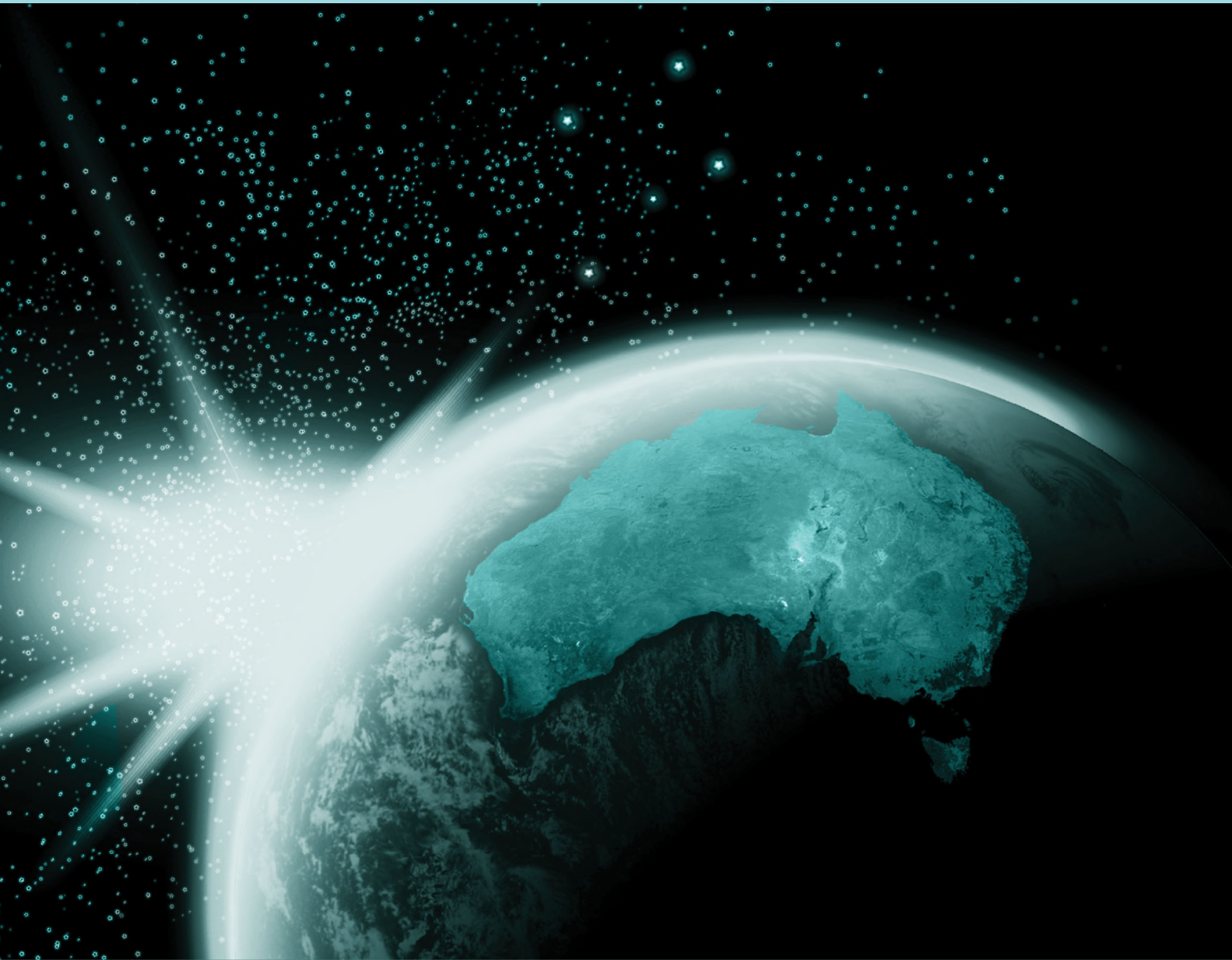




Australian Government
Department of Industry,
Innovation and Science



2017 STATE OF SPACE REPORT

A report by the Australian Government Space Coordination Committee

space.gov.au

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- Department of Home Affairs
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Abbreviations

Abbreviation	Description
ACCESS	Australian Community Climate and Earth-System Simulator
ACMA	The Australian Communications and Media Authority
ADF	Australian Defence Force
ADS-B	Automatic Dependent Surveillance – Broadcast
AIS	Automatic Identification System
AGD	The Attorney-General’s Department
AGO	Australian Geospatial-Intelligence Organisation
Airservices	Airservices Australia
ALOS	Advanced Land Observation Satellite
AMSA	The Australian Maritime Safety Authority
AO-GEOSS	Asia-Oceania Global Earth Observing System of Systems
APRSAF	Asia-Pacific Regional Space Agency Forum
APT	Asia-Pacific Telecommunications
ARSGs	Australian Radiocommunications Study Groups
ARTC	Australian Rail Track Corporation
ASKAIC	Australian SKA Industry Consortium
ASKAP	Australian Square Kilometre Array Pathfinder
ATM	Air traffic management
ATMS	Advanced Train Management System
Beidou	GNSS being developed by China
The Bureau	Bureau of Meteorology
C2G2	Combined Communications Gateway Geraldton
CAA	Cooperating Agency Agreement
CASA	The Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CASS	CSIRO Astronomy and Space Science
CCEO	CSIRO Centre for Earth Observation
CDSCC	Canberra Deep Space Communication Complex
CEO	Centre for Earth Observation
CEOS	Committee on Earth Observation Satellite
CI	Critical Infrastructure
CIC	Critical Infrastructure Centre
CIR	Critical infrastructure resilience

Abbreviation	Description
CMA	China Meteorological Agency
COPOUS	UN Committee on the Peaceful Uses of Outer Space
COSMIC-2	Cosmic Observing System for Meteorology, Ionosphere, and Climate 2
CRC	Cooperative Research Centres
CRCSI	Australia and New Zealand CRC for Spatial Information
CSIG	Cross Sectoral Interest Group
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWR	Department of Agriculture and Water Resources
DCA	The Department of Communications and the Arts
DEA	Digital Earth Australia
DEE	Department of Environment and Energy
Defence	Department of Defence
DEM	Digital Elevation Model
DFAT	The Department of Foreign Affairs and Trade
DIIS	The Department of Industry, Innovation and Science
DIRD	Department of Infrastructure and Regional Development
DMTC	Defence Materials Technology Centre
DST	Defence Science and Technology
EO	Earth observation
EOS	Earth observation from space
ESA	The European Space Agency
ESIMS	Earth stations in motion
FYSO	Five-year Spectrum Outlook
HF	High frequency
GA	Geoscience Australia
Galileo	GNSS being developed by the European Commission through ESA
GDA2020	Geocentric Datum of Australia 2020
GEO	Geostationary Earth Orbit
GEOGLAM	Rangelands and Agricultural Crop Monitoring
GFOI	Global Forest Observation Initiative
GGRF	Global Geodetic Reference Frame
GLONASS	GNSS owned and operated by Russia
GNSS	Global Navigation Satellite System
GPM	Global Precipitation Mission
GPS	Global Positioning System – GNSS owned and operated by the USA

Abbreviation	Description
GPS-RO	GPS Radio Occultation
GSO	Geosynchronous orbit
HASS	High Altitude Sensor Systems
HF	High frequency
HIWC	high ice water content
Home Affairs	Department of Home Affairs
IAC	International Astronautical Congress
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICAO	International Civil Aviation Organization
IDC	Inter-Departmental Committee
IFR	Instrument Flight Rules
IGS	International GNSS Service
IMT	International Mobile Telecommunications
ISRO	Indian Space Research Organisation
ISS	International Space Station
ITRF	International Terrestrial Reference Frame
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
JAXA	Japanese Aerospace Exploration Agency
JPSS-1	Joint Polar Satellite System 1
JRCC	Joint Rescue Coordination Centre
LAGEOS-1	LAser GEOdynamics Satellite-1
LEO	Low Earth Orbit
LEOSAR	Low-altitude Earth Orbit Search and Rescue
LRIT	Long Range Identification and Tracking
MASTREP	Modernised Australian Ship Tracking and Reporting System
MEOSAR	Medium-altitude Earth Orbit Search and Rescue
MILAMOS	Manual on International Law Applicable to Military Uses of Outer Space
MWA	Murchison Widefield Array
NAVIC	Navigation with Indian Constellation
NEO-IP	National Earth Observations from Space Infrastructure Plan
nbn	NBN Co Limited
NOAA	US National Oceanic and Atmospheric Administration
NPI	National Positioning Infrastructure
NSAT	National Situational Awareness Tool

Abbreviation	Description
NWP	Numerical Weather Prediction
OAR	Office of Airspace Regulation
OGC	Open Geospatial Consortium
PBN	Performance Based Navigation
PM&C	Department of the Prime Minister and Cabinet
PNT	Positioning, navigation and timing
QZSS	Quasi-Zenith Satellite System
RAAF	Royal Australian Air Force
R&D	Research and development
RMM	Risk Mitigation Mission
RNP	Required Navigation Performance
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft Systems
SAR	Synthetic Aperture Radar
SARP	Standards and Recommended Practices
SBAS	Satellite-based augmentation system
SCC	Australian Government Space Coordination Committee
SCOPE-Nowcasting	Sustained Coordinated Processing of Environmental Satellite data for Nowcasting
SEMCRG	Space Environment Management CRC
SERC	Space Environment Research Centre
SG-RFC	WMO Steering Group on Radio Frequency Coordination
SIAA	Space Industry Association of Australia
SKA	Square Kilometre Array
SLR	Satellite Laser Ranging
SWS	Space Weather Service
TCBM	Transparency and confidence building measures
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
USGS	US Geological Survey
VAST	Viewer Access Satellite Television
WMO	World Meteorological Organization

Abbreviation	Description
WRC	World Radiocommunication Conference
ZTD	Zenith Total Delay

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 inputs to national security, law enforcement and to the safety of all Australians during 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 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.

Notably, the Australian Government is undertaking a review of space industry capability to enable our nation to capitalise on the increasing opportunities within the global space industry sector. On 25 September 2017, the Australian Government announced its intention to establish an Australian space agency. This announcement was guided by input to the review of Australia's space industry capability. The review report is due in March 2018.

Complementing this is the revision of the *Space Activities Act* 1998, which continued in 2017 with the drafting of the Space Activities Amendment (Launches and Returns) Bill 2018. Introduction of the Bill to Parliament is planned for 2018.

The 2017 State of Space Report documents the Australian Government's activities in civil space for the 2017 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:

- 1 **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.
- 2 **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.
- 3 **National interest:** addressing space-related issues that ensure Australia's national security, economic, and social objectives are appropriately achieved.
- 4 **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:

- **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.
- **EOS** delivers crucial data that enables 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, providing services to regional and remote areas that previously had poor or non-existent terrestrial based internet services.
- **Space Situational Awareness** contributes to understanding of the space environment, and includes detecting, tracking and identifying objects in space, and understanding the effects of adverse space weather and space debris.

Apart from corporately owned communication satellites, Australia is completely reliant on foreign owned satellites systems for access to critical PNT and EOS data.

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. DIIS is the central point of contact and coordination for the Australian 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:

1. **Policy and regulation:** coordinated activities undertaken by Australian 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.
2. **Space capability:** support for the provision of the physical infrastructure, R&D activity, and human capital required to leverage opportunities and benefits derived from space systems.
3. **National interest:** addressing space-related issues that ensure Australia's national security, economic, and social objectives are appropriately achieved.
4. **International engagement:** building on Australia's engagement as a global citizen by participating and collaborating in international space initiatives and agreements.

¹ Bryce, 'Global Space Industry Dynamics', accessed 10 January 2018, <https://www.industry.gov.au/industry/IndustrySectors/space/Documents/BRYCE-Australia-Global-Space-Industry-Dynamics-Paper.pdf>; 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 Australian 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. The Government's National Innovation and Science Agenda aims 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 Australian 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 Australian 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 Australian Government's involvement in civil space and also chairs the Australian Government Space Coordination Committee (SCC), a forum for information sharing and coordinating the Australian Government's activities and priorities in civil space activities. The SCC membership is comprised of Australian Government agencies with an interest in civil space:

- **DIIS:** policy, regulation, and central point of contact and coordination for civil space activities.
- **Defence:** civil space activities that overlap with defence-related issues in space.
- **GA:** PNT, and EO
- **The Bureau:** space weather observations and services, EO services and science. These include weather, climate and environmental monitoring and infrastructure, as well as ranging, calibration and validation activities.
- **CSIRO:** space science and EO science. CSIRO manage and run critical international space-related infrastructure.
- **DCA:** policy oversight of radiocommunications services and spectrum management (including satellite communication) in Australia.

² www.innovation.gov.au

- **ACMA:** regulation of radiocommunications services, including radiocommunications licencing of space based communications systems in Australia and ITU satellite filing coordination.
- **DFAT:** engagement on space-related international security issues.
- **Home Affairs:** critical infrastructure resilience policy.
- **AGD:** the Office of International Law within AGD provides legal advice to Government on international space law.
- **DIRD:** PNT as it relates to the transport sector.
- **DEE:** EO as it relates to environmental management.
- **DAWR:** PNT and EO as it relates to biosecurity surveillance and management, monitoring of natural resource condition and agricultural production systems.

PM&C, 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 twice in the 2017 calendar year.
- SCC members were briefed on activities undertaken by the Australian Government and industry including progress updates on:
 - preparations for, and subsequently reports on the 2017 IAC held in Adelaide in September 2017
 - the review of the *Space Activities Act 1998*
 - a Review of Australia's Space Industry Capability
 - activities of the SCC working groups.

Review of Australia's Space Industry Capability

On 13 July 2017, the then Minister for Industry, Innovation and Science, Senator the Hon Arthur Sinodinos AO announced a review of Australia's space industry capability to lead a national strategy for the sector that reflects both Australia's developing strengths and national interests for the next decade. Ensuring that the right strategic framework is in place to support the growth of Australia's space industry is core to the review process.

The review is being led by an Expert Reference Group and is chaired by former CSIRO Chief Executive Dr Megan Clark AC. The membership of the Expert Reference Group brings together a wealth of experience from a range of backgrounds. The Terms of Reference of the group – see below – focuses on understanding the opportunities and capabilities within the space industry, as well as how the Australian space industry sector can address existing needs and priorities.

Review of Australia’s Space Industry Capability - Terms of Reference

- The Review of Australia’s Space Industry Capability will build on the principles set out in the existing *Australia’s Satellite Utilisation Policy (2013)* by developing a strategic framework for the Australian space sector that supports leadership, innovation, opportunity and entrepreneurship across the sector along with our broader national interests.
- The Review will specifically address the following matters:
 - identifying Australia’s current industry capability and areas of comparative advantage for Australia to develop,
 - technologies and practices that promote innovation in both the downstream (users of space technologies) and upstream (providers of space technologies) elements of space activities, particularly in areas of niche capability and competitive advantage,
 - Australia’s level of regional engagement and international collaboration, including identifying critical future and existing partnerships,
 - identifying capability gaps to support the global competitiveness of Australian firms in the civil space sector,
 - strategies to promote Australian firms engaged in the civil space sector, both domestically and internationally,
 - risks and opportunities, including ongoing access to space data and associated infrastructure essential to our national interests,
 - alignment with other sectors and Australian Government priorities, including Defence and cyber security, and meeting Australia’s international obligations, and
 - the most effective institutional arrangements to support the strategic direction of Australia’s space industry.
- Consultations with key stakeholders and state jurisdictions will be conducted as part of this review with a focus on the matters set out above.
- The review commenced in July 2017 and will be completed by the end of March 2018.

Through the review, the Expert Reference Group consulted widely with a focus on examining Australia’s current capability and areas of comparative advantage, as well as Australia’s regional and international engagement within the sector. Importantly, it also considered how the space industry sector aligns with other sectors and Australian Government priorities.

Full details of the consultation process are available at <https://www.industry.gov.au/industry/IndustrySectors/space/Pages/Review-of-Australian-Space-Industry-Capability.aspx>.

The Expert Working Group commissioned three analytical reports that serve as an evidence base to inform its considerations. These reports investigate Australia’s current space industry capability, the dynamics of the global space industry, and global space strategies and best practice. These reports, and the written submissions to the review, were publicly released through the department’s website

at <https://www.industry.gov.au/industry/IndustrySectors/space/Pages/Review-of-Australian-Space-Industry-Capability.aspx>.

On 25 September 2017, and on the basis of feedback received through the Expert Reference Group's consultations, the Australian Government committed to establishing a national space agency to ensure Australia has a long-term plan to grow its domestic space industry.

Specifically, the Australian Government considers that an agency is essential to:

- develop a national plan that identifies areas of focus for Australia in the space sector;
- enhance coordination of domestic activities in Australia's space sector;
- more proactively engage with international partners; and
- enhance support to develop Australia's space industry capability.

In making this announcement, the Australian Government tasked the Expert Reference Group to provide advice on the Charter for the agency.

The Expert Reference Group's final strategy, including advice on the Charter for the agency, will be provided to the Australian Government in March 2018.

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*, 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.

Key activities and developments

- In August 2017, Cuberider launched a second payload to the International Space Station (ISS) to conduct student experiments for Australian high schools as part of the 'Create for Space' program.
- In April 2017, three Australian CubeSats were launched to ISS under the QB50 project and were deployed in May 2017. The QB50 project is coordinated through Belgium's von Karman Institute for Fluid Dynamics. Authorisations under the *Space Activities Act* were issued to the Universities of Sydney, New South Wales and Adelaide. The QB50 project is carrying out research on the thermosphere. It also will demonstrate a model for small scale research missions.
- The second communications satellite in the nbn 'Sky Muster' series commenced commercial operations on 2 May 2017. NBnCo-1A and NBnCo-1B Sky Muster satellites have been authorised under the Act.
- The Buccaneer CubeSat, developed under collaboration between UNSW and DST Group was successfully launched on a Delta-II rocket on 18 Nov 2017, from Vandenberg Air Force Base in California. Successful communication with the Buccaneer satellite was established on its first pass over Australia. An international network of ground stations monitoring spacecraft was able to aid in early orbit determination. The first Buccaneer CubeSat, the RMM, is examining key technologies involved in conducting the main mission, this includes the ability to deploy a 3m antenna from a 35cm CubeSat and conduct research activities.

- DST contributions to the Air Force small satellite missions M1 and M2 (ground station support, exploitation environments and performance evaluation).

Future activities

- The Buccaneer Main Mission will be launched within the next five years.

Reform of the Space Activities Act 1998

A review of the *Space Activities Act 1998* concluded in December 2016. The review found that the *Space Activities Act 1998* should be reformed.

A legislative proposals paper was prepared which provided the key findings of the review, and set out proposed reforms to the legislation. The legislative proposals paper provided stakeholders the opportunity to comment on specific reform proposals. A total of nine submission on the legislative proposals paper were received.

Following consideration of this feedback, a Bill has been drafted with a view to its introduction in Parliament in 2018. Reforms under consideration include:

- That the objects of the legislation be streamlined to appropriately balance risk with Australian benefit, including a focus on Australia's international obligations and the establishment of a system of regulation for those activities.
- That a licence type to authorise payloads be introduced.
- That requirements currently outlined in the Space Activities Regulations 2001, which are more relevant to launch, be transferred to the proposed new 'Australian launch permit' licence.
- That a high level statement committing applicants to consider the space environment be considered.
- Proposals for possible changes in relation to fees and insurance.

Agreement between Australia and the USA concerning Space Vehicle Tracking and Communication Facilities

On 17 October 2017, the Agreement between the Government of Australia and the Government of the United States of America concerning Space Vehicle Tracking and Communication Facilities was signed in Washington DC, USA. Since then, the Australian Government has brought into effect a new Agreement on Space Vehicle Tracking and Communication Facilities with the Government of the United States (the Agreement). The new bi-lateral Agreement consolidates the existing arrangements which have evolved over a succession of amendments since 1960 when the Treaty was first put in place (see 2.4.1 *International Agreements and Partnerships*).

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.

The ACMA's future work priorities are outlined in the ACMA's FYSO which outlines the ACMA spectrum management priorities and identifies activities to be undertaken by the ACMA during the 2017-18 financial year. Industry feedback on the FYSO is used by the ACMA to inform development

of next year's spectrum work program. Information on key activities related to space based communications is below, more detailed information is contained in the FYSO.

Key activities and developments

- The ACMA, in consultation with the DCA, continues to engage internationally on the coordination, development and implementation of measures to enhance spectrum usage for satellite communications and space research services.
- Domestically, our key spectrum planning priorities over the next five years are to:
 - support the deployment of novel satellite systems (particularly small satellites)
 - protect radio astronomy facilities
 - consider and action if appropriate identification of possible additional bands for ubiquitous satellite use
 - develop arrangements to support earth stations in motion in the fixed satellite service.
- Through licensing, ACMA seeks to provide access to the spectrum for as many services as possible without harmful interference. During the 2016-2017 financial year, ACMA assessed and issued over 1,569 new and renewed radiocommunications apparatus licences for space systems.³
- ACMA has been working closely with DCA on implementing the recommended changes to improve Australia's spectrum management framework.
- On 20 October 2017, following public consultation the ACMA finalised interim arrangements⁴ providing more flexible regulatory and licensing arrangements for fixed-satellite services using ubiquitous earth stations in motion in the Ka-band. The arrangements are to be reviewed after WRC-19.
- On 26 October 2017, the ACMA released its FYSO. Submissions from industry on the FYSO closed 18 December 2017 and will be used to inform the ACMA development of next year's spectrum work program.

Future activities

Upcoming activities for ACMA include:

- Review of licensing procedures for space based communications systems licensing procedures. One of the key purposes of the review is to consider whether in light of trends in spaced-based communications systems that licensing procedures are appropriate and commensurate with the risk of interference.
- 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 trends in the spectrum needs of space-based communications systems, as well as developments in emerging space-based technologies and applications with the view of determining whether future reviews and updates to regulatory arrangements are likely to be necessary to support continued innovation in the sector.
- The business as usual work of assessing and issuing space systems radiocommunication licences.

³ See ACMA and Office of the eSafety Commissioner annual reports 2016-17 <http://www.acma.gov.au/theACMA/annual-report>

- Releasing for comment in the first half of 2018 a spectrum work program for 2018-19.
- Working with DCA on the spectrum review.
- Submitting of information related to the Australian satellite systems to the ITU on behalf of Australian satellite operators.

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 – the ITU does not directly engage with satellite operators. The ACMA is the Australian administration for this ITU process.

The 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.⁵

The 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

- Submitting of information related to the Australian satellite systems to the ITU on behalf of Australian satellite operators (including Defence, nbn and Optus).
- Exchanging of coordination information concerning the satellite systems with other administrations.
- Providing support, in accordance with the ITU Radio Regulations, for matters relating to satellite coordination activities of Australian satellite operators.
- Assessment of 856 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.

Future activities

- The 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.

⁵ <http://acma.gov.au/Industry/Spectrum/Spectrum-planning/Space-systems-regulation/reformed-space-policies-procedures-space-systems-regulation-acma>

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 WMO SG-RFC in order to share expertise in radiofrequency issues in meteorology and Earth observations.

Key activities and developments

- Agenda item 1.13 for WRC-19 is considering allocation of the 24.25-27.25 GHz range for IMT, also known as mobile broadband, There is a significant risk that unwanted emissions from both base station and user equipment operating in this range will cause unacceptable interference into the neighbouring band (23.4-24GHz passive band) which is used by Earth Observations satellites, including the GPM. GPM rainfall is a key source of global rainfall data that is potentially more important in Australia than in other developed nations, due to the sparsity of rain measuring instrumentation in much of the country. The Bureau is seeking support from the Australian community to help to protect the 23.4-24GHz passive band.
- The Bureau attends ACMA meetings related to WRC-19 and DCA meetings on Government spectrum matters that have resulted from the Spectrum Reform process.

2.1.3 Other relevant regulation

Reform of the Radiocommunications Act 1992

In 2015, the Australian Government announced it would implement the recommendations of the Spectrum Review, to:

- replace the current legislative arrangements with new legislation;
- better integrate the management of public sector and broadcasting spectrum into the spectrum management framework; and
- review spectrum pricing.

The Australian Government's intention is to meet the current and future demands of spectrum users by simplifying the current arrangements, removing regulatory barriers to innovation and promoting the efficient use of spectrum, including through the use of market-led mechanisms.

Key activities and developments

A consultation package on the spectrum reforms was released in May 2017 comprising:

- an exposure draft of the Radiocommunications Bill 2017 and accompanying information paper;
- papers on approaches to broadcast spectrum and transitional arrangements; and
- papers on spectrum pricing and Commonwealth held spectrum.

The exposure draft of the Radiocommunications Bill 2017 was informed by stakeholder feedback, including on a legislative proposals consultation paper.

Future activities

- A further draft of the Radiocommunications Bill, together with drafts of the Transitional and Consequential Amendments Bill and the Radiocommunications Licence Tax Bill, will be released for public consultation before introduction of the legislation into Parliament.

Aviation safety: administration and regulation of Australian airspace

The OAR, within the CASA, has carriage of the regulation of Australian-administered airspace, in accordance with section 11 of the *Airspace Act 2007*.⁶

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

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

CASA administers CASR Part 101, which applies regulatory restrictions to the operation of unmanned rockets, including high powered rockets. 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.

Key activities and developments

- The OAR receives multiple agency and industry enquiries annually, including 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* recognising that the nature of space related activity is changing to include sub-orbital flights, high altitude surveillance capabilities, high altitude communications systems, low earth orbit balloon and RPAS activity. This emerging issue requires significant work internationally and domestically to define the boundaries of space, particularly given that CASA administration and regulation of airspace has been limited to activities up to 60,000 feet over Australia's area of airspace responsibility.

⁶ <https://www.casa.gov.au/airspace/landing-page/airspace-regulation>

2.2 Space capability

Access to satellite-derived data, and the development and retention of relevant infrastructure and skills, provide the following 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 Australian 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 Australian 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.

2.2.1 Infrastructure

National Positioning Infrastructure

GNSS have a key role in Australia's economy, supporting increased productivity, safety and convenience to a wide range of societal endeavours. To enhance the capability offered by the foreign-owned GNSS constellations over Australia, ground infrastructure has been deployed by government and industry. The primary investment by the Australian Government is through GA's Regional GNSS network, and the AuScope GNSS array, which was developed under the National Collaborative Research Infrastructure Strategy. AMSA has also invested in GPS ground infrastructure aimed at enhancing shipping safety.

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 including SBAS.

Key activities and developments

- Geoscience Australia is leading a test project of a SBAS for the Australasia region. An SBAS will overcome the current gaps in mobile and radio communications and, when combined with on-ground operational infrastructure and services, will ensure that accurate positioning information

can be received anytime and anywhere within Australia and New Zealand. The two-year project will test two new satellite positioning technologies including next generation SBAS and Precise Point Positioning, which will provide positioning accuracies of sub-metre and ten centimetres, respectively.

- The testbed is supporting a comprehensive testing program across ten industry sectors in Australia and New Zealand including agriculture, aviation, construction, mining, maritime transport, road transport, spatial, utilities and consumer. This testing is being coordinated by the CRCSI and will explore the potential safety, productivity, efficiency and environmental benefits of SBAS.
- Together GA's Regional GNSS network and the AuScope GNSS array consist of over 130 GNSS ground stations. All of these stations have been upgraded to track the latest GNSS signals and constellations.
- GA maintains one of the most complete public archives of GNSS data from continuously operating ground stations in the Asia-Pacific region with data from over 600 stations being made available to industry and science on a daily basis.
- Access and reliability of the real-time data streams from Australia's Regional GNSS network and AuScope GNSS array have been improved through the deployment of a caster service in the cloud.
- A database and online web application to record and manage metadata from GNSS ground stations has been developed. The database conforms to International and OGC standards and allows for the machine-to-machine transfer of GNSS metadata.
- Datum Modernisation
 - Australia's coordinate reference frame has been updated to the GDA2020 to reflect the movement of the Australian tectonic plate of seven centimetres per year. Coordinates have moved approximately 1.8 metres northeast, compared to the previous coordinate reference frame, GDA94.
 - Before the update, spatial datasets (e.g. maps) in Australia were offset from positioning data provided by global navigation satellites, like GPS, by about 1.8 metres. This was not a major issue given that mobile phone technology was only accurate to about five metres. However, the SBAS trial anticipates providing positioning data accurate to about 10 centimetres. Users will start to notice that satellite navigation data and maps are not aligned.
 - The modernisation of the Australia's coordinate reference frame will ensure that positioning data observed from GNSS like GPS, combined with SBAS, can be easily and accurately aligned to spatial datasets. This will have significant benefits for industries and applications that rely on accurate positioning such as precision agriculture, the emerging intelligent transport sector, mobile location based services and automated mining operations.
 - GDA2020 will improve the interoperability of data to drive spatial innovation and enable improved decisions that affect people's safety, prosperity, and environment.

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.⁷

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.

⁷ ACIL Allen Consulting Pty Ltd (2015). *The Value of Earth Observations from Space to Australia*. CRC for Spatial Information. Available at: <https://goo.gl/x7Go4A>

The Australian Government, primarily through GA, 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 nine metre tracking antennas at Alice Springs, at the heart of Australia, receiving data from a range of Earth observation missions on an operational basis. A \$4 million investment by GA has augmented the facility to enable it to provide command and control support to key partner missions.⁸ Alice Springs provides this support to the USGS' current and future *Landsat* missions, assuring data access to Australia while also contributing back to a program that has supported Australia to track how its landscape is changing since 1979.

The Bureau owns and operates ten polar tracking and geostationary satellite antennas across Australia and Antarctica, supported by processing, archive and distribution facilities 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 Bureau 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

- In September 2017, CSIRO announced an agreement with UK-based Surrey Satellite Technology Ltd for a 10 per cent share of the tasking and data acquisition capabilities from the NovaSAR-S S-band SAR satellite. The \$10.45 million agreement gives CSIRO tasking and download rights

⁸ <http://www.ga.gov.au/news-events/features/alice-springs-antenna-upgrade>

world-wide, and a priority over Australia's Exclusive Economic Zone, for seven years, and the ability to access the raw data directly from the satellite into Australian receiving stations. It also gives a license to use and share the data with researchers and other Australian companies and organisations. Australian access to the satellite will be managed as a National Facility by CSIRO.

- Major upgrades to satellite ground station facilities including:
 - A \$3 million upgrade of GA's facility in Alice Springs that has put it at the heart of international satellite programs, performing a critical role in controlling satellites and ensuring acquisition of vital data.
 - The Bureau's recently upgraded polar tracking antennas at Crib Point, Darwin, Casey, Davis allow reception of data from new generation satellites such as Metop-A and -B, NPP and the recently launched JPSS-1.
 - The Bureau has installed a COSMIC-2 antenna in Darwin, in partnership with the US NOAA and the NSPO. The antenna will provide back-up spacecraft command for the mid latitude inclination of six satellites which will be launched in early 2018. COSMIC-1 has been a major source of GPS-RO data for the past ten years. The COSMIC-2 mission will provide a revolutionary increase in the number of atmospheric and ionospheric observations (up to 10,000 per day) that will greatly benefit the research and operational communities.
- Ongoing operation and development of a regional data access and analysis hub in support of Europe's *Copernicus* program. The data hub supports uptake of data from the *Sentinel* satellites in Australia, South-East Asia and the South Pacific. It is a key Australian contribution to regional cooperation through the AO-GEOSS initiative. The project is a partnership between GA, CSIRO and the governments of New South Wales, Queensland and Western Australia.
- The Bureau continues to receive real time Himawari-8 data and products via a dedicated link to the Japan Meteorological Agency. The products are made available freely to the public via the website, and now include lightning information as a new layer.
- Establishment of the CCEO. This CCEO will support the following CSIRO activities in Earth observation science:
 - Coordinating delivery of underpinning EO science, including a satellite data quality assurance and calibration and validation work program, and Earth observation informatics expertise for the management of petabyte-scale EO datasets and support of sophisticated time-series analysis tools, web-services, model-data fusion and model-data assimilation science and applications projects.
 - 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 sensing systems, including oversight of the DMTC High Altitude Sensor Systems Program (for which CSIRO provides the Program Leader on secondment).
 - Tasking and control of the Australian share of NovaSAR operations.
- CSIRO and GA, working with domestic and international partners, are also establishing multiple new initiatives around furthering the Open Data Cube technology, initiated within Australia, to support the use of new generation meteorological satellites for non-meteorological applications. Regionally, CSIRO is assisting the Vietnam National Satellite Centre and the NZ Centre for Space Science and Technologies in establishment of DataCube platforms in these agencies.
- CSIRO and GA are also supporting the use of Earth observation information for informing progress towards the UN Sustainable Development Goals.
- CSIRO has been assisting:

- The ABS 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
- GEO with the use of EO data for:
 - Sustainable Development Goals
 - The GEOGLAM Flagship and
 - GFOI.

Future activities

- Further enhancements to the regional *Copernicus* data access and analysis hub, including potential expansion of the datasets included beyond the *Sentinel* missions.
- Reception and validation of satellite observed lightning data from FY-4A as part of the Bureau's bilateral agreement with the CMA.
- The Bureau is developing machine learning techniques for extracting information from large volume satellite datasets.
- GA will explore opportunities for the private sector to leverage its facility in Alice Springs to support acquisition of additional satellite data over Australia, while ensuring ongoing robust support to the *Landsat* program.
- GA, CSIRO and the Bureau, working through the SCC's EOS Working Group, will release an Australian Government Earth Observation Infrastructure Coordination Plan. This plan will describe the specific activities agencies will undertake over coming years to implement the National Earth Observations from Space Infrastructure Plan.
- The SCC's EOS Working Group will continue to support the Australian Government consideration of the future national research infrastructure required to support exploitation of EO.
- Support the evolution of Earth Observation Australia as a national coordination group fostering cooperation between the Australian Government, industry, research and other groups in the national Earth observation community.

VAST

VAST provides viewers in remote areas—and those in digital television terrestrial black spots in metropolitan and regional areas—with access to a range of commercial and national free-to-air television services equivalent 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.

Key activities and developments

- Over 250,000 individual VAST decoders have been approved to connect to the commercial free-to-air television services across Australia.

DEA

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

The Australian Government has invested \$15.3 million (from 2017-18 to 2018-19) to establish DEA. DEA makes it quicker and easier to access and analyse Earth observation satellite data to produce readily accessible information and insights about Australia's changing landscape, coastline and

oceans. DEA builds on the award-winning Australian Geoscience Data Cube project, the technology for which has now been released to the international community as a free open source tool through the Open Data Cube initiative.

DEA lowers the technical barriers to using satellite data such that businesses from start-ups to established companies can operate on a level playing field, avoiding the need for the major capital investment in data storage and processing that has prevented businesses from exploiting this data in the past. In its initial phase, DEA will focus on leveraging satellite data to improve government business, including applications that streamline implementation of environmental regulations that affect businesses.

As well as making new applications and research possible, DEA 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 Australian Government is working to implement the DEA program as an enduring capability, with priorities including:
 - maintaining deep historical satellite data, ensuring researchers can tap the deep 'time series' essential for characterisation of environmental change
 - incorporating 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
 - integrating 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)
 - enhanced visualisation functionality, enabling researchers to explore the datasets interactively and present results in a form more suitable for decision making
 - advanced data analytics functionality, ensuring users are able to ask the necessary questions of the data
- The Australian Government has also made the code underpinning DEA 'open source' through the Open Data Cube project. GA and CSIRO are working with international partners on collaborative development projects to enhance and implement the technology, with a particular focus on supporting the application of satellite imagery for the Sustainable Development Goals. This work also aims to establish an international network of compatible systems to make it easier for governments, researchers and industry to work together on exploitation of Earth observation satellite data. Through collaboration with the CEOS, over 20 nations are now working with the technology.
- CSIRO, consistent with its role and priorities, is also progressing:
 - engagement with the private sector in exploitation of Open Data Cube technology under the 'Earth Analytics Industry Innovation Hub' project
 - 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 DEA and the Open Data Cube technology.

Future activities

- The Australian Government is exploring opportunities to:
 - provide enhanced and sustained calibration/validation facilities and datasets through increased cooperation with state and territory governments, the research community, and international partners
 - expand the range of applications provided by DEA
 - provide Australian industry with access to reliable, standardised satellite data and robust digital infrastructure that can be used to build new digital products and services for commercial purpose
 - 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 recently approved international 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 CASS Business Unit.⁹ CASS operates two major national space facilities: the ATNF¹⁰ and the CDSCC.¹¹ CASS has approximately 275 full-time equivalent 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

- ASKAP located at the Murchison Radio Observatory in the mid-west of WA, is now being commissioned and is introducing, pioneering and testing revolutionary technologies vital to the SKA in areas of remote area electrical engineering, digital systems, computing, big data signal transport, and operations in a radio-quiet zone.¹² Key results and techniques generated through the development of ASKAP are contributing to the international SKA design and development effort. ASKAP is also building industry involvement and green energy power systems that will be relevant to the much larger SKA project. Recent early science with CSIRO's innovative phased array feed receivers is now demonstrating capability for breakthrough science discovery. CSIRO is a partner in seven international pre-construction consortia, designing aspects of the SKA ranging from infrastructure to high speed digital signal processing.
- CSIRO is the centre agent for the Pawsey Supercomputing Centre that both supports and is involved in a range of SKA-related activities. It supports two of the SKA precursor projects, the ASKAP and the 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

⁹ <http://www.csiro.au/en/Research/Astronomy>

¹⁰ <http://www.atnf.csiro.au/>

¹¹ <http://www.cdsc.nasa.gov/>

¹² <http://www.atnf.csiro.au/projects/askap/>

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.

ATMS

The Government owned ARTC is continuing to develop its ATMS, a new technology specifically designed for and by the ARTC that uses digital GPS navigation and broadband communications to locate and route trains in real time.¹³

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.
- 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.
- Advanced trials of the system have been successfully taking place between Port Augusta and Whyalla since 2015, with the most recent trial successfully completed in June 2017.

Future activities

- Additional on-track tests, using locomotives and an ATMS fitted road-rail vehicle, in 2017-18.
- The ATMS is expected to become the primary safeworking system between Port Augusta and Whyalla, South Australia in late 2018.
- The Tarcoola to Kalgoorlie section of the interstate rail network scheduled be ready to facilitate the next phase of the ATMS trial in 2018.

2.2.2 Research and development

Satellite based data and products

The Australian Government uses satellite imagery to produce a range of national products that underpin decision making by governments, industry, researchers, and society more generally.¹⁴ 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.

CSIRO through its NovaSAR investment will be providing unique tasking and SAR data capabilities to advance the development of new applications of these data for Australian researchers and institutions.

¹³ <https://www.artc.com.au/projects/atms/>

¹⁴ www.ga.gov.au

GA 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. Through the Digital Earth Australia program, this range of products will increase, with priorities identified through consultation with other Australian Government agencies.

Many of the Bureau's forecast, warning, climate and water services rely on the availability of near real time meteorological satellite imagery and products. The Bureau uses satellite observations to develop products and services for Antarctic weather forecasting, aviation forecasting, tropical cyclone warning and volcanic ash monitoring. In addition, a wide range of internal and external users currently require products derived from both polar and geostationary satellite data.

One of the most important applications of EOS data in the Bureau is the use of this data in operational NWP. Recent studies have shown that satellite data comprises 95 per cent of observations used by weather models and 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.

Key activities and developments

- Through GA, the Australian 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.
- The Bureau continues to invest in the development of new products that are used by forecasters, aviation, defence, agriculture and energy industries, and the general public. The Bureau is currently developing products using observations from the new generation of satellites, including Himawari-8, Suomi-NPP, MetOp-A/B/C, and JPSS-1. The Bureau continues to invest in 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 national security, the aviation industry, agricultural industry and emergency services and the public.
- The Australian Government uses satellite imagery to produce a range of national products that underpin decision making by governments, industry, researchers, and society more generally.¹⁵
- The Bureau, GA and RMIT are producing ZTD data in near real time. The Bureau is conducting initial testing for the assimilation of this data in the ACCESS.
- The Bureau is collaborating with GA and several universities on activities related to the use of GNSS and GPS for total column water vapour estimation and radio-occultation for monitoring of atmospheric temperature and humidity as well as ionospheric monitoring. These are used in the Bureau's weather forecasting models.

Future activities

- The Australian Government, through its network of partnerships with both national and international experts, and with industry, will continue to develop and refine products to take

¹⁵ www.ga.gov.au

advantage of new science and technology. CSIRO plays a critical role in research and development in this area, with DEA intended to provide a platform that:

- makes this research process more cost-effective and efficient; and
- provides a pathway for proven products to be delivered sustainably.
- 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 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 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 has developed, and demonstrated with the Buccaneer mission, 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 Defence Science and Technology Strategy for Space that will identify and invest in strategic space technologies that have the potential to deliver game-changing capabilities for Australia's armed forces in advanced small satellite missions and comprehensive space domain awareness.

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. Successful communications with the Buccaneer satellite was established on its first pass over Australia.

Key activities and developments

- The Buccaneer RMM was successfully launched on 18 Nov 2017 from Vandenberg Air Force Base in California.
- An international allied network of ground stations monitoring spacecraft was able to aid in early orbit determination.
- The Buccaneer RMM is examining key technologies involved in conducting the main mission, including the ability to deploy a 3 metre antenna from a 35 centimetre cube satellite.

Future activities

- The Buccaneer Main Mission will be launched within five years.

CRC Program

The Government funds two space-related CRC, established through the Australian Government CRC Program,¹⁶ which supports industry-led collaborations between researchers, industry and the community:

1. CRCSI¹⁷
2. SEMCRC¹⁸

Key activities

1. The CRCSI is an international research and development agency that conducts user-driven research to find robust solutions to three major challenges:
 - solving the technical challenges that will permit Australia to use all global and regional navigation satellite system signals to deliver two centimetre positioning accuracy to anybody, anywhere outdoors in real-time
 - improving the ability and efficiency of Government and industry to rapidly create and value-add spatial information products from mobile devices and cloud-based infrastructure
 - developing new intelligent ways to improve the organisation, access and use of spatial data in Australia and New Zealand through automation, methodologies to manage data, robust data tracking systems and application efficiencies to support value-added use.

The solutions to these challenges will lead to innovation and productivity advances in the following key industry sectors that are the focus of this research: Agriculture, Natural Resources and Climate Change; Defence; Energy and Utilities; the Built Environment; and Health.

The CRCSI was first established in 2003 and granted \$16 million of Commonwealth funding over seven years with total cash and in-kind contributions of \$80.7 million invested. The second iteration of the CRC commenced in 2010 and a further \$32.2 million was granted over 8.5 years. Total cash and in-kind contributions invested in the second iteration was \$160 million.

Key outcomes include:

- **NRM Spatial Hub.** The NRM Spatial Hub allows graziers and land managers to map, plan, analyse and monitor farm infrastructure, pasture conditions and groundcover to improve land and natural resource management. This can occur at paddock-scale or across an entire property using the most recent satellite imagery, along with 30 years of historical Landsat records. Data is processed online and delivered to the farmer within 30 seconds of the request using low bandwidth communications. In 2017, the NRM Hub was spun out as a separate business, FarmMap Australia. It currently has over 800 subscribers representing 60 million hectares of grazing property across Australia.
- **The National Urban Digital Elevation Model.** Under a Council of Australian Governments mandate, the CRCSI was selected to develop a high-resolution (15cm vertical accuracy) DEM along Australia's urbanised coastline, covering some 200,000 square km. The aim was to improve Australia's preparedness and resilience in the face of climate change and

¹⁶ <https://www.business.gov.au/assistance/cooperative-research-centres-program>

¹⁷ <http://www.crcsi.com.au/>

¹⁸ <http://www.serc.org.au/>

rising sea levels. The resultant database is now publicly available and administered by GA. Derived maps have received over 300,000 downloads and the coastal risk portal has had over 130,000 users to date. The work has won several awards including the 2015 UN Lighthouse Award at the Paris Conference of Parties for innovation in elevation data standards, data acquisition, data fusion, distribution and public use and widespread impact nationally and internationally. Moreover, the CRCSI and GA established the National Elevation Data Framework to coordinate ongoing development of digital elevation data for Australia.

- **Precise Positioning.** The CRCSI's Positioning Program has been delivering applied research for over a decade in support of the National Positioning Infrastructure (NPI). Their research has addressed major technical challenges, solutions will allow delivery of 2-5 centimetre 3D positioning in real time anywhere outdoors using the six global and regional navigation satellite systems (GPS, GLONASS, Beidou, Galileo, QZSS, and NAVIC). Several world firsts have been achieved by CRCSI research teams including using an Australian-generated, QZSS-delivered correction message to guide Australia's first fully autonomous robotic tractor in real time, and the development of a novel approach to Precise-Point-Positioning and Real-Time-Kinematics, reducing dependence on expensive ground infrastructure. The Positioning Program's principal outcome is the ACS, providing the computational heart of the NPI and delivering the outputs needed to support real-time, quality-assured positioning to users across Australia and New Zealand. The NPI and ACS together will drive innovation and deliver massive benefits to a range of industries.

2. SEMCRC is managed by the 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 for LEO objects;
- developing techniques, algorithms and databases to assist in predicting and thus avoiding potential collisions in space; and
- developing technologies to mitigate the deterioration of the space environment by preventing debris-on-debris collisions in space.

The SEMCRC was established in 2014 and granted \$20 million of Commonwealth funding over five years with total cash and in-kind contributions of \$58 million invested

Key outcomes include:

- **SERC Atmospheric Mass Density Model.** Significant progress has been made on the SERC Atmospheric Mass Density Model which allows for more accurate orbit predictions for low earth orbit objects and is a major contribution to the industry.
- **SERC GEO Tracker Telescope.** Construction of the SERC 0.7m GEO Tracker Telescope was completed on 17 May 2017. First light was achieved on 29 May 2017 with successful tracks of LAsER GEODynamics Satellite-1 (LAGEOS-1) and Optus C1 satellites. The SERC GEO Tracker Telescope will be further developed to provide a fully automated tracking system to feed data (information about space objects) into the SERC Space Object Catalogue (SOC) for conjunction assessments.
- **SERC Space Object Catalogue.** Significant advancement has been made towards the development of the SERC Space Object Catalogue during the reporting period. The catalogue is populated with over 60 space objects and is now in testing mode.

Industry collaboration and development

CSIRO continues to build on its partnerships with industry to deliver breakthrough innovation that will contribute up and down the supply chain and grow the Australian space industry, in areas ranging from imaging and sensor technologies to autonomous robotics to materials and manufacturing processes. CSIRO has initiated several activities in support of industry development in 2017, including:

- Providing \$2.7 million in seed funding for the establishment of the HASS program through the DMTC, an independent, not-for-profit company that builds Australian capability through collaborative programs involving industry, research and defence partners. The HASS program aims to enhance defence capabilities and build Australian industrial capability in sensor and on-board data processing technology for unmanned aerial systems and small satellite platforms. CSIRO provides the HASS Program Leader on secondment. Four initial projects were selected in September 2017.
- Convening a Space 2.0 workshop for Australian space start-up companies, to explore opportunities to collaborate with and build capability within local industry. This initiative was supported by Main Sequence Ventures, manager of the CSIRO Investment Fund.
- Active participation in relevant national industry groups including the ASKAIC and the SIAA.

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

- 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.

Through these arrangements the Government undertakes activities that develop government-business partnerships to:

- progress technological space research and indigenous space capabilities which contribute to national security; and
- 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

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

Key activities and developments

- Defence and the United States have jointly established a C-band space surveillance radar at the Harold E. Holt Naval Communications Station near Exmouth in Western Australia, and are currently working to relocate a United States owned optical Space Surveillance Telescope to Australia. Both assets will be operated by 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.
- Defence is working with industry partners on the development of niche indigenous space surveillance capabilities, including both space-based and ground-based 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 operation of the Space Surveillance Telescope.

Radiofrequency spectrum management for defence-related satellite networks

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. Emerging challenges include the risk of interference to other space systems from large constellations of non-GSO satellites and GSO satellites that support ESIMS.

Future activities

- 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 AGO has received 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.
- The office is currently building the ground stations, antenna sites and commercial relationships in accordance with Government approval.
- The system will provide for the direct tasking of commercial imagery satellites and the direct receipt of the resulting imagery; the imagery will be sent into Defence GEOINT Domain to meet AGO customer requirements.

Future activities

- AGO has designed a study to examine the business case for the acquisition of a sovereign GEOINT satellite capability in accordance with the Defence White Paper. This will commence in early 2018 and extend over two years.

Combined Communications Gateway Geraldton

Defence has partnered with the United States Department of Defense to establish the Combined Communications Gateway Geraldton (C2G2). The Memorandum of Understanding for C2G2, signed in October 2014, enables the United States to establish a Gateway capability in Australia. The facility will be jointly shared by the United States and Australia, and will allow both partners to access Wideband Global SATCOM resources.

Key activities and developments

- A request for tender for facility construction is in process and it is expected that a contractor will be selected in March 2018. Construction will commence after that date.

Future activities

- Defence anticipates that C2G2 will reach an Initial Operating Capability in early 2020 and Final Operating Capability in early 2021.

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

DIIS overseas and provides secretariat support to the Space CSIG, which operates within the TISN for CI Resilience.¹⁹ The TISN operates within the purview of Home Affairs.

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 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 2018.

¹⁹ <http://tism.gov.au/>

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.

GA 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.
- The Bureau continues to provide satellite-based support for aviation safety through volcanic ash advisories, improved fog detection, and high ice water content (HIWC) detection.
- Ongoing improvements to GA's bushfire monitoring system, Sentinel, to enhance use of data from the next-generation geostationary satellite Himawari. This provides expert users with updates on hotspots every 10 minutes.

Future activities

- Automation of certain manual observations to improve the efficiency of our forecasting processes. Some of these will involve satellite-based solutions.

nbn Sky Muster satellites

The second nbn satellite commenced commercial operations on 2 May 2017. The nbn satellite network provides the opportunity to access fast broadband to over 400,000 homes and businesses, predominantly in regional, rural and remote Australia.²⁰ This includes more than 200,000 premises that previously had poor or non-existent access to terrestrial internet services.

Key activities and developments

- nbn's ISS concluded on 28 February 2017, superseded by the nbn Sky Muster satellites.
- As at February 2018, more than 85,000 homes and businesses have active nbn Sky Muster satellite services.
- nbn is developing a range of products with satellite capability, including enterprise satellite services to support business applications in regional and remote Australia, a mobility solution to support applications suited for in-flight Wi-Fi and facilitate improvements in sectors such as

²⁰ <http://www.nbnco.com.au/connect-home-or-business/information-for-home/satellite.html>

health and defence, and enhanced services such as video and multicast, and managed plans to allow unmetered data over Sky Muster for education products.

Aircraft navigation and positioning

Australian aviation has transitioned from the use of ground-based navigation aids to GNSS technology.²¹

GNSS allows more flexibility for aircraft navigation in the en route 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.

GNSS is also the enabling technology for ADS-B, which has allowed Airservices to provide surveillance services for most of the continent for a much lower cost than could have been achieved by adding additional radar facilities to the existing air traffic management network.

This increased reliance on satellite-based technology solutions has enabled Airservices, as Australia's civil air navigation service provider, to continue to realise safety and efficiency gains in the national 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 ICAO PBN regulatory framework, using the RNP specifications and GNSS as the enabling technology.
- Since February 2016, all aircraft operating under the IFR are required to carry GNSS navigation avionics.
- The introduction of PBN/RNP/GNSS navigation supports 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 to reduce fuel burn.
- Instrument approach / departure procedures using PBN/RNP/GNSS support engine idle descent and curved path. These can be 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.
- Use of ADS-B to improve the safety and efficiency of air traffic services at a viable cost for most of the Australian continent.

Future activities

- ICAO supports the implementation of Approach with Vertical Guidance for approach and landing operations. GNSS, with SBAS, is an enabling technology. Australian aviation is contributing to the SBAS Test-bed, established to assess the benefits 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 for aviation navigation.
- GPS is also expected to be a vital and common part of RPA operations in the future.

²¹ <http://www.airservicesaustralia.com/projects/nrp/>

- 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.

Maritime safety: detection of Cospas-Sarsat distress beacons

Cospas-Sarsat is an international satellite-based distress beacon detection system.²² During 2016, 484 people were rescued in Australia in incidents involving activation of a 406 MHz beacon. Australia is an active participant in the Cospas-Sarsat Programme and is one of the largest users of distress beacons in the world.²³ Australia has the second-largest distress beacon population in the world, with an estimated population of over 500,000 operational beacons.

Australia has two satellite tracking stations near Bundaberg in Queensland and Albany in Western Australia. These stations track the existing LEOSAR satellites.

Cospas-Sarsat is implementing a new satellite constellation known as MEOSAR.

Key activities and developments

- The two satellite tracking stations for the LEOSAR system have continued to operate, meeting required performance standards.
- The new MEOSAR capability is undergoing commissioning tests before commencing full operations. Data from the Mingenew (Western Australia) satellite tracking station for the MEOSAR system is also being used operationally by the Australian Joint Rescue Coordination Centre.

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 DIRD, responsible for the strategic policy framework for aviation in Australia. 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 GNSS PBN as their primary means of navigation capability from February 2016. Additionally, CASA mandated 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.
- 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.

²² <http://www.cospas-sarsat.int/>

²³ <https://www.amsa.gov.au/search-and-rescue/sar-response-capability-and-technology/cospas-sarsat-sar-satellite-system/>

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

Space Concession

The Space Concession provides a duty-free tariff concession for eligible imported goods for use on authorised space projects.²⁴ 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.

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, the Bureau, CSIRO and GA work closely with Earth observation satellite operators directly, and through the CEOS to explore opportunities to exploit satellite data in innovative ways (see below). Key partners include NASA, the European Commission, USGS, NOAA, JMA, JAXA, China Meteorological Administration and ESA. 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 comprise 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 Australia-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 CNES for investigating the cosmic microwave background and 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 ISRO and was the prime ground station for the Cassini end of mission in September 2017.
- As set out earlier in the report at 2.1.2, the Australian Government has brought into effect a new Agreement on Space Vehicle Tracking and Communication Facilities with the Government of the United States. The new bi-lateral Agreement consolidates the existing arrangements which have evolved over a succession of amendments since 1960 when the Treaty was first put in

²⁴ More information about the Space Concession including eligible imported goods for use in authorised space projects is available at <http://business.gov.au>.

place. The Agreement is supported by a CAA between NASA and CSIRO which sets out the operational responsibilities of both agencies in managing the tracking facilities.

- CDSCC and the ATNF completed further research tests to assist the NASA Near Earth Asteroid program in tracking asteroids from the Southern Hemisphere to improve orbit determination. Asteroids 3122 Florence and 2012 TC4 were detected using CDSCC's DSS35 34m antenna and the Narrabri Compact Array 20m receive antennas. This demonstrated the feasibility of quick deployment asteroid tracking with smaller apertures in Australia. 2012 TC4 passed within 40,000km of Earth and results from the CSIRO program together with UNSW and Jet Propulsion Lab provided further refinement of this asteroid's orbit data.
- In November 2017, the DSN moved to a new space tracking operating paradigm called 'Follow the Sun' operations, under which CDSCC has full control of the global DSN for nine hours per day. This change has resulted in valuable new operational efficiencies for the DSN.

Engagement with Combined Space Operations initiative

Defence is a member of the Combined Space Operations initiative along with the United States, United Kingdom, Canada and New Zealand. France and Germany have been invited to join the initiative in 2018. 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

- Defence representatives participated in the Policy and Legal, Operations and Capabilities and Architectures Working Groups throughout the year.
- The Principals' Board met in London in September 2017, where France and Germany were invited to join the initiative.
- Defence also participated in a number of annual multinational space exercises hosted by the US Department of Defense:
 - Global Sentinel, space situational awareness exercise.
 - Global Lightning, space command post and battle staff exercise.
 - Global Thunder, space command post and field exercise.
 - Schriever Wargame, future focused space command and control and warfighting exercise.

Future activities

- Australia will act as the initiative Executive Secretariat in 2018, and will host the Principals' Board in Australia in late 2018.
- Defence will continue to develop and expand Australian partnerships in space with like-minded nations.

Sustained access to PNT and SLR capabilities

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

Key activities and developments

- Geoscience Australia and NASA have an agreement to jointly operate a SLR station at Yarragadee, Western Australia. This SLR station contributes data to the ITRF and to managing satellite assets.
- The JAXA and GA have an agreement for exchanging regional GNSS data, including data from Japan's 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 has an agreement with ISRO associated with SLR and microwave tracking of NAVIC.
- 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 EO capabilities

Australia, through the Bureau, GA and CSIRO, has established partnerships with key satellite-operating nations to promote continued access to critical datasets. 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 Australian Government can benefit from scientific, technological and operational developments and expertise from other countries.

The Australian 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 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 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 USGS 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.
- GA is an International Co-operator in the United States Landsat program, and has acquired data from these missions since 1979.
- GA and the 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 SLR station at Yarragadee, Western Australia. This SLR station contributes data to the ITRF and to managing satellite assets.

- 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. The European Union has recently released a Horizon 2020 “call” that will provide financial support for cooperation between Australian and European participants on EOS application development.
- GA and ISRO are developing an agreement to: undertake satellite calibration/validation using Australian corner reflectors; and share full resolution Ocean Colour Monitoring data on Australian waters.

Future activities

- GA will continue to implement its core strategic partnerships: with the European Commission (and its partners ESA and EUMETSAT) around the Copernicus program; and with the USGS around the critical Landsat program.
- GA and CSIRO will also work jointly to broaden their international engagement, including: continuing discussions with the United Kingdom Space Agency on EOS-related cooperation, with a view to establishing a cooperation arrangement; and, in light of recent changes to Japanese EOS data policy, increasing their engagement with JAXA on exploitation of medium-resolution data such as the ALOS missions. Both agencies will also continue to cooperate with other space agencies on EOS-related topics of mutual benefit as part of their membership of CEOS.
- The Bureau will continue to co-sponsor the annual Asia-Oceania Meteorological Satellite Users Conference. Its 8th meeting was held in Russia in October 2017.

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

DFAT is responsible for Australia’s multilateral and bilateral engagement on space issues.

Key activities and developments

- DFAT coordinated a whole-of-government response to a Russian Government proposal for cooperation in satellite navigation.
- DFAT made representations to the Netherlands’ Government for assistance to restore communications with an Australian CubeSat.
- DFAT assisted DIIS in the final stages of its negotiations with UN Office of Outer Space Affairs in relation to the International Astronautical Congress and an International Astronautical Federation Workshop in Adelaide in September 2017.
- DFAT hosted a visit by the Director of the UN Office of Outer Space Affairs, Simonetta Di Pippo, in September 2017. The visit included a roundtable at DFAT, an address to DFAT staff and lunch with astronomers and space engineers from ANU and the University of New South Wales.
- DFAT hosted a roundtable in September 2017 for the EU Space Envoy François Rivasseau, Director of Security Policy and Space Policy at the European External Action Service.
- A DFAT officer attended the first workshop of the MILAMOS project in Adelaide in February 2017.

Future activities

- DFAT will continue to advance Australia's space security and civil space interests with bilateral partners and in multilateral forums.

2.4.2 International forums

Advocate Australia's space interests in United Nations forums

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

- On 8 February 2017, DFAT delivered an intervention in the Scientific and Technical Subcommittee of COPUOS encouraging regular, tangible progress with a view to finalising the Guidelines on the Long Term Sustainability of Outer Space at the June 2018 COPUOS Plenary.
- With input from Australian agencies in the Space Coordination Committee, in June 2017 DFAT submitted a report to COPUOS on the steps Australia has taken to implement transparency and confidence building measures (TCBM) recommended in the 2013 report of the Group of Governmental Experts on TCBMs.
- At DFAT's invitation, Stephen Freeland, Professor of International Law, University of Western Sydney, joined the Australian delegation to the 56th session of the Legal Subcommittee of COPUOS in April in Vienna.
- In October, DFAT coordinated Australia's responses to First Committee resolutions on space.

Future activities

- The finalisation of the Guidelines on the Long Term Sustainability of Outer Space at the June 2018 COPUOS Plenary.
- Participation in the UNISPACE +50, as a special segment of the 61st COPUOS in June 2018.

Promote Australian space expertise and experience internationally

Through its overseas network, DFAT promotes the experience and expertise of Australia's space research and industry sector and supports 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 Australian 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.²⁵

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 ARSGs. The work of the ARSGs mirrors that of the ITU-R and its Working Parties.

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

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 2015.²⁶
 - Australian Government and industry spectrum users are participating in a range of international forums leading up to the 2019 WRC in order to influence harmonisation outcomes in the national interest.
 - On 22 May 2017 the Government released its response to the Review of the ACMA. Among other things, the Government accepted the Review's recommendation that the Department of Communications and the Arts be responsible for Head of Delegation roles to key international policy-setting forums including the WRC, with the ACMA continuing to provide technical support. The Department is currently working with the ACMA on arrangements to implement the Review's recommendation.

Future activities

- ACMA and the Department of Communications and the Arts 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.
- Australia will host the next major regional international forum, the third meeting of the Asia-Pacific Telecommunity Conference Preparatory Group for WRC-19, in Perth from 12-16 March 2018. The ACMA is leading organisation of the meeting, in consultation with the Department of Communications and the Arts.

International GNSS Service

Through GA, the Australian Government is chairing the 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

²⁵ <http://acma.gov.au/theACMA/Library/researchacma/Occasional-papers/the-acmas-international-engagement>

²⁶ <http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/International-planning-ITU-and-other-international-planning-bodies/wrc-15-summary-of-outcomes>

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.

UN-GGIM Sub-Committee on Geodesy

Through GA, the Government co-chairs the UN-GGIM Sub-Committee on Geodesy (formerly the GGRF Working Group) with Russia.

Key activities and developments

- In August 2017 the Working Group was upgraded to become a Sub-Committee on Geodesy. The SCoG is now co-chaired between Australia and Russia.
- Following the tabling of the GGRF Roadmap at the August 2016 meeting of the UN GGIM committee of experts, the working group/Sub-committee has been working on the development of an implementation plan. This draft plan is due for submission to the August 2018 meeting of the UN GGIM committee of experts.

International CEOS

CSIRO serves as the Australian principal on CEOS and, on behalf of Australia, served as the 2016 Chair of CEOS. Australia ended its term as Outgoing Chair in November 2017.

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. CSIRO is now serving as the Vice-Chair of the CEOS Strategic Implementation Team with support from GA. 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.

Through participation in CEOS, agencies also support the work of the GEO.

Future activities

- CSIRO, with support from GA, will serve as the Vice-Chair of the CEOS Strategic Implementation Team until October 2019, and as the SIT Chair from 2020 to 2021. This will include hosting the 2018 and 2019 meetings of the Strategic Implementation Team, which bring together space agency leaders and top technical experts together, in Australia.
- CSIRO and GA will support active participation of their experts in key CEOS working groups, including leadership roles in groups relating to Future Data Architectures, Land-Surface Imaging, Information Systems, Calibration and Validation, and the Sustainable Development Goals.

APRSAF

The 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.²⁷

²⁷ <https://aprsaf.org>

Key activities and developments

- DIIS and GA participated in the 24th APRSAF in Bengaluru, India 14-17 November 2017.

WMO Space Programme

As a member of the WMO, the Bureau participates in the various activities of the WMO Space Programme. The objective of the WMO Space Programme is to promote the availability and utilisation of satellite data and products for weather, climate, water and related applications to WMO members. It coordinates environmental satellite matters and activities throughout all WMO programmes and gives guidance on the potential of remote sensing techniques in meteorology, hydrology, and related disciplines.

The WMO Space Programme has four main components: the space-based observing system, access to satellite data and products, awareness and training, and space weather coordination.

WMO is a member of the CGMS, which is the group for global coordination of meteorological satellite systems.

Other satellite related WMO programs that the Bureau participates in include the Nowcasting and Mesoscale Research Working Group, which promotes and aides the potential use of numerical modelling and assimilation of high resolution satellite data.

Key activities and developments

- The Bureau hosts monthly Regional Focus Group meetings, providing satellite meteorology training for WMO members in Asia-Oceania and the South Pacific.
- The Bureau leads various activities in SCOPE-Nowcasting, which aims to provide consistent satellite products for nowcasting and severe weather risk reduction.
- The Bureau continues to provide near real-time LEO data from the Australian Region, to data assimilation centres worldwide, via the DBNet initiative.

IAC

The IAC was held in Adelaide, South Australia from 25 to 29 September 2017. The IAC is regarded as the world's largest annual interdisciplinary meeting in the astronautical industry. The 2017 IAC attracted over 4,400 participants from over 70 countries. Delegates included space professionals, academics, major corporations, government representatives, students and media.

Key activities and developments

- The Australian Government announced the creation of a national space agency during the IAC.
- DIIS led an Australian Government exhibition booth of 144sqm at the IAC 2017 in Adelaide showcasing civil space products and domestic and international partnerships from twelve Commonwealth Government organisations ("participants"), including two CRCs.
- DST Group supported the International Astronautical Congress 2017 Government stand with the Buccaneer small satellite model, support staff and several technical presentations.
- AGO contributed to the Australian Government stand at the IAC and gave a one hour presentation on AGO's role and DEF799, an Earth observation focussed Department of Defence major project.
- CSIRO also hosted a booth during IAC, where among others the formal agreement for NovaSAR was signed with Surrey Satellite Technology Ltd, witnessed by the British High Commissioner.

Future activities

- Plans are underway to attend the 2018 IAC in Bremen, Germany.

3 Commonwealth agency functions

3.1 AGD

AGD's Office of International Law provides legal advice to Government on international law. This includes advice on legal issues relating to space, to ensure Australia's engagement in the space domain is consistent with Australia's international obligations.

Key space-related activities

- AGD's Office of International Law provides legal advice to Government on key international space law treaties.

Website

www.ag.gov.au

3.2 ACMA

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 and the Arts.

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 The Bureau

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.

The Bureau's SWS provides a broad range of space weather services associated with measuring, modelling and forecasting the near space environment. The SWS supports defence, navigation, aviation, resource exploitation and other industry sectors.

Key space-related activities:

- The Bureau provides space weather services primarily for defence and communications activities and is a recognised global leader in this field.
- 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 ACCESS. Space based observations are a crucial input for the data assimilation modules of the ACCESS weather and seasonal prediction models as well as our ocean forecast models. The lead time for the prediction of weather events is critically dependent on these observations.

Website

www.bom.gov.au

3.4 CSIRO

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 approximately 350 staff involved in space activities. CSIRO has developed extensive capability in space-related areas that include Earth observation, communications, advanced aerospace technologies, spacecraft tracking and radio astronomy.

Key space-related activities:

CSIRO operates two national space facilities, the Australia Telescope National Facility and the Canberra Deep Space Communication Complex, and carries out space-related activities in the following areas:

- EOS; this includes: joint responsibility for national EOS capabilities with the Bureau of Meteorology and Geoscience Australia, development of advanced EOS processing methods, applications and services, partnership in the NovaSAR satellite, fostering collaborative international scientific relationships, and providing national representation on international organisations such as CEOS.
- Radio astronomy, including operation of the ASKAP telescope, the Parkes radio telescope and the Australia Telescope Compact Array, and development of big data management infrastructure and expertise.
- Spacecraft tracking and communications, including ‘Follow the Sun’ operation of the Deep Space Network and management of key treaty-level agreements with NASA.

These activities are coordinated primarily through CSIRO Astronomy and Space Science.

CSIRO also continues to grow its space-related capabilities in other areas, ranging from materials and manufacturing to cybersecurity and satellite sensor systems.

Website

www.csiro.au

3.5 DCA

DCA is responsible for policy oversight on the licensing of spectrum used for space activities, and international spectrum management activities.

A key area of work for the Department was providing advice to the Australian Government, and information to the public, regarding nbn provision of satellite broadband services to premises predominantly in 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 Defence

Space is an important enabler for the ADF as a modern, networked military. 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.

Defence responsibilities in space are:

- Contributing to space situational awareness: 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 jointly operate space-monitoring infrastructure in Australia.
- Engagement with international partners on military use of space: 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: Defence works to secure radiofrequency spectrum resources for its satellite networks, in accordance with ITU rules.
- Space-based geospatial intelligence collection: AGO, within 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.
- PNT: Defence continues to monitor the US GPS Modernisation program, and will begin transitioning to modernised GPS equipment when new services are made available. The Department of Defence supports a GPS monitoring station in South Australia and is assisting in the installation of a second monitoring station in Western Australia.
- Support to industry: Defence's strategic and coordinated approach to the defence industry is delivering greater support to the space sector. Notably, the CDIC Centre for Defence Industry Capability delivers advice and support to industry and intelligence, surveillance, reconnaissance, space and cyber have been identified as priority investment areas for both the Defence Innovation Hub and the Next Generation Technologies Fund.

Key space-related activities:

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.
- has established a three-year space research and development program between the University of New South Wales at the Australian Defence Force Academy in Canberra and the RAAF to

deliver world-class space education to Defence personnel and inform the future direction of Defence space capability.

- provided one Government expert to the MILAMOS drafting team, and hosted one of three drafting workshops in 2017.
- is conducting a project through the AGO to provide enhanced space-based commercial imagery capability for the Defence. It is also conducting a study into the costs and options for the acquisition of a sovereign geospatial intelligence satellite capability, in accordance with the Defence White Paper.
- 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 Defence S&T Strategy for Space to identify and invest in strategic space technologies that have the potential to deliver game-changing capabilities in Advanced Small Satellite Missions and Comprehensive Space Domain Awareness.
 - partnered with UNSW Canberra to develop and undertake the all-Australian Buccaneer small satellite mission launched in November 2017.
 - is contributing to the RAAF small satellite missions M1 and M2.

Website

www.defence.gov.au

3.7 DFAT

DFAT provides foreign, trade and development policy advice to the Government. We work with foreign governments, the private sector, NGOs, academia and other Australian Government agencies to ensure that Australia's pursuit of its global, regional and bilateral interests are advanced and protected.

DFAT's key space responsibilities lie in space security issues (with Defence), UN engagement, multilateral and bilateral agreements and commitments, space issues that affect bilateral and regional relationships, and civil space matters to the extent that they affect the above.

DFAT is a member of the DIIS-led Space Coordination Committee, Space Law Inter-Departmental Working Group, Experts Group on Domestic Space Launch Capability, IDC on the Review of the *Space Activities Act* and inter-agency consultations with the Expert Reference Group undertaking a Review of Australia's Space Industry Capability.

DFAT (with Defence) leads Australia's participation in Trilateral Space Security Dialogue with the US and Japan.

Website

www.dfat.gov.au

3.8 Home Affairs

Home Affairs is a central policy agency, providing coordinated strategy and policy leadership for Australia's national and transport security, federal law enforcement, criminal justice, cyber security, border, immigration, multicultural affairs, emergency management and trade related functions.

Through the CIC, Home Affairs implements the *Critical Infrastructure Resilience Strategy* to enhance critical infrastructure resilience in the face of all hazards. Home Affairs implements the strategy in partnership with industry through TISN. It actively contributes to the work of the Space CSIG within the TISN, which is overseen by DIIS.

Key space-related activities

- The NSAT was a valuable national resource that increased situational awareness by improving crisis management collaboration across governments. Emergency Management Australia, in partnership with Geoscience Australia and members of the EMSINA, launched EM-Link in September 2017, superseding NSAT. EM-Link is a digital version of NSAT that provides a quick, comprehensive and up-to-date listing of emergency management related geospatial web services for a chosen hazard and/or region.

Additional information

The CIC

- The CIC manages national security risks from foreign involvement in Australia's critical infrastructure.
- The CIC is focused on assessing the risks of sabotage, espionage and coercion in the five priority sectors of telecommunications, gas, electricity, water and ports.
- The CIC works with state and territory governments, regulators and private owners and operators to identify risks and develop and implement asset-specific mitigation strategies and sector-wide best practice guidelines.
- The CIC engages with critical infrastructure owners and operators through the TISN.

CIR Strategy

- The CIR Strategy seeks to ensure 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 to businesses, governments and the community, as well as to other critical infrastructure sectors.
- There are four key outcomes in the 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 eight sector groups (Banking and Finance; Health; Food and Grocery; Transport; Communications; Water Services; Energy; Commonwealth Government) 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.homeaffairs.gov.au | www.cicentre.gov.au | www.tisn.gov.au

3.9 GA

GA is the Australian Government's national geoscience organisation, applying geoscience to Australia's most important challenges. It is the Australian 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 PNT and non-meteorological operational use of 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 Australian 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).
 - GA is responsible for the International GNSS Service Analysis Coordination Centre, which produces satellite orbit and clock products in support of high precision GNSS positioning applications

- GA is trialling near-real-time atmospheric water vapour products derived from GNSS observations, in partnership with the BOM to support short range and storm forecasting.
- Earth observations from space (EOS)
 - GA is jointly responsible for EOS capabilities with the Bureau and CSIRO
 - GA co-chairs the SCC’s EOS Working Group (AEOSWG) with CSIRO and the Bureau.
- GA is working to:
 - Implement the 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 GNSS data; and strengthened linkages with domestic and international providers;
 - Test a SBAS which is currently transmitting three test signals. The first signal was switched on in June 2017, improving positioning accuracy from 5.0 to 0.5 metres. The second and third signals were operational in September and October, respectively, and have further improved positioning accuracy to 10 cm across the region.
 - Implement the DEA. DEA will make it quicker and easier to access Earth observation satellite data and analyse it to produce readily accessible information and insights about Australia's changing landscape, coastline and oceans. In its initial phase, DEA will focus on leveraging satellite data to improve Government business, including applications that streamline implementation of environmental regulations that effect businesses. DEA will also lower the technical barriers to using this data such that businesses from start-ups to major established companies operate on a level playing field.
 - Implement the NEOS-IP with CSIRO and the Bureau. 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 Australian Government agencies to realise the benefits of EOS data.
 - Website

www.ga.gov.au

3.10 DIIS

DIIS has three key areas of responsibility on civil space:

1. **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.
2. **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.
3. **Policy function: advancement of Australia’s space capabilities.** The space sector is a driver of advanced technologies which have significant potential to generate technology spill-overs that can flow into other sectors of the economy and advance Australia’s positioning in global markets.

Key space-related activities

- DIIS is reforming the *Space Activities Act 1998* to ensure it remains relevant to advances in technology and that it does not inhibit innovation or opportunities for Australians to participate in the changing global market for space. Further details of the reform is in (see 2.1.2 *Space Regulation*) of this report; including that further stakeholder consultation is planned in 2018.
- 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 (2012)
 - 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 (2017).

DIIS provides the secretariat for the Space CSIG established under the TISN (see Section 3.1).

Websites

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

3.11 DIRD

DIRD is responsible for providing policy advice and targeted research, delivering administered items and regulation in respect of the Australian 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:

- Australian Maritime Safety Authority (AMSA)
- Civil Aviation Safety Authority (CASA)
- Airservices Australia.

Website

www.infrastructure.gov.au

3.11.1 AMSA

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

- Australia's JRCC with a capacity to respond to 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 visual and electronic aids to navigation to meet the needs of commercial shipping), which includes 16 Differential GPS reference stations, necessary for ocean and coastal navigation
- vessel tracking services, including administration of the MASTREP, use of shore based and satellite based AIS and LRIT of ships.
- a HF distress and safety maritime radio communication network.
- oil spill preparedness and response, including use of satellite-based synthetic aperture radar for oil spill monitoring for compliance and emergency response

Key space-related activities:

- AMSA is a significant user of satellite technology for a number of applications including aviation and maritime search and rescue, 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 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

3.11.2 CASA

In accordance with its legislated obligations, CASA develops, promulgates and oversees the implementation of appropriate aviation safety standards based on ICAO 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

3.11.3 Airservices

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 and firefighting services. The Agency also 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 and voice
- Ground/remote ground communication: datalink, voice and network.

Website

www.airservicesaustralia.com

Membership of the Australian Government Space Coordination Committee

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