



Australian Government
Department of Industry,
Innovation and Science



STATE OF SPACE REPORT:

Australian Government Space Coordination Committee

2015

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Table of Contents

Executive Summary	1
Australian Communications and Media Authority.....	9
Synopsis.....	9
Key Space-Related Activities for 2015	9
<i>International engagement</i>	9
<i>Management of access to spectrum for space services</i>	10
<i>New & existing Australian satellite networks</i>	10
Background	11
Key Partnerships.....	15
<i>International partnerships</i>	15
<i>Domestic partnerships</i>	15
Key Priorities Beyond 2015	16
Attorney-General's Department	17
Synopsis.....	17
Key Space-Related Activities for 2015	17
Background	17
<i>Critical Infrastructure Resilience Strategy</i>	17
<i>The TISN for Critical Infrastructure Resilience</i>	18
Key Priorities Beyond 2015	19
Bureau of Meteorology.....	20
Synopsis.....	20
Key Space-Related Activities for 2015	20
Background	21
<i>Himawari</i>	21
<i>COSMIC-2</i>	22
<i>Upgrading the Bureau's Polar Orbiting Reception Systems</i>	22
<i>FY-4 Turn Around Ranging Stations</i>	23
<i>Australian VLab Centre of Excellence</i>	23
Key Partnerships.....	23
<i>Japan Meteorological Agency</i>	23
<i>China Meteorological Agency</i>	24
<i>Korea Meteorological Agency</i>	24
<i>UK Met Office</i>	24
<i>National Oceanic and Atmospheric Administration</i>	24
<i>World Meteorological Organization</i>	24

Key Priorities Beyond 2015	25
<i>Supercomputer replacement programme</i>	25
<i>Implementing recommendations of the Bureau's R&D review</i>	25
<i>Verification processes</i>	25
Commonwealth Scientific and Industrial Research Organisation.....	26
Synopsis.....	26
Key Space-Related Activities for 2015	27
Background	27
<i>Radio-astronomy and spacecraft tracking and communications</i>	27
<i>Earth observation from space</i>	28
<i>Space applications and technologies</i>	30
Key Partnerships	30
Key Priorities Beyond 2015	31
Department of Communications.....	33
Synopsis.....	33
Key Space-Related Activities for 2015	34
Background	34
<i>National Broadband Network Satellite Services</i>	34
<i>Viewer Access Satellite Television</i>	34
<i>Reissue of 15 year spectrum licences</i>	35
Key Partnerships	35
ACMA	35
<i>World Radiocommunication Conference 2015</i>	35
<i>International Organisation for Standardization</i>	35
<i>Standards Australia</i>	35
<i>Open Geospatial Consortium</i>	36
Key Priorities Beyond 2015	36
Department of Defence.....	37
Synopsis.....	37
Key space-related activities for 2015.....	37
Key Partnerships	37
Key Priorities Beyond 2015	38
Department of the Environment	39
Synopsis.....	39
Key space-related activities for 2015.....	39
Background	39
<i>Global Forest Observations Initiative</i>	39
<i>National Greenhouse Accounts</i>	40
<i>Ongoing monitoring of environmental programmes</i>	40
Key Partnerships	40

Department of Foreign Affairs and Trade (DFAT)	41
Synopsis.....	41
Key Space-Related Activities for 2015	41
Background	42
<i>Talks with the United States and Japan</i>	42
<i>The ARF Space Security Workshop</i>	42
Key Partnerships	42
Key Priorities Beyond 2015	43
Department of Industry, Innovation and Science	44
Synopsis.....	44
Key Space-Related Activities for 2015	44
Background	45
<i>Framework relating to civilian space activities</i>	45
<i>Australian Government Space Coordination Committee</i>	45
<i>Space Cross Sectoral Interest Group</i>	46
<i>Civil space-related Cooperative Research Centres</i>	47
<i>International agreements</i>	48
<i>International forums</i>	48
<i>Australian Space Research Program</i>	48
<i>Capabilities of Australian civil space sector</i>	49
<i>Space Concession</i>	49
Key Partnerships	49
<i>Domestic partnerships</i>	49
<i>International partnerships</i>	49
Key Priorities Beyond 2015	50
Department of Infrastructure and Regional Development - Overview	51
Department of Infrastructure and Regional Development - Aviation	52
Synopsis.....	52
Key Space-Related Activities	53
Background	53
<i>ADS-B</i>	53
<i>GNSS</i>	54
<i>Timing</i>	55
Key Priorities Beyond 2015	56
<i>CASA</i>	56
<i>Airservices</i>	56

Department of Infrastructure and Regional Development - Maritime	58
Synopsis.....	58
Key Space-Related Activities for 2015	58
Background	60
<i>A Differential Global Positioning System network to provide differential correction service.....</i>	60
<i>Vessel Traffic Service within the Great Barrier Reef & Torres Strait.....</i>	60
<i>Facilities for Australian Global Maritime Distress and Safety System.....</i>	61
<i>Search and Rescue functions</i>	62
<i>Improved detection of satellite distress beacons</i>	62
<i>Detection of ships' Automatic Identification System transmission by satellites.....</i>	63
<i>Long Range Identification and Tracking</i>	64
<i>Promulgation of Maritime Safety Information.....</i>	65
<i>Satellite monitoring of aids to navigation status and performance.....</i>	66
<i>Pollution Surveillance</i>	66
<i>Disaster Response</i>	67
<i>Oil Spill Response Atlas</i>	68
<i>Ad-hoc uses.....</i>	68
Key Outcomes.....	69
<i>A Differential Global Positioning System network to provide differential correction service.....</i>	69
<i>Improved detection of satellite distress beacons</i>	69
<i>Detection of ships' Automatic Identification System transmission by satellites.....</i>	70
<i>Pollution Surveillance</i>	70
Key Partnerships.....	70
<i>Pollution monitoring</i>	70
Key Priorities Beyond 2015	71
Department of Infrastructure and Regional Development - Rail.....	73
Synopsis.....	73
Key space-related activities.....	73
Background	73
Key Outcomes.....	73
Key Partnerships.....	74
Key Priorities Beyond 2015	74

Department of Infrastructure and Regional Development – Roads.....	75
Synopsis.....	75
<i>Telematics</i>	75
<i>Intelligent Transport Systems</i>	75
<i>Heavy vehicle telematics</i>	76
Key Partnerships.....	77
Key Priorities Beyond 2015	78
Geoscience Australia	79
Synopsis.....	79
Key Space-Related Activities for 2015	79
Background.....	80
Key Partnerships.....	84
Key Priorities Beyond 2015	86
Glossary of Acronyms	87

Executive Summary

This report provides a consolidated summary of civilian space-related activities being conducted by Commonwealth Government agencies represented on the Australian Government Space Coordination Committee (SCC agencies). The SCC provides a forum for information sharing between Australian Government agencies on civilian space activities. Agencies represented on the SCC and which have contributed to this report include:

- Australian Communications and Media Authority;
- Attorney-General's Department;
- Bureau of Meteorology;
- Commonwealth Scientific and Industrial Research Organisation;
- Department of Communications;
- Department of Defence;
- Department of the Environment;
- Department of Foreign Affairs and Trade;
- Department of Industry, Innovation and Science;
- Department of Infrastructure and Regional Development; and
- Geoscience Australia.

SCC agencies were asked to outline their involvement in key civil space activities as they relate to policy principles set out in *Australia's Satellite Utilisation Policy* (ASUP). The ASUP policy principles are:

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

Highlights

SCC agencies are involved extensively in civil space-related activities. The following is a selection of those activities, grouped with reference to the ASUP policy principles (noting that many of the activities listed relate to more than one of the policy principles):

Principle 1 – Focus on space applications of national significance

Space applications that have significant security, economic and social impacts, specifically Earth Observation, Satellite Communications and Position, Navigation and Timing.

- A key area of work for the *Department of Communications* was providing advice to the Government, and information to the public, regarding NBN Co Limited's provision of satellite communications services in regional and remote Australia. It also administered funding for the provision of commercial free-to-air digital television services on the Viewer Access Satellite Television (VAST) service.
- Our national transport system, which is regulated through agencies in the *Infrastructure and Regional Development* portfolio, relies extensively on satellite technology. The aviation and maritime sectors are significant users of communications, navigation and surveillance services provided by satellite based infrastructure. The rail and road sectors are at earlier stages of utilisation but their usage is expected to increase, particularly with the uptake of Intelligent Transport System applications.
- The *Bureau of Meteorology* and other government and partner agencies own a network of ground stations through which Australia secures access to satellite data. The Bureau's ground station network receives data from over 15 satellites, and provides complete coverage of the Australian continent and other regions of relevance. Observations from this network support the Bureau's forecast and warning services, emergency services, aviation services, and are used for products for the public, shipping and defence.
- *CSIRO* is jointly responsible for Earth Observation from Space (EOS) capabilities with the Bureau of Meteorology and Geoscience Australia. It invests approximately \$15 million per annum in EOS, including operating the Earth Observation and Informatics (EOI) Future Science Platform (FSP), a million-dollar per year investment in transformational science supporting Earth observation science and applications. It also

leads multi-million dollar national Earth observation related investments in research infrastructure, including the Terrestrial Ecosystem Research Network (TERN) AusCover facility and the Integrated Marine Observing System (IMOS) Satellite Remote Sensing Facility.

- The *Department of the Environment* uses data derived from satellites to support international forest monitoring as part of its participation in the Global Forest Observations Initiative. It also uses satellite data to monitor land use changes, such as land clearing. This feeds into estimates of carbon emissions and sequestration, which are needed to meet Australia's international reporting obligations under the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.
- Satellite-based positioning plays a vital and growing role in areas as diverse as transport, agriculture, construction and mining. *Geoscience Australia* (GA) is responsible for developing and implementing Australia's fundamental National Positioning Infrastructure (NPI). The NPI will ensure Australia has a modern, fit-for-purpose and internationally compatible PNT capability, including: modernised ground-tracking infrastructure; improved data analysis and performance monitoring; greater access to quality-assured Global Navigation Satellite System (GNSS) data; and strengthened linkages with domestic and international providers. GA also operates the Australian Regional GNSS Network, which provides the national coordinate framework (datum) for all spatial data in Australia, as well as the South Pacific Regional GNSS Network (SPRGN).

Principle 2 – Assure access to space capability

Ensuring resilient access to those space systems on which we currently rely and to those important to our future national security, economic, environmental and social well-being.

- The *Bureau of Meteorology* is preparing for the reception and dissemination of data from Himawari-8, Japan's new generation geostationary meteorological satellite. Himawari-8 was operational in July 2015 and will be followed by the launch of Himawari-9 in 2016. The Himawari satellites will enhance the Bureau's weather watch capability and improve its warning capability in tracking and subsequently predicting changes in weather conditions. The Bureau will also become a partner in the COSMIC-2 (Constellation Observing System for Meteorology, Ionosphere, and Climate) programme in 2016, when it hosts a COSMIC-2 ground station near Darwin. COSMIC-2 will

deliver a revolutionary increase in the number of atmospheric and ionospheric observations (up to 10,000 per day), providing substantial benefits for the research and operational communities.

- In collaboration with domestic and international partners, *Geoscience Australia* operates key components of the global geodetic infrastructure and develops strong relationships between Australia and key satellite-operating nations to promote continued access to critical datasets.
- In 2014, the *Department of Industry, Innovation and Science* released a joint statement with Japan on collaborative opportunities for the Quasi-Zenith Satellite System (QZSS). Following the release of the joint statement, a Precision Agriculture demonstration project with Japan, conducted by Japanese and Australian partners, was completed successfully in March 2015. The project used QZSS to guide (with high precision) a robotic tractor operating autonomously at night on a farm in Jerilderie NSW.

Principle 3 – Strengthen and increase international cooperation

Strengthening those relationships and cooperative activities on which Australia relies, and will continue to rely to a substantial degree, for space system capabilities.

- The *Australian Communications and Media Authority* manages Australia's participation in international space-related radiocommunications issues including those considered in the Radiocommunication Sector of the ITU (ITU-R), the treaty-level World Radiocommunication Conference (WRC) and the Asia-Pacific Telecommunity (APT).
- The *Bureau of Meteorology* collaborates with peer agencies in Japan, China and Korea, as well as with the UK Met Office and the US National Oceanic and Atmospheric Administration. It operates satellite positioning systems and services for the China Meteorological Administration's (CMA) geostationary satellites (Fengyun-2 East and West), and has committed to continue this service for CMA's next generation satellites, FY-4. It also participates actively in the World Meteorological Organization.
- *CSIRO* collaborates actively with overseas agencies with civil space-related responsibilities, notably NASA and the European Space Agency. It serves as the Australian principal on the international Committee on Earth Observation Satellites (CEOS), which it will Chair from November 2015 to November 2016. Through the Canberra Deep

Space Communication Complex (CDSCC), it is tracking over 40 deep space missions for NASA and other international agencies. CDSCC recently supported significant events such as the arrival at Mars of two missions to study the Martian atmosphere (NASA's MAVEN and the Indian Mars Orbiter Mission) and ESA's Rosetta comet landing.

- *Geoscience Australia* has key partnerships with Japan, the United States, the European Union, France and China, and is active in a range of international fora. In 2015-16 it will support the work of the international Committee of Earth Observation Satellites by performing the role of Executive Officer. It is chairing the International GNSS Service for a four year term beginning 1st January 2015. It co-chairs with Norway the Global Geodetic Reference Frame Working Group of the UN Committee of Experts on Global Geospatial Information Management.
- The *Department of Industry, Innovation and Science* manages a number of bilateral and multilateral agreements relating to civil space activities, notably an agreement with the United States relating to space vehicle tracking and communications.

Principle 4 – Contribute to a stable space environment

Continuing to support rules-based international access to the space environment; promoting peaceful, safe and responsible activities in space.

- The *Australian Communications and Media Authority* manages access to spectrum for space services under legislation which is intended, among other things, to maximise the overall public benefit derived from using the radiofrequency spectrum
- The *Department of Industry, Innovation and Science* administers the provisions of the Government's legislative/administrative framework relating to civilian space activities. The framework relates to certain space activities in Australia or by Australians overseas, including the launch of satellites. The department is responsible for coordinating with other government agencies to ensure civil space activities do not jeopardise public safety, property, the environment, Australia's national security, foreign policy or other international obligations. It also implements certain international obligations that Australia is party to. The Space Environment Management CRC, established under the CRC Programme administered by the department, conducts research aimed at reducing the threat to space-based infrastructure from space debris.

- The *Department of Foreign Affairs and Trade* is investing significant effort in supporting the development of international norms of responsible behaviour in outer space, including by helping build the capacity of countries in our region to engage fully in international discussions on space security.

Principle 5 – Improve domestic coordination

Enhancing the coordination, understanding and strategic direction of Australia’s uses and approach to space.

- The *Department of Industry, Innovation and Science* provides the central point of contact and coordination for all Australian civil space activities. It chairs and provides secretariat support for the Australian Government Space Coordination Committee (SCC – see above). The SCC is supported by technical working groups on Position, Navigation and Timing (chaired by Geoscience Australia), Earth Observation from Space (chaired on a rotating basis by Geoscience Australia, CSIRO and the Bureau of Meteorology) and Space Law (chaired by the Department of Defence). The department participates in these working groups.
- The *Attorney-General’s Department* partnered with *Geoscience Australia* and the Australian Geospatial-Intelligence Organisation to develop the National Situational Awareness Tool (NSAT). The NSAT enables geospatial incident and meteorological data to be shared in real time between jurisdictions and the Australian Government. It was operational in its initial phase from October 2013 and has been used extensively since.

Principle 6 – Support innovation, science and skills development

Promoting collaboration between Australian public and private research and development organisations with industry in space-related activity, including space science, research and innovation in niche areas of excellence or national significance.

- *CSIRO* is collaborating with *Geoscience Australia* and the National Computational Infrastructure (NCI) to establish the Australian Geoscience DataCube (AGDC) infrastructure capability at the Australian National University. The DataCube will provide access to over 28 years of Earth observation satellite data time-series on petabyte storage “spinning-disk” for use in development of new applications for such data by Australia’s Earth observation research sector. *CSIRO* also engages in activities related to space applications

and technologies, including wireless technology, sensor networking and high precision manufacturing capabilities.

- The CRC for Spatial information, established under the CRC Programme administered by the *Department of Industry, Innovation and Science*, aims to create a coordinated national network of satellite system reference stations; undertake research into the establishment of an Australian and New Zealand spatial information market place; automate the production of essential spatial information products; and combine existing data stores with the rapidly increasing stream of data from Earth observation satellites.

Principle 7 – Enhance and protect national security and economic wellbeing

Ensuring that Australia’s space capabilities will be used to enhance, and guard against threats to, our national security and economic well-being.

- Responsibility for engagement on space-related international security issues rests with the Department of Foreign Affairs and Trade (DFAT). Throughout 2014-15, DFAT led a whole-of-government approach to developing and articulating Australia’s policy positions on space-related security issues internationally. These positions have been communicated through regular bilateral dialogues, trilateral talks (with the United States and Japan) and meetings in regional and international fora.
- In 2014, the *Department of Industry, Innovation and Science* facilitated establishment of a Space Community of Interest (SCoI) as part of the Trusted Information Sharing Network (TISN) convened by the *Attorney General’s Department*. The SCoI was formed to bring together interested parties from industry, academia and government to explore vulnerabilities arising from this dependence and develop options to mitigate risk. The TISN is the primary vehicle for implementing the Government’s new Critical Infrastructure Resilience (CIR) Strategy, which was launched by the Attorney-General on 21 May 2015. The outcome sought by the CIR is that critical infrastructure owners and operators are effective in managing both foreseen and unforeseen risks to the continuity of their operations. Following the release of the CIR Strategy, the SCoI transitioned to a Space Cross Sectoral Interest Group.
- Space is an important enabler for the Australian Defence Force as a modern, networked military. The *Department of Defence* uses both

military and civil space-based systems for a range of applications, including global position, navigation and timing; satellite communication; and weather forecasting. Defence also contributes to US-led efforts to better understand the space environment through space situational awareness.

Australian Communications and Media Authority

Synopsis

The Australian Communications and Media Authority (ACMA) is a statutory authority within the Australian Government portfolio of Communications. The ACMA is Australia's regulator for broadcasting, the internet, radiocommunications and telecommunications.

With respect to civil space activities, the ACMA's responsibilities include:

- 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 International Telecommunication Union (ITU).

These activities enable the use of, for example, fixed, broadcasting, mobile, scientific and radionavigation satellite services.

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

The regulatory framework under which space-related work in the ACMA is undertaken includes the ITU Constitution, Convention and Radio Regulations; the Radiocommunications Act 1992 (the Act), the Australian Communications and Media Authority Act 2005 (the ACMA Act); and the ACMA's Principles for Spectrum Management. Within the ACMA, there is a designated area which considers civil space activities. However, the work spans across every level of the organisational hierarchy and, depending on the topic, work may be undertaken in various areas.

Key Space-Related Activities for 2015

International engagement

- Management of Australia's participation in international space-related radiocommunications issues includes those considered in the Radiocommunication Sector of the ITU (ITU-R); and the treaty-level World Radiocommunication Conference (WRC).

- This includes involvement in changes to the regulatory framework for satellite communications.

Management of access to spectrum for space services

- The ACMA's ongoing work includes management of access to the radiofrequency spectrum; for example, access to frequencies for satellite communications and licensing of space services.
- The ACMA provides a regulatory framework for satellite communications to and from Australia. This includes providing advice to and sharing relevant information with both international and domestic stakeholders.
- During 2015, the ACMA has reviewed some of the regulatory arrangements associated with the radiocommunications licensing of some satellite services. This includes a proposal to remake the Radiocommunications (Communication with Space Object) Class Licence 1998 (the CSO class licence) and make the Radiocommunications (Radionavigation-Satellite Service) Class Licence 2015 (the RNSS class licence).
- The CSO class licence 'sunset' in the last quarter of 2015, and the ACMA has formed the preliminary view that this instrument is operating effectively and efficiently and, as such, continues to form a necessary and useful part of the ACMA's legislative framework. Accordingly, the ACMA proposes to remake the instrument prior to the sunset date.
- The proposed RNSS class licence is part of the ACMA's approach to efficient and effective licensing for radiocommunication services. It proposes to authorise RNSS receivers at the 'Earth end', without the need for an associated apparatus licence at the 'space end'. These arrangements reduce red tape for industry while maintaining compliance with the Act.

New & existing Australian satellite networks

- The ACMA assesses new and supports existing Australian satellite networks¹. Current ACMA policies and procedures can be found in *Australian procedures for the coordination and notification of satellite systems (January 2012)*.

¹ Australian satellite networks are those networks submitted/filed to the ITU by the ACMA.

- ACMA provides assistance to existing Australian satellite network operators.

Key relevant space-related activities conducted by the ACMA fall under ASUP Principles 1, 2 and 4.

Background

General background for space-related activities undertaken at the ACMA is provided below.

Principle 1: Focus on space applications of national significance

In relation to space communications, the ACMA:

- oversees Australian satellite networks adherence to international agreements and provisions of the ITU;
- protects Australian assignments in the ITU Radio Regulations broadcasting-satellite service (BSS) and fixed-satellite service (FSS) Plans;
- assesses the potential for interference between space and terrestrial services; and
- participates in whole-of-government consideration regarding foreign investment in space companies and/or infrastructure.

These activities are considered to be key because the ACMA seeks to ensure that Australian satellite networks adhere to the Radio Regulations, international agreements and domestic policies. This includes seeking to ensure that the interference environment to and from Australian satellite networks is in compliance with the Radio Regulations and domestic law and policy.

In relation to these activities, there are associated social and economic benefits. Operations in compliance with the regulations, agreements and policies are authorised, with the associated successful communications providing revenue (from commercial operations) and less tangible/public benefits (from government-related operations) for Australia.

Principle 2: Assure access to space capability

- The ACMA seeks to manage access to spectrum for space services, under a regulatory framework as set out in primary legislation through the ACMA Act and the Radiocommunications Act.

- The Act requires that the ACMA manage the radiofrequency spectrum in order to, among other things, maximise the overall public benefit derived from using the radiofrequency spectrum.
- The Australian Radiofrequency Spectrum Plan is prepared under section 30 of the Act and provides for high level planning of various radiocommunications services, including satellite communications.
- The Act provides for spectrum access using three types of licence:
 - Spectrum licences: a spectrum licence authorises the licensee to use a parcel of spectrum space (a particular frequency band within a particular geographic area) for a period of up to 15 years². Upon expiry, if a spectrum licence band is to remain under a spectrum licence regime, options available to the ACMA under the Act include undertaking a re-allocation process and re-issuing licences to the same licensees. An alternative option available to the ACMA is to revert the band back to an apparatus licensing regime. This requires public consultation as well as a recommendation to, and a decision by, the Minister for Communications.
 - Apparatus licensing: an apparatus licence is issued under Part 3.3 of the Act³, which authorises the licensee to operate the radiocommunication devices to which the licence relates. There are four types of space-related apparatus licences - space, space receive, Earth and Earth receive licences. A network⁴ that has communications with space objects such as satellites will likely require one or more licences. Upon receipt of a licence application, the ACMA makes necessary assessments before deciding whether to issue a licence. There are a range of conditions that the ACMA may attach to a licence to ensure that

² A licensee must comply with the licence conditions and the technical framework (which includes emission limits, determinations regarding unacceptable levels of interference, and advisory guidelines) established for the band by the ACMA and the Act.

³ More details about this Section (including the types of apparatus licences that may be issued) can be found at <https://comlaw.gov.au/Details/C2015C00143>.

⁴ In this context, a *network* means a satellite network which has the same meaning as it has in the ITU Radio Regulations. It describes the physical parameters of a network of radiocommunications links (including Earth station parameters).

the operation of the radiocommunication equipment satisfies applicable requirements⁵.

- Class licensing: class licensing is used by the ACMA to manage spectrum used by services which use a limited set of common frequencies using equipment under a common set of conditions. Class licences authorise users of designated segments of spectrum to operate on a shared basis. A class licence is not issued to an individual user, and does not involve licence fees. A space-related class licence that is regularly used is the CSO Class Licence⁶.
- Through licensing, the ACMA seeks to provide access to the spectrum for as many services as possible without harmful interference⁷. Such an outcome would lead to economic and social benefit for Australia through commercial, non-commercial and government use of spectrum.

Principle 4: Contribute to a stable space environment

- The ACMA seeks to contribute to a stable space environment through participation in international fora designed to encourage collaboration in frequency use.
- According to the Constitution of the ITU, the purposes of the ITU include: to maintain and extend international cooperation among all its Member States for the improvement and rational use of telecommunications of all kinds. All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference⁸ to the radio services or communications of other

⁵ Example of such conditions include: (1) Operation of this Earth station must be in accordance with frequency assignments recorded in the [Master International Frequency Register](#) of the ITU, or (2) Prior to the frequency assignments being recorded in the Master International Frequency Register, an Earth station may operate in accordance with the operating parameters published by the ITU in Special Sections of International Frequency Information Circulars and in accordance with any agreements reached as a result of an ITU frequency coordination process.

⁶ The CSO Class Licence authorises Earth stations' communication with space objects, provided an appropriate space or space receive apparatus licence is in force and operating in those bands contained in the CSO.

⁷ Under [the Act](#), a person must not operate an unlicensed radiocommunication device (as specified in section 46 of the Act), except for certain circumstances such as emergency operations (as specified in section 49 of the Act).

⁸ Harmful interference: interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations.

Members or of recognized operating agencies, or of other duly authorised operating agencies which carry on a radio service, and which operate in accordance with the provisions of these Regulations⁹.

- In addition, the ACMA represents approved satellite operators in the ITU process, and seeks to achieve outcomes internationally which reflect Australia's space-related interests. Such outcomes lead to benefits for Australia. For example, the ACMA is working with satellite operators on a proposal to provide greater certainty in relation to the suspension of satellite networks. Specifically, the ACMA's role includes the following.
- The ACMA oversees extensive industry and stakeholder consultation to prepare for international meetings. This is facilitated by the ACMA's Preparatory Group (PG) for WRC-15 (PG WRC-15) Australian Radiocommunications Study Groups (ARSGs).
- The work of the ARSGs mirrors that of the ITU-R Study Groups (SGs) and its Working Parties (WPs).
- Responsibilities of the ARSGs include to study, coordinate and provide expert advice to the ACMA to assist in the development of Australian positions and contributions for Australian delegations to ITU-R meetings. The two ARSGs that are responsible for space-related work are ARSGs 4 (satellite services) and 7 (science services).
- The ACMA also coordinates Australian inputs to the Asia-Pacific Telecommunity (APT), which is an intergovernmental body representing the Asia-Pacific region in communication, information and innovation technologies, including space. The APT PG (APG) is the APT Conference PG for WRC. The main objectives of APG are to develop APT Common Proposals for WRCs and APT Common Views on the matters related to ITU-R, and to assist APT Member countries in their preparations for WRCs and ITU-R meetings so that the interests of the region are protected.
- In addition, the APT Wireless Group (AWG) is a programme group within the APT. One objective of the AWG is to promote new wireless applications including those related to space.

⁹ Source: <http://www.itu.int/en/history/Pages/ConstitutionAndConvention.aspx>

- The ACMA also provides advice to the government and satellite operators about national and international regulatory requirements as required/appropriate.

Key Partnerships

Partnerships with the below¹⁰ stakeholders are considered essential because they help the ACMA to achieve its responsibilities and key activities as indicated in previous sections.

International partnerships

- International Telecommunication Union (ITU) and ITU member states.
- The Asia-Pacific Telecommunity (APT) and APT member states.
- International satellite operators/owners with an interest in having their filings submitted to the ITU by Australia/ACMA.
- European Space Agency (ESA).

Major activities the ACMA is undertaking with key international stakeholders include meetings, such as:

- the Fourth and Fifth APT Conference Preparatory Group meetings (APG15-4 and APG15-5).
- ESA/ACMA 2015 Annual Spectrum Management Meeting.
- The Second Session of the ITU-R Conference Preparatory Meeting (CPM) and other preparatory meetings for the World Radiocommunication Conference 2015 (WRC-15).
- WRC-15.

Domestic partnerships

- Australian government departments/agencies/companies in areas such as defence, space science or telecommunications.
- Australian satellite operators (AsiaSpace, Defence, Intelsat, KaComm, nbn, Optus and Sirion) and potential/prospective Australian satellite operators.
- Australian satellite industry.

¹⁰ It should be noted that the lists of the partnerships in this section are not intended to be exhaustive lists, but rather indicative ones.

Major activities the ACMA is undertaking with key domestic partnerships include:

- discussions and meetings with the stakeholders in relation to applications to submit satellite networks with the ITU via the ACMA;
- providing advice to Australian government departments/agencies/companies on matters relating to space regulation, policy and licensing; and
- consultation during the proposal to remake the Radiocommunications (Communication with Space Object) Class Licence 1998 (the CSO class licence) and making the Radiocommunications (Radionavigation-Satellite Service) Class Licence 2015 (the RNSS class licence).

Key Priorities Beyond 2015

Currently, ACMA key priorities beyond 2015 are anticipated to include:

- Similar activities as identified in the *Key space-related activities for 2015* section above.
- A body of work under ASUP Principle 2 - Spectrum licensing: The 27 GHz band is currently subject to spectrum-licensed arrangements Australia wide. The technical arrangements for the band were originally optimised to support the deployment of Local Multipoint Distributions Services (LMDS). However, LMDS did not experience the expected level of commercial deployment and has not been widely adopted in the band. Spectrum licences in the band are due to expire in January 2016. The ACMA is currently reviewing possible future licensing arrangements in the band. This body of work is considered to be a future key activity of the ACMA because the ACMA seeks to fulfil its obligations under Part 3.2 of the Act. Part 3.2 of the Act is about, among other things, the issuing and reissuing of spectrum licences.
- Consideration of changes made to the Radio Regulations at WRC-15 and associated implementation of changes to domestic regulation.

Attorney-General's Department

Synopsis

The Attorney-General's Department (AGD) coordinates the Trusted Information Sharing Network (TISN) for Critical Infrastructure Resilience. It actively contributes to the work of the Space Cross-Sectoral Interest Group (CSIG) within the TISN, which is overseen by the Department of Industry, Innovation and Science.

AGD also provides legal advice on international law related to space and utilises satellite technology in emergency management response planning.

Key Space-Related Activities for 2015

- The Australian Government's new Critical Infrastructure Resilience Strategy was launched by the Attorney-General in May 2015. The aim of the Strategy is the continued operation of critical infrastructure in the face of all hazards.
- The Space CSIG (formerly Space Community of Interest) produced a report, presented to the TISN in late 2015, on the risks associated with critical infrastructure dependencies on space-based assets.
- AGD's Office of International Law provides legal advice on international space law, to ensure Australia's engagement in the space domain is consistent with our international rights and obligations.
- AGD partnered with Geoscience Australia and the Australian Geospatial-Intelligence Organisation to develop the National Situational Awareness Tool (NSAT). The NSAT was operational in its initial phase by October 2013, and has been used extensively since. The department continues to work with its partners to further expand and improve the NSAT in order to provide a truly nationally consistent approach to situational awareness.

Background

Critical Infrastructure Resilience (CIR) Strategy

The aim of the CIR Strategy is the continued operation of critical infrastructure in the face of all hazards. More resilient critical infrastructure will help to achieve the continued provision of essential services (provided by critical

infrastructure) to businesses, governments and the community, as well as to other critical infrastructure sectors.

There are two core policy objectives under the new CIR Strategy. The first objective is for critical infrastructure owners and operators to be effective in managing reasonably foreseeable risks to the continuity of their operations, through a mature, risk-based approach. The second objective is for critical infrastructure owners and operators to be effective in managing unforeseen risks to the continuity of their operations through an organisational resilience approach.

Four key outcomes will be delivered through the CIR Strategy:

- A strong and effective business-government partnership.
- Enhanced risk management of the operating environment.
- Effective understanding and management of strategic issues.
- A mature understanding and application of organisational resilience.

The new CIR Strategy consists of two documents: the Policy Statement and the Plan. The Policy Statement outlines the Australian Government's policy approach to critical infrastructure. It is an enduring document, with a proposed review date of 2020.

The Plan details how the Policy Statement will be implemented in practice. It describes a range of information sharing and resilience building activities, which will primarily be implemented through the TISN. The Plan is a 'living' document that is likely to be revised on an annual basis.

The TISN for Critical Infrastructure Resilience

The TISN is a forum where owners and operators of critical infrastructure work together and share information on threats and vulnerabilities and develop strategies to mitigate risk.

The TISN comprises seven sector groups (Banking and Finance; Health; Food and Grocery Chain; Transport; Communications; Water Services; Energy) with members including owners and operators of critical infrastructure, Commonwealth, State and Territory government agency representatives and peak and national bodies.

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

The Space CSIG is a key outcome of ASUP.

In developing the NSAT, extensive consultation was undertaken with the Emergency Management Spatial Information Network of Australia and each state and territory fire and emergency service, to enable geospatial incident and meteorological data to be shared in real time between jurisdictions and the Australian Government.

Key Priorities Beyond 2015

The Space CSIG will work with other critical infrastructure sectors to explore in greater detail the risks, threats and potential mitigations arising from increasing critical infrastructure dependencies on space-based assets.

Bureau of Meteorology

Synopsis

The Bureau of Meteorology 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 World Meteorological Organization (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 plans, builds and operates satellite reception infrastructure and maintains significant technical, engineering and science capability within the Observation and Infrastructure portfolio. The Information Systems and Services portfolio provides the information and communications technology (ICT) capability that delivers satellite-derived products and services to the Australian community, and supports leading-edge forecasting and climate research. Observations from space continue to contribute to the enhancement of the Australian Community Climate and Earth System Simulator (ACCESS) developed within the Environment and Research portfolio.

Key Space-Related Activities for 2015

The Bureau is continuing to prepare for the reception and dissemination of data from Japan's new generation geostationary meteorological satellite, Himawari-8. In October 2014 the Japan Meteorological Agency launched Himawari-8, a new generation geostationary satellite. The satellite will be operational in July 2015, followed by the launch of Himawari-9 in 2016. These

satellites will replace the MTSAT series of satellites, which are currently the Bureau's primary source of geostationary satellite data. The Bureau is planning for service continuity from July 2015, followed by the delivery of enhanced products between July and December 2015.

The Bureau will become a partner in the COSMIC-2 (Constellation Observing System for Meteorology, Ionosphere, and Climate) programme in 2016, when it hosts a COSMIC-2 ground station near Darwin. The functions of the ground station will be data reception and also back-up spacecraft command. Planning for the ground station commenced in 2015.

The Bureau is in the process of procuring new satellite reception systems to replace an aging network of tracking antennas. The new systems, which will be installed at Crib Point (near Melbourne), Darwin, and Casey and Davis (Antarctica) in 2015-16, will be able to receive data in real time from Suomi-NPP (NOAA), METOP-A/B/C (EUMETSAT), JPSS-1/2 (NOAA/NASA), and FY-3 (CMA).

The Bureau has commenced planning for the installation of a FY-4 Turn Around Ranging Station (TARS) at Crib Point. The Bureau currently operates the FY-2 Turn Around Ranging Station (TARS) for CMA's geostationary satellite FY-2E. In 2016, the China Meteorological Administration (CMA) will launch Feng Yun-4A (FY-4A) the first of their new generation geostationary satellites.

The Bureau's Virtual Laboratory (VLab) Centre of Excellence (CoE) coordinates training in meteorology for forecasters. In 2015 VLab is conducting training in the use of 10 minute satellite imagery and products from Himawari-8.

Background

Himawari

Himawari-8 features a highly advanced imager, the Advanced Himawari Imager (AHI), which provides a significant improvement on the current generation MTSAT imager:

- Higher temporal resolution – ten minute imagery compared with the hourly imagery currently received;
- Larger number of imaging channels – 16 versus 5, including the ability to create 'true' colour imagery;
- Higher radiometric resolution – 4 times improvement; and
- Increased spatial resolution – 4 times improvement.

The increased spatial and temporal resolution will enhance the Bureau's weather watch capability and improve its warning capability in tracking and subsequently predicting changes in weather conditions.

The Bureau will be the only point of entry for real-time Himawari-8 data into Australia. The data will be redistributed for use by other government and non-government users, particularly CSIRO, Geoscience Australia, research agencies, and Pacific Island operational forecast centres.

Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC-2)

GPS Radio Occultation (GPS-RO) has emerged as one of the top five data streams for global Numerical Weather Prediction (NWP) over the past decade, and is currently assimilated within ACCESS. The COSMIC constellation of satellites has been the main source of operational GPS-RO data over the past eight years. Due to the success of COSMIC, there will be a follow-on RO mission (COSMIC-2) that will include six satellites in low-inclination orbits in late 2016, and another six satellites in high-inclination orbits in early 2018. 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. Further information is available at: <http://www.cosmic.ucar.edu/cosmic2/>.

Upgrading the Bureau's Polar Orbiting Reception Systems

Australia secures its access to satellite data through a network of ground stations owned by the Bureau and other Government and partner agencies, as well as through alternative dissemination methods such as the internet. The Bureau's ground station network receives data from over 15 satellites, and provides complete coverage of the Australian continent and other regions of relevance. Observations from this network support the Bureau's forecast and warning services, emergency services, aviation services, and are used for products for the public, shipping and defence.

The Bureau is modernising the tracking antennas used to receive data from polar orbiting satellites, in order to ensure that the infrastructure is operationally robust and functionally fit for purpose. Local reception of polar orbiting satellite observations from satellites such as Suomi-NPP and Metop will ensure that observations are received in time for the very short data cut-off of the assimilation forecast cycle in regional ACCESS, which will improve the detection of small-size localised severe weather events, and also increase the resilience of the NWP systems.

FY-4 Turn Around Ranging Stations (TARS)

The Bureau currently operates satellite positioning systems and services for the China Meteorological Administration's (CMA) geostationary satellites (Fengyun-2 East and West), and has committed to continue this service for CMA's next generation satellites, FY-4. As part of this commitment, the Bureau will install four FY-4 antennas at Crib Point near Melbourne in 2015.

Through the continuation and extension of the collaboration with CMA, Australia fulfils international obligations to provide meteorological data to the international meteorological community. Australia benefits greatly under this system, particularly through free access to the meteorological satellite data of Japan, the USA, China and Europe.

Australian VLab Centre of Excellence

The Australian (Melbourne) Virtual Laboratory (VLab) Centre of Excellence (CoE) is one of a number of CoEs under the umbrella of the World Meteorological Organisation / Coordination Group for Meteorological Satellites (WMO-CGMS). The Australian VLab CoE coordinates training in Satellite Meteorology over WMO Region V (South Pacific) and it is sponsored by the Japanese Meteorological Agency. The monthly Regional Focus Group meetings are a great opportunity to discuss current developments in satellite meteorology relevant to the Australasian and South West Pacific region in the context of weather and forecast discussions.

In January 2015, the VLab Centre of Excellence launched the first phase of a national training campaign in the use of Himawari-8. Weekly online tutorials instructed forecasters in Australia and overseas on how to use the 10 minute data and derived products. Phase two of the training campaign will run from May to July 2015, followed by a third Phase in July when Himawari becomes operational.

Key Partnerships

Japan Meteorological Agency (JMA)

The Bureau of Meteorology and the Japan Meteorological Agency (JMA) have had a close collaborative relationship since 1977, when JMA launched their first geostationary satellite, GMS-1. In March 2006 the Bureau and JMA formalised their collaboration through an exchange of letters.

In November 2014, a further exchange of letters formalised arrangements for Bureau access to Himawari data, and provided a framework for collaboration in the areas of meteorological product development, interaction with the World

Meteorological Organization's Regional Association V (South Pacific), and exchange of scientific expertise.

Other collaborative activities include cooperation between Darwin and Tokyo Volcanic Ash Advisory Centres and the reciprocal back up services; effective operational and technical cooperation on tsunami forecast and warning services; and collaboration on research activities that hold mutual interest to both agencies.

China Meteorological Agency (CMA)

Australia and China meet every two years under a Memorandum of Understanding (MoU) that was signed in March 1985. The MoU provides for exchange of information and the undertaking of cooperative activities in the areas of satellite data, numerical weather prediction, forecasting and climate science. Over nearly two decades, the relationship has developed into a strategic and enduring alliance with significant benefits for Australia.

Korea Meteorological Agency (KMA)

The MOU between the Bureau and KMA on cooperation in meteorology was signed in February 1996. Cooperative activities between the Bureau and KMA are in the areas of data assimilation and NWP system operation, operational ocean forecast systems, climate prediction, climate data services, forecast and warning systems, and aviation meteorology.

UK Met Office (UKMO)

The Bureau collaborates with UKMO on various activities, including the Unified Model/ACCESS (the Bureau's Numerical Weather Prediction model), in the areas of high impact weather and hydrological services, the implementation of model-based seasonal prediction, and on business development in high-value tailored weather and climate services.

National Oceanic and Atmospheric Administration (NOAA)

The Bureau has bilateral collaboration with NOAA on various activities, including tsunami warning systems technology and deployment, digital forecasting and services delivery, hydrological/flood forecasting systems, and fire weather forecaster exchange.

World Meteorological Organization

The WMO is a specialized agency of the United Nations. It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources. WMO promotes cooperation in the

establishment of networks for making meteorological, climatological, hydrological and geophysical observations, as well as the exchange, processing and standardization of related data, and assists technology transfer, training and research.

The Bureau must fulfil Australia's international obligations under the Convention of the WMO. Australia is a very active participant in the WMO, making a strong contribution to its work programmes and activities. The Bureau and Australia benefits significantly through this engagement, for example, through access to meteorological data from WMO members and meteorological satellite operators.

Key Priorities Beyond 2015

Supercomputer replacement programme

The Bureau's replacement supercomputer, announced in the May 2015 Federal Budget, is scheduled to become operational from July 2016. The increase in computing power capacity will enable the production of ensembles and hourly weather forecasts and high resolution seasonal outlooks. The new supercomputer will deliver substantial benefits to end-users by enabling forecasts to be more accurate, more up-to-date, more certain and more responsive with on-demand capability.

Implementing recommendations of the Bureau's R&D review

Implementation of the recommendations from the Bureau's R&D review has commenced. A key theme of the review was to develop a stronger link between research and the delivery of services.

Verification processes

The Bureau Verification Board was established in January 2015. The Board, which is chaired by the Director of Meteorology, will guide future verification activities including the communication of verification results, guide the verification community of practice, and shape improvements in verification systems.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Synopsis

CSIRO is a statutory authority within the Australian Government portfolio of Industry, Innovation and Science. CSIRO's key functions are 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; and
- 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.

CSIRO has approximately 300 staff involved in space activities, focussed primarily on using space-based systems and data streams to perform research and deliver nationally significant outcomes, where space provides the most effective and efficient means for delivering this impact.

Consistent with this strategy, CSIRO has developed extensive capability in space-related areas that include spacecraft tracking and communications, radio-astronomy, Earth observation, and space applications and technologies, including those related to satellite navigation and satellite communications. It has achieved globally recognised innovation in the areas of Earth observation and related informatics, provided leadership in space forums, progressed innovative radio-astronomy development under the Australian Square Kilometre Array Pathfinder (ASKAP) programme, maintained its responsibilities with NASA for space tracking of deep space missions, and assisted the construction of new ground station infrastructure.

Key Space-Related Activities for 2015

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

- radio-astronomy;
- spacecraft tracking and communications;
- Earth observation from space, and
- space applications and technologies, including those related to satellite navigation and satellite communications.

Background

Radio-astronomy and spacecraft tracking and communications

CSIRO's radio-astronomy, spacecraft tracking and communications activities are carried out by CSIRO Astronomy and Space Science (CASS). CASS operates two major national space facilities: the Australia Telescope National Facility (ATNF) and the Canberra Deep Space Communication Complex (CDSCC). CASS has approximately 300 staff in total.

Radio-astronomy

CSIRO's radio-astronomy activities (operated as the Australia Telescope within CASS) are increasingly focused towards the international Square Kilometre Array (SKA) project and ongoing development of the Murchison Radio-astronomy Observatory range. This has seen an increase in CASS personnel and capability in Western Australia.

CSIRO is commissioning its ASKAP radio telescope located at Murchison. Results and techniques generated through the development of ASKAP will contribute to the international SKA design and development effort. ASKAP will introduce and test revolutionary technologies vital to the much larger SKA in areas of electronic engineering, digital systems, computing and big data signal transport, while building industry involvement and trialling green energy power systems that will also be relevant to the SKA. The commissioning and early science team has made great strides in performing astronomical observations with the first generation Phased Array Feeds on the 6-antenna Boolardy Engineering Test Array (BETA).

Spacecraft tracking and communications

Spacecraft tracking and communications are handled by the CDSCC, which is operated by CSIRO on behalf of the Australian Government for NASA. CDSCC currently tracks over 40 deep space missions for NASA and other international agencies including the European Space Agency (ESA), the

Japan Aerospace Exploration Agency (JAXA) and the Indian Space Research Organisation (ISRO). CDSCC recently supported significant events such as the arrival at Mars of two missions to study the Martian atmosphere (NASA's MAVEN and the Indian Mars Orbiter Mission) and ESA's Rosetta comet landing.

NASA has recently invested some \$120 million in Australia on two new 34 metre antenna constructions (DSS-35 and DSS-36) at CDSCC. DSS-35 was formally opened in February 2015. The CSIRO-NASA space tracking relationship demonstrated at CDSCC also extends to CSIRO management of the Tracking Data Relay Satellite System (TDRSS) facility at Yarragadee in WA and management of NASA ballooning facilities located at Alice Springs.

Earth observation from space (EOS)

CSIRO shares responsibility for the Australian Government's civilian Earth observation activities with Geoscience Australia and the Bureau of Meteorology.

CSIRO invests approximately \$15 million per annum in Earth observation capabilities. Earth observation-related activities are undertaken by approximately 100 staff, across all 9 Flagships as well as CSIRO's National Facilities. It also operates the Earth Observation and Informatics (EOI) Future Science Platform (FSP), a million-dollar per year investment in transformational science supporting Earth observation science and applications.

The EOI FSP supports the following main CSIRO activities in Earth observation science:

- coordinating delivery of underpinning Earth observation science and providing ongoing support to CSIRO-wide EOI teams and Flagship projects. This support includes providing an accredited and recognised satellite data quality assurance and calibration and validation (cal/val) work programme. Science application areas include, but are not limited to: corals, coasts and oceans, land-use and land-cover, agriculture, minerals and mining, biosecurity, biodiversity, water quantity, hydrology, water quality, and environmental assessments;
- providing access to Earth observation informatics expertise and infrastructure (High Performance Computing informatics and information sciences). This provides Earth observation teams with: a step-change in their ability to manage current and future petabyte-scale Earth observation datasets; support for sophisticated time-series analysis tools, web-services, and support for model-data fusion and

model-data assimilation science and applications projects across the organisation;

- supporting inter-agency and international cooperation by providing the primary point of contact on matters of Earth observation for CSIRO. CSIRO serves as the Australian principal on the international Committee on Earth Observation Satellites (CEOS), and will Chair CEOS from November 2015 to November 2016. 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; and
- providing linkages to the Earth Observation industry, and innovative applications development for next generation satellite sensors, or airborne systems, which address government, agency, public and industry users both nationally and internationally.

CSIRO leads significant multi-million dollar national EOS-related research infrastructure investments. These include the Terrestrial Ecosystem Research Network (TERN) AusCover facility and the Integrated Marine Observing System (IMOS) Satellite Remote Sensing Facility. CSIRO is also a member of the consortium which operates the Western Australian Satellite Technology and Applications Consortium (Perth).

CSIRO is a partner with Geoscience Australia and the National Computational Infrastructure (NCI) on the establishment of the Australian Geoscience DataCube (AGDC) infrastructure capability at the Australian National University. The DataCube will provide access to over 28 years of Earth observation satellite data time-series on petabyte storage “spinning-disk” for use in development of new applications for such data by Australia’s Earth observation research sector. It will incorporate all new Earth observation data streams from next generation Earth observing sensors such as Himawari (Japan) and the Sentinels (ESA).

For the past 20 years CSIRO has designed and maintained the AeroSPAN/AeroNet aerosol measuring network , whose measurements have been essential for many meteorological and Earth observation based research and applications nationally and internationally (data distributed through NASA’s AErosol RObotic NETwork, AERONET).

CSIRO co-chairs (with Geoscience Australia and the Bureau of Meteorology) the Australian Government Earth Observation from Space Working Group (AGEOSWG). AGEOSWG was established in 2013 to provide a link to the

Australian Government Space Coordination Committee (SCC) for Commonwealth government agencies using Earth observation data.

In June 2015, CSIRO signed a Memorandum of Intent with the European Space Agency, focusing on collaboration between Australian and European researchers in the evaluation of satellite data for use in Australia, while jointly developing new applications and space technologies for future satellites. The agreement is intended to improve Australia's overall access to data from ESA's Earth observation missions, benefitting governments, researchers, industry and the general public.

In January 2015 CSIRO, in conjunction with Geoscience Australia, released a report to the EOS community entitled "An audit of satellite calibration and validation facilities and activities in Australia".

Space applications and technologies

CSIRO engages in activities related to space applications and technologies through other Divisions and research areas including wireless technology, sensor networking and high precision manufacturing capabilities, for example to develop a field-based microgravity meter.

CSIRO is a partner in two international multi-million dollar space-related projects, the joint NASA-ESA Solar Orbiter mission and the USA-led Laser Interferometer Gravitational-Wave Observatory (LIGO), and has additional space-related interests in fields including space situational awareness and in situ resource utilisation.

Key Partnerships

CSIRO upholds and contributes to the sustainment of International Treaties/Exchanges of Notes and Memoranda, particularly in relation to NASA and the European Space Agency:

- Exchange of Notes between the Government of Australia and the United States of America on space vehicle tracking and communications facilities;
- Exchange of Notes between the Government of Australia and the United States of America concerning the conduct of scientific balloon flights;
- an Agreement between the Australian Government and the European Space Agency (ESA) for a Cooperative Space Vehicle Tracking Program; and

- a Memorandum of Intent between the European Space Agency and the Commonwealth Scientific and Industrial Research Organisation concerning Cooperation in Earth Observation.

Key Priorities Beyond 2015

CSIRO will progress in the areas of Earth observation, innovative radio-astronomy development and space tracking of deep space missions, and continue to develop space situational awareness knowledge. Other priorities are as follows:

- CSIRO will continue the innovative ASKAP R&D programme to increase efficiency, reduce manufacturing complexity, and lower the overall cost, weight and build time of radio-astronomy instruments to ensure Australia's future in SKA;
- CSIRO will uphold and contribute to the sustainment of International Treaties/Exchanges of Notes and Memoranda as they apply to space engagements between Australia and other Nations;
- CSIRO will maintain Deeds of Agreement with the Australian Communications and Media Authority for the coordination and radio interference management of a satellite network;
- CSIRO will coordinate the CEOS Chairmanship in 2016 via a multi-agency secretariat, and support active participation by Australian experts in key CEOS working groups before and after the specific chairmanship period;
- CSIRO will ensure other interactions with portfolios and agencies in research, development, applications and exploitation of Earth observation, satellite communications and other aspects of space technology;
- CSIRO will assist NASA to complete and commission the second of two new 34 metre deep space communications antennas at CDSCC (the first of which was completed and commissioned in 2014);
- CSIRO will maintain partnership of national Earth observation facilities including the Australian Government Water Resources Observation Network (WRON), the Terrestrial Ecosystem Research Network (TERN), the Integrated Marine Observing System (IMOS), and the WA Centre of Excellence for 3D Mineral Mapping;

- CSIRO will continue to provide international leadership within the multinational Group on Earth Observations, and provide technical expertise and support for the development of Group on Earth Observations initiatives on forestry, agriculture, oceans and inland and coastal water quality monitoring and hydrology, among others;
- CSIRO will continue preparation for systematic processing of spaceborne synthetic aperture and imaging spectrometry data for Australia with the aim of contributing these pre-processed datasets for inclusion into the Australian Geoscience DataCube.

Department of Communications

Synopsis

Satellite communications provide the opportunity to improve access to communications services – particularly for regional, rural and remote Australia, and people living in areas otherwise unable to access terrestrial communications networks. They can provide more equitable access to basic communications, such as TV broadcasting, internet and telephone services, delivering widespread productivity, social and economic benefits. They allow regional, rural and remote organisations to capitalise on further opportunities, facilitating contact with existing and potential customers and enabling them to compete more effectively with businesses in urban areas. They can assist in addressing physical, economic and social isolation, and bring about improved health and safety outcomes, including in emergency situations.

The Department of Communications has broad remits to advise the Government on the adoption and use of digital technologies, on the delivery of competitive and efficient communications infrastructure and on the promotion of efficient communications markets. In relation to civil space, the department:

- advises the Government on opportunities arising from the innovative adoption and use of digital technologies as well as the necessary market settings to deliver competitive and efficient digital infrastructure to drive growth in the digital economy. This includes satellite-related communication policy issues;
- is responsible for strengthening whole-of-government spatial data policy and facilitating and coordinating spatial data management across Australian Government agencies. It also supports national spatial capabilities through its sponsorship of ANZLIC—the Spatial Information Council, which is the peak intergovernmental organisation dealing with the collection, management and use of spatial information in Australia and New Zealand;
- administers funding for the Viewer Access Satellite Television service;
- works to enhance the international policy framework for satellite communication systems through the International Telecommunication Union’s World Radiocommunication Conference (WRC).

Key Space-Related Activities for 2015

The key space-related activities of the Communications portfolio in 2015 related to:

- National Broadband Network Satellite Services;
- Viewer Access Satellite Television (VAST); and
- Reissue of 15 year spectrum licences.

Background

National Broadband Network Satellite Services

A key area of work for the department was providing advice to the Government, and information to the public, regarding NBN Co Limited's (nbn's) provision of satellite communications services in regional and remote Australia through its interim satellite service (ISS).

The ISS targeted users across regional and remote areas of Australia, and on coastal islands, who lack access to an alternative terrestrial broadband service. The ISS experienced strong demand, reaching capacity in December 2013.

The first of two Ka-Band satellites that nbn will use for the Service is expected to be in operation by mid-2016, lifting broadband quality for users in regional and remote locations.

On 3 April 2014, the Government announced that nbn had agreed to provide a subsidy for up to 9,000 additional households, farms and small businesses across Australia to address the continuing lack of access to commercial broadband services in regional, rural and remote Australia.

Viewer Access Satellite Television (VAST)

The department administered funding for the provision of commercial free-to-air digital television services on the Viewer Access Satellite Television (VAST) service.

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

VAST also carries a range of ABC and SBS radio services. ABC and SBS are funded directly through their Budget appropriations to provide their services on VAST.

As at 30 April 2015, 237,000 individual decoders had been approved to connect to the commercial free-to-air television services in 197,500 households across Australia (approval is not needed to access the ABC and SBS on VAST).

Reissue of 15 year spectrum licences

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

Spectrum licences in the 27 GHz band, which are used for the purpose of satellite communication, will expire on 17 January 2016. ACMA is consulting with licensees on potential future arrangements for this band.

Key Partnerships

ACMA

The department works closely with the Australian Communications and Media Authority (ACMA) in implementing the Government's communications policy objectives.

World Radiocommunication Conference 2015 (WRC-15)

The next ITU WRC-15 is to be held in Geneva, Switzerland from 2 to 27 November 2015. WRC reviews and revises the ITU Radio Regulations, the international treaty governing the use of radiofrequency spectrum and satellite orbits. The department is monitoring the development of the preliminary Australian positions on ITU WRC-15 agenda items.

International Organisation for Standardization (ISO)

ISO is an independent, non-governmental membership organisation and the world's largest developer of voluntary International Standards. ISO is made up of 163 member countries which are the national standards bodies around the world, with a Central Secretariat that is based in Geneva, Switzerland. International open standards provide specifications for products, services and systems, to ensure quality, safety and efficiency as well as supporting international trade.

Standards Australia

The Australian representative to the ISO is Standards Australia. Three officers of the department's Data Policy Branch are voting members of Standards Australia's IT-004 Committee on spatial standards. They participate in ISO-

derivative standards development in Australia and provision of policy advice through Standards Australia to the ISO committee TC-211.

Open Geospatial Consortium (OGC)

The OGC is an international industry consortium of 514 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. OGC® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT. The standards empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

The department promotes the use of OGC standards in open interface and data interoperability initiatives and also supports OGC's ANZ Forum as a local level activity. This includes sponsoring two of the quarterly meetings in Australia-New Zealand. The purpose of the ANZ Forum is to provide OGC members as well as interested parties from business and industry an opportunity to discuss interoperability issues. The department's NationalMap utilises OGC standards which provides a visualisation platform for public data.

Key Priorities Beyond 2015

As noted above, the first of two Ka-Band satellites that nbn will use for the long term satellite service is expected to be in operation by mid-2016. These will provide high-speed broadband coverage to premises in nbn's satellite footprint across mainland Australia and Tasmania as well as outback areas, islands off the coast and external territories such as Norfolk Island, Christmas Island, and the Cocos Islands.

The department will represent Australia's interests at the forthcoming World Radiocommunication Conference in November 2015. This conference will review the international treaty arrangements governing the global use of the radiofrequency spectrum, which includes coordination and allocation of frequencies for satellite services and orbital slots.

Department of Defence

Synopsis

Space is an important enabler for the Australian Defence Force as a modern, networked military. Defence uses both military and civil space-based systems for a range of applications, including global position, navigation and timing; satellite communication; and weather forecasting. Defence also contributes to US-led efforts to better understand the space environment through space situational awareness.

Key space-related activities for 2015

The Government will release a new Defence White Paper that provides its long-term plan for Australia's defence. The Defence White Paper will address the policies, capabilities, and defence partnerships required to achieve Australia's defence objectives, including through space.

In 2014 Australia joined with Canada, the United Kingdom and the United States in establishing a formal partnership on combined space operations. This partnership enables the sharing of space-related information and resources to synchronise space operations among the partners. In 2015 Defence continues to explore options for cooperating amongst these partners to advance our interests in space.

Defence is currently working with the US to relocate two US space sensors to Western Australia. These sensors will be operated by the Royal Australian Air Force, and will contribute to the US Space Surveillance Network. This will help to protect space systems by providing satellite operators around the world with warnings of possible collisions between space objects. In addition, Defence is working with industry partners on the development of an indigenous space surveillance capability

Defence also maintains a program of research on enhancing Defence's use of space, through the Defence Science and Technology Organisation.

Key Partnerships

Australia's Alliance with the United States is a key pillar of our Defence planning, and defence space cooperation is an important element of this relationship. We have a shared goal in enhancing space security and

ensuring that all states will continue to make use of the benefits that space provides.

Defence also works with the United Kingdom and Canada through the Combined Space Operations partnership described above.

Key Priorities Beyond 2015

Beyond 2015, Defence will continue to make use of the advantages that space systems confer, work to build the resilience of the space systems upon which we rely and continue to develop and expand our partnerships in space with like-minded nations.

Department of the Environment

Synopsis

The Department of the Environment designs and implements the Australian Government's policies and programmes to protect and conserve the environment, water and heritage and to promote climate action. The environmental framework is being delivered under four pillars – clear air, clean water, clean land and national heritage.

Key space-related activities for 2015

The department's use of data derived from satellites relates to:

- international forest monitoring – the Global Forest Observations Initiative;
- the National Greenhouse Accounts; and
- ongoing monitoring of environmental programmes.

Background

International Forest Monitoring – the Global Forest Observations Initiative

The department leads Australia's participation in the Global Forest Observation Initiative (GFOI). The GFOI aims to ensure the availability of space data that will allow development of forest Measurement, Reporting and Verification systems and ultimately participate in the REDD+ programme under the United Nations Framework Convention on Climate Change (UNFCCC). It supports the implementation of the UN programme – Reducing Emissions from Deforestation and Degradation (REDD+).

The GFOI contributing partners include Australia, Norway, United States, the UN Food and Agriculture Organisation (FAO) and the Committee on Earth Observation Satellites (CEOS). Australian Government has been providing technical support and guidance to developing countries to implement national forest monitoring and reporting capabilities consistent with the UNFCCC accounting rules.

Integrating space based remote sensing data with ground based measurements enables developing countries to efficiently and cost effectively report on greenhouse gas emissions and removals from the forest sector.

National Greenhouse Accounts

The department uses Landsat satellite data to monitor annual, national scale land use changes such as land clearing and reforestation activities.

This information is essential for the Full Carbon Accounting Model to estimate carbon emissions and sequestration from human induced land use changes consistent with the international reporting obligations under the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

Satellite data also supports the sequestration projects under the Emissions Reductions Fund (ERF).

Ongoing monitoring of environmental programmes

Satellite data is used to varying extents to help assess natural resource management activities, including grant programmes. It is also used in compliance monitoring of development conditions that have been imposed through the environmental impact assessment process.

It is expected that the department's use of satellite data will increase as part of ongoing work programme through increased collaboration with Geoscience Australia, CSIRO and other agencies. For example, the department is currently working with CSIRO to assess habitat conditions using time series satellite data.

Key Partnerships

The Department of the Environment collects environmental information from a number of sources including earth observation data provided by Geoscience Australia. The department collaborates extensively with state and commonwealth agencies including CSIRO in utilising earth observation data for natural resources management, water, climate change and biodiversity policy implementation.

Department of Foreign Affairs and Trade (DFAT)

Synopsis

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

Throughout 2014-15, DFAT led a whole-of-government approach to developing and articulating Australia's policy positions on space-related security issues internationally. These positions have been communicated through regular bilateral dialogues, trilateral talks (with the United States and Japan) and in regional and international fora. Of particular importance has been work to develop international norms on the responsible use of outer space, including through multilateral consultations at United Nations Headquarters in New York in July 2015 on the European Union's initiative for a Code of Conduct for Outer Space Activities.

DFAT also partnered with Japan, the United States and Indonesia to financially support developing country participation in the 2nd ARF Space Security Workshop, held in Tokyo in November 2014.

Over the coming year, these priorities remain extant. DFAT will continue to allocate its resources selectively by prioritising participation in international discussions and meetings that are key to Australia's objectives, as set out in the ASUP.

Key Space-Related Activities for 2015

DFAT will continue to strengthen Australia's relationships with established and emerging space partners through discussions in bilateral and multilateral fora, including in relation to ground-based civil space infrastructure in Australia. In 2015 DFAT:

- participated in talks with partners on space security issues, including through bilateral and the Trilateral Space Security Talks with the United States and Japan in September 2015 (ASUP Principles 3 and 4);

- will support the third ARF Space Security Workshop, to be held in Shanghai in December 2015 (ASUP Principles 3 and 4);
- continued to invest significant effort in supporting the development of international norms of responsible behaviour in outer space, in particular in relation to space debris (ASUP Principle 4); and
- continued talks with international counterparts relating to the establishment and maintenance of ground-based civil space infrastructure in Australia (ASUP Principle 7).

Background

Trilateral and bilateral Talks with the United States and Japan

Annual talks with United States and Japanese counterparts provide an opportunity for a whole-of-government exchange on space-related international security issues and to coordinate our regional and international efforts on space debris and capacity building. The talks also strengthen Australia's two key bilateral relationships on space-related security matters.

The ARF Space Security Workshop

The ARF Space Security Workshop is an important initiative raising regional awareness and enhancing cooperation on space-related security issues. It provides capacity building opportunities for developing ARF member states and an opportunity for Australia to engage regional partners on key space-related international policy issues. The workshop also assists in assuring space security remains on the ARF's work agenda.

Key Partnerships

DFAT takes a whole-of-government approach to its international engagement activities, working closely with the Department of Defence, Department of Industry, Innovation and Science, the Attorney-General's Department, the Department of the Prime Minister and Cabinet, and the Department of Communications.

At the international level, DFAT continues to strengthen key partnerships with the US Department of State, the Japanese Ministry of Foreign Affairs and the EU's European External Action Service. DFAT also works with regional partners, particularly the ASEAN member states, in ensuring regional architecture considers space-related security issues. Engagement in the

United Nations and the Conference on Disarmament remains a priority, and helps frame DFAT's international agenda.

Key Priorities Beyond 2015

International cooperation on space-related issues will continue to grow apace. The increasing importance of space security will intensify as more countries seek to take advantage of the decreasing costs of space-based activities. DFAT's priority will continue to be engagement with established and emerging partners on space security related issues, particularly with the pressing issue of space debris. DFAT will continue to engage with various initiatives for international cooperation to address other space-related challenges, including the non-weaponisation of space.

DFAT will provide overseas development assistance funding for a workshop for APEC partners to be held in Australia in 2016 on a framework for regional collaboration on Earth observation systems. The project promises wide-reaching benefit to APEC economies, communities and the environment and will showcase Australian world leading research infrastructure. It is led by the Department of Industry, Innovation and Science, in collaboration with Geosciences Australia, the Australian Institute of Marine Science, the Australian Integrated Marine Observing System, and other Australian and international agencies leading in Earth observation systems.

Department of Industry, Innovation and Science

Synopsis

The vision of the Department of Industry, Innovation and Science (the department) is to enable growth and productivity for globally competitive industries. In relation to civil space, the department's role is to facilitate the coordination, understanding and strategic direction of Australia's uses and approach to civil space. Through its Civil Space and ICT Policy Section, located in the Manufacturing and Services Policy Branch of its Sectoral Growth Policy Division, the department is the central point of contact and coordination for all Australian civil space activities.

As part of this role, the department chairs and provides secretariat support for the Australian Government Space Coordination Committee (SCC). The SCC was established under ASUP to provide a forum for information sharing between Australian Government agencies on civil space activities and initiatives. The department also provides secretariat support for the Space Cross Sectoral Interest Group, which is part of the Trusted Information Sharing Network convened by the Attorney-General's Department.

The department administers the framework relating to civilian space activities and oversees compliance with international agreements on space. Through Ausindustry, it also administers two civil space-related Cooperative Research Centres - are the CRC for Spatial information (CRCSI) and the Space Environment Management CRC (SEMCR).

The department has a role in monitoring the global space-related environment and trends within commercial supply chains that may present opportunities for Australian firms.

Key Space-Related Activities for 2015

The department's key space-related activities for 2015 are:

- administering the framework relating to civilian space activities;
- chairing and providing support for the Australian Government Space Coordination Committee (SCC);
- providing secretariat support for the Space Cross Sectoral Interest Group;

- administering civil space-related Cooperative Research Centres (CRCs);
- negotiating and managing international agreements;
- participating in international forums relevant to national priorities;
- evaluating the Australian Space Research Program;
- examining capabilities within Australian space-related firms and assessing the commercial environment for space activities; and
- administering the Space Concession, which supports industry development by providing duty-free entry of goods imported for use in a space project.

Background

Administer the framework relating to civilian space activities

The department administers the provisions of the Government's framework relating to civilian space activities and is responsible for the ongoing development of subsidiary material. The framework comprises three key documents:

- Space Activities Act 1998;
- Space Activities Regulations 2001; and
- Space Activities (Approved Scientific or Educational Organisations) Guidelines 2015.

The framework relates to certain space activities conducted in Australia or by Australians overseas, including the launch of satellites. It also implements certain international obligations that Australia is party to.

The department is responsible for coordinating with other Government agencies to ensure civil space activities do not jeopardise public safety, property, the environment, Australia's national security, foreign policy or other international obligations. The Act also ensures that Australian entities are able to compensate in the event of unintentional damage or harm from their space-related activity.

In 2015 the Minister for Industry and Science granted NBN Co Limited an Overseas Launch Certificate under the Space Activities Act 1998 to authorise the launch of two communication satellites in 2015 and 2016.

Australian Government Space Coordination Committee (SCC)

The SCC was established in 2013 pursuant to Principle 5 of ASUP (Improve domestic coordination), to provide a forum for information sharing between agencies on civilian space activities. Its membership includes: the Attorney-

General's Department; Department of Infrastructure and Regional Development; the Australian Communications and Media Authority; Bureau of Meteorology; CSIRO; Department of Agriculture; Department of Communications; Department of Defence; Department of the Environment; Department of Foreign Affairs and Trade; and Geoscience Australia. The Department of Prime Minister and Cabinet and the Treasury are observers. The department chairs and provides the secretariat for the SCC.

The SCC is supported by technical working groups on Position, Navigation and Timing (chaired by Geoscience Australia), Earth Observation from Space (chaired on a rotating basis by Geoscience Australia, CSIRO and the Bureau of Meteorology) and Space Law (chaired by the Department of Defence). The department participates in these working groups.

The SCC met three times in 2014-2015.

Space Cross Sectoral Interest Group

Australia has a significant dependence on space systems and space derived information in areas such as environmental monitoring, disaster response, biosecurity, security, intelligence, law enforcement and border security.

In 2014, the department facilitated establishment of a Space Community of Interest (SCoI) as part of the Trusted Information Sharing Network (TISN), administered by the Attorney General's Department. The SCoI was formed to bring together interested parties from industry, academia and government to explore vulnerabilities arising from this dependence and develop options to mitigate risk.

In 2015 the SCoI prepared its 'First Pass Risk Analysis Report' which identifies the key risks to space infrastructure and assets. This report will provide the basis for facilitating further in-depth consultation with the seven TISN sector groups (Energy, Transport, Banking and Finance, Health, Food and Grocery, Water Services and Communications) to identify and quantify the potential impact on Australia's critical infrastructure from the failure of space systems.

Following the release of the new Critical Infrastructure Resilience Strategy by the Attorney General in May 2015, the SCoI transitioned to a Space Cross Sectoral Interest Group. This transition will provide an opportunity to strengthen the group's active engagement with other TISN sector groups, with the goal of improving understanding within the critical infrastructure sectors of the risks that may result from a reliance on space assets and developing strategies to mitigate these risks.

Administer civil space-related Cooperative Research Centres (CRCs)

The department is responsible for the CRC Programme, which supports industry-led collaborations between researchers, industry and the community.

Two CRCs are focused on research relating to civil space. These are the CRC for Spatial information (CRCSI) and the Space Environment Management CRC (SEMCRRC).

Research through the CRCSI is organised around three application research themes – Positioning, Rapid Spatial Analytics and Spatial Infrastructure – and four key programme areas – Agriculture; Natural Resources and Climate Change; Defence; Built Environment and Health.

CRCSI aims to create a coordinated national network of satellite system reference stations; undertake research into the establishment of an Australian and New Zealand spatial information market place; automate the production of essential spatial information products; and combine existing data stores with the rapidly increasing stream of data from earth observation satellites.

CRCSI projects of particular note include:

- The Analysis Centre Software (ACS) project. The ACS will implement a new precise positioning technique (PPP-RTK) developed in the CRCSI that will enable real-time positioning services across Australia and its maritime jurisdictions with improved accuracy and timeliness.
- The Array-Precise Point Positioning (PPP) System, developed by researchers at Curtin University with financial support from CRCSI. Using multiple antennae, the system achieves substantial improvements in the accuracy, reliability and time to initially establish position compared to single antenna systems. Work is under way to commercialise the system.

SEMCRRC aims to develop technologies which will reduce the threat to space-based infrastructure from space debris. SEMCRRC is managed by the Space Environment Research Centre and is conducting a number of research programmes aimed at:

- developing solutions for reliable and accurate observation and tracking of space objects, better monitoring and cataloguing of space debris, orbit conjunction analysis and collision mitigation;
- improving the accuracy and reliability of orbit predictions;
- developing techniques, algorithms and databases to assist in predicting and thus avoiding potential collisions in space; and

- developing technologies to mitigate the deterioration of the space environment by preventing debris-on-debris collisions in space.

Negotiate and manage international agreements

In 2014 the department participated in the development of a joint statement with Japan on collaborative opportunities for the Quasi-Zenith Satellite System (QZSS). Following the release of the joint statement, a Precision Agriculture demonstration project with Japan, conducted by Japanese and Australian partners, was completed successfully in March 2015. The project used QZSS to guide (with high precision) a robotic tractor operating autonomously at night on a farm in Jerilderie NSW.

The department manages a number of other bilateral and multilateral agreements, including:

- a 2004 cooperation in the field of the exploration and use of outer space for peaceful purposes treaty with Russia;
- a 2011 space tracking treaty with the European Space Agency;
- a 2012 Memorandum of Understanding on space cooperation with India;
- a 2012 scientific balloon flight treaty with the United States; and
- a 2013 space tracking treaty with the United States.

Participate in international forums

The department is a participant in the Asia-Pacific Regional Space Agency Forum (APRSAF). APRSAF was established in 1993 to enhance space activities in the Asia-Pacific region. Space agencies, governmental bodies, international organizations, private companies, universities, and research institutes from over 40 countries and regions take part in APRSAF.

The department is also a member of the International Astronautical Federation (IAF). IAF is an international space advocacy organisation which aims to foster space research, development and application of space activities for peaceful purposes.

Evaluate the Australian Space Research Program

In May 2015 the department commissioned Ernst and Young to conduct a final evaluation of the Australian Space Research Program (ASRP).

ASRP was a \$40 million, competitive merit-based grant programme which operated between 2009 and 2013. Its objective was to provide one-off support to develop Australia's emerging and niche space capabilities in areas of national significance or excellence. Fourteen projects were funded across four funding rounds.

The evaluation is scheduled to be completed by late 2015.

Examine capabilities of Australian civil space sector

In April 2015 the department commissioned Asia Pacific Aerospace Consultants to conduct an analysis of the capabilities of the Australian civil space sector. The analysis will deliver a report which identifies: Australia's industry capability in civil space; domestic and global supply chain opportunities in civil space; growth opportunities in civil space applications for domestic and international markets; and case studies of Australian organisations that have found success in commercial civil space activities.

The project is scheduled to be completed by December 2015.

Administer the Space Concession

The department delivers the Space Concession Program through Ausindustry. The Space Concession provides duty-free entry of goods imported for use in "space projects", provided certain conditions are met. The main policy objective of the Space Concession is to increase the competitiveness of the space industry in Australia, while ensuring compliance with international obligations.

Key Partnerships

Domestic partnerships

Consistent with its coordinating function, the department maintains relationships with other Commonwealth government departments and agencies represented on the SCC (see above).

International partnerships

Consistent with its coordination role, DIS maintains relationships with a wide range of international government departments and agencies. Key international partnerships include:

- Australia's collaboration with Japan, which has facilitated a range of strategic partnerships related to the application of research for industry development and a culture of shared leadership in key international forums, such as the Asia-Pacific Regional Space Agency Forum (APRSAF). This relationship has enhanced Australia's standing as a key contributor to global space and geospatial development.
- Australia's collaboration with the United States (US). Australia and the US have a long-standing relationship on space-related activities and have entered into a number of treaty level agreements. Through the National Aeronautics and Space Administration (NASA), the US has

made substantial investments in space-related infrastructure in Australia, including at the Canberra Deep Space Communication Complex (CDSCC) at Tidbinbilla.

Key Priorities Beyond 2015

The department will:

- be the central point of contact for civil space activities in Australia;
- administer the Space Activities Act 1998, and engage further with our international partners on the development of any necessary treaty-level agreements;
- review the Space Activities Act 1998;
- engage with the civil space industry sector, particularly in the context of the Government's Industry Growth Centre agenda; and
- review opportunities for industry development arising from the construction and operation of the Square Kilometre Array .

Department of Infrastructure and Regional Development - Overview

Our national transport system relies increasingly on satellite technology, particularly position, navigation and timing (PNT) services for communications, navigation and surveillance (CNS). Core applications in Australia utilise data and signals provided from the Global Positioning System (GPS) of the United States.

The wider application of satellite technology in our transport systems can provide enhanced safety, capacity, efficiency and environmental benefits.

The aviation and maritime sectors are significant users of satellite services for CNS provided by satellite based infrastructure, primarily GPS.

The availability of PNT services with a high degree of accuracy, reliability and availability is increasingly associated with more precise aircraft and maritime operations.

By comparison, the rail and road sectors are at the early stages of utilisation of satellite based technology although this is expected to increase in the future.

In the rail sector, the Advanced Train Management System (ATMS) is intended to replace traditional trackside infrastructure with digital technology-based train control in the future.

ATMS will provide for greater capacity on existing rail infrastructure by allowing trains to run closer together. It will also provide safety benefits through the ability to automatically safely slow and stop a train.

Technology developing in the area of Intelligent Transport Systems (ITS) is expected to lead to an increase in demand for PNT signals, including those provided by Space Based Augmentation Systems (SBAS), by the road transport sector in the future. The current main example is the Intelligent Access Program, which provides heavy vehicle operators with greater access to the road network in exchange for monitoring their compliance with road access conditions.

Details for each of the four major transport sectors are provided in the four following entries, covering: Aviation; Maritime; Rail; and Roads.

Department of Infrastructure and Regional Development - Aviation

Synopsis

Australia is transitioning to a satellite based air traffic management (ATM) system supported by a consolidated network of ground-based infrastructure.

This transition includes communications, navigation and surveillance (CNS) and timing services that are increasingly dependent on satellite provided technologies. With the deployment of upgraded and additional core GNSS (Global Navigation Satellite System) service providers and related augmentation systems the reliance on space-based systems will increase.

The key Government agencies involved in civil air traffic management are the Civil Aviation Safety Authority (CASA), the national civil aviation safety regulator, and Airservices Australia (Airservices).

CASA develops, promulgates and oversees the implementation of appropriate aviation safety standards based on International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs).

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

Airservices provides air traffic management, air navigation and associated services.

Airservices is currently investing over \$1 billion over the next five years in new and upgraded air traffic facilities and services, including satellite based ATM technology.

Australian aviation has been using satellite based technology since the early 1990s in CNS/ATM applications.

CASA has established mandated Automatic Dependent Surveillance – Broadcast (ADS-B) and Performance-based Navigation (PBN) requirements which transition the aviation industry to the wider application of satellite based applications in aircraft and air traffic control.

ADS-B is being implemented to expand surveillance of air traffic across the whole of Australia.

Satellite communications (SATCOM) technologies are also being used to provide reduced separation and flexible routing in aircraft oceanic operations.

GNSS based PBN is being implemented, which will enable just under 200 conventional, ageing ground-based navigation aids to be decommissioned.

PBN will enable more direct and flexible route structures without the need for ground-based systems.

For aircraft operators, GNSS based navigation equipment will be used for departure, en route, arrival and approach operations.

Both systems are consistent with the ICAO Global Air Navigation Plan for the improvement of air navigation and global harmonisation.

Global harmonisation of CNS/ATM systems is important for interoperability of Australian aircraft operating internationally but also to enable foreign aircraft to operate in Australian airspace.

Key Space-Related Activities

CASA has put in place key ADS-B mandates that apply to aircraft operating in Australian airspace under the instrument flight rules (IFR). The key ADS-B implementation dates are:

- From 12 December 2013 all aircraft operating at or above FL290 (i.e. above 29,000 feet) were required to have ADS-B transmitting equipment.
- From 6 February 2014 all IFR capable aircraft new to the Australian register were required to be equipped with ADS-B.
- From 4 February 2016 all IFR aircraft operating in Class A, B, C or E airspace within the 500 NM quadrant north and east of Perth must be ADS-B equipped.
- From 2 February 2017 all aircraft operating under IFR will be required to be equipped with 1090 MHz Extended Squitter ADS-B.

The implementation of these regulatory mandates is supported by Airservices major capital investment in infrastructure, such as a nation-wide ADS-B surveillance network.

Background

ADS-B

ADS-B is an advanced surveillance technology that enables equipped aircraft to continually broadcast their identification, current position, altitude, and

velocity through an on-board transmitter that can be received by ADS-B ground stations or other ADS-B equipped aircraft. Aircraft equipped with ADS-B OUT equipment provide air traffic controllers with real-time position information that is more accurate than the information available with current radar-based systems.

ADS-B allows surveillance of equipped air traffic across Australia for a relatively modest cost, increasing safety and the efficient use of airspace.

This is a significant benefit as Australia's radars are mainly located around capital cities and larger regional centres, particularly on the east coast, which is in contrast to the extensive radar coverage in Europe and the United States of America.

GNSS

Aviation uses a Global Navigation Satellite System (GNSS) to support the following activities:

Aircraft Communication

Most Controller-Pilot and Pilot-Pilot voice communication is via Very High Frequency (VHF) radio. In oceanic areas satellite Controller-Pilot datalink communications is the prime means of communication. High Frequency (HF) radio is used at low altitude in remote areas and as a secondary means of communication oceanic. A limited amount of satellite telephone is used in place of HF radio.

Ground Facility Communication

To provide the required very high level of reliability, redundant diverse communications paths are used between ground facilities. Buried optic fibre is widely used. At more remote facilities satellite links are used to connect voice and data communications to the control centre.

Aircraft Navigation

Unlike terrestrial radio navigation aids which support aircraft navigation along fixed routes determined by the location of the ground aid, GNSS supports aircraft navigation along any pre-planned path.

Australia is implementing the ICAO PBN regulatory framework, using the Required Navigation Performance (RNP) specifications and GNSS as the enabling technology.

The introduction of PBN/RNP/GNSS navigation supported the optimisation of the fixed route network and enables advanced operations such as User Preferred Route, where each flight has a tailored wind optimised flight path.

Instrument approach/departure procedures using PBN/RNP/GNSS support engine idle descent and curved path. These are used to minimise aircraft noise and place the residual noise away from sensitive areas. These advanced procedures are in use at an increasing number of Australian airports.

PBN/RNP/GNSS has brought increased aircraft safety, reduced aircraft emissions and enables more efficient aircraft operations that reduce costs.

Aircraft Surveillance

Air Traffic Control has traditionally used radar to monitor the position of aircraft. The introduction of ADS-B, an automatic position reporting system using GNSS to determine aircraft position, has made electronic surveillance of aircraft across Australia economically viable.

Electronic aircraft surveillance allows safe use of smaller separation distances between aircraft allowing greater use of optimal aircraft altitude with reduction in operating costs. Electronic surveillance also enables electronic safety net separation processing including Short Term Conflict Alert, Clear Level Adherence Monitor, and Route Adherence Monitor.

GNSS is an enabling technology used to support global tracking of aircraft.

Timing

The Air Traffic Management System uses GNSS to provide precision timing to support many of its systems.

Advanced Surface Movement Guidance and Control Systems (A-SMGCS)

A-SMGCS is a multi-sensor air traffic surveillance system that enables aircraft and vehicles on the aerodrome runways and taxiways to be accurately tracked in all visibility conditions by Air Traffic Control (ATC).

It is an important system for reducing the risk of a collision between aircraft and between aircraft and ground based vehicles. The technology relies primarily on aircraft Mode S transponder and ADS-B transmissions.

Airservices has introduced A-SMGCS at Sydney, Melbourne, Brisbane and Perth airports.

Terrain Awareness and Warning System (TAWS)

TAWS includes a digital terrain map against which the position and altitude of the aircraft is compared. If the terrain poses a threat to the aircraft, a warning is provided to the pilots.

Aircraft position for TAWS is determined using GNSS.

Automatic Dependent Surveillance-Contract (ADS-C)

The presentation of automatic position reports (ADS-C) from aircraft flying oceanic or in remote areas on Air Traffic Controllers' displays allows the same safety and efficiency benefits to be realised where installation of radar is not practical or economically unviable. ADS-C usually communicates with the air traffic management system via a SATCOM data link.

Performance-based Navigation (PBN)

ICAO's highest priority is to rapidly implement PBN in order to maximise the associated safety, economic and environmental benefits which have been made possible by advances in navigation technology and the development of internationally agreed navigation standards.

This initiative aims to safely maximise the utilisation of available airspace through initiatives such as reductions in oceanic and en-route separation standards and track miles flown during approach-to-land procedures in terminal airspace.

PBN is being implemented in Australia and will be based on GNSS.

Key Priorities Beyond 2015

CASA

The GNSS and ADS-B implementation dates for future avionics mandates are as follows:

- From 4 February 2016 – all existing aircraft operating under the IFR must be GNSS equipped.
- From 4 February 2016 - aircraft operating under the IFR in Class A, B, C or E airspace and that is within the arc of a circle that starts 500 NM true north from Perth aerodrome and finishes 500 NM true east from Perth aerodrome must carry serviceable ADS-B transmitting equipment;
- From 2 February 2017 – all existing aircraft operating under the IFR must carry serviceable ADS-B transmitting equipment.

Airservices

Aircraft Communication

VHF voice radio will remain the prime means of controller-pilot communications. In oceanic areas there will be increased use of satellite datalink controller-pilot communication and satellite telephone, replacing HF voice radio.

Ground Facility Communication

Fibre optic remains the preferred ground-to-ground communications means; satellite links will continue to be used to provide communication to remote ground facilities without fibre communications.

Aircraft Navigation

Mandatory carriage of PBN/RNP/GNSS navigation is required by 4 February 2016. This will allow the existing network of terrestrial navigation aids to be rationalised resulting in significant costs savings to the aviation community.

ICAO has set worldwide direction for the implementation of Continuous Approach with Vertical Guidance (APV) on approach to landing. Australia will continue to examine options for the increased availability of APV at Australian airports.

Aircraft Surveillance

Mandatory carriage of ADS-B by IFR aircraft is required by February 2017.

Satellite reception of aircraft ADS-B signals will allow the benefits of ADS-B to be realised by aircraft operating over continental Australia and over oceanic areas. Airservices is closely monitoring the operational development of this technology by other administrations.

OneSKY Australia

On 27 February 2015 the Deputy Prime Minister and the Minister for Defence jointly announced the OneSky initiative.

OneSky will bring civil and military air traffic control together under one air traffic management system for the first time, improving aviation efficiency and safety.

Once implemented, Airservices Australia and Defence will share technology and information, giving Australia an advanced and integrated air traffic control system.

OneSky will be introduced via a phased transition from 2018 to 2021.

OneSky will replace the current civilian system, the Australian Advanced Air Traffic System, which was first developed and commissioned in the late 1990s.

Department of Infrastructure and Regional Development - Maritime

Synopsis

The Australian Maritime Safety Authority (AMSA) provides a range of regulatory functions and services that significantly use satellite based technology including:

- the Joint Australian Rescue Coordination Centre (JRCC) with a capacity to handle maritime and aviation distress situations and by maintaining two COSPAS-SARSAT¹¹ ground stations and the Mission Control Centre for the detection of satellite distress beacons;
- the provision of navigational services (in the main, a network of aids to navigation to meet the needs of levy-paying commercial shipping), which includes 16 Differential GPS reference stations, necessary for ocean and coastal navigation;
- vessel tracking services, including administration of the Modernised Australian Ship Tracking and Reporting System (MASTREP), and use of shore based and satellite based automatic identification systems (AIS) and long range identification and tracking (LRIT) of ships; and
- a high frequency (HF) distress and safety maritime radio communication network.

Key Space-Related Activities for 2015

AMSA is a significant user of satellite technology for a number of applications including aviation and maritime search service response, pollution surveillance, oil spill and disaster response, ship and navigation safety and ad-hoc imagery.

AMSA collects and uses satellite-sourced AIS information for ship reporting, monitoring and other emerging purposes.

AMSA's JRCC uses satellite detections of distress beacons for search and rescue. PNT information obtained from GNSS is widely used in Search and Rescue functions.

¹¹ Cospas-Sarsat is an international distress beacon detection system. See <http://cospas-sarsat.int/en> for further details.

AMSA collects and uses satellite-sourced aircraft tracking information through various data-sharing arrangements with different aircraft operators and Airservices Australia.

AMSA is also active in international bodies, such as the IMO, the ITU, the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), ICAO and Cospas-Sarsat, which deal (in part) with radionavigation and satellite based systems, procedures, policies and radio communications.

AMSA used satellite-based Synthetic Aperture Radar (SSAR) data through a service provider, to monitor illegal oil discharges from vessels within Australian waters.

AMSA's key activities involving a space-based element are provided below. These activities have been categorised under the three main space applications of national significance: Earth Observations from Space (EOS); Position, Navigation and Timing (PNT) and, Satellite Communications (SC).

#	Key AMSA Activities	EOS	PNT	SC
1	A Differential Global Positioning System (DGPS) network to provide differential correction service		Y	
2	Vessel Traffic Service (VTS) in the Great Barrier Reef and Torres Strait		Y	Y
3	Facilities for Australian Global Maritime Distress and Safety System (GMDSS) Network			Y
4	Search and Rescue (SAR) functions	Y	Y	Y
5	Improved detection of satellite distress beacons		Y	Y
6	Detection of ships' Automatic Identification System transmission by satellites (S-AIS)		Y	Y
7	Facilities for IMO-mandated Long Range Identification and Tracking (LRIT)		Y	Y
8	Promulgation of Maritime Safety Information (MSI)			Y
9	Satellite monitoring of aids to navigation (AtoN) status and performance		Y	Y
10	Pollution Surveillance	Y	Y	
11	Disaster Response	Y		
12	Use of Oil Spill Response Atlas (OSRA) during marine oil pollution incidents	Y		
13	Ad-hoc uses	Y	Y	Y

Background

1. A Differential Global Positioning System (DGPS) network to provide differential correction service – ASUP Principles 1, 2, 5, 6 & 7

GNSS (in particular GPS) has become the primary means by which ships determine their position and timing for navigation.

As the International Maritime Organization (IMO) has issued operational requirements for worldwide radionavigation systems, GNSS integrity has become as important as observation of position.

AMSA operates a Differential Global Positioning System (DGPS) network that comprises 16 medium frequency (MF) broadcasting stations at selected sites around Australia's coast.

The broadcast MF signal coverage extends approximately 150 nautical miles offshore. These DGPS stations are co-located with GPS reference and integrity monitoring stations.

Integrity monitoring is a vital feature of AMSA's DGPS network. The GPS reference stations test for GPS signals that are out of specification and immediately notify user receivers to disregard such signals.

With the use of DGPS, a warning is generated within a few seconds of the satellite becoming 'unhealthy', compared to the GPS system itself, where up to 12 hours can elapse before notification is received.

2. Vessel Traffic Service within the Great Barrier Reef and Torres Strait – ASUP Principles 1, 2, 5 & 7

Vessel Traffic Services (VTS) are shore-based organisations that provide a range of services from the provision of simple information messages to ships (such as position of other ships, navigational and meteorological hazard warnings) to navigational assistance and traffic organisation within a port (port VTS) or waterway (coastal VTS).

Usually, ships entering a VTS area report to the VTS authority using marine very high frequency (VHF) radio. In some instances reports may also be made using satellite communications. A traffic image is maintained by the VTS. The ships are tracked by the VTS using radar, AIS information received by either terrestrial or satellite based receivers, or other means, including satellite based technology.

The Great Barrier Reef and Torres Strait Vessel Traffic Service (REEFVTS) is a coastal VTS introduced by the Australian Government in 2004 to improve the safety and efficiency of vessel traffic in the region.

REEFVTS is jointly managed by Maritime Safety Queensland and AMSA and its designated area extends from Torres Strait and the Great North East Channel to the waters of the Great Barrier Reef from Cape York to the southern boundary of the GBR Marine Park.

REEFVTS uses three types of sensor input, including satellite technology, to identify and monitor the transit of individual ships. These sensor inputs are radar, AIS (terrestrial and satellite) and Automated Position Reporting (APR) via satellite (Inmarsat-C) as part of the mandatory Ship Reporting System (REEFREP) operating in the Great Barrier Reef and Torres Strait.

The information from these sensors is integrated to provide a single traffic image. REEFVTS relies heavily on ships having accurate position information with high reliability from the GNSS.

3. Facilities for Australian Global Maritime Distress and Safety System (GMDSS) Network - ASUP Principles 1, 2, 5 & 7

The Global Maritime Distress and Safety System (GMDSS) designates four Inmarsat ocean regions and each region has a number of associated Land Earth Stations (LEEs), which provide the interface between ships at sea and shore telecommunication networks.

The Australian LES is located at Perth (WA) and serves both the Indian Ocean Region (IOR) and Pacific Ocean Region (POR). The Perth LES is part of the Inmarsat global network, which also uses an LES at Burum in the Netherlands, giving access to the Atlantic Ocean Regions (East and West) and Indian Ocean.

The Australian Government has designated its surrounding waters as GMDSS Sea Area A3. Ships within A3 Sea Area will typically transmit a ship-shore alert either via Inmarsat-C, Inmarsat-B, Fleet77, high frequency (HF) Digital Selective Calling (DSC) and/or satellite Emergency Position Indicating Radio Beacon (EPIRB).

The Australian GMDSS HF DSC network is provided by the remote-controlled stations located at Charleville (QLD) and Wiluna (WA). The network consists of a HF DSC alerting network with the ability to provide follow-on HF voice or telex communications on at least two frequencies simultaneously.

The network is centrally controlled and operated from Canberra alongside the JRCC with the remote HF sites being unmanned. The sites are linked directly

by diverse satellite paths (Ku-band satellite and C-band) to the Network Control Centre (NCC) as well as the Back-up Network Control Centre.

AMSA's JRCC undertakes distress communications (including broadcast of Inmarsat-C distress relays) with ships via the Perth and other Inmarsat LES. Also, for safety-related operational communications to ships at sea, the JRCC uses various systems including satellite communications.

4. Search and Rescue functions - ASUP Principles 2, 5, 6 & 7

AMSA is responsible for monitoring the transmission of COSPAS-SARSAT 406 MHz satellite distress beacons throughout the Australian Search and Rescue Region. AMSA has established two ground stations (also known as local user terminals or LUTs) for the COSPAS-SARSAT system. These two LUTs are located at Albany (WA) and Bundaberg (QLD) and they are connected to the Mission Control Centre (MCC - also known as data distribution centres) at the JRCC, Canberra. New Zealand has established LUTs for Low Earth Orbiting (LEO) and geostationary orbit (GEO) satellites at Wellington, which are also linked to the MCC in Canberra.

PNT information obtained from GNSS is widely used in Search and Rescue (SAR) functions. Any navigational or distress positioning information invariably relies on GNSS. At an operational level, AMSA uses accurate positional data to define and plot search areas.

At a tactical level, it is used by all SAR units to ensure they search allocated areas. This includes the navigation of SAR aircraft, SAR vessels, coastal and inland SAR units using hand-held GNSS devices. An increasing number of marine products are being developed that use GNSS positional data for tracking and distress alerting. Examples include: the SPOT Satellite GPS Messenger (providing personal satellite messaging and emergency communication services) and Iridium-based products.

Additionally, AMSA uses Iridium communications satellites for tracking self-locating datum marker buoys (SLDMB). These buoys are designed to measure surface ocean currents, which AMSA uses to estimate drift in search and rescue and pollution incidents.

5. Improved detection of satellite distress beacons - ASUP Principles 1-3, 5-7

The International COSPAS-SARSAT system is in the process of upgrading its satellite system by placing search and rescue receivers on new medium-altitude earth orbiting (MEO) satellites.

These receivers will augment search and rescue receivers currently installed on LEO and GEO satellites. The augmented system will dramatically improve both the speed and location accuracy of distress beacon detections, and is expected to be operational by 2017.

The Australian component of the MEOSAR satellite system includes construction of a satellite receiving ground station (Medium Earth Orbit Local User Terminal - MEOLUT) in WA and installation of a central processing computer in Canberra.

The Australian MEOSAR equipment is expected to be ready for operational use in 2017.

6. Detection of ships' Automatic Identification System transmission by satellites (S-AIS) - ASUP Principles 1, 2, 3, 5, 6 & 7

Automatic Identification System (AIS) is a ship and shore-based data exchange system operating in the very high frequency (VHF) maritime band.

AIS is used to exchange information such as vessel identification, position, course, speed and cargo type between ships for safety of navigation, and between ships and shore for maritime domain awareness and efficient ship movement.

AIS is currently being used for numerous other applications – far more than what it was originally intended. Some examples include: vessel tracking, as an aid to navigation; and exchange of application specific messages.

Detection of ships' AIS transmissions by low-Earth orbiting satellites is a commercial reality which AMSA uses to: enhance maritime domain awareness; examine ship traffic patterns; plan ship routing systems; assist search and rescue operations; assist in responding to oil spills and identifying polluters; and to aid in navigation planning.

Satellite AIS (S-AIS) provides an extension to Australia's terrestrial AIS receiver network, providing coverage for the Australian search and rescue region. Currently, AMSA's provider of S-AIS uses ground receiving stations outside Australia. Continuous coverage in time is not possible yet, but the satellite constellation is increasing and AMSA will benefit from a more fully populated S-AIS constellation.

AIS data acquired by satellite is also used to verify whether proposals for offshore exploration and extraction operations are proximate to shipping traffic.

AMSA uses both terrestrial and satellite historical AIS ship positions in coastal and high seas environments to ascertain traffic patterns for subsequent nautical advice to proponents of resource exploration and production.

Such nautical advice also has a roll-on effect to the Australian Hydrographic Services for nautical charting action, and for issuing amendment to relevant nautical publications.

AMSA operates an Under Keel Clearance Management (UKCM) system in the Torres Strait to assist ships transiting through the established shipping route. The UKCM system requires ships' positions to be monitored via AIS so that minimum under-keel clearance is not violated.

Spatial data sourced from various satellite systems is used in emerging Marine Spatial Planning initiatives, with facilitation of inter and intra agency support.

From 1 July 2013, the Australian Ship Reporting System (AUSREP) was replaced by the MASTREP (Modernised Australian Ship Tracking and Reporting System). MASTREP uses terrestrial and satellite detection of ship broadcast AIS information to provide a near real-time plot of ships' positions for both the JRCC and AMSA's other statutory requirements.

This information significantly enhances JRCC Australia's ability to identify ships to assist in the event of a search and rescue incident.

7. Long Range Identification and Tracking (LRIT) - ASUP Principles 1, 2, 3 & 7

Long Range Identification and Tracking (LRIT) refers to an IMO-mandated system that requires vessels to automatically transmit their identity, position and date/time of position at six hour intervals.

LRIT is an international maritime domain awareness (MDA) initiative which allows States to receive position reports from vessels operating under their flag, vessels seeking entry to a port within their territory, or vessels operating in proximity to the State's coastline. MDA provides enhanced security, environmental protection and safety/search-and-rescue benefits.

LRIT system design is based on a multi-tiered receiving system of data centres comprising of distributed data centres that report through a central International Data Exchange (IDE). Vessel position reports are made available to States for purchase whenever a vessel is within 1000 nautical miles of the purchasing coast or when a vessel is seeking entry to a State's port.

States establish an LRIT data centre, which can be: a national LRIT data centre (NDC), a Regional or Cooperative LRIT data centre (RDC or CDC respectively). The regulation for LRIT references an International LRIT data centre (IDC), however this has not yet been implemented.

Existing GMDSS Inmarsat C can be used to provide the LRIT information. In addition, there are small approved L-band satellite terminals (Inmarsat or Iridium) that can be used for LRIT. In search and rescue situations, AMSA's JRCC can remotely command a ship's LRIT terminal to update reporting at an increased rate, up to once every 15 minutes, at no cost to the JRCC.

AMSA has contracted the services of an overseas data provider for the LRIT NDC solution. As such, there is no dedicated infrastructure for LRIT in Australia. However, the Inmarsat LES in Perth (WA) may be used by the ships to transmit their LRIT messages.

Australia has expanded its NDC to become a Cooperative Data Centre (AusCDC). The AusCDC is also operated by AMSA's LRIT provider, with services for Palau, Papua New Guinea, Cook Islands and New Zealand under a cooperative arrangement.

8. Promulgation of Maritime Safety Information - ASUP Principles 1, 2, 3, 5 & 7

Maritime Safety Information (MSI), such as navigation warnings, is issued by the JRCC within Australia's maritime area (search and rescue region, and NAVAREA X). The MSI also contains a section, approved by the Bureau of Meteorology (BoM), on meteorological information promulgated in a similar manner under the GMDSS.

The JRCC and the BoM provide MSI through Inmarsat's SafetyNET system. In addition to SafetyNET, the JRCC may avail itself of the Inmarsat-B/Fleet77's "All Ships" broadcast facility for search and rescue type broadcasts. These broadcasts cover an entire ocean region.

Under the World Wide Navigational Warnings Service (WWNWS), Australia is the area Coordinator for NAVAREA X. The JRCC issues two main types of warnings, (coastal warnings and long range warnings) to align, as closely as possible with WWNWS and Inmarsat recommendations. NAVAREA X warnings are promulgated on Inmarsat-C on both the POR and IOR satellites.

The JRCC may initiate the following types of broadcast using Inmarsat-C Enhanced Group Calling (EGC): distress messages, urgency messages, NAVAREA X warnings, AUSCOAST warning and general messages.

The BoM initiates two types of broadcasts: forecasts and warnings.

9. Satellite monitoring of aids to navigation status and performance - ASUP Principles 1, 2, 3, 5 & 7

Satellite AIS is being used to provide a second means to verify the operational status of AIS aids to navigation (AtoN), as a backup to the terrestrial AIS network. In addition, small Inmarsat and Iridium satellite terminals are used to provide status of visual, radar, and other AtoN, outside the range of terrestrial cellular mobile networks, whether near land or further off the coast.

Within AMSA's AtoN network, there are over one hundred AtoN that utilise satellites for remote monitoring purposes.

Additionally, there are a number of AtoN that use satellite information for other purposes such as timing and synchronisation (e.g. AIS stations - base stations, repeaters and AIS AtoN) and tide gauge sites that use timing information and, AtoN with GPS-synchronised lights.

For satellite monitoring the AtoN are polled via satellite twice per day and the reports are sent to AMSA's AtoN contractor via email where they are logged in a database. AMSA utilises satellite monitoring for AtoN in remote areas that do not have 3G or 4G mobile network, fixed line or AIS coverage.

10. Pollution Surveillance - ASUP Principles 1, 2, 3, 5, 6 & 7

Under the National Plan, AMSA manages several oil spill response decision support systems, and conducts research into the use of other technology and services that could assist in oil spill response and monitoring.

In 2012 and 2013, AMSA conducted two successful three month trials in the use of Satellite-based Synthetic Aperture Radar (SSAR) for oil spill detection and monitoring Australian waters, which has now been implemented long term to identify and assist when responding to marine pollution incidents. AMSA has completed a tender process for a 4-year contract for an ongoing Satellite-based Synthetic Aperture Radar (SSAR) oil spill detection and monitoring.

Apart from providing on-going monitoring for potential oil spills, the service will also provide on-going response support during an actual oil spill event. If a significant oil spill incident occurs during the monitoring contract, the scope of services can be scaled up to support the response to the incident and an emergency service activated by the service provider.

Supporting information such as AIS vessel tracking and offshore installations are integrated into the imagery to support the image interpretation for discriminating man made slicks and for locating and identifying the possible polluters.

The purpose of the initial trials was to demonstrate the utility of near real-time SSAR oil spill and vessel monitoring for Australian conditions and to test the capabilities of a recognised service provider and of AMSA to receive, assess and respond appropriately to alerts of a suspected or known spill within Australian waters.

The trials demonstrated that near real-time SSAR would work for Australian conditions. They met all of AMSA's expectations, including daily satellite coverage over the areas chosen, and the delivery of near-real-time notifications supported by analysis and imagery.

This project will be a major contribution to AMSA's strategic vision in terms of marine environment protection and environmental response. In particular, it will assist in providing effective monitoring and enforcement of illegal discharges in Australia's EEZ.

In relation to enforcement activity, positive information derived from SSAR imagery will provide real evidence to substantially enhance capability for legal proceedings against vessels that violate Australian pollution laws.

11. Disaster Response - ASUP Principles 3, 5, 6 & 7

The International Charter, "Space and Major Disasters", provides a unified system of satellite data acquisition and delivery through authorised users to areas affected by natural or man-made disasters.

The Charter was activated by Australia to receive satellite imagery, free of charge, during the Rena oil spill incident in October 2011 (New Zealand), and during the search for missing Malaysian Airline flight MH370 in March-May 2014.

Under the Charter, during the Rena incident a number of satellite imagery types were received that greatly assisted the response efforts. The imagery used was mainly of high-resolution and multi-spectral, but some SSAR imagery was also used.

It was found that in an oil spill situation there are varying degrees of benefits in using different types of imagery. The SSAR imagery captured during one of the spills clearly showed the extent of the oil slick whilst the high-resolution, multi-spectral imagery was useful for locating drifting shipping containers which had fallen overboard from Rena.

The main issue however, was that of imagery acquisition frequency, which can be critical during an oil spill incident. Because of the fast dynamics of the oil slick and containers moving with the current, and the large delays between

acquisition and final delivery of satellite imagery, the images provided limited benefits.

The main benefit was the provision of a method for validating and quantifying the accuracy of the trajectory models generated for the spill.

Any advances in satellite based or ground based technology, leading to immediate image acquisition and delivery, would greatly improve the benefits of such Earth observation systems during oil spill and other disaster situations.

12. Oil Spill Response Atlas (OSRA) - ASUP Principles 1, 2, 3, 5, 6 & 7

AMSA's Oil Spill Response Atlas (OSRA) is a resource atlas based on a spatial database and customised Geographic Information System (GIS)-embedded toolkit designed to streamline the delivery of vital modelling, environmental, biological and logistical information to marine spill responders during marine pollution incidents.

Geospatial data is collected from the various agencies that are involved in oil spill response, and updates to the database are carried out on a regular basis.

Apart from GIS layers, the database also contains extensive satellite remote sensing images covering most of the Australian coastline. On some occasions, these are provided by the States/NT although they are mostly derived from other sources.

The satellite imagery is mainly optical/multi-spectral and is used within OSRA to provide various types of information to support a response such as:

- definition of shoreline types to assist shoreline assessment and clean up teams;
- logistical information relating to access points, existing infrastructure (e.g. road access, boat ramps, jetties etc.) and surrounding topography, all of which are essential factors in planning for equipment deployments, access to affected shores, and waste management;
- to detect and quantify the growth, spread and movement of oil. This then helps to validate and refine oil spill trajectory models used for monitoring an oil spill.

13. Ad-hoc uses - ASUP Principles 1, 2, 3, 5, 6 & 7

Derived satellite imagery products support the work of users across AMSA. For search and rescue purposes, satellite imagery at various scales is used to provide situation awareness of topography and vegetation at an incident site. Hybrid geospatial information solutions (e.g. street maps overlaid onto

satellite imagery) are used for location of accidental distress alerting beacon activations.

On several occasions the SENTINEL national bushfire detection system has also been used for searches involving missing aircraft.

High resolution satellite imagery and aerial photography are used to verify site leases or for construction purposes. Coarser satellite imagery or larger cell sizes is not generally used.

High resolution satellite imagery and satellite based synthetic aperture radar information have been used to support search and rescue activities which have occurred in the Antarctic area of the Australian Search and Rescue Region.

In combination with AIS data, additional ad-hoc multi-spectral or panchromatic satellite imagery can also be acquired to provide supporting evidence of vessel discharges when undertaking marine pollution investigations to support prosecutions.

Key Outcomes

1. A Differential Global Positioning System (DGPS) network to provide differential correction service

AMSA's DGPS network was completed in 2002. In 2006, the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) assessed the current and future use of the DGPS system and recommended that in the short to medium term, the DGPS radio beacon remains the most cost effective method for integrity monitoring and providing differential corrections.

IALA further advised national members should recapitalise their DGPS network to ensure their continued reliability. AMSA has subsequently undertaken a partial recapitalisation of its network (four sites) to provide sufficient new equipment and spare parts to sustain the equipment for a further five to ten years.

An AMSA 2014 survey indicated 98.5% of the respondents found AMSA's DGPS service useful.

2. Improved detection of satellite distress beacons

AMSA has a contractor installing MEOSAR equipment in Australia. Australia is working collaboratively with New Zealand to establish MEOSAR capability in the Australian and New Zealand Search and Rescue Regions. It is

expected that the Australian and New Zealand MEOSAR capability will be operational by 2017.

3. Detection of ships' Automatic Identification System transmission by satellites (S-AIS)

AMSA is planning to negotiate a contract extension until the September quarter 2016 with the current provider of satellite AIS data.

4. Pollution Surveillance

The 2012 and 2013 trials were able to successfully meet AMSA's most critical expectations:

- adequacy of satellite coverage – coverage over Australian waters was sufficient for an effective daily spill monitoring. This was comparable to acquisitions over Europe, where this service has been running successfully since 2006.
- image acquisition – acquired up to twice daily (dawn and dusk), as required.
- delivery timing – the service provider was able to deliver analysed imagery in near real-time at an average of 54 and 69 minutes respectively, from satellite acquisition to delivery to AMSA.
- reporting quality – the service provider's system was suitable for AMSA's needs in terms of both near real-time priority and routine communication.
- reception of alerts – AMSA was able to receive and interpret the information through the JRCC, assess the report and deliver it to the Pollution Duty Officer for action.
- AMSA completed a tender process for a 4-year contract for an ongoing Satellite-based Synthetic Aperture Radar (SSAR) oil spill detection and monitoring.

Key Partnerships

Pollution monitoring

- The SSAR Oil Spill Monitoring service is provided to AMSA by a leading overseas service provider specialised in the delivery of this type of service. The provider was selected through a competitive tender process, and will be providing the ongoing capability until June 2017.

- In addition, AMSA has recently signed a Memorandum of Understanding with the CSIRO for the provision of scientific services, advice and support in the context of oil spill planning, preparedness, response and recovery activities. This will also extend to support, upon request, in expert interpretation of satellite imagery (including SSAR) obtained from the service provider during a pollution response and including during the ongoing monitoring phase.

Key Priorities Beyond 2015

AMSA's significant procurement activities for the 2015-2016 financial year are:

- Post-contract work in establishing a satellite receiving ground station (MEOLUT) in WA and installing a central processing computer in Canberra;
- tendering for a contractor to provide full implementation of an oil spill monitoring service in Australian waters; and
- researching and building Australian capability to deliver an oil spill monitoring service in the future.

AMSA has engaged, through a tender process, a service provider until 30 June 2017 to fully implement Satellite-based Synthetic Aperture Radar (SSAR) for oil spill monitoring in selected areas of interest.

The two main objectives are:

- identification of marine pollution incidents for the purpose of compliance and/or response; and
- maintaining the capability to use and scale up access to the service during a response.

Currently, there are no established service providers within Australia that are able to provide the same level of integrated and effective oil spill monitoring service as that which is being provided by the current overseas provider.

It is intended that AMSA continue to use the services of an external service provider in the short term; however, it envisages that a local Australian capability to deliver the same service would be gradually developed in the near future to meet the same level of service.

AMSA will explore and research over the next few years how this capability could be established. Other key priorities (within 3-5 year time frame) include:

- Using Cospas-Sarsat MEOSAR data operationally;

- Increasing the acquisition of satellite AIS data, and improving the latency of data (perhaps via Australian ground stations);
- Enhancing the use of satellite imagery for marine oil spill response;
- Improving use of satellite imagery for remote area search and rescue activities;
- Renewal by the June quarter 2017 of contracts for Inmarsat distress and safety services through the Perth Land Earth Station (and Burum, the Netherlands);
- Monitoring developments in satellite-provided PNT;
- Working nationally and internationally to enhance data communications for ships at sea (by terrestrial and satellite means); and
- AMSA is also working to establish real-time data feeds of satellite derived ADS-C information for search and rescue purposes following the increasing global priority for tracking aircraft at all times. Future developments in space-based ADS-B systems will see AMSA seeking this data for real-time search and rescue purposes. Development of the new Global Aeronautical Distress and Safety System (GADSS) includes search and rescue as a major integrated component of this new system which will have impacts on AMSA's search and rescue function.

Department of Infrastructure and Regional Development - Rail

Synopsis

The Australian Rail Track Corporation (ARTC), the national interstate rail track access manager, is involved in the development of a digital Global Positioning System (GPS) based train management system to replace ageing track side signalling equipment.

Key space-related activities

Much of the signalling infrastructure across the interstate rail network is at the end of its physical life, and the Advanced Train Management System (ATMS) is intended to replace this trackside infrastructure with digital technology-based train control in the future.

Stage One of the ATMS Implementation project is aimed at deploying ATMS as the accredited and approved safe working system for trains operating between Port Augusta and Whyalla in South Australia. In 2015, ARTC is progressing project planning and preparations for the subsequent phases of the ATMS Project.

This stage will allow ARTC to demonstrate the capability of ATMS on a section of network that lends itself to a simple, relatively low risk deployment that can be used to prove its potential for wider roll out.

Background

The ATMS is a communications based safe working system being developed by ARTC to replace traditional trackside signalling across the interstate rail network including the Hunter Valley rail network. The system will replace physical train control and signalling systems with an advanced geographical system utilising global positioning, mobile broadband communications and satellite technology.

Key Outcomes

In 2013-14 ARTC successfully completed a proof of concept and safety trial of ATMS between Port Augusta and Crystal Brook in South Australia with the

Australian Government contributing \$45 million towards the \$102.4 million project.

ATMS will improve productivity of Australia's interstate rail freight network by reducing transit times and enable additional capacity to be unlocked from existing infrastructure while making rail freight transport safer and more efficient.

ATMS also has the potential to improve rail safety through the ability to automatically stop a train where a potential safety issue has been detected by the system.

Key Partnerships

Stage One of ATMS implementation is being jointly delivered by ARTC and Lockheed Martin Australia.

Key Priorities Beyond 2015

Stage One of ATMS implementation is expected to be completed in 2016.

Once operational, ATMS will become the accredited standard for train management across the national rail network managed by the ARTC.

Department of Infrastructure and Regional Development – Roads

Synopsis

In relation to road transport, technology developing in the area of Intelligent Transport Systems (ITS) is expected to lead to an increase in demand for position, navigation and timing (PNT) signals by this sector in the future.

The current main example of the use of satellite technology in road transport in Australia is the Intelligent Access Program (IAP), which provides heavy vehicle operators with greater access to the road network in exchange for monitoring their compliance with road access conditions.

Transport agencies have formed Transport Certification Australia which provides a technology platform to apply in-vehicle regulatory compliance monitoring of heavy vehicles in exchange for greater access to the road network, through IAP.

Work is also being progressed by governments and industry to investigate opportunities to leverage in-vehicle telematics for other regulatory and commercial purposes. This work is particularly focusing on demonstrating the benefits to operators of adopting such in-vehicle technology.

Key space-related activities

Telematics

An implementation plan for the voluntary uptake of Electronic Work Diaries (EWDs) is being developed by the National Transport Commission (NTC) and the National Heavy Vehicle Regulator, to be provided to Australia's Transport and Infrastructure Ministers.

Intelligent Transport Systems

'Intelligent Transport Systems' (ITS) is an umbrella term for the use of information and communication technology in the transport network to improve transport outcomes. 'Cooperative Intelligent Transport Systems' (C-ITS) is a subset of ITS in which the different elements of the transport network – vehicles, roads, infrastructure – share information with each other. C-ITS applications have the potential to improve safety, productivity, efficiency and environmental outcomes for the transport network, such as through applications designed for collision avoidance and reducing congestion.

C-ITS can utilise a variety of communication mediums, but will primarily utilise dedicated short range communications (DSRC), using the 5.9 GHz radio band. DSRC will allow vehicles to communicate directly with each other, delivering a high level of integrity with low system latency. The 5.9 GHz spectrum has been reserved by the Australian Communications and Media Authority with the issue of Spectrum Embargo 48 in April 2008 for possible future use for ITS.

In July 2015 Europe adopted the 5.9GHz band to harmonise the development and deployment of ITS applications (including DSRC) for road safety and traffic efficiency¹². Additional spectrum for ITS applications will be considered at the November 2015 World Radiocommunication Conference (WRC-15) for future automotive applications such as vehicle radar.

Satellite technology is also expected to be a key element of some C-ITS applications and there is emerging interest in the use of cellular networks to support the uptake of ITS.

Strongly associated with these ITS developments are the advances in automated vehicle technology that are likely to have a profound impact on the productivity, safety and environmental performance of Australia's transport systems in the medium to long-term. Vehicles with a relatively high level of automation, such as self-parking or autonomous emergency braking, are already commercially available. By 2020 several manufacturers expect to offer vehicles that can undertake all necessary driving functions in certain situations under driver supervision.

Heavy vehicle telematics

Governments in Australia are closely examining the use of in-vehicle telematics for regulatory purposes. The aim is to drive the voluntary uptake of technology to improve road safety, reduce transport costs and cut emissions, through a partnership approach between government and industry.

Telematics applications often use Global Navigation Satellite System (GNSS) technology to gather and analyse information about heavy vehicle movements.

¹² European Electronics Communications Committee Decision (08/01) amended 3 July 2015 , Helsinki - see <http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCDEC0801.PDF>

An important application of satellite based heavy vehicle telematics is the Intelligent Access Program (IAP). This is a voluntary programme that uses the GNSS to monitor heavy vehicles' road use.

Road agencies can provide transport operators using IAP with greater access to their road networks; the data generated by IAP provides them with the assurance that heavy vehicles are complying with agreed access conditions. The IAP is administered by Transport Certification Australia, which certifies and audits IAP Service Providers.

Telematics applications often use GNSS technology to gather and analyse information about heavy vehicle movements. The aim is to drive the voluntary uptake of technology to improve road safety, reduce transport costs and cut emissions, through a partnership approach between government and industry.

A further example of the potential use of in-vehicle telematics for regulatory purposes is the Electronic Work Diary (EWD). The EWD is an electronic recording system that can record work and rest time for a fatigue-regulated heavy vehicle driver.

EWDs will utilise GNSS technology to track vehicle location and time, thereby allowing assurance as to work time.

Australian Governments are also working on longer-term reforms to heavy vehicle charging and investment arrangements, which in future could see increased use of telematics technology. Governments are investigating options to utilise in-vehicle telematics to monitor road usage and charge operators for the cost of that usage. Revenue from these charges would then flow back to road investment according to where on the network that vehicle was used. While technically feasible, the broader issues involved are complex and further work is required before governments could consider heavy vehicle charging reforms utilising these types of technology.

Key Partnerships

The Department of Infrastructure and Regional Development (the department) is a member of the Austroads Cooperative ITS Project Industry Reference Group. The Group comprises key industry representatives and academia, and is used to consult on key elements of the operational framework required to support the deployment of C-ITS in Australia.

As part of its ITS work programme, the department has funded Transport Certification Australia to work in partnership with the European Union and the US to develop and implement harmonised standards for ITS, as a means of

ensuring interoperability across borders for safety purposes and in support of commerce.

The department supports Australia's membership of the OECD International Transport Forum (ITF) which is an intergovernmental organisation with 57 member countries and acts as a think tank for transport policy.

Key Priorities Beyond 2015

The department has responsibility for developing and implementing national reforms in surface transport policy and regulation to achieve efficient, productive, safe, and sustainable outcomes which are environmentally friendly and enhance Australia's international competitiveness.

The department will work with States, Territories and other stakeholders to review Australia's ITS policy framework. The review due for completion in early 2016 will:

- guide the consistent implementation, integration and uptake of ITS across land transport modes;
- provide for standardisation for national and interdependent supplier/provided systems; and
- promote innovation in the ITS sector within Australia.

The ITF's 2015-16 programme of work includes use of GPS vehicle-location technologies that may enable smarter and more productive use of transport infrastructure including roads. The ITF's research will continue to inform the department's work on ITS and other technologies relevant to transport infrastructure.

Geoscience Australia (GA)

Synopsis

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

Key Space-Related Activities for 2015

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:

- Building Australia's Resource Wealth
- Ensuring Australia's Community Safety
- Securing Australia's Water Resources
- Managing Australia's Marine Jurisdictions
- Providing Fundamental Geographic Information
- Maintaining Geoscience Knowledge and Capability

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

The GA work programme supports the work of other Australian Government agencies, state and territory governments, researchers, international partners, and industry.

Background

Positioning, Navigation and Timing (PNT) and Earth Observations from Space (EOS)

GA is the Australian Government agency responsible for Australia's fundamental National Positioning Infrastructure (NPI) and services, and is jointly responsible for EOS capabilities with the Bureau of Meteorology and CSIRO. Its leadership in these areas is strongly linked to *Australia's Satellite Utilisation Policy*. GA chairs the Australian Government PNT Working Group (PNT-WG), and co-chairs the Australian Government Earth Observations from Space Working Group (AEOSWG) with CSIRO and the Bureau of Meteorology. These groups promote national coordination and planning, including coordinated advice on domestic and international policy, standards and research.

Australia does not operate EOS satellites and is highly dependent on a small number of satellites. Leveraging the full diversity of satellite data available is therefore challenging, which limits societal benefits and could significantly disrupt operations in the event of satellite outages or failures. GA in collaboration with BOM and CSIRO works to address these issues and secure the future pipeline of key EOS data for Australia. GA does this by identifying priority missions, engaging with satellite operators to identify valuable contributions that GA can make to their programmes, and undertaking the technical work necessary to ensure that data can be integrated into the national imagery supply chain with minimal disruption.

Three key drivers of the GA work programme are development of the National Positioning Infrastructure (NPI), implementation of the National Earth Observations from Space Infrastructure Plan (NEOS-IP) and implementation of the Australian Geoscience Data Cube - a national capability to map and detect change in the Australian landscape as it happens using Earth observations from space.

National Positioning Infrastructure

- Australia is well placed to take advantage of a multi-GNSS future in order to strengthen and expand the nation's fundamental positioning capability. Australia's geographic location provides full visibility to all new GNSS constellations, including regional augmentations across the Asia-Pacific. Through collaborative partnerships with providers of these systems, GA leads and coordinates PNT activities aimed at enhancing

access to these systems, and the downstream scientific, commercial and public good applications they enable.

- The NPI will ensure Australia has a modern, fit-for-purpose and internationally compatible PNT capability, including modernised ground-tracking infrastructure; improved data analysis and performance monitoring; greater access to quality-assured Global Navigation Satellite System (GNSS) data; and strengthened linkages with domestic and international providers.
- In December 2014 GA established the NPI Advisory Board (NPI-AB) to advise GA on developing and implementing the NPI. The Board comprises 10 individual experts from government and industry across Australia and New Zealand, including representatives from Transport, Agriculture, Construction, Spatial, Surveying, Mapping, Mining, and Original Equipment Manufacturers (OEM). The NPI-AB is chaired by GA and the Board will establish Technical Working Groups (TWG) to address priority issues for the NPI.
- GA is leading work to develop and implement the next generation datum underpinning Australia's NPI. In May 2015, the Intergovernmental Committee on Surveying and Mapping (ICSM) endorsed the Datum Modernisation Roadmap proposed by ICSM's Permanent Committee on Geodesy (PCG). GA chairs the PCG and will implement the Datum Modernisation Roadmap, ensuring Australia's NPI is aligned to the global coordinate system supporting PNT and EOS.

The National Earth Observations from Space Infrastructure Plan (NEOS-IP)

- Developing national EOS infrastructure will modernise Australia's national observatory networks and calibration facilities; strengthen domestic and international partnerships; improve scientific analysis and operational mapping and monitoring; and strengthen data and knowledge sharing, and the efficiency of accessing this information through open data policies. This infrastructure will support industry, researchers and government agencies to realise the benefits of EOS data.

The Australian Geoscience Data Cube

- The Australian Geoscience Data Cube provides the capacity to apply EOS to monitor the landscape and detect change as it happens. This ability to monitor the landscape at continental-scale is critical to

Australia's engagement with enduring issues in natural resource management, including water security, ecosystem health and agricultural productivity.

Operational service delivery

GA operates the Australian Regional GNSS Network, which was recently expanded to over 130 stations through the National Collaborative Research Infrastructure Strategy (NCRIS) and co-funding from State and Territory governments under the AuScope initiative. The ARGN establishes the national coordinate framework (datum) for all spatial data in Australia. GA also operates the South Pacific Regional GNSS Network (SPRGN) funded under the Pacific Sea Level Monitoring Project (PSLMP).

GA in collaboration with domestic and international partners operates key components of the global geodetic infrastructure, including two Satellite Laser Ranging Stations (SLR), three radio telescopes in the Very Long Baseline Interferometry (VLBI), and two Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) beacons.

GA and Institut Géographique National France have an agreement to jointly operate two DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) ground facilities. DORIS is a Doppler satellite tracking system developed for precise orbit determination and precise ground location. It is on-board the Cryosat-2, Jason-2, HY-2A and SARAL altimetric satellites and the remote sensing satellite SPOT-5. It also flew with SPOT-2, SPOT-3, SPOT-4, TOPEX/POSEIDON, ENVISAT and Jason-1.

GA has initiated work to develop a sovereign GNSS analysis capability to analyse multi-constellation data for use in the Australian region, enabling independent monitoring and reporting on system health and performance. The project takes advantage of Australia's geographic location where visibility to all current and emerging GNSS systems will be at a global high.

GA and the University of Tasmania have an agreement to operate the national Very Long Baseline Interferometry (VLBI) array. The VLBI array contributes to the terrestrial reference frame (TRF), the international celestial reference frame (ICRF), and Earth orientation parameters (EOP), which underpins all space activity.

GA operates ground stations and communication links to acquire EOS data directly from satellites under agreements with satellite operators. GA also cooperates with satellite operators to maintain and share global satellite

imagery archives and knowledge for reliable acquisition and distribution of EOS data.

GA calibrates satellite data to produce consistent scientific measurements of the state of the land surface over time. These measurements are foundation data for scientific analysis and operational mapping and monitoring. GA also works with the national and international science communities to apply and develop new techniques for quick and reliable production of relevant information from satellite data sources.

GA is working to complete a \$3 million upgrade that will put Alice Springs at the heart of international satellite programmes, performing a critical role in controlling satellites and ensuring acquisition of vital data.

GA works with the National Computational Infrastructure to improve national capabilities for the management, calibration, processing, analysis and distribution of satellite data.

Promoting well-being

GA is working to ensure the nation is well placed to realise the full industry-wide benefits of PNT and EOS. This work builds on earlier planning and consultation developing the NPI Plan and National EOS Infrastructure Plan (NEOS-IP) under *Australia's Satellite Utilisation Policy*. Both Plans examined existing investment and future capability requirements for PNT and EOS over a 10-year period to 2020. Recommendations from the Plans have informed development of the Policy and key activities of the GA work programme.

PNT and EOS already offer considerable benefits to Australia through industry capability, productivity gains, community safety, research, innovation and skills development. Early studies estimate that PNT and EOS already contribute greater than \$3 billion each to GDP, with considerable potential to increase this. Precise positioning alone is said to increase GDP by between \$73 billion and \$134 billion net present value by 2030 from productivity gains to the agriculture, construction and mining sectors alone.

GA produces national products from satellite observations, such as bushfire hot-spots; national mapping of surface water; the Australian Geographic Reference Image, which is a base for accurate mapping in remote areas; the National Dynamic Land Cover Dataset; and specialist products to support emergency response and recovery. These products provide crucial information to those seeking to make informed decisions about agriculture, water management and the environment.

Key Partnerships

Domestic partnerships

Whole-of-nation planning through GA is contributing to whole-of-nation awareness and understanding on the societal and economic returns that derive from a highly accessible, accurate and trusted positioning capability. GA is working to ensure issues such as protection of radio spectrum, efficient and effective data licensing and access arrangements, minimum positioning requirements across key industries, and increased resilience against system vulnerabilities are well managed.

GA facilitates domestic engagement on capability development and risk mitigation through the PNT-WG, the NPI Advisory Board and the Space Community of Interest (CoI) within the Attorney General's Trusted Information Sharing Network (TISN) for Critical Infrastructure Resilience. GA also chairs the program board and is program manager for the Cooperative Research Centre for Spatial Information (CRCSI) Positioning Program.

GA works closely with CSIRO to undertake research and development for new techniques and applications of EOS data across a range of application domains. It maintains close contact with commercial satellite data providers with a view to ensuring access to relevant data for Australia.

International partnerships

Bilateral partnerships

GA develops strong relationships between Australia and key satellite-operating nations to promote continued access to critical datasets. It has key partnerships with Japan, the United States, the European Union, France and China;

Japan

- The Japan Aerospace Exploration Agency (JAXA) and GA have an agreement for exchanging regional GNSS data, including data from Japan's Quasi-Zenith Satellite System (QZSS). Geoscience Australia provides data from stations in Australia, Antarctica and the South Pacific and JAXA provides data to GA from its regional ground stations. GA also operates a QZSS monitoring station in Australia on behalf of JAXA.

United States

- GA is an International Co-operator in the United States Landsat programme, and has acquired data from these missions since 1979.
- GA and the US Geological Survey (USGS) have established a comprehensive partnership agreement to pool resources to implement a shared vision for continental-scale monitoring of land surface change using time-series of Earth observations to detect change as it happens.
- GA and NASA have an agreement to jointly operate a Satellite Laser Ranging (SLR) station at Yarragadee, Western Australia. This SLR station contributes to the terrestrial reference frame (TRF) and managing satellite assets.

European Union

- Geoscience Australia is implementing a strategic partnership between Australia and the European Union to implement the Copernicus programme. This partnership will see Australia play a key role in supporting the use of Copernicus data in South-East Asia and Pacific regions.

China

- GA and Wuhan University, China, are currently developing an agreement for GA to operate three Beidou/GNSS ground stations in Australia at Yarragadee WA, Mount Stromlo ACT and Katherine NT. These stations will contribute to precise Beidou satellite orbit determination in the Southern Hemisphere.

Geoscience Australia works closely with a range of other international satellite operators, including JAXA and the European Space Agency (ESA), 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.

Multilateral efforts

GA also works multilaterally in a range of fora:

- In 2015-16 GA will support the work of the international Committee of Earth Observation Satellites (CEOS) by performing the role of Executive Officer. CEOS coordinates the activities of 31 space agencies and 132 satellites.

- It will chair the International GNSS Service (IGS) for a four year term beginning 1st January 2015. The IGS is a voluntary federation of over 200 self-funding agencies, universities, and research institutions in more than 100 countries. Since 1994, the IGS has provided free and open access to the highest precision GNSS data available worldwide. IGS products support scientific advancement and public benefit and contribute significantly to civilian PNT activities worldwide. GA is the first non-European country to chair the IGS.
- It co-chairs with Norway the Global Geodetic Reference Frame (GGRF) Working Group of the UN Committee of Experts on Global Geospatial Information Management (UN-GGIM). In February 2015, the UN General Assembly adopted its first ever geospatial resolution, the Global Geodetic Reference Frame for Sustainable Development (GGRF). The resolution was put forward by the Permanent Mission of Fiji and co-sponsored by 52 Member States. The GGRF underpins the global coordinate system supporting geospatial data observation and analysis, particularly for space-based infrastructure and services.

Key Priorities Beyond 2015

Planning and development of the NPI and EOS infrastructure remain key drivers of the GA work programme beyond 2015. Short-term priorities include: strengthened coordination for domestic and international PNT and EOS activities; critical upgrades to the ground infrastructure segments for EOS and GNSS operations; strengthened awareness and engagement on the industry-wide applications and benefits of PNT and EOS; and further development of the Australian Geoscience Data Cube for national scale EOS analysis, and Australia's sovereign GNSS analysis capability supporting increased positioning performance and risk mitigation.

Longer-term priorities include new investment to fully implement and operationalise NPI and EOS infrastructure. These priorities are driven by the widespread economic benefits that assured access to fundamental PNT and EOS will deliver Australia, including innovation, skills development, research, domestic and international cooperation and downstream commercial enterprise.

Glossary of Acronyms

Acronym	Acronym definition
ACMA	Australian Communications and Media Authority
ADS-B	<i>Automatic Dependent Surveillance – Broadcast</i> - An air traffic surveillance technology that enables aircraft to be accurately tracked by air traffic controllers and other pilots without the need for conventional radar.
AGD	Attorney-General's Department
AGDC	<i>Australian Geophysical DataCube</i> - A series of data structures and tools which organise and enable the analysis of large gridded data collections. A key element is the calibration and standardisation of the data. This increases the value which can be derived from earth observation, and other sources of large gridded datasets, as it allows for the rapid development of information products to enable informed decision making across government and private industry.
AGEOSWG	Australian Government Earth Observations from Space Working Group
AIS	<i>Automatic Identification System</i> - A maritime communications device, using the Very High Frequency (VHF) radio broadcasting system, enabling appropriately equipped vessels and shore-based stations to send and receive identification information. AIS can improve the safety of navigation and protection of the environment by assisting in the effective navigation of ships.
AMSA	Australian Maritime Safety Authority
APG	Asia-Pacific Telecommunity Preparatory Group
API	Advance Publication information - Before a satellite network can be brought into use over Australia, the Australian Communications and Media Authority must provide a general description of the network, known as the <i>Advance Publication Information</i> , to the International Telecommunication Union (ITU).
APT	Asia-Pacific Telecommunity
ARSG	Australian Radiocommunications Study Group
ARTC	Australian Rail Track Corporation
ASEAN	Association of Southeast Asian Nations
ASKAP	<i>Australian Square Kilometre Array Pathfinder project</i> - A next-generation radio telescope incorporating novel receiver technologies and leading-edge ICT systems. It will be made up of 36 antennas, each 12 metres in diameter, working together as a single instrument. It will be capable of high dynamic range imaging using novel wide-field of-view phased array feeds. ASKAP, as well as being a world-leading telescope in its own right, will provide an important test-bed for, and work in conjunction with, the future Square Kilometre Array (SKA) project.
A-SMGCS	Advanced Surface Movement Guidance and Control Systems
ASRP	Australian Space Research Program

Acronym	Acronym definition
ASUP	Australia's Satellite Utilisation Policy
ATM	Air Traffic Management
ATMS	Advanced Train Management System
ATNF	Australia Telescope National Facility
AUSREP	Australian Ship Reporting System
AWG	Asia-Pacific Telecommunity Wireless Group
BSS	ITU Broadcasting-Satellite Service
Bureau	Bureau of Meteorology
CASA	Civil Aviation Safety Authority
CASS	CSIRO's Astronomy and Space Science
CDC	Cooperative Data Centre
CDSCC	Canberra Deep Space Communications Complex
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CNS	Communications, Navigation, Surveillance
COI	Community of Interest
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFAT	Department of Foreign Affairs and Trade
DGPS	<i>Differential Global Positioning System</i> - A method of providing differential corrections to a Global Positioning System (GPS) receiver in order to improve accuracy.
DSC	<i>Digital Selective Calling</i> - A standard for sending pre-defined digital messages via the medium frequency, high frequency and very high frequency maritime radio systems. It forms a core part of the Global Maritime Distress Safety System (GMDSS). ⁴
DSRC	<i>Dedicated Short Range Communications</i> - a two-way short- to-medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications.
DSTO	Defence Science Technology Organisation
EC	European Commission
EGC	<i>Enhanced Group Calling</i> - a message broadcast service within the Inmarsat-C communication system.
EO	Earth Observation
EOI	Earth Observation and Informatics
EOS	Earth Observation from Space
EPIRB	<i>Emergency Position Indicating Radio Beacon</i> - A beacon used to alert search and rescue services in the event of an emergency.
ESA	European Space Agency
EWD	Electronic Work Diary
FSS	<i>Fixed Satellite Service</i> - satellites communicating with Earth stations located at fixed, specified locations on the Earth.
GA	Geoscience Australia

GEO	Geostationary Orbit.
GIS	Geographic Information System
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
HF	High Frequency
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IAP	Intelligent Access Program
ICAO	International Civil Aviation Organisation
IDC	International Long Range Identification and Tracking data centre
IFR	Instrument Flight Rules
IMO	International Maritime Organization
IMOS	Integrated Marine Observing System
IOR	Indian Ocean Region
ISRO	Indian Space Research Organisation
ISS	Interim Satellite Service
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
LEO	Low Earth Orbit
LES	Land Earth Station
LIGO	<i>Laser Interferometer Gravitational-Wave Observatory</i> - A large-scale physics experiment aiming to directly detect gravitational waves.
LRIT	Long Range Identification and Tracking
MASTREP	Modernised Australian Ship Tracking and Reporting System
MAVEN	<i>Mars Atmosphere and Volatile Evolution</i> Mission – A NASA Mars Scout mission, carrying eight instruments, designed to orbit Mars and explore its upper atmosphere.
MCC	Mission Control Centre
MDA	Maritime Domain Awareness
MEO	Medium-altitude Earth Orbit
MEOLUT	Medium Earth Orbit Local User Terminal
MF	Medium Frequency
MLM	Multi-Lateral Meeting
MODIS	Moderate Resolution Imaging Spectroradiometer
MoU	Memorandum of Understanding
MSI	Maritime Safety Information
NASA	National Aeronautics and Space Administration
NBN	National Broadband Network
NCC	Network Control Centre
NCI	National Computational Infrastructure
NCRIS	National Collaborative Research Infrastructure Strategy
NDC	National Data Centre
NPI	National Positioning Infrastructure
NTC	National Transport Commission

OSRA	Oil Spill Response Atlas
PBN	Performance-Based Navigation
PG	Preparatory Group
PNT	Position, Navigation, Timing
POR	Pacific Ocean Region
QZSS	Quasi-Zenith Satellite System
RCC	Rescue Coordination Centre
RDC	Regional Data Centre
REEFREP	Ship Reporting System
REEFVTS	Great Barrier Reef and Torres Strait Vessel Traffic Service
SAR	Search and Rescue
SATCOM	Satellite Communications
SCC	Space Coordination Committee
SG	Study Group
SKA	<i>Square Kilometre Array</i> - A radio telescope project involving institutions from over 20 countries, which will be the largest and most capable radio telescope yet constructed. Australia and southern Africa will host different SKA components.
SLDMB	<i>Self-Locating Datum Marker Buoys</i> - A drifting surface buoy designed to measure surface ocean currents.
SSA	<i>Space Situational Awareness</i> - The ability to view, understand and predict the physical location of natural and manmade objects in orbit around the Earth, with the objective of avoiding collisions.
SSAR	<i>Satellite-based Synthetic Aperture Radar</i> - Synthetic Aperture Radar IS a form of radar which is used to create images of an object.
TAWS	Terrain Awareness and Warning System
TCP	Transformational Capability Platform
TDRSS	<i>Tracking Data Relay Satellite System</i> - A network of American communications satellites (each called a Tracking and Data Relay Satellite (TDRS)) and ground stations used by NASA for space communications.
TERN	Terrestrial Ecosystem Research Network
TISN	Trusted Information Sharing Network
TOC	Transparency, Oversight and Compliance
UKCM	<i>Under Keel Clearance Management</i> - A System is provided by the Australian Maritime Safety Authority (AMSA) as an aid to navigation for large ships
UNGGE	United Nations Group of Governmental Experts
AST	Viewer Access Satellite Television
VHF	Very High Frequency
VTS	Vessel Traffic Service
WMO	World Meteorological Organisation
WP	Working Party
WRC	World Radiocommunication Conference
WRC-15	World Radiocommunication Conference 2015
WRON	Australian Government Water Resources Observation Network

WTR	Woomera Test Range
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