importance of space technologies to innovation, and of ensuring that regulatory frameworks are relevant to changing technologies and markets.
- Public consultations and international liaison commenced in February 2016 and concluded on 30 April 2016.⁵
- The findings from this input were consolidated into an analysis report compiled by Professor Freeland.
- Consultations with government agencies are ongoing.

Future activities

- The Review outcomes will be submitted to the government for consideration before the end of the 2016 calendar year.

Management of access to spectrum for space services

As part of its spectrum management work, ACMA develops new and reviews existing spectrum planning and coordination frameworks, and assesses and issues radiocommunications licenses for space systems.

Key activities and developments

- ACMA is developing regulatory arrangements for earth stations in motion (ESIMs) and communicating with geostationary space stations in the fixed-satellite service in the frequency

⁴ www.industry.gov.au/spacereview

⁵ Public submission to the review are available at: <http://www.industry.gov.au/industry/IndustrySectors/space/Pages/Submissions.aspx>

bands 19.7–20.2 GHz and 29.5–30.0 GHz in accordance with International Telecommunication Union (ITU) Resolution 156 (WRC-15). In June 2016, ACMA released a consultation paper on the proposed assessment procedure and licence conditions for ESIMs. The consultation period closed on 1 July 2016 and the ACMA expects to finalise arrangements by end of 2016.⁶

- Through licensing, ACMA seeks to provide access to the spectrum for as many services as possible without harmful interference. During the 2015-2016 financial year, ACMA assessed and issued 1,514 new and renewed radiocommunications apparatus licences for space systems.⁷
- ACMA has been working closely with DCA on implementing the recommended changes to improve Australia's spectrum management framework.⁸
- ACMA developed coordination arrangements to support operation of the European Space Agency (ESA) New Norcia Earth station facility. These arrangements are documented in Radiocommunications Assignment and Licensing Instruction MS 43, which was released in January 2016.⁹
- In October 2016 the ACMA released its forward work program for the next five years, the 2016-2020 Five Year Spectrum Outlook (FYSO). The FYSO is updated each year and provides an overview of ACMA's spectrum management priorities over the next 12 months to medium term, and ACMA's plans to address them.¹⁰
- In October 2016 the ACMA released for comment a proposal to update the Australian Radiofrequency Spectrum Plan (ARSP) based on the revision of the ITU Radiocommunication Sector (ITU-R) Radio Regulations adopted at the World Radiocommunication Conference (WRC) 2015 (WRC-15).¹¹ The ARSP is a legislative instrument indicating which parts of the radiofrequency spectrum are allocated to which radiocommunications services (including satellite and space services).

Future activities

- Upcoming activities for ACMA include:
 - Considerations of comments received from the consultation and completion of the regulatory arrangements for ESIMs supporting ITU Resolution 156 (WRC-15).
 - Review of frequency coordination requirements between apparatus-licensed microwave fixed point-to-point links (6 and 6.7 GHz bands) and earth stations in the fixed satellite services communicating with geostationary satellite.
 - Monitoring of development in the use of Earth stations in motion for consideration of possible future reviews and development of future regulatory arrangements beyond arrangements being developed to implement ITU Resolution 156 (WRC-15).
 - Monitoring emerging space-based technologies for consideration of possible future reviews and updates to arrangements for space-based communications systems.
 - The business as usual work of assessing and issuing space systems radiocommunications licenses
 - Working with DCA on the spectrum review
 - Updating the ARSP towards the expected completion date of 1 January 2017.

⁶ <http://www.acma.gov.au/theACMA/regulatory-arrangements-for-stations-in-motion>

⁷ See ACMA 2015-2016 annual report <http://www.acma.gov.au/theACMA/annual-report>

⁸ <https://www.communications.gov.au/publications/spectrum-review-report>

⁹ <http://www.acma.gov.au/theACMA/coordination-arrangements-with-esa-new-norcia-earth-station>

¹⁰ <http://www.acma.gov.au/theACMA/five-year-spectrum-outlook-2016-20>

¹¹ <http://www.acma.gov.au/theACMA/proposed-update-to-the-australian-radiofrequency-spectrum-plan>

Pricing of access to radiofrequency spectrum for satellite and space-based services

ACMA is responsible for managing access to radiofrequency spectrum bands through radiocommunications licence arrangements, and resolving competing demands for that spectrum through price-based allocation methods.

Key activities and developments

- ACMA is conducting a review of apparatus licence taxes for satellite and space-based services, focusing mostly on the Ka-band (17.3–51.4 GHz, for the purposes of this review).¹²
- The review aims to adjust spectrum taxes to encourage more efficient use of spectrum, and encourage more satellite and space-based investment in Australia.
- Submission to the consultation closed on 23 September 2016.

Future activities

- ACMA will consider the comments received and progress work towards completion of this review.

Coordination of Australian satellite filings

Work on satellite filings with the ITU is considered a spectrum management function under the *Australian Communications and Media Authority Act 2005*. The ITU's international process of management of frequencies for satellite communications is one of administration only – it does not directly engage with satellite operators. ACMA is the Australian administrator for this ITO process.

ACMA assesses new and manages the coordination and notification of existing Australian satellite systems in accordance the process ACMA sets out in its *Australian procedures for coordination and notification of satellite systems* document.¹³

ACMA also conducts satellite coordination with new foreign satellite systems that have the potential to cause harmful interference to Australian assignments in the ITU Radio Regulations broadcasting-satellite service and fixed-satellite service plans, and to Australian terrestrial services.

Key activities and developments

- ACMA submitted information related to the Australian satellite systems to the ITU on behalf of Australian satellite operators (including the Department of Defence, nbn and Optus). ACMA also exchanged coordination information concerning the satellite systems with other administrations. ACMA provided support, in accordance with the ITU-R Radio Regulations, for matters relating to satellite coordination activities of Australian satellite operators.
- ACMA assessed 586 publications for proposed foreign satellite networks—initiating coordination processes (where necessary) with foreign administrations on their proposed satellite networks with Australian spectrum requirements and responding to their reciprocal requests of Australia.

¹² http://www.acma.gov.au/theACMA/review-of-taxation-arrangements-for-satellite-services?utm_medium=email&utm_campaign=IFC%20192016%20Satellite%20Pricing%20delete%20after%20use&utm_content=IFC%20192016%20Satellite%20Pricing%20delete%20after%20use+CID_0adee129dd7ce6f59c63de626c0890ab&utm_source=SendEmailCampaigns&utm_term=review%20the%20consultation%20paper

¹³ <http://acma.gov.au/Industry/Spectrum/Spectrum-planning/Space-systems-regulation/reformed-space-policies-procedures-space-systems-regulation-acma>

Future activities

- ACMA will continue to undertake the satellite coordination work and to manage Australian satellite filings, as these bodies of work help to protect Australian interests and to maximise the benefits of spectrum/orbital resources through working cooperatively with other ITU member states.

Access to radiofrequency spectrum for Earth observations from space

The competition for spectrum presents a serious threat to the sustainability of Earth observations from space. At particular risk is passive satellite sensing which involves the measurement of very low levels of naturally-emitted radiation in a number of frequency bands. The radio frequencies required to observe geophysical variables are determined by fundamental physics and are unalterable.

Also at risk are those parts of the spectrum used for transferring data from the satellite to the ground stations, and for command and control of satellites from the ground.

The Bureau and GA have a high level of interest in securing long term access to those parts of the spectrum that are essential for delivering weather, water, land management and climate services to the Australian community.

Through the Bureau, Australia's earth observation agencies actively engage with ACMA during each WRC preparatory process by coordinating a number of Agenda items.

The Bureau also participates in the World Meteorological Organization (WMO) Steering Group on Radio Frequency Coordination (SG-RFC) in order to share expertise in radiofrequency issues in meteorology and Earth observations.

Key activities and developments

- The Bureau was part of the Australian delegation to the ITU-R WRC-15 held in Geneva from 8 to 27 November 2015.
- A key outcome of WRC-15 was the establishment of mandatory emission levels to protect passive microwave observations in the 1400-1427 MHz band. All 17 Agenda items of interest to the meteorological community had outcomes in agreement with positions developed by the SG-RFC. WRC -15 outcomes are summarised on the ACMA website.
- A further key outcome was the protection of spectrum used by C-band synthetic aperture radar sensors, including the Sentinel-1 satellite missions operated by the European Commission, which will provide regular fully free and open data over Australia.
- The Bureau will be represented at the following meetings:
 - WMO Steering Group for Radio Frequency Coordination (SG-RFC); October 3-6, Melbourne (Hosted by the Bureau).
 - Space Frequency Coordination Group (SFCG); Sep 2017, Montreal, Canada (Hosted by the Canadian Space Agency). An X-band workshop is to be held in conjunction with the meeting.
 - ITU-R Study Group 4 (Satellite Services) and Working Party (4A, 4B, 4C) meetings: 21 September – 7 October 2016.

2.1.3 Other relevant regulation

Reform of the Radiocommunications Act 1992

As part of the Spectrum Review, the government will replace the current legislative arrangements for spectrum management with new legislation.¹⁴ The current framework is outdated. The reforms will implement simpler and more adaptable arrangements to meet the current and future demands of spectrum users and enable industry and consumers to make the most of the spectrum.

Key activities and developments

- In August 2015 the government announced it had considered and agreed to implement the recommendations of the Spectrum Review. One of these recommendations was to replace current legislative arrangements with new legislation.
- At the RadComms 2016 conference on 10 March 2016 the Minister for Communications, Senator the Hon Mitch Fifield, announced the release of a legislative proposals consultation paper for a Radiocommunications Bill.
- Public consultation on the legislative proposals paper closed on 29 April 2016.¹⁵

Future activities

- The next stage of consultation will include an exposure draft of the legislation, anticipated to be released in late 2016.

Aviation safety: administration and regulation of Australian airspace

The Office of Airspace Regulation within the Civil Aviation Safety Authority (CASA) has carriage of the regulation of Australian-administered airspace, in accordance with section 11 of the *Airspace Act 2007*.¹⁶

CASA must also take into account the capacity of Australian-administered airspace to accommodate changes to its use. In exercising its powers and performing its functions, CASA must regard the safety of air navigation as the most important consideration.

Key activities and developments

- The Office of Airspace Regulation has engaged with one commercial organisation in relation to the launch and recovery of high altitude (including sub-orbital and orbital) rockets.

Future activities

- CASA will contribute as required to assist DIIS in revising the Space Activities Act.

Air safety: rocket regulations

Under the *Civil Aviation Act 1988*, CASA is charged with the responsibility for safety regulation of civil air operations in Australian territory by developing and promulgating appropriate, clear and concise

¹⁴ www.communications.gov.au/what-we-do/spectrum/spectrum-reform

¹⁵ Public submissions are available on www.communications.gov.au/have-your-say

¹⁶ <https://www.casa.gov.au/airspace/landing-page/airspace-regulation>

aviation safety standards. This responsibility extends to the regulation of rocketry insofar as rocketry has the potential to create a hazard to air navigation.

Key activities and developments

- CASA administers Civil Aviation Safety Regulation (CASR) Part 101, which applies regulatory restrictions to the operation of unmanned rockets, including high powered rockets.¹⁷
- CASR Part 101 also provides that, among other things, a person operating a rocket needs to seek CASA approval of an area for the operation of rockets.

Future activities

- Again, CASA will contribute as required to assist DIIS in revising the Space Activities Act.

2.2 Space capability

Access to satellite-derived data and the development and retention of relevant infrastructure and skills required to leverage the opportunities from this data helps to provide key benefits to Australia:

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

The government undertakes activities that address the development and retention of relevant space-related competencies by supporting the provision and development of infrastructure, R&D and skills.

In strengthening key space-related capabilities, the government aims to enhance its international partnerships to secure access to space systems and the information they provide, and to assist in areas such as research collaborations, skill and knowledge transfer and development, sharing resources and information, influencing capability development and encouraging the peaceful use of space.

Australia also identifies and develops its nascent and growing space capabilities, which adds to Australia's standing in the global space sector.

¹⁷ Guidance material is available on the CASA website (www.casa.gov.au) regarding the regulatory arrangements in respect of the operation of unmanned rockets -Advisory Circular AC101-2(0).

2.2.1 Infrastructure

National Positioning Infrastructure

Global Navigation Satellite Systems (GNSS) play an increasing role in Australia's prosperity, bringing enhanced productivity, safety and convenience to a wide range of society endeavours. To enhance the capability over Australia offered by the foreign owned GNSS constellations ground infrastructure has been deployed by government and industry. The primary investment by the Australian Government is through Geoscience Australia's Regional GNSS network, and the AuScope GNSS array which was developed under the National Collaborative Research Infrastructure Strategy. The Australian Maritime Safety Authority has also invested in GPS ground infrastructure aimed at enhancing safety in the Maritime Transport Industry.

Current planning includes a modernisation of this ground tracking infrastructure with possible densification, the development of sovereign GNSS analysis software to generate GNSS augmentation products, and further consideration of product delivery mechanisms.

National Earth observations from space infrastructure planning and operation

EOS satellites contribute billions of dollars of economic, environmental, and societal value to Australia each year.

Australia does not operate EOS satellites and is highly dependent on a small number of foreign satellites. Leveraging the full diversity of satellite data available is therefore challenging, and the benefits derived from EOS could be significantly undermined in the event of satellite outages or failures.

The government, primarily through Geoscience Australia, BOM and CSIRO, works to address these issues and secure the future pipeline of key EOS data for Australia.

The government:

- analyses national data requirements
- identifies priority missions
- engages with satellite operators to identify valuable contributions that Australia can make to their programs
- negotiates data access
- acquires data, both via satellite ground stations and via network connections
- undertakes the technical work necessary to ensure that data can be integrated into the national imagery supply chain with minimal disruption
- works with user groups to ensure they are able to fully exploit the data for their purposes.

The government also works to develop national EOS infrastructure that support industry, researchers and government agencies to realise the benefits of EOS data by:

- modernising Australia's national observatory networks and calibration facilities
- strengthening domestic and international partnerships
- improving scientific analysis, and operational mapping and monitoring
- strengthening data and knowledge sharing, and the efficiency of accessing this information through open data policies.

GA operates redundant 9m tracking antennas at Alice Springs, at the heart of Australia, receiving data from a range of Earth observation missions on an operational basis. In 2016, a \$3m investment by GA augmented the facility to enable it to provide command and control support to key partner missions. Alice Springs will provide this support to the United States Geological Survey's current and future *Landsat* missions, assuring data access to Australia while also contributing back to a programme that has supported Australia to track how its landscape is changing since 1979.

The government, through its agencies, owns and operates satellite reception and processing facilities including a continental-scale direct reception network with two sites in Antarctica in order to meet its needs for real time satellite observations. The reception ground stations consist of antenna systems (mounts, dishes, domes), hardware and software for tracking, reception and processing, data communications comprising commercially available land-based, mobile and space-based telecommunications services, and real-time meteorological databases (comprising observed and processed data and forecast products). The Bureau also provides a positioning (ranging) service for the Chinese Fengyun 2 satellites from the Crib Point facility.

The government routinely replaces ageing ground infrastructure with new reception systems, to ensure that data streams from the new generation satellites can be received, and to improve reliability of the polar tracking hardware. Geostationary and polar orbiting data are received from multiple satellites to ensure resilience in the network.

Key activities and developments

- Major upgrades to satellite ground station facilities including:
 - A \$3 million upgrade of GA's facility in Alice Springs that will put it at the heart of international satellite programs, performing a critical role in controlling satellites and ensuring acquisition of vital data.
 - Installation of 4 new polar tracking antennas (Crib Point, Darwin, Casey, Davis)
- Initial release of a regional data access and analysis hub in support of Europe's *Copernicus* programme. The data hub will support uptake of data from the *Sentinel* satellites in Australia, South-East Asia and the South Pacific. The project will be continuously enhanced over coming years, through a partnership between GA, CSIRO and the governments of New South Wales, Queensland and Western Australia.
- Operational availability of Himawari-8 data and products via the establishment of dedicated link to the Japan Meteorological Agency, and a new public web page.
- Establishment of the CSIRO Earth Observation and Informatics (EOI) Future Science Platform (FSP), a million-dollar investment in underpinning capabilities supporting Earth observation science. The EOI FSP supports the following main CSIRO Activities in Earth Observation Science:
 - Coordinating delivery of underpinning EO Science, ongoing support to CSIRO wide EOI teams and Flagship projects, which includes an accredited and recognised solid satellite data quality assurance and calibration and validation work program.
 - Access to Earth Observation Informatics Expertise and Infrastructure (High Performance Computing-Informatics and Information Sciences), that provides EO teams a step-change in ability to manage current and future petabyte-scale EO Datasets; that support sophisticated time-series analysis tools, web-services, model-data fusion and model-data assimilation science and applications projects across the organisation.
 - Support for inter-agency and international cooperation, providing the primary point of contact on matters of Earth Observation for CSIRO.

- Linkages to EO Industry and innovative applications development for next generation satellite sensors, or airborne systems, addressing government, agency, public and industry users both nationally and internationally.
- CSIRO, working with its partners, is also establishing multiple new initiatives around furthering the Australian Geoscience Data Cube (AGDC) concept to Analysis Ready Data Future Data Architectures, the use of new generation meteorological satellites for non-meteorological applications and a study on the feasibility of an aquatic ecosystem imaging spectrometer. CSIRO is also instrumental in furthering the use of Earth Observation information for informing the progress towards the United Nations (UN) Sustainable Development Goals.

CSIRO is assisting 1) the Australian Bureau of Statistics in its role as co-chair of the UN Statistical Division Global Working Group on Big Data for Official Statistics on the use of EO data for official statistics, 2) The Group on Earth Observations (GEO) with the use of EO data for: Sustainable Development Goals; GEOGLAM (Rangelands and Agricultural Crop Monitoring) Flagship and the GFOI (Global Forest Observation Initiative).

- CSIRO has established a Space to Ground Sensing platform that will be an incubator for EO sensors from *in situ*, in the atmosphere and in space.

Future activities

- Further enhancements to the regional Copernicus data access and analysis hub.
- The Bureau will install a Turn Around Ranging Station (TARS) to support China's next-generation geostationary meteorological satellites, in 2017.
- Reception and validation of satellite observed lightning data as part of the Bureau's bilateral agreement with the China Meteorological Agency (CMA).
- The government is finalising a \$3 million upgrade of GA's facility in Alice Springs that will put it at the heart of international satellite programs, performing a critical role in controlling satellites and ensuring acquisition of vital data.
- The government, coordinated through the SCC's EOS Working Group, is addressing a national Earth Observations from space infrastructure plan.

Viewer Access Satellite Television

Viewer Access Satellite Television (VAST) provides viewers in remote areas—and those in digital television terrestrial black spots in metropolitan and regional areas—with access to an equivalent range of commercial and national free-to-air television services to those that are available in metropolitan areas.

DCA administers funding for VAST that provides free-to-air commercial television services. The provision of ABC and SBS services via VAST are funded directly through their Budget appropriations.

Future key activities and developments

- As at 30 June 2016, approximately 250,000 individual decoders had been approved to connect to the commercial free-to-air television services in over 200,000 households across Australia.
 - Approval is not needed to access the national public broadcasting services on VAST.

Australian Geoscience Data Cube (AGDC)

The AGDC provides the capacity to apply EOS to monitor the landscape and detect change as it happens.¹⁸

The AGDC program is led by GA in partnership with CSIRO and the National Computing Infrastructure.

This ability to monitor the landscape at continental-scale is critical to Australia's engagement with enduring issues in natural resource management, including water security, ecosystem health, and agricultural productivity.

As well as making new research possible, this technology lowers the 'start up' costs for individual projects ultimately enabling governments to get better 'value for money' for their research investments. It also provides Australia with an asset through which to engage international collaborators in their projects.

Key activities and developments

- The government is working to enhance the AGDC to ensure that it:
 - is exploited by Australian Government agencies to improve their business, through the development of new applications
 - includes deep historical satellite data, ensuring researchers can tap the deep 'time series' essential for characterisation of environmental change
 - includes data from new satellite missions, including Europe's Copernicus program, to give users confidence that 'new' observations will continue to flow long into the future
 - includes new types of satellite data, including thermal infrared data (which can help track moisture), synthetic aperture RADAR data (which can 'see' in all weather conditions), and data from geostationary satellites (which can provide updates every 10 minutes)
 - has enhanced visualisation functionality, enabling researchers to explore the datasets interactively and present results in a form more suitable for decision making
 - has advanced data analytics functionality, ensuring researchers are able to ask the necessary questions of the data.
- The government has also made the code underpinning the Data Cube 'open source' and is working with international partners on collaborative development projects, with the goal of establishing an international network of compatible systems to make it easier for governments, researchers and industry to work together on exploitation of EOS data.
- CSIRO, consistent with its role and priorities, is progressing:
 - engagement with the private sector in exploitation of AGDC technology
 - the use of new generation meteorological satellites for non-meteorological applications
 - studies on the feasibility of an aquatic ecosystem imaging spectrometer, and how such data would enhance the applications provided through the AGDC.

Future activities

- The government is exploring opportunities to:
 - expand the range of applications provided by the AGDC to key client groups

¹⁸ <http://www.datacube.org.au/>

- expand the geographical footprint, enabling researchers to study the broader Asia-Pacific Ocean-Indian Ocean-Southern Ocean region as well as the Australian continent and Australia’s Antarctic territories
- enhance access for industry, and for researcher-industry collaboration, so that algorithms and techniques pioneered by the research community can be translated into products and services
- implement the newly endorsed Discrete Global Grid System standards, making it easier for researchers to integrate socio-economic datasets (such as economic data, demographic data, etc.) with EOS satellite Earth observation data.

Radio-astronomy and spacecraft tracking and communications

CSIRO’s radio-astronomy, spacecraft tracking and communications activities are carried out by its Astronomy and Space Science (CASS) Division.¹⁹ CASS operates two major national space facilities: the Australia Telescope National Facility (ATNF)²⁰ and the Canberra Deep Space Communication Complex (CDSCC).²¹ CASS Division has approximately 275 FTE staff. More information about CSIRO’s cooperation with NASA can be found in section 2.4.1 *International agreements and partnerships*.

Key activities and developments

- The Australian Square Kilometre Array Pathfinder (ASKAP), now being commissioned and located at the Murchison Radio Observatory in WA, will introduce, pioneer and test revolutionary technologies vital to SKA in areas of electrical engineering, digital systems, computing and big data signal transport.²² Key results and techniques generated through the development of ASKAP will contribute to the international SKA design and development effort. ASKAP will also build Industry involvement and trial green energy power systems that will be relevant to the much larger SKA project. Recent tests of CSIRO’s innovative phased array feed receivers have achieved targets for system performance and are now demonstrating capability for breakthrough science discovery.
- CSIRO is the centre agent for the Pawsey Supercomputing Centre that both supports and is involved in a range of Square Kilometre Array (SKA) related activities. It supports two of the SKA precursor projects, the ASKAP and the Murchison Widefield Array (MWA). Both the Pawsey Supercomputing Centre’s infrastructure and operational support are critical for the success of these SKA precursors.
- Pawsey is also involved in the SKA Pre-construction Project, which has been underway since 2013. The Pawsey Supercomputing Centre is a member of the Science Data Processor consortium, which is responsible for designing the computing environment used to produce image products from the telescope. This includes a commitment of two full-time equivalent positions over three years to provide valuable input to the design process based on experience gained from supporting the ASKAP and MWA precursor projects.

¹⁹ <http://www.csiro.au/en/Research/Astronomy>

²⁰ <http://www.atnf.csiro.au/>

²¹ <http://www.cdsc.nasa.gov/>

²² <http://www.atnf.csiro.au/projects/askap/>

Advanced Train Management System

The government owned Australian Rail Track Corporation (ARTC) is continuing to develop its Advanced Train Management System (ATMS), a new technology specifically designed for and by the ARTC that uses digital Global Positioning System (GPS) navigation and broadband communications to locate and route trains in real time.²³

The ATMS implementation is being jointly delivered by ARTC and Lockheed Martin Australia. This will allow enhanced safety, greater efficiency and increased capacity of rail infrastructure. Once fully developed, the ATMS technology will be capable of broader application both in Australia and internationally.

Key activities and developments

- ARTC continues to deploy ATMS for trains operating between Port Augusta and Whyalla.
- ARTC completed Phase 1 trials of ATMS in early 2016, which demonstrated the reliability of the system on real rail traffic.
- The Office of the National Rail Safety Regulator approved ARTC's application to vary its rail safety accreditation for the introduction of ATMS in July 2016.

Future activities

- The ATMS is expected to become the primary safeworking system between Port Augusta and Whyalla, South Australia in mid 2017.

2.2.2 Research and development

Satellite based data and products

The government uses satellite imagery to produce a range of national products that underpin decision making by governments, industry, researchers, and society more generally.²⁴ As a large country, Australia relies on satellite data to provide regularly updated maps and information at national scale. Government agencies work to continuously improve these products in a manner that reflects the importance of ensuring continuity of long-term datasets while being responsive to current priorities.

Geoscience Australia provides a range of national products describing the state of Australia's land and marine jurisdictions and how they are changing over time. These products support key industries, such as the resources and agricultural sectors, as well as supporting sustainable evidence-based approaches to natural resource management and environmental protection.

One of the most important applications of EOS data in the Bureau is the use of this data in operational Numerical Weather Prediction (NWP). Recent studies have shown that in the southern hemisphere, satellite data increases the forecast duration by a factor of four for the same day forecast, therefore NWP is completely reliant on EOS for competitive performance.

Other key uses of satellite observations are weather forecasting, climate monitoring, and water accounting, as well as in industries such as aviation and defence. The Bureau is investing in the development of new and enhanced satellite based products to deliver the most benefits to users.

²³ <https://www.artc.com.au/projects/atms/>

²⁴ www.ga.gov.au

Key activities and developments

Through GA, the government provides products that support:

- disaster risk reduction and emergency response, including bushfire hot-spots maps
- water resource management, including national mapping of surface water
- coastal management, through products that map changes in the inter-tidal zone
- land management, including the National Dynamic Land Cover Dataset
- accurate mapping in remote areas, including the Australian Geographic Reference Image, and specialist products to support emergency response and recovery.

These products provide crucial information to those seeking to make informed decisions about agriculture, water management, and the environment.

The Bureau has recruited two scientists to assist with the assimilation of satellite observations into the NWP model and undertaken R&D on new and enhanced satellite based applications to better meet the requirements of the aviation industry, agricultural industry and emergency services.

Future activities

- The government, through its network of partnerships with both national and international experts, and with industry, will continue to develop and refine these products to take advantage of new science and technology. CSIRO plays a critical role in this area.
- For the Bureau, a particular focus will be R&D on new/improved satellite applications, to better meet the public need for enhanced thunderstorm and rainfall forecasts, and to improve the performance of the Marine Water Quality Dashboard.

Research and development on space systems

The Defence Science and Technology (DST) Group delivers valued scientific advice and innovative technology solutions for the Department of Defence and national security. The DST Group has existing space R&D programs in position navigation and timing, satellite communications, and intelligence, surveillance and reconnaissance.

Key activities and developments

- DST Group has commenced a strategic research initiative in space systems that has three core research areas in:
 - understanding the space environment with a focus on space situational awareness
 - operating small satellites with innovative and niche capabilities
 - exploiting data from space-based systems contributing to defence capabilities.
- DST Group is developing a node of a multi-national ground station network that will support Australian, collaborative and international partner small satellite missions.
- DST Group is conducting R&D with Australian and international partners in space situational awareness object detection, tracking and information fusion from extant and novel sensor systems.
- DST Group is developing a space R&D strategy for consideration by the Department of Defence's Next Generation Technologies Fund to identify and invest in strategic space technologies that have the potential to deliver game-changing capabilities for Australia's armed forces.

Buccaneer small satellite mission

Buccaneer is an all-Australian small satellite mission to fly an advanced digital high-frequency radio receiver to demonstrate calibration capabilities. DST Group is partnering with the UNSW Canberra to develop and undertake the mission, and with collaborators from the USA who are providing launch opportunities.

Key activities and developments

- DST Group is developing the 3.4 metre antenna and receiver payload for the Buccaneer satellite.

Future activities

- A Buccaneer risk mitigation launch is scheduled for early 2017, with the full mission launch in the 2018+ timeframe.

National products from satellite data

The government uses satellite imagery to produce a range of national products that underpin decision making by governments, industry, researchers, and society more generally.²⁵

As a large country, Australia relies on satellite data to provide regularly updated maps at national scale.

Key activities and developments

- Through GA, the government provides products that support:
 - disaster risk reduction and emergency response, including bushfire hot-spots maps
 - water resource management, including national mapping of surface water
 - land management, including the National Dynamic Land Cover Dataset
 - accurate mapping in remote areas, including the Australian Geographic Reference Image, and specialist products to support emergency response and recovery.
- These products provide crucial information to those seeking to make informed decisions about agriculture, water management, and the environment.

Future activities

- The government, through its network of partnerships with both national and international experts, and with industry, will continue to develop and refine these products to take advantage of new science and technology.

Cooperative Research Centres Program

The government funds two space-related Cooperative Research Centres, established through the government Cooperative Research Centres (CRC) Programme,²⁶ which supports industry-led collaborations between researchers, industry and the community:

1. CRC for Spatial information (CRCSI)²⁷

²⁵ www.ga.gov.au

²⁶ <https://www.business.gov.au/assistance/cooperative-research-centres-programme>

²⁷ <http://www.crcsi.com.au/>

2. Space Environment Management CRC (SEMCR)²⁸

Key activities and developments

- Research through the CRCSI is organised around three application research themes:
 1. Positioning
 2. Rapid Spatial Analytics
 3. Spatial Infrastructure
- The themes are supported by four key program areas:
 1. Agriculture, Natural Resources and Climate Change
 2. Defence
 3. Built Environment
 4. Health.
- The Space Environment Management CRC is managed by the Space Environment Research Centre (SERC). It conducts a number of research programs aimed at:
 - developing solutions for reliable and accurate observation and tracking of space objects, better monitoring and cataloguing of space debris, orbit conjunction analysis and collision mitigation
 - improving the accuracy and reliability of orbit predictions
 - developing techniques, algorithms and databases to assist in predicting and thus avoiding potential collisions in space
 - developing technologies to mitigate the deterioration of the space environment by preventing debris-on-debris collisions in space.

2.2.3 Skills development

PhD support in satellite data assimilation

The Bureau has started a program to top up PhD scholarships on joint research projects with Australian universities. These are for new projects and will involve close collaboration between the sectors with students experiencing both the University and publically funded research agency environments. The Bureau will award around five new top-ups per year, each lasting for the period of the scholarship.

Key activities and developments

- The initial round is currently being evaluated with 20 submissions being received, including four that are EOS-related.
- This activity is planned to continue into the future and provides an opportunity to develop talent in this key area.

2.3 National interest

The government protects national interests by implementing a range of domestic, alliance and international arrangements.

²⁸ <http://www.serc.org.au/>

Through these arrangements the government undertakes activities that develop government-business partnerships to: 1) progress technological space research and indigenous space capabilities which contribute to national security; and 2) identify and mitigate against vulnerabilities derived from our reliance on space assets that could impact our economic prosperity.

By exploring wider access to new and existing space-borne capabilities, the government can better address emerging and traditional security challenges.

2.3.1 National security

Space situational awareness

The Department of Defence contributes to the understanding the space environment through strengthening its space situational awareness capabilities.

Key activities and developments

- The Department of Defence has established the space surveillance C-band radar operated jointly by Australia and the United States, and is currently working to relocate a United States optical space surveillance telescope to Australia. Both assets will be located at the Harold E. Holt Naval Communications Station near Exmouth in Western Australia. The radar and telescope will increase our capacity to detect and track objects in space, including space debris, and predict and avoid potential collisions.
- The Department of Defence is working with industry partners on the development of niche indigenous space surveillance capabilities, including both space-based and ground-based intelligence, reconnaissance and surveillance systems.

Future activities

- Existing infrastructure at the Harold E. Holt Communications Facility will be upgraded over the decade to FY 2015-26, including infrastructure upgrades to support the installation of the United States space surveillance telescope.

Radiofrequency spectrum management for defence-related satellite networks

The Department of Defence works to secure radiofrequency spectrum resources for Defence satellite networks and to manage interference to and from other countries' satellite networks and terrestrial systems, in accordance with ITU rules. Defence must ensure access to satellite communications, which enables communication for network enabled operations.

Key activities and developments

- The WRC held in Geneva from 2 – 26 November 2015 established new regulations pertaining to satellite network systems that are relevant to defence-related satellite systems.

Future activities

- The Department of Defence will provide input to the development of national positions leading into the WRC in 2019 and associated forums pertaining to the regulation of satellite spectrum resources.

Enhanced Commercial Access Capability

In line with guidance of the 2016 Defence White Paper, the Australian Geospatial-Intelligence Organisation (AGO) is developing a program for government approval to provide an enhanced space-based commercial imagery capability to Defence.

Key activities and developments

- AGO has created an office responsible for the development of commercial satellite imagery capability, policy and governance.
- AGO is developing a project for government approval to provide a direct tasking and receipt facility for commercial satellite imagery.

Future activities

- AGO will conduct further capability development activities, including an options study, to meet Defence White Paper intent to improve access to space based imagery.

Combined Communications Gateway Geraldton

The Department of Defence is overseeing the establishment of the Combined Communications Gateway Geraldton (C2G2). C2G2 is a United States Gateway that will be built at the Australian Defence Satellite Communications Station near Geraldton, Western Australia. The United States is able to place C2G2 in Australia as agreed under a Memorandum of Understanding between Australia and the United States. The facility will be jointly shared by the United States and Australia, and will support the United States' Wideband Global SATCOM of which Australia is a partner.

Key activities and developments

- Australia's contribution to C2G2 was approved by the government in April 2016.

Future activities

- The United States is currently in negotiations with an Australian contractor for construction of C2G2.
- The Department of Defence anticipates an Initial Operating Capability from C2G2 in Q1 2018.

Understanding risks associated with Australia's reliance on space-enabled services

DIIS overseas and provides secretariat support to the Space Cross-Sectoral Interest Group (CSIG), which operates within the Trusted Information Sharing Network for Critical Infrastructure Resilience (TISN).²⁹ The TISN operates within the purview of AGD.

The Space CSIG was established within the TISN to facilitate greater understanding among TISN Sector Groups on the essential services that space-enabled services provide to Australia's Critical Infrastructure (CI).

Key activities and developments

- In October 2015, the Space CSIG completed its preliminary work identifying the key risks associated with Australia's increasing dependency on space technologies.

Future activities

- The Space CSIG's next body of work will provide CI owners and operators with information on how these risks might impact the CI operations.
- The Space CSIG will implement its new work plan in 2017.

2.3.2 Economic and social wellbeing

Environmental intelligence for safety, sustainability, security, well-being and prosperity

The Bureau contributes to national social, safety, security, economic, and environmental goals by providing weather, water, space weather and oceanographic services and by undertaking research into science and environment-related issues in support of its operations and services.

Many economically important, weather-sensitive industries rely on the Bureau's services for their own effective operation. These include emergency services, defence, aviation, shipping, resources, agriculture and water.

Geoscience Australia provides spatial information to support Australia's emergency services to coordinate and implement their responses to natural disasters. The ability for satellite data to provide a national 'picture', particularly on days when multiple events are unfolding across different regions, is critical at a national level.

Earth observations from space underpin many of these services.

Key activities and developments

- Major upgrade to the Bureau's supercomputing and data management capability will enable more precise and frequent forecasts—benefiting the economy and community.
- Major upgrade to Geoscience Australia's bushfire monitoring system, Sentinel, to integrate data from the next-generation geostationary satellite Himawari. This provides expert users with updates on hotspots every 10 minutes.

²⁹ <http://tism.gov.au/>

Future activities

- Automation of certain manual observations to improve the efficiency of our forecasting processes. Some of these will involve satellite-based solutions.
- Development of protocols for integration of products from the European Commission's Copernicus Emergency Management Service into the national framework. The service has been trialled during New South Wales flooding with good feedback from end users.

Reissue of 15-year spectrum licences

DCA maintains policy oversight of the process for reissuing 15-year spectrum licences to existing licence holders. These licences include spectrum used for satellite communications.

Spectrum licences in the 27 GHz band, which are used for the purpose of satellite communication, expired on 17 January 2016.

In November 2015, following consulting with licensees on potential future arrangements for the 27 GHz band, the Minister for Communications made the legislative instruments to revert the 27 GHz band from spectrum licensing to apparatus licensing.

Key activities and developments

- 5 November 2015 – The Minister for Communications made the Radiocommunications (Class of Services) Amendment (Removal of 27 GHz Band) Determination 2015.³⁰
- 5 November 2015 – The Minister for Communications made the Radiocommunications (Spectrum Designation—27 GHz Band) Repeal Notice 2015.³¹
- 17 January 2016 – Spectrum licences in the 27 GHz band expired.
- 18 January 2016 – 27 GHz band reverted to apparatus licensing.

Launch of the second nbn satellite

The second nbn satellite was successfully launched on 6 October 2016. The nbn satellite network is expected to provide access to fast broadband to over 400,000 homes and businesses in regional, rural and remote Australia.³²

Key activities and developments

- Both satellite launches were from the Guiana Space Centre in French Guiana. The launches were managed by French launch services provider Arianespace.
- The nbn satellite service began commercial operations on 29 April 2016.

³⁰ <https://www.comlaw.gov.au/Details/F2015L01773>

³¹ <https://www.legislation.gov.au/Details/F2015L01769>

³² <http://www.nbnco.com.au/connect-home-or-business/information-for-home/satellite.html>

Aircraft navigation and positioning

Australian aviation has transitioned from the use of ground-based navigation aids to Global Navigation Satellite Systems (GNSS) technology.³³

GNSS allows more flexibility for aircraft navigation in the enroute and terminal phases of flight, and more repeatable approach and landing operations leading to increased safety. The transition is in line with best practice in the global aviation industry.

This increased reliance on satellite-based technology solutions has enabled Airservices Australia (Airservices), as Australia's air navigation service provider, to continue to realise safety and efficiency gains in the national air traffic management (ATM) system, and has been enabled by the aviation equipment mandates put in place by the aviation safety regulator, CASA.

Key activities and developments

- Australia has implemented the International Civil Aviation Organization (ICAO) Performance Based Navigation (PBN) regulatory framework, using the Required Navigation Performance (RNP) specifications and GNSS as the enabling technology.
- Since February 2016, all aircraft operating under the Instrument Flight Rules (IFR) are required to carry GNSS navigation avionics.
- The introduction of PBN/RNP/GNSS navigation supported the optimisation of the fixed route network and enables advanced operations such as User Preferred Routing, where each flight has a tailored wind optimised flight path.
- Instrument approach / departure procedures using PBN/RNP/GNSS support engine idle descent and curved path. These are used to minimise aircraft noise and place the residual noise away from sensitive areas; reducing aircraft noise exposure.
- PBN/RNP/GNSS has brought increased aircraft safety, reduced aircraft emissions and enabled more efficient aircraft operations, enabling operators the opportunity to leverage better economic outcomes from their investment in GNSS technology.

Future activities

- ICAO supports the implementation of Approach with Vertical Guidance for approach and landing operations. GNSS, with Satellite-based augmentation system (SBAS), is an enabling technology, and Australia continues to keep under review the scope for developing an SBAS capability for Australia based on future national needs, including for aviation.
- GNSS will continue to be the enabling technology for aircraft navigation for the foreseeable future, with support by the backup terrestrial navigation aid network (also known as the BNN) for aviation navigation.
- GPS is also expected to be a vital and common part of Remotely Piloted Aircraft (RPA) operations in the future.
- The aviation sector's use of GNSS currently is confined to the GPS (USA) constellation L1 signal. It is anticipated that L5 and additional constellations provided by Russia (GLONASS), Europe (Galileo), and China (Beidou) will also be used in the future.

³³ <http://www.airservicesaustralia.com/projects/nrp/>

Maritime safety: detection of Cospas-Sarsat distress beacons

Cospas-Sarsat is an international satellite-based distress beacon detection system.³⁴ In 2015, 183 lives were saved in the Australian Search and Rescue Region due to Cospas-Sarsat distress beacon activations. Australia is an active participant in the Cospas-Sarsat Programme and is one of the largest users of distress beacons in the world.³⁵ Australia has the second-largest distress beacon population in the world, with an estimated population of over 500,000 beacons.

Australia has two satellite tracking stations near Bundaberg in Queensland and Albany in Western Australia. These stations track the existing Low-altitude Earth Orbit Search and Rescue (LEOSAR) satellites.

Cospas-Sarsat is implementing a new satellite constellation known as Medium-altitude Earth Orbit Search and Rescue (MEOSAR).

Key activities and developments

- The two satellite tracking stations for the LEOSAR system have continued to operate, meeting required performance standards.
- A new satellite tracking station for the MEOSAR system was built near Mingenew in Western Australia in October 2015. Data from the site is now undergoing testing at the central processing computer in Canberra, which also receives MEOSAR distress beacon detection data from the New Zealand MEOSAR satellite tracking station.

Future activities

- The MEOSAR distress beacon detection system will commence operational use in Australia in late 2016.

Satellite based air traffic management

Under the *Civil Aviation Act 1988*, in exercising its powers and performing its functions, CASA must regard the safety of air navigation as the most important consideration.

The key government agencies involved in civil ATM are CASA, the national civil aviation safety regulator; Airservices, the national civil air navigation service provider; and the Department of Infrastructure and Regional Development, responsible for the strategic policy framework for aviation in Australia. The Department of Defence (Defence) is also a significant provider and user of air traffic services and facilities in Australia.

Key activities and developments

- CASA mandated for all aircraft capable of flight under the IFR to be equipped for Global Navigation Satellite System performance-based navigation (GNSS PBN) as their primary means of navigation capability from February 2016. Additionally, CASA has mandated Automatic Dependent Surveillance – Broadcast (ADS-B) for all flights conducted under the IFR, using GNSS as the geographic position-source, from February 2017. CASA also mandated the fitment of Mode S transponder equipment for aircraft operated in certain circumstances to enhance capability in the electronic surveillance of aircraft for ATM.

³⁴ <http://www.cospas-sarsat.int/>

³⁵ <https://www.amsa.gov.au/search-and-rescue/sar-response-capability-and-technology/cospas-sarsat-sar-satellite-system/>

- Airservices provides ATM, communication, navigation and surveillance (CNS) and associated services, and implementation of CASA's regulatory mandates is supported by Airservices' major capital investment in infrastructure, such as a national ADS-B surveillance network. Defence also is investing in ADS-B equipment and infrastructure, supporting civil aviation arrangements.

Future activities

- The last of this suite of IFR aviation equipment mandates (ADS-B for all IFR aircraft) comes into effect from 2 February 2017.

Investigating options for enhanced positioning information to the land transport sector

Positioning information is an important enabler for a range of transport technologies, such as on-board telematics devices and navigational aids. Emerging transport technologies, such as connected vehicles, will require access to positioning information with higher levels of accuracy and integrity (for example in order to tell which lane a vehicle is travelling in, rather than just on which road).

On 4 August 2016, Australia's federal, state and territory transport ministers agreed to a *National Policy Framework for Land Transport Technology* and accompanying action plan.³⁶ As part of this action plan, Australian governments will investigate options for next-generation delivery of enhanced positioning (including private sector involvement) for the land transport sector.

Ensuring that Australia has access to an appropriate positioning capability will be important for facilitating the deployment of these new technologies and realising a range of economic and social benefits, including improved safety, productivity, environmental performance and accessibility of transport services.

Key activities and developments

- Australia's transport Ministers, through the COAG Transport and Infrastructure Council, agreed to this action on 4 August 2016. This work will commence in 2016-17.

Future activities

- DIRD will report back to the Transport and Infrastructure Council on the results of this work.

Space Concession

The Space Concession will benefit companies proposing to establish and develop operations in the high technology, high value-added space sector in Australia.³⁷ It encourages the transfer of sophisticated space-related technology and technical expertise to Australia by providing duty-free entry of eligible goods imported for use in a "space project".

The Space Concession aims to increase the competitiveness of the space industry in Australia and assist the Australian space industry to comply with certain international obligations. The Space Concession provides a duty-free tariff concession for eligible imported goods for use on authorised space projects.

³⁶ A copy of the National Policy Framework for Land Transport Technology is available from <http://transportinfrastructurecouncil.gov.au/publications>

³⁷ More information about the Space Concession including eligible imported goods for use in authorised space projects is available at <http://business.gov.au>.

2.4 International engagement

The government invests in strengthening Australia's national capabilities and continued access to critical space-based datasets through international engagement. For example, GA, the Bureau and CSIRO work closely with Earth observation satellite operators, including NASA, the European Commission, United States Geological Survey, National Oceanic and Atmospheric Administration, Japan Meteorological Agency, Japan Aerospace Exploration Agency, China Meteorological Administration and ESA to explore opportunities to exploit satellite data in innovative ways (see below). CSIRO also has long standing collaborations with international space agencies, notably NASA and ESA, to track international deep space missions.

The government engages with its international partners through:

1. international agreements and partnerships
2. international forums.

2.4.1 International agreements and partnerships

Supporting international deep space missions

The CDSCC is one of three facilities around the world that contributes to NASA's Deep Space Network, an international array of large radio antennas that supports NASA's space exploration missions. CSIRO, on behalf of the government, operates the CDSCC for NASA.

The DC-NASA relationship also extends to CSIRO's management of the Tracking Data Relay Satellite System facility at Yarragadee in Western Australia, and the NASA ballooning facilities located at Alice Springs in the Northern Territory, which now attract use from the French Space Agency (CNES) for investigating the cosmic microwave background and the Japanese Aerospace Exploration Agency (JAXA) for gamma ray astronomy.

Key activities and developments

- CDSCC currently tracks over 40 space deep space missions for NASA and specific International Space Agencies such as ESA, JAXA and the Indian Space Research Organisation (ISRO) and was the prime ground station for the New Horizons mission fly past of Pluto and Jupiter Orbit insertion with Juno.

Future activities

- The US-Australian Bilateral Space Tracking Treaty & Contract valued at \$80M continues to 26 February 2018, with work to update this agreement currently in progress.
- NASA has invested some \$120M in Australia on new 34 metre antenna constructions (DSS35 & DSS36) at CDSCC. The last of the new antennas will be completed in October 2016 and confirms space tracking activity in Australia will continue for several more decades. Australia has already surpassed 50 years of space tracking collaboration with the USA.

Engagement with Combined Space Operations partnership

The Department of Defence is a member of the Combined Space Operations partnership along with the United States, United Kingdom, Canada and New Zealand. This partnership enables the sharing of space-related information and resources to synchronise space operations among the partners. It also enables the reinforcement of the importance of the responsible use of space between defence departments.

Key activities and developments

- The Department of Defence joined with the United States, United Kingdom and Canada in 2014 to establish the formal multinational Combined Space Operations partnership. New Zealand joined in 2015.
- In 2016, the Department of Defence continued to explore options for cooperating amongst these partners to advance Australian interests in space.

Future activities

- Beyond 2016, the Department of Defence will continue to develop and expand Australian partnerships in space with like-minded nations.

Sustained access to PNT and Satellite Laser Ranging (SLR) capabilities

Australia, through Geoscience Australia has maintained key relationships with the USA (NASA) on geodetic infrastructure management and data sharing. GA has also developed a number of PNT related agreements with Japan and China.

Key activities and developments

- GA and NASA have an agreement to jointly operate a Satellite Laser Ranging (SLR) station at Yarragadee, Western Australia. This SLR station contributes data to the International Terrestrial Reference Frame (ITRF) and to managing satellite assets.
- Japan
 - The Japan Aerospace Exploration Agency (JAXA) and GA have an agreement for exchanging regional GNSS data, including data from Japan's Quasi-Zenith Satellite System (QZSS).
 - GA provides data from stations in Australia, Antarctica, and the South Pacific, and JAXA provides data to GA from its regional ground stations. GA also operates a QZSS monitoring station in Australia on behalf of JAXA.
- China
 - GA and Wuhan University, China, have an agreement for GA to operate three Beidou/GNSS ground stations in Australia at Yarragadee, Western Australia; Mount Stromlo, Australian Capital Territory; and Katherine, Northern Territory. When deployed these stations will contribute to precise Beidou satellite orbit determination in the Southern Hemisphere.

Sustained access to Earth Observation capabilities

Australia, through the Bureau, GA and CSIRO, has established key partnerships with key satellite-operating nations to promote continued access to critical datasets. For example, international cooperation is critical to the operational success of the Bureau, and monitoring and predicting the state of the atmosphere requires participation in international arrangements for the collection and exchange of global environmental information.

International collaboration also ensures that the government can benefit from scientific, technological and operational developments and expertise from other countries. Through these engagements, the government is able to achieve a more robust operational service, strengthen its capabilities, build its profile and reputation, and foster goodwill and collaboration with key partners.

The government's international EOS activities span all levels of engagement, from high level international collaboration focussing on access to data, information exchange and technical capacity-building through WMO and Committee on Earth Observation Satellites (CEOS) programs, and membership of EOS science teams.

Key activities and developments

- The Bureau has a number of EOS-related bilateral agreements with meteorological services and space agencies in Japan, China, Korea, and the US.
- The Bureau is collaborating with NOAA to become a partner in the COSMIC-2 (Constellation Observing System for Meteorology, Ionosphere, and Climate) program, by hosting a COSMIC-2 ground station near Darwin.
- The Bureau's training centre is recognised internationally as a leader in satellite meteorological training, and was the first training centre in the Asia/Oceania region to develop training material for Himawari.
- GA works closely with a range of other international satellite operators, including the United States Geological Survey and the European Commission to explore opportunities to access and apply EOS to important challenges. GA provides regular calibration and validation support to space agency missions, and operates a number of important calibration facilities.
 - United States
 - GA is an International Co-operator in the United States Landsat program, and has acquired data from these missions since 1979.
 - GA and the US Geological Survey (USGS) have established a comprehensive partnership agreement to pool resources to implement a shared vision for continental-scale monitoring of land surface change using time-series of Earth observations to detect change as it happens.
 - GA and NASA have an agreement to jointly operate a Satellite Laser Ranging (SLR) station at Yarragadee, Western Australia. This SLR station contributes data to the International Terrestrial Reference Frame (ITRF) and to managing satellite assets.
 - European Union (EU)
 - GA is implementing a strategic partnership between Australia and the EU to implement the Copernicus program. This partnership will see Australia play a key role in supporting the use of Copernicus data in South-East Asia and Pacific regions.
 - GA is implementing a Regional Copernicus Data Access/Analysis Hub that will streamline access to data from Europe's Sentinel satellites in the South-East Asia and South Pacific region.

- GA is also collaborating with the EU to promote cooperation between Australian and European researchers and industry to exploit EOS data.
- India
 - GA and ISRO are developing an agreement to: undertake satellite calibration/validation using Australian corner reflectors; share full resolution Ocean Colour Monitoring data on Australian waters; establish a ground station in Australia to support the Indian Regional Navigation Satellite System (IRNSS), and undertake satellite laser ranging to the IRNSS satellites from Australia.

Future activities

- GA will continue to implement its core strategic partnerships: with the European Commission (and its partners ESA and EUMETSAT) around the *Copernicus* programme; and with the United States Geological Survey around the critical *Landsat* programme. GA will also continue to cooperate with other space agencies on EOS-related topics of mutual benefit.
- The Bureau will continue to co-sponsor the annual Asia-Oceania Meteorological Satellite Users Conference. Its 7th meeting was held in South Korea in October 2016.
- The Bureau of Meteorology will install a Turn Around Ranging Station (TARS) to support China's next-generation geostationary meteorological satellites, in 2017. Through the continuation and extension of the collaboration with CMA, Australia fulfils international obligations to provide meteorological data to the international meteorological community. Australia benefits greatly under this system, particularly through free access to the meteorological satellite data of Japan, the USA, China and Europe.

Manage Australia's relations with bilateral and regional partners on space issues

DFAT is responsible for Australia's multilateral and bilateral relations on space issues.

Key activities and developments

- DFAT led Bilateral and Trilateral Space Security Talks with the United States and Japan, in Tokyo on 27 October 2016.
- DFAT provided a speaker to the fourth ASEAN Regional Forum Space Security Workshop in Singapore on 24 – 25 October 2016.
- It has been agreed that regular officials' talks will take place between relevant Australian and Indian Government Agencies to take forward the 2012 Memorandum of Understanding between Australia and India on cooperation on Civil Space Science, Technology and Education.
- DFAT negotiated arrangements with two foreign governments in relation to their use of ground-based civil space infrastructure in Australia.
- DFAT participated in talks with a private sector company in relation to ground-based civil space infrastructure in Australia.

2.4.2 International forums

Advocate Australia's space interests in United Nations fora

DFAT advocates Australia's space interests in the UN Committee on the Peaceful Uses of Outer Space (COPUOS), the Conference on Disarmament and the First Committee of the UNG General Assembly.

Key activities and developments

- Stephen Freeland, Professor of International Law, University of Western Sydney, participated for Australia in the 55th session of the Legal Subcommittee of COPUOS which was held from 4 – 15 April 2016 in Vienna.
- Australia is a long standing advocate for the long term sustainability (LTS) of outer space and a participant in the UN Working Group on the LTS Guidelines. We co-chaired one of the four expert groups - group D on “Regulatory regimes and guidance for actors in the space arena”. COPUOS agreed to a first set of 15 guidelines for the Long-term Sustainability of Outer Space Activities at its Plenary in Geneva on 8-17 June 2016.

Future activities

- DFAT is consulting with domestic agencies and foreign counterparts over the next 12 months on a proposal led by the United Kingdom, Germany, Italy and the EU for Principles of Responsible Behaviour in Space. It is envisaged that this will form the basis of a UN mandate in 2017 to negotiate a more comprehensive set of measures.

Promote Australian space expertise and experience internationally

Through its overseas network DFAT promoted the experience and expertise of Australia’s space research and industry sector and supported Australia’s bid to host major space events.

Key activities and developments

- The Australian Embassy in Washington and UNSW Canberra hosted the ‘Australian Space Celebration’ in Washington on 5 April 2016. The event showcased Australian space science and industry to approximately 250 guests from US industry, government and academia. It also highlighted the government’s efforts to create a foundation for growth in the Australian Space Sector through its National Innovation and Science Agenda and the Review of the Space Activities Act.
- The Australian Embassy in Washington represented Australia at the 32nd Space Symposium in Colorado Springs on 11-14 April 2016. The Symposium was a valuable opportunity to gain visibility from a sizeable international audience for Australia’s experience and expertise in space, our international space collaboration, recent policy and capability developments and the unique advantages we offer as a space partner.

Engagement on international space spectrum activities

ACMA seeks to contribute to a stable space environment through participation in international forums designed to encourage collaboration in frequency use.³⁸

ACMA oversees extensive industry and stakeholder consultation to prepare for international meetings. This is facilitated by ACMA’s Preparatory Group for the ITU/ITU-R WRCs Australian Radiocommunications Study Groups (ARSGs). The work of the ARSGs mirrors that of the ITU-R Study Groups and its Working Parties.

ACMA also coordinates Australian inputs to the Asia-Pacific Telecommunity (APT), which is an intergovernmental body representing the Asia-Pacific region in communication, information and innovation technologies, including space.

³⁸ <http://acma.gov.au/theACMA/Library/researchacma/Occasional-papers/the-acmas-international-engagement>

Key activities and developments

- ACMA managed and led a large number of Australian delegations to international radiocommunications meetings including:
 - The final regional Asia–Pacific Telecommunity Preparatory Group for WRC 2015 held in Seoul, Republic of Korea from 27 July to 1 August 2015.
 - The ITU WRC 2015, held in Geneva, Switzerland from 2–27 November 2015.³⁹

Future activities

- ACMA will continue to participate in APT and ITU meetings to actively promote Australian space interests and to contribute to ensure that regional and international radio regulatory documents capture Australian space interests.

International GNSS Service

Through GA, the government is chairing the International GNSS Service (IGS) for a four year term which began on 1 January 2015. The IGS is a voluntary federation of over 200 self-funding agencies, universities, and research institutions in more than 100 countries. Since 1994, the IGS has provided free and open access to the highest precision GNSS data available worldwide. IGS products support scientific advancement and public benefit, and contribute significantly to civilian PNT activities worldwide. Australia is the first non-European country to chair the IGS.

Global Geodetic Reference Frame Working Group

Through GA, the government co-chairs the Global Geodetic Reference Frame (GGRF) Working Group of the UN Committee of Experts on Global Geospatial Information Management (UN-GGIM) with Norway.

Key activities and developments

- In August 2016 the Working Group completed the development of a GGRF Roadmap, which was subsequently endorsed by the UN-GGIM.
- The GGRF underpins the global coordinate system supporting geospatial data observation and analysis, particularly for space-based infrastructure and services.

International Committee on Earth Observation Satellite

CSIRO serves as the Australian principal on CEOS and, on behalf of Australia, was elected as the 2016 Chair of CEOS. CSIRO will hold this position until November 2016. GA is an Associate of CEOS and participates in a range of working groups, including the Working Group on Calibration/Validation and the Working Group on Information Systems and Services. The Bureau is also an Associate of CEOS, as it has significant interest in the use of EO terrestrial and marine data for meteorological and climate applications. CEOS coordinates the activities of 31 space agencies and 132 satellites. CEOS is an international body that brings together 55 organisations operating over 130 satellites to collaborate on civil space-based Earth observation missions, data systems, and global initiatives.

³⁹ <http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/International-planning-ITU-and-other-international-planning-bodies/wrc-15-summary-of-outcomes>

Future activities

- The 30th CEOS Plenary was held in Brisbane, Australia from 31 October – 2 November 2016. The directors of the CEOS international space agencies including the relevant EU Director General participated in the CEOS Plenary.
- CSIRO will act as outgoing chair until the end of 2017 after having handed over the CEOS Chairmanship in 2016 to the USGS, via a multi-agency secretariat. GA support the CEOS Executive Officer until 2017.
- CSIRO will support active participation of its experts in key CEOS working groups before and after the specific chairmanship period.

Asia-Pacific Regional Space Agency Forum

APRSAF was established in 1993 to enhance space activities in the Asia-Pacific region. Space agencies, governmental bodies, international organisations, private companies, universities, and research institutes from over 40 countries and regions take part in APRSAF annually.⁴⁰

Key activities and developments

- DIIS and CSIRO participate in the Asia-Pacific Regional Space Agency Forum (APRSAF).
- Bali, Indonesia hosted the 22nd session of APRSAF in December 2015.
- The 23rd session of APRSAF was hosted in Manila, Philippines from 15 – 18 November 2016.

International Astronautical Congress

IAC is regarded as the world's most important annual interdisciplinary meeting for the space sector. It is the largest global space conference, bringing together an international delegation of approximately 3,000 people, including space professionals, academics, major corporations, government representatives, students and the media.

On 3 October 2014, the General Assembly of the International Astronautical Federation announced that Adelaide will host IAC in September 2017.

The most recent IAC was hosted in Guadalajara, Mexico from 26 – 30 September 2016.

Key activities and developments

- DIIS contributed towards the Australian exhibition booth at IAC 2016 in Mexico. Other government agencies also contributed to display materials to showcase Australia's space capabilities at the exhibition booth.
- DIIS, with input from a number of industry and government stakeholders, developed a five-minute video showcasing Australian capabilities in civil space for display at the Australian exhibition booth at IAC 2016.
- DIIS presented a paper on the government's review of the Space Activities Act, as part of the Symposium on Space Policy, Regulations and Economics, in the 'Game Changers in the Space Economy' technical session.⁴¹

⁴⁰ <https://aprsaf.org>

⁴¹ Seneta, A. 2016. *Maximizing opportunities for Australian players in global supply chains*, presented at the 67th IAC, Guadalajara, Mexico.

Future activities

- Through the SCC, the government will consider its options for a whole-of-government presence at IAC 2017 in Adelaide.
- CSIRO will participate in organising remote STEM education demonstrations utilising the space tracking facility at CDSCC.
- CSIRO will participate in organising an EO session IAC 2017

3 Commonwealth agency functions

3.1 Attorney-General's Department

AGD has two key areas of responsibility around civil space:

1. *Policy function – critical infrastructure resilience (CIR) and national security.* AGD leads policy development and implementation relating to Australia's critical infrastructure. AGD coordinates the Trusted Information Sharing Network (TISN) for Critical Infrastructure Resilience. It actively contributes to the work of the Space Cross Sectoral Interest Group (CSIG) within the TISN, which is overseen by DIIS.
2. *Legal function – international law.* AGD's Office of International Law provides legal advice on international space law, to ensure Australia's engagement in the space domain is consistent with our international rights and obligations.

Key space-related activities

- *National Situational Awareness Tool.* AGD partnered with Geoscience Australia and (the then) AGO to develop the National Situational Awareness Tool (NSAT). The dynamic information the NSAT provides remains a highly valuable national resource – significantly increasing situational awareness and improving government collaboration. The NSAT was operational in its first phase by October 2013. Two versions have been released since, capturing a wider range of web services across all hazards and many ongoing improvements to all existing web services.

Additional information

CIR Strategy

- The aim of the CIR Strategy is the continued operation of critical infrastructure in the face of all hazards. More resilient critical infrastructure will help achieve the continued provision of essential services (provided by critical infrastructure) to businesses, governments and the community, as well as to other critical infrastructure sectors.
- There are two core policy objectives under the CIR Strategy. The first objective is for critical infrastructure owners and operators to be effective in managing reasonably foreseeable risks to the continuity of their operations, through a mature, risk-based approach. The second objective is for critical infrastructure owners and operators to be effective in managing unforeseen risks to the continuity of their operations through an organisational resilience approach.
- Four key outcomes are being delivered through the CIR Strategy:
 1. A strong and effective business-government partnership.
 2. Enhanced risk management of the operating environment.
 3. Effective understanding and management of strategic issues.
 4. A mature understanding and application of organisational resilience.

The TISN for CIR

- The TISN is a forum where owners and operators of critical infrastructure work together and share information on threats and vulnerabilities and develop strategies to mitigate risk.
- The TISN comprises seven sector groups (Banking and Finance; Health; Food and Grocery Chain; Transport; Communications; Water Services; Energy) with members including owners and

operators of critical infrastructure, Commonwealth, State and Territory government agency representatives and peak and national bodies.

- CSIGs within the TISN provide an opportunity for cross-sectoral consultation between key stakeholders and government on specific matters. CSIGs are convened when a specific critical infrastructure issue demands attention and may be disbanded once the issue has been adequately addressed.

Websites

www.ag.gov.au | www.tisn.gov.au

3.2 Australian Communications and Media Authority

ACMA is a statutory authority within the Communications and the Arts portfolio. ACMA is Australia's regulator for broadcasting, radiocommunications, telecommunications and online content.

ACMA's regulatory functions and responsibilities are set out in the *Australian Communications and Media Authority Act 2005*. With respect to civil space activities, listed below are some key responsibilities of ACMA – part of the work enables the use of, for example, fixed, broadcasting, mobile, scientific and radionavigation satellite services.

- Managing domestic access to the radiofrequency spectrum through the development and maintenance of a regulatory framework for satellite services in Australia, including licensing;
- Representing Australia's space spectrum management interests internationally, including the filing and coordination of Australian satellite systems with the ITU.

ACMA also provides advice in areas of its responsibilities to the Minister for Communications.

Key elements of the regulatory framework under which space-related work in ACMA is undertaken are the:

- the ITU Constitution, Convention and Radio Regulations
- the *Radiocommunications Act 1992*
- ACMA's Principles for Spectrum Management.

Key space-related activities

- Major space-related activities that are core to ACMA's functions are:
 - management of access to spectrum for space services
 - engagement on international space spectrum activities
 - satellite coordination
 - assessing new and managing the coordination and notification of existing Australian satellite systems filed with the ITU.

Website

www.acma.gov.au

3.3 Bureau of Meteorology

The Bureau is Australia's national weather, climate and water agency. It operates under the authority of the *Meteorology Act 1955* and the *Water Act 2007* which provide the legal basis for its activities. The Bureau must also fulfil Australia's international obligations under the Convention of the WMO and related international meteorological treaties and agreements.

The Bureau's expertise and services assist Australians in dealing with the realities of their natural environment, including drought, floods, fires, storms, tsunami and tropical cyclones. Through regular forecasts, warnings, monitoring and advice, spanning the Australian region and Antarctic territory, the Bureau provides one of the most fundamental and widely used services of government.

The Bureau's forecast, warnings, climate and water services are underpinned by meteorological, hydrological and oceanographic observations. Observations are also stored for future use as part of Australia's national climate record. For this reason, the Bureau invests a significant portion of its resources in taking and recording of observations, including observations from space.

Key space-related activities:

- The Bureau plans, builds and operates satellite reception infrastructure and maintains significant technical, engineering and science capability.
- The Bureau delivers satellite-derived products and services to the Australian community, and supports leading-edge forecasting and climate research.
- Observations from space continue to contribute to the enhancement of the Australian Community Climate and Earth System Simulator (ACCESS).

Website

www.bom.gov.au

3.4 Commonwealth Scientific and Industrial Research Organisation

CSIRO is an independent statutory authority constituted and operating under the provisions of the *Science and Industry Research Act 1949*, which designates functions to:

- conduct scientific research to benefit Australian industry and the community, and to contribute to the achievement of national objectives
- encourage and facilitate the application of the results of scientific research
- manage and make available national facilities for scientific research
- contribute to scientific collaboration between Australia and other countries
- contribute to training the next generation of Australian researchers.

Under the *Science and Industry Research Act 1949*, CSIRO is granted powers to undertake a broad range of activities consistent with performing the above functions. These include arranging for scientific research to be undertaken on behalf of the organisation; forming partnerships, joint ventures and spin-off companies; and deriving income from intellectual property through licensing and royalty arrangements.

The organisation employs 350 staff involved in space activities, primarily focussed on using space-based systems and data streams to perform research and deliver nationally significant outcomes, where space provides the most effective and efficient means for delivering this impact.

Consistent with this strategy, CSIRO has developed extensive capability in space-related areas that include EO; navigation and communication; advanced aerospace technologies, spacecraft tracking and radioastronomy

Key space-related activities:

CSIRO carries out space-related activities in the following areas:

- Earth observation from space-in close collaboration with GA and the Bureau, industry and academia
- Radio-astronomy
- Spacecraft tracking and communications
 - Implement the National Earth Observations from Space Infrastructure Plan (NEOS-IP) with GA and the Bureau of Meteorology. Developing national EOS infrastructure will modernise Australia’s national observatory networks and calibration facilities; strengthen domestic and international partnerships; improve scientific analysis, and operational mapping and monitoring; and strengthen data and knowledge sharing, and the efficiency of accessing this information through open data policies. This infrastructure will support industry, researchers, and government agencies to realise the benefits of EOS data.
 - Co-develop the AGDC with GA and NCI. The AGDC provides the capacity to apply EOS to monitor the landscape and detect change as it happens. This ability to monitor the landscape at continental-scale is critical to Australia’s engagement with enduring issues in natural resource management, including water security, ecosystem health, and agricultural productivity.
 - CSIRO has established a Space to Ground Sensing platform that will be an incubator for EO sensors from *in situ*, in the atmosphere and in space.

Website

www.csiro.au

3.5 Department of Communications and the Arts

The Department is responsible for policy oversight on the licensing of spectrum used for space activities.

A key area of work for the Department was providing advice to the government, and information to the public, regarding nbn provision of satellite broadband services to regional, rural and remote Australia.

The Department is also responsible for preparing advice to the Minister for Communications as a shareholder Minister of nbn. Part of this role includes monitoring nbn’s broadband satellite program.

Website

www.communications.gov.au

3.6 Department of Defence

Space is an important enabler for the Australian Defence Force as a modern, networked military. The Department of Defence uses both military and civil space-based systems for a range of applications, including global positioning, navigation and timing; satellite communications; surveillance and

reconnaissance; mapping; and weather forecasting. It also has an interest in maintaining assured access to space, as space plays a vital role in all ADF and coalition operations.

The Department of Defence responsibilities in space are:

- **Contributing to space situational awareness:** The Department of Defence contributes to efforts to better understand the space environment and help ensure the security of our space-based assets. This includes working with the United States to locate and jointly operate space-monitoring infrastructure in Australia.
- **Engagement with international partners on military use of space:** The Department of Defence engages with international partners on the military use of space through the Combined Space Operations initiative and bilateral partnerships and talks.
- **Managing radiofrequency spectrum access:** The Department of Defence works to secure radiofrequency spectrum resources for its satellite networks, in accordance with ITU rules.
- **Space-based geospatial intelligence collection:** The Australian Geospatial-Intelligence Organisation, within the Department of Defence, is responsible for space-based imagery collection in support of Australian government national security, foundation data and intelligence requirements.
- **Space R&D:** DST Group contributes significantly to the development of Australia's space capabilities through a number of R&D programs in collaboration with international and domestic partners.

Key space-related activities:

- The Department of Defence:
 - has relocated one United States space sensor to Western Australia and is currently working with the United States to relocate a second complementary sensor to the same location
 - is working with the United States to establish and jointly operate the C2G2 near Geraldton, Western Australia
 - has engaged with the Combined Space Operations initiative since 2014 in partnership with the United States, United Kingdom, Canada, and New Zealand
 - proactively works to secure radiofrequency spectrum resources for Defence satellite networks.
- The AGO is developing a program to provide enhanced space-based commercial imagery capability for Defence.
- The DST Group:
 - commenced a strategic research initiative in space systems that has three core research areas in:
 - Understanding the space environment with a focus on space situational awareness
 - Operating small satellites with innovative and niche capabilities
 - Exploiting data from space-based systems contributing to defence capabilities.
 - is developing a node of a multi-national ground station network that will support Australian, collaborative and international partner small satellite missions
 - is developing a space R&D strategy to identify and invest in strategic space technologies that have the potential to deliver game-changing capabilities
 - partnered with UNSW Canberra to develop and undertake the all-Australian Buccaneer small satellite mission.

Website

www.defence.gov.au

3.7 Department of Foreign Affairs and Trade

DFAT has responsibility for international security issues, including for space. The department works with key international partners and through regional forums such as the Association of Southeast Asian Nations (ASEAN) Regional Forum (ARF), and in international forums, including the United Nations and the Conference on Disarmament.

Website

www.dfat.gov.au

3.8 Geoscience Australia

Geoscience Australia (GA) is the government's national geoscience organisation, applying geoscience to Australia's most important challenges. It is the government's technical adviser on all aspects of geoscience, and custodian of the geographical and geological data and knowledge of the nation.

GA supports civil space activities through leadership and planning, operational service delivery, ongoing maintenance of infrastructure and data, strategic partnerships, and knowledge-transfer. These activities create value for stakeholders by supporting capability development and critical decision-making across the agency's six strategic priorities:

1. Building Australia's Resource Wealth
2. Ensuring Australia's Community Safety
3. Securing Australia's Water Resources
4. Managing Australia's Marine Jurisdictions
5. Providing Fundamental Geographic Information
6. Maintaining Geoscience Knowledge and Capability

GA is the lead agency for Positioning, Navigation and Timing (PNT) and non-meteorological operational use of Earth Observations from Space (EOS) in Australia. GA provides geoscience infrastructure, knowledge and expertise that assures access to space capability, supports innovation, science skills and development, strengthens domestic and international coordination, and protects economic well-being.

The GA work program supports the work of other government agencies, state and territory governments, researchers, international partners, and industry.

Key space-related activities

- Positioning, Navigation and Timing (PNT)
 - GA is the government agency responsible for Australia's fundamental National Positioning Infrastructure (NPI)
 - GA chairs the SCC's PNT Working Group (PNT-WG).
- Earth observations from space (EOS)

- GA is jointly responsible for EOS capabilities with the Bureau of Meteorology and CSIRO
- GA co-chairs the SCC’s EOS Working Group (AEOSWG) with CSIRO and the Bureau of Meteorology.
- GA is working to:
 - Implement the National Positioning Infrastructure (NPI) Plan. The NPI will ensure Australia has a modern, fit-for-purpose and internationally compatible PNT capability, including modernised ground-tracking infrastructure; improved data analysis and performance monitoring; greater access to quality-assured Global Navigation Satellite System (GNSS) data; and strengthened linkages with domestic and international providers;
 - Implement the National Earth Observations from Space Infrastructure Plan (NEOS-IP) with CSIRO and the Bureau of Meteorology. Developing national EOS infrastructure will modernise Australia’s national observatory networks and calibration facilities; strengthen domestic and international partnerships; improve scientific analysis, and operational mapping and monitoring; and strengthen data and knowledge sharing, and the efficiency of accessing this information through open data policies. This infrastructure will support industry, researchers, and government agencies to realise the benefits of EOS data; and
 - Develop the AGDC. The AGDC provides the capacity to apply EOS to monitor the landscape and detect change as it happens. This ability to monitor the landscape at continental-scale is critical to Australia’s engagement with enduring issues in natural resource management, including water security, ecosystem health, and agricultural productivity.

Website

www.ga.gov.au

3.9 Department of Industry, Innovation and Science

DIIS has three key areas of responsibility around civil space:

1. **Regulatory function: administration of the Space Activities Act.** The Space Activities Act regulates rocket launches from Australia (or by Australians overseas) and the return of space objects to Australia. The Minister for Industry, Innovation and Science has responsibility for civil space and the department administers the Space Activities Act on behalf of the Minister.
2. **Policy function: advancement of Australia’s space capabilities.** The space sector is a driver of advanced technologies which have significant potential to generate technology spillovers that can flow into other sectors of the economy and advance Australia’s positioning in global markets.
3. **Coordination function:** The department chairs the SCC (see 2.1.1 Policy) and is the central point of contact and coordination for the government’s involvement in civil space.

Key space-related activities

- DIIS is conducting a review of the Space Activities Act to examine whether it remains relevant to advances in technology and to ensure that it does not inhibit innovation or opportunities for Australians to participate in the changing global market for space. The review commenced in August 2015 and will conclude in the latter half of 2016.
- DIIS manages a number of bilateral and multilateral agreements, including the:
 - Treaty with Russia on cooperation in the field of the exploration and use of outer space for peaceful purposes (2004)

- Space tracking treaty with ESA (2011)
- Memorandum of Understanding with India on space cooperation, technology and education (2012)
- Treaty with the United States on scientific balloon flight (2012)
- Space tracking treaty with the United States (2013).

Websites

www.industry.gov.au | www.space.gov.au

3.10 Department of Infrastructure and Regional Development

DIRD is responsible for providing policy advice and targeted research, delivering administered items and regulation in respect of the government's infrastructure, transport and regional development policies and programs. It works to:

- promote, evaluate, plan and invest in infrastructure and regional development
- foster an efficient, sustainable, competitive, safe and secure transport system
- facilitate local partnerships between all levels of government and local communities
- provide good governance in the Australian territories.

DIRD's interests in civil space include the application of satellite-enabled services for road, rail, maritime and aviation sectors. These activities are carried out by DIRD and its portfolio agencies:

- AMSA
- CASA
- Airservices.

Website

www.infrastructure.gov.au

3.10.1 The Australian Maritime Safety Authority

AMSA provides a range of regulatory functions and services that significantly use satellite based technology including:

- the Joint Australian Rescue Coordination Centre (JRCC) with a capacity to handle maritime and aviation distress situations and by maintaining two COSPAS-SARSAT ground stations and the Mission Control Centre for the detection of satellite distress beacons
- the provision of navigational services (in the main, a network of aids to navigation to meet the needs of levy-paying commercial shipping), which includes 16 Differential GPS reference stations, necessary for ocean and coastal navigation
- vessel tracking services, including administration of the Modernised Australian Ship Tracking and Reporting System (MASTREP), use of shore based and satellite based automatic identification systems (AIS) and long range identification and tracking (LRIT) of ships
- a high frequency (HF) distress and safety maritime radio communication network.

Key space-related activities:

- AMSA is a significant user of satellite technology for a number of applications including aviation and maritime search service response, pollution surveillance, oil spill and disaster response, ship and navigation safety and ad-hoc imagery.
- AMSA is also active in international bodies, such as the IMO, the ITU, the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), ICAO and Cospas-Sarsat, which deal (in part) with radionavigation and satellite based systems, procedures, policies and radio communications.

Website

www.amsa.gov.au

3.10.2 Civil Aviation Safety Authority

In accordance with its legislated obligations, CASA develops, promulgates and oversees the implementation of appropriate aviation safety standards based on ICAO Standards and Recommended Practices (SARPs).

Many of these SARPs establish the framework and required performance standards for use of satellite based technologies in Australia's ATM system to ensure national safety-based applications and global compatibility.

Key space-related activities:

- Continued access to high fidelity GPS data is a fundamental enabler for the continued safe and efficient operation of air traffic management services in Australia.

Website

www.casa.gov.au

3.10.3 Airservices Australia

Airservices is a Commonwealth Statutory Authority established by the *Air Services Act 1995*.

Airservices is the service provider responsible for Australia's airspace management, aeronautical information, aviation communications, radio navigation and aviation rescue fire fighting services.

The Agency undertakes functions as required under the *Air Navigation Act 1920*.

Airservices gives effect to many of Australia's obligations under the *Convention on International Civil Aviation* (the Chicago Convention).

Airservices utilises the following satellite based services:

- Aircraft navigation and positioning
- Precision timing
- Aircraft/controller communication:
 - datalink
 - voice
- Ground/remote ground communication

- datalink
- voice
- network.

Website

www.airservicesaustralia.com

Annex A

Membership of the Australian Government Space Coordination Committee

AGENCY	REPRESENTATIVE	CONTACT
Department of Industry, Innovation and Science	Dr Anne Byrne (Chair) Ms. Jennifer Doyle (Secretariat)	anne.byrne@industry.gov.au Jennifer.doyle@industry.gov.au
CSIRO	Dr Alex Held Dr Ed Kruzins Dr Arnold Dekker Mr Phil Crosby Ms Kimberly Clayfield Mr Roger Franzen	Alex.held@csiro.au Ed.Kruzins@csiro.au Arnold.Dekker@csiro.au Phil.Crosby@csiro.au kimberley.clayfield@csiro.au ; Roger.Franzen@csiro.au
Bureau of Meteorology	Ms Agnes Lane Dr Anthony Rea Ms Elizabeth McDonald Dr Sue Barrell	A.Lane@bom.gov.au A.Rea@bom.gov.au e.mcdonald@bom.gov.au s.barrell@bom.gov.au
Geoscience Australia	Mr Gary Johnston Mr John Dawson Mr Grant Hausler Dr Adam Lewis Mr Jonathon Ross Mr Andrew Barnicoat Mr Medhavey Thankappan	Gary.Johnston@ga.gov.au John.Dawson@GA.gov.au Grant.Hausler@GA.gov.au adam.lewis@ga.gov.au Jonathon.Ross@GA.gov.au andrew.barnicoat@ga.gov.au Medhavy.Thankappan@ga.gov.au
Department of Communications and the Arts	Ms Kate Feros Mr Chris Fogarty Ms Anne Jeyaseelan	Kate.Feros@communications.gov.au Chris.Fogarty@communications.gov.au Anne.Jeyaseelan@communications.gov.au
Department of Defence	Mr Darren May Mr Simon McDonald Mr Duncan Blake Ms Glenver Parker Major Owen Bishop Mr Alec Tattersall Mr Paul Cronan Ruobing Yan	Darren.May@defence.gov.au Simon.McDonald@Defence.gov.au Duncan.Blake@defence.gov.au Glenva.parker@defence.gov.au owen.bishop@defence.gov.au alec.tattersall@defence.gov.au paul.cronan1@defence.gov.au ruobing.yan1@defence.gov.au
Australian Communications and Media Authority	Mr Mark Arkell Mr Dat Vo Mr Christopher Hose	Mark.Arkell@acma.gov.au Dat.Vo@acma.gov.au Christopher.Hose@acma.gov.au
Department of Prime Minister and Cabinet		Helen.Owens@pmc.gov.au Craig.Daly@pmc.gov.au
Department of Infrastructure and Regional Development	Mr Charles Hausknecht Mr Jim Wolfe	Charles.Hausknecht@infrastructure.gov.au Jim.Wolfe@infrastructure.gov.au
Department of the Treasury	Mr Damian Dunn Ms Cherie Parker Mr Simon Winkler	Damien.dunn@treasury.gov.au ; Cherie.Parker@TREASURY.GOV.AU Simon.Winckler@TREASURY.GOV.AU

AGENCY	REPRESENTATIVE	CONTACT
Department of Foreign Affairs and Trade	Mr Peter Brooks Mr Henry Fox	Peter.Brooks@dfat.gov.au Henry.Fox@dfat.gov.au
Attorney-General's Department	Mr Lachlan Saunders	Lachlan.Saunders@ag.gov.au
Department of Environment and Energy	Mr Rob Sturgiss Ms Shanti Reddy Mr Anthony Bennie	rob.sturgiss@Environment.gov.au shanti.reddy@Environment.gov.au Anthony.Bennie@environment.gov.au
Department of Agriculture and Water Resources	Mr Mathew Miller Mr Michael Jerks Mr Graeme Shennan	Matthew.Miller@daff.gov.au Michael.Jerks@ag.gov.au Graeme.Shennan@ag.gov.au