

The Future of Space Made in NSW

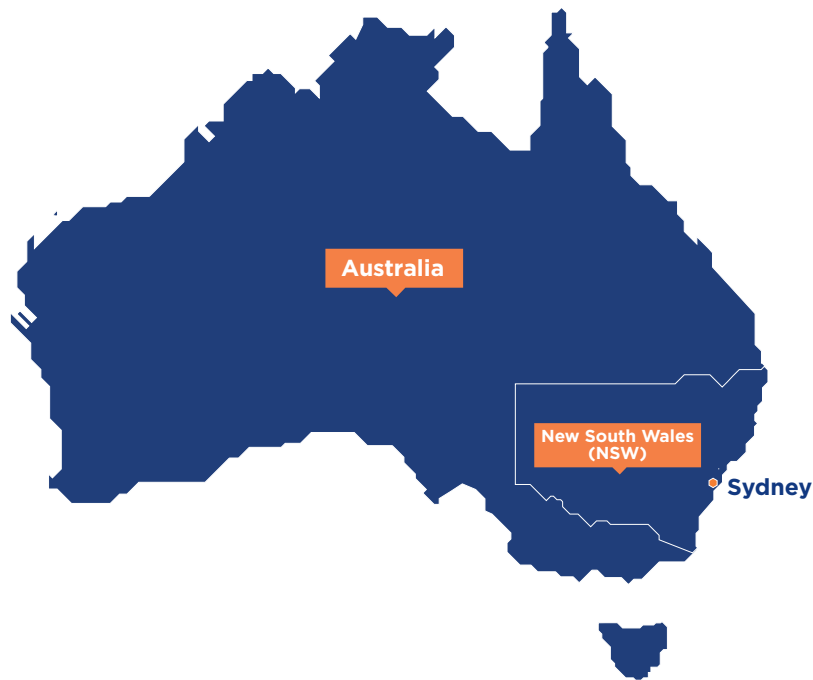


About Australia

The Australian economy has outperformed the country's peers for more than two decades. Now in its 27th year of consecutive growth, Australia's economic resilience and strength are unsurpassed among major advanced economies. The nation offers a smart, multicultural workforce with an enterprising mindset and the skills to drive innovation and grow international business.

Australia prides itself on stable institutions and good governance, making it one of the safest places in the world to do business. It boasts a globally integrated economy that plays a key role in shaping Asia's dynamic economic future.

There is no better business partner than Australia.



27 years of uninterrupted economic growth



2.9% economic growth, one of the highest industrial economic growth rates for developed countries globally



4th largest economy in the Asia-Pacific region



13th largest economy in the world



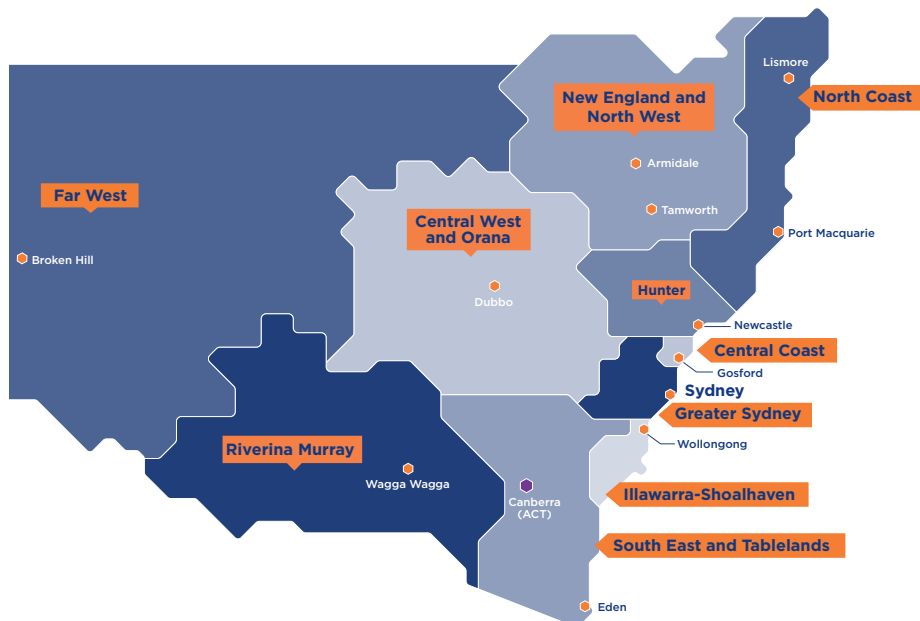
Ranked No. 1 smartest country in the Asia Pacific and 4th smartest country in the world



AAA credit rating Higher in credit quality than the US, UK, France, Japan, Hong Kong, Republic of Korea and New Zealand

About Sydney and New South Wales

New South Wales (NSW), with its iconic capital city of Sydney, is Australia's most populous state and largest economy. A cosmopolitan and regional powerhouse, the state seamlessly blends business strength, access to Asia, and one of the world's most enviable lifestyles. Boasting a AAA credit rating, NSW is experiencing Australia's largest infrastructure boom and is home to a highly skilled, innovative and creative workforce.



ABOUT NSW:

Capital city:	Sydney
NSW population:	7.9 million
Sydney population:	5.1 million
NSW time zone:	GMT +10:00
Climate:	Sub-tropical and mediterranean
Sydney summer temperature average:	18-27 °C
Sydney winter temperature average:	7-18 °C
Coastline:	2,007 km
Official language:	English
Currency:	Australian dollars (AUD)
International airport:	Sydney Airport

NSW is Australia's leading source of highly skilled and diverse talent



Sydney is **No. 1 in the Asia Pacific** and **No. 3** globally for top 100 ranked universities



NSW is home to **three of Australia's top five** highest ranked research universities

NSW is Australia's most innovative state with a strong culture of entrepreneurship



Sydney is the **2nd highest ranked city in the Asia-Pacific** region for innovation



NSW is the **startup capital of Australia**, home to more than 40% of all startups

NSW is Australia's most secure and liveable place to do business



Sydney is the **highest-ranked capital city** in Australia for quality of life



NSW is set to deliver on the **biggest infrastructure program in Australian history**, with a **A\$87.2 billion** pipeline of infrastructure

NSW is Australia's largest market



Home to **7.9 million people**, more than Singapore and Hong Kong



The state is **Australia's largest economy: A\$500 billion**, larger than Malaysia, Singapore and Hong Kong

Sector overview

The global space industry is experiencing significant growth as space-related technologies are rapidly adopted by other industries to enhance their output. Space-derived products, services and applications are used by a multitude of other industries, including communications, transportation, energy, aviation, advanced manufacturing, robotics, agriculture, construction and information technology. As the financial and risk barriers to participation in the space industry decrease, the exponential growth of the sector is set to continue, forecast to reach over US\$1 trillion by 2040.¹

Consumer-focused commercial space activities now outstrip government-funded programs as the primary source of space technology and services. As the global space economy has grown from US\$15 billion in 1973 to over US\$330 billion in 2016, commercial activities have grown to 77% of all space undertakings.

There has never been a better time to establish your space business in NSW. In 2018 the Australian Government launched the Australian Space Agency with the goal of tripling the national space economy from A\$4 billion to A\$12 billion in 2030 and developing 12,000 additional highly skilled jobs.

With the largest portion of the Australian space industry based in NSW, the state is well placed, economically, politically and geographically, to maximise the benefits to business from this new space era.

In the business of space

NSW is the leading Australian state for space capabilities and activities.



Organisations headquartered in NSW generate **50-75% of all space-related revenue** generated in Australia.



50% of Australia's space export revenue is generated by NSW organisations.



41% of all Australian space businesses are based in NSW.



NSW is the leading state for space innovation and entrepreneurship, with 38% of all Australian space startups based in NSW.



NSW is a leader in space education and training, with 31% of Australian university departments active in space based in the state. Around 30% of people involved in space activities are based in NSW, the largest percentage of any state.

¹ www.morganstanley.com/ideas/investing-in-space

NSW has the broadest and strongest space capability in Australia. NSW is the only Australian state that boasts capability across every sector of the space industry and across the entire value chain:

- space systems
- launch activities and support services
- ground systems
- space-enabled services and applications
- space activity support services
- space-related research and development
- space education and training
- space-related associations and public information activities.

NSW is Australia's leading state for most of these space capability segments, with particular strengths in high-tech instrumentation, ground station infrastructure, smart payloads development, space and intra-space communications, and commercialisation of space data. NSW is home to:

- 63% of space legal services
- 60% of satellite broadcast companies
- 50% of space financial services
- 49% of Australia's satellite communications sector
- 46% of satellite equipment suppliers

- 40% of ground station company owners/operators
- 35% of satellite communication companies
- 30% of satellite equipment manufacturers
- around 30% of Australian staff involved in space activities
- 26% of space technical support and business consultancy services
- the headquarters of six of the eight satellite operators in Australia.

NSW Satellite ground station facilities





Image courtesy of Optus facilities in Belrose.



Case study: International reputation backed by engineering rigour—Optus Satellite

Optus Satellite is Australia's leading satellite provider, owning and operating the largest fleet of satellites in Australia and New Zealand. It is the only network provider in Australia to own and operate its own satellites.

With over 30 successful years of operation, Optus Satellite provides a wide range of tailored customer solutions to meet all domestic and regional satellite communication needs, including through its own mobile network.

Belrose in NSW is the company's primary uplink site, covering 27,900 square metres and housing the Satellite Operations Centre (SOC) and Satellite Control Facility (SCF).

The SOC manages a comprehensive range of digital satellite services including subscription TV, free-to-air TV, radio, internet, consumer broadband Internet Protocol, video conferencing, voice and data services, and mobile back haul support.

The team of highly skilled staff provides round-the-clock network monitoring, support and troubleshooting of its highly complex geostationary satellite platforms and extensive teleport facilities.

The SCF performs the primary satellite operations functions for the Optus fleet and third-party entities, including the National Broadband Network Sky Muster™ fleet.

The technical team at Belrose has played a major role in the specification, design, procurement, launch and operation of 17 geostationary spacecraft, gaining an international reputation for operational excellence and customer focus backed up by engineering rigour.

The Optus Satellite workforce and Optus' NSW infrastructure, makes it an aerospace business with unique industry capability that is unparalleled in Australia.

NSW—the heart of Australian industry and the gateway to the Asia Pacific

Australia's most diversified economy

NSW is Australia's largest and most diversified economy, providing a ready and varied customer and partner base through which to test, optimise and commercialise space technologies. More than 41% of the top 500 companies in Australia by revenue are located in NSW. Locating in NSW offers proximity to:

- over 60% of Australia's regional ICT headquarters
- more than 60% of Australia's fintech industry
- the largest number of defence bases and capabilities of any state and territory
- a large mining industry, which contributes 40% of the state's total merchandise export revenue. NSW is home to nearly 60 operational mines and hundreds of exploration companies²
- an agriculture industry worth over A\$12 billion to the NSW economy.

Sydney is the gateway to Australia and the Asia Pacific

NSW provides the best geographical access to industry in Australia and the Asia-Pacific region—Sydney Airport is Australia's largest transport and logistics hub. Unparalleled regional connectivity has seen multinational companies such as Apple, Google, IBM, Nokia, SAP, Thales, Boeing and Vodafone base their Asia-Pacific operations in Sydney.

Australia's finance capital

Sydney is the financial hub of Australia, home to the headquarters of 62% of financial services companies and more than 90% of international banks operating in Australia.³ Over the five years to 2017, NSW has seen more than A\$800 million in venture capital investment, twice the total of the other states and territories combined.⁴

An innovative and collaborative ecosystem

NSW is the startup capital of Australia, with an extensive network of investors, co-working spaces, conferences, education partners, accelerators and incubators located across the state. Sydney is the only city in the southern hemisphere ranked in the world's top 20 startup ecosystems, and one of only four located in the Asia-Pacific region.⁵

The Sydney Startup Hub, established by the NSW Government, provides 17,000 square metres of space accommodating 2,500 people over 11 floors, in Sydney's central business district. It brings together leading incubators and accelerators in a high-density startup cluster.

2 www.resourcesandgeoscience.nsw.gov.au/about-us/news/2018/resources-infographics-snapshot-january-2018

3 The Australian Prudential Regulation Authority, August 2018; NSW Department of Industry.

4 The Australian Private Equity & Venture Capital Association Ltd (AVCAL), 2017 Year Book, www.avcal.com.au/stats-research/yearbooks

5 startupgenome.com/report2017



Image courtesy of Australian Centre for Space Engineering Research.

Case study: The application of space-enabled technology in the wider economy—FluroSat

FluroSat is building the future of precision agriculture, providing a software platform that enhances the monitoring and management of farms. It is working towards an agricultural industry that uses seamless data flow between remote sensing, field-based 'internet of things' and automated equipment, where systems learn more with each passing season.

FluroSense, FluroSat's flagship product, uses

artificial intelligence (AI) powered by the most advanced multispectral and hyperspectral imager available, unique crop-specific machine learning and crop models from agronomic scientists at the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Through NSW Department of Industry's Boosting Business Innovation Program, FluroSat received TechVouchers to support its research collaboration with the University of Sydney.

The company was also the recipient of a Minimal Viable Product grant and Building Partnerships grant from Jobs for NSW.

FluroSat's technology is being adopted by enterprise customers who are using the company's products to gain efficiencies and accuracy in multiple-farm management.

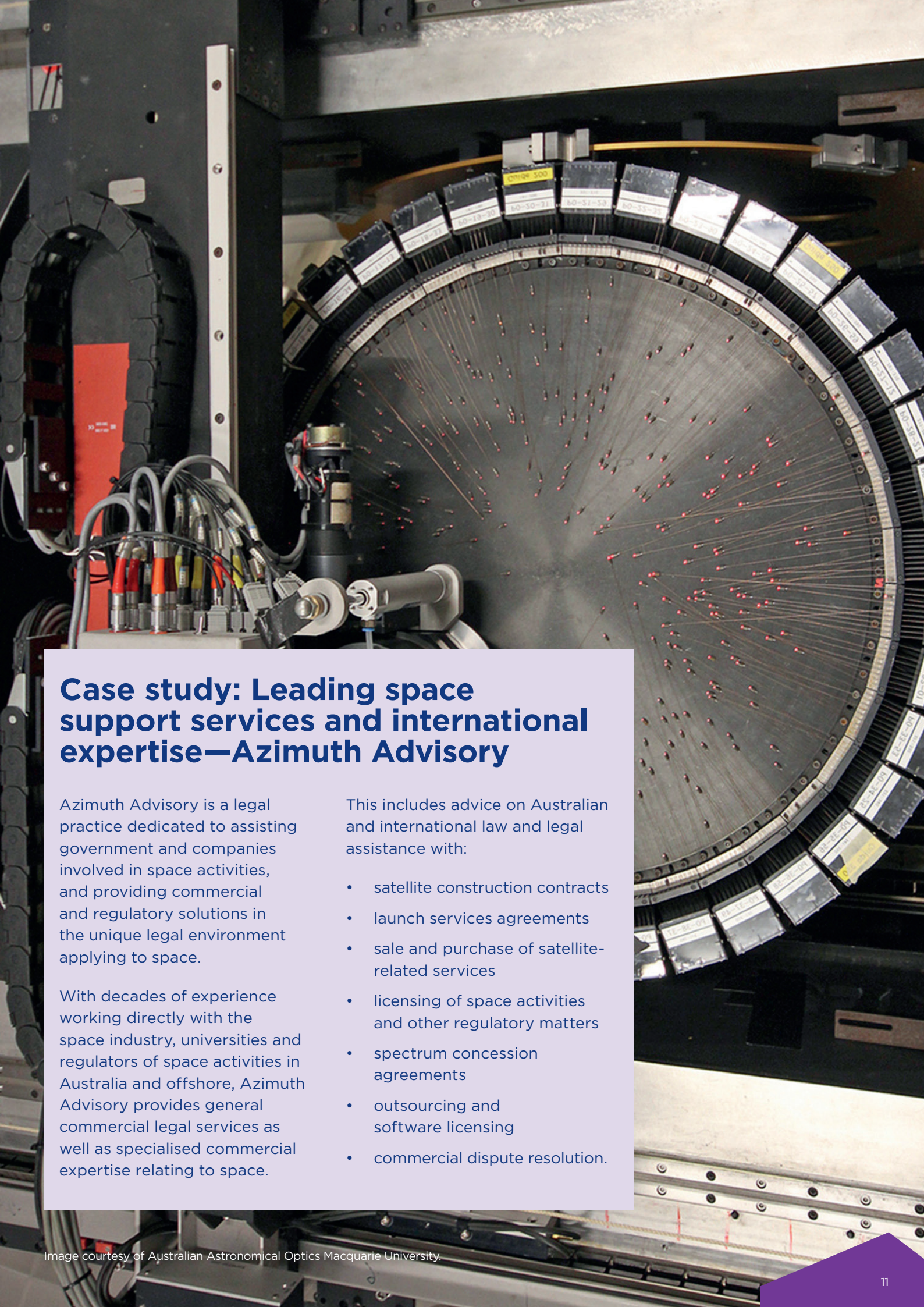
Strengths in space support services

NSW is home to 31% of space activity support services in Australia and leads all other states in this capability. NSW is particularly strong in space legal and finance, and provision of space technical advice and space business consultancy. NSW possesses internationally leading space legal expertise, with providers offering bespoke advice to small to medium-sized enterprises (SMEs) and companies seeking to understand regulatory, licencing and legal issues of particular relevance to space businesses.

NSW's research and development capabilities

NSW is a leader in space-related research and development (R&D), with 35% of space science R&D and 21% of space engineering R&D produced in the state's universities and research organisations. This includes 26 departments spread across eight universities actively engaged in space-related programs:

- Charles Sturt University
- Macquarie University
- University of New South Wales
- University of Newcastle
- University of Sydney
- University of Technology Sydney
- Western Sydney University
- University of Wollongong.



Case study: Leading space support services and international expertise—Azimuth Advisory

Azimuth Advisory is a legal practice dedicated to assisting government and companies involved in space activities, and providing commercial and regulatory solutions in the unique legal environment applying to space.

With decades of experience working directly with the space industry, universities and regulators of space activities in Australia and offshore, Azimuth Advisory provides general commercial legal services as well as specialised commercial expertise relating to space.

This includes advice on Australian and international law and legal assistance with:

- satellite construction contracts
- launch services agreements
- sale and purchase of satellite-related services
- licensing of space activities and other regulatory matters
- spectrum concession agreements
- outsourcing and software licensing
- commercial dispute resolution.

Key space capabilities

A number of prominent infrastructure and research organisations located in NSW offer specific space expertise.

Australian Astronomical Optics

The instrumentation arm of the Australian Astronomical Observatory is based at Macquarie University in NSW. It serves as one of the two main arms in the National Optical Instrumentation Capability, comprising a group of around 35 instrumentation scientists and engineers, astronomers and data scientists. The centre designs, develops and constructs high-precision astronomical instruments for major international and domestic astronomical telescopes, including the conception of new instruments.

The facility is also developing an industry-facing activity to provide precision measurement and optic assembly services and commercialise internally developed intellectual property (IP).

Australian Centre for Astrobiology

Located at the University of New South Wales (UNSW) in Sydney, this centre is a world-leading research organisation examining the mysteries of extraterrestrial life, including being actively involved in research into the possibility of life on Mars and other planets. It is one of only two centres outside the USA that are Associate Members of the NASA Astrobiology Institute.

Australian Centre for Space Engineering Research

The centre is located within the School of Electrical and Telecommunications Engineering in the Faculty of Engineering at UNSW. Established in 2010, the Centre has research strengths in global navigation satellite systems (GNSS) design, earth observation satellite systems, cubesat development in radiation-tolerant field programmable gate arrays (FPGA), novel satellite structures utilising rapid manufacture, GNSS remote observation research and research into off-Earth mining technologies.

Australian Telescope National Facilities

Sydney is home to the headquarters of the Australian Telescope National Facilities and NSW is home to a significant portion of its radiotelescopes, including the Mopra Observatory 22-metre dish near Coonabarabran, the Australia Telescope Compact Array of six 22-metre dishes near Narrabri, and the Parkes Observatory 64-metre dish, which is often used to support NASA space missions.

Australian Research Council (ARC) Training Centre for CubeSats, Unmanned Aerial Vehicles and Their Applications (CUAVA)

Located at the University of Sydney, this is the only space research centre funded by the Australian Research Council. CUAVA aims to train the next generation of workers in cutting-edge advanced manufacturing, entrepreneurship, and commercial space and unmanned aerial vehicle applications. The centre will facilitate the development of capabilities and applications of CubeSats, unmanned aerial vehicles (UAVs) and their instruments for earth observations, Global Positioning System (GPS), satellite communications and space weather purposes. CUAVA seeks to progress these devices to create significant commercial value with a wide range of applications.

CSIRO's Astronomy and Space Science Division headquarters

The headquarters for CSIRO's Astronomy and Space Science Division is located at CSIRO's Marsfield site in Sydney. The agency has developed new multi-pixel receivers for the world's two largest radio telescopes, allowing them to scan the sky several times faster. The unit has also developed an advanced phased array feed receiver, which will be deployed on the Australian Square Kilometre Array Pathfinder, making it the fastest radio telescope in the world.

Bureau of Meteorology Space Weather Service Division headquarters

The headquarters of the Space Weather Service Division of the Bureau of Meteorology is based in Sydney. This is a leading worldwide centre for predicting and warning of strong electromagnetic space weather events that can damage electricity grids and satellites. Predictions and warnings from this centre are broadcast around Australia and the world.

Research infrastructure

NSW research infrastructure can support other space sector activities, including capabilities for materials science, imaging and data storage. Examples include:

- Australian National Fabrication Facility
- National Imaging Facility
- Australian Microscopy and Microanalysis Research Facility
- Australia's Nuclear Science and Technology Organisation (ANSTO) facilities.



Case study: A pioneering, NSW-founded, space company reducing the barriers to entry into the space sector—Saber Astronautics

Saber Astronautics has come a long way since it was founded in 2008 by a couple of space engineers. The company, based in Sydney, employs six staff and has recently picked up an Australian defence contract valued at more than A\$1 million. The contract involves using Saber's advanced machine learning capabilities to detect degraded electronic signals—a technology with the potential to be applied in commercial space operations, autonomously protecting the quality of satellite data during solar storms.

Saber's mission is to reduce the barriers to entry into the space sector. It builds cutting-edge technology for the emerging commercial space industry that can also be used in more traditional sectors, including agriculture, mining and defence.

Saber applies R&D in the areas of artificial intelligence, optimisation systems and technical simulation to reduce waste in systems, connect platforms with customers and solve complex challenges.

It has provided a wide range of capabilities to support Army and Navy joint operations, and in the commercial space sector.

The company's signature product is the recently developed Predictive Groundstation Interface (PIGI)—mission control software designed for the modern age. This satellite operating technology can predict a satellite's performance and display it to an operator, allowing companies to monitor and control many satellites with minimal effort. This is an enabler for new Australian space companies seeking to enter the global market.

A video-game-quality interface allows users to reach any point of the spacecraft or environment, while world-class data mining enables the system to give meaning to the data.

'Operators can now make decisions rapidly, with accurate information, given in the context they need', Dr Held says. 'As part of the PIGI project, we proved the ability to model damage to a NASA spacecraft during space weather events.'

'The models proved to be time-invariant and general solution accurate even up to eight years later. The algorithms adapt perfectly to other industries, and scale from single object to systems of systems.'

Saber has developed three different levels of licences for PIGI, catering to casual users such as students and hobbyists; small businesses gearing up for live missions; and large corporate and government users. Held says the 'democratisation' of space has opened up barriers that previously made it very difficult for small space companies to get a foothold in the market, which is largely based in the US.

'We do a lot of technical R&D and commercialise it with a view towards making space more user-friendly for the general population.' CEO Dr Jason Held



Image courtesy of Saber Astronautics.

Supporting research capabilities

NSW is home to a broad range of deep tech and advanced manufacturing R&D centres that can complement or enhance the space sector.

Australian Centre for Field Robotics

Located at Sydney University, this centre has world-renowned expertise in robotics with applications in space and other arenas. As one of the world's largest robotics research institutes, the centre focuses on the research, development and application of autonomous and intelligent robots, and systems for use in outdoor environments. Its aerospace, mechanical and mechatronic facilities include:

- field robotics laboratory—major facilities for development of autonomous systems including air, ground and subsea robots
- UAV laboratory and flight testing facilities
- variable stability flight simulator
- wind tunnel facilities.

The Australian Centre for Field Robotics is also building a planetary rover prototype with increased mobility compared to conventional Mars rovers, and motion planning software developed to take advantage of the platform's reconfigurability and reduce energy usage.

Australian Research Council centres of excellence

NSW is home to a number of Australian Research Council (ARC) centres of excellence (CoE) that collaborate nationally, internationally and with industry.

- **ARC CoE in Exciton Science:** A partnership between the University of Sydney, University of NSW, CSIRO and the Australian Defence Science and Technology Organisation (DSTO), the CoE aims to manipulate the way light energy is absorbed, transported and transformed in advanced molecular materials. Expected outcomes and benefits include new Australian technologies in solar energy conversion, energy-efficient lighting and displays, security labelling and optical sensor platforms.

- **ARC CoE for Engineered Quantum Systems:**

A partnership between the University of Sydney, Macquarie University and DSTO, the CoE intends to pioneer designer quantum materials, quantum engines and quantum imaging systems at the heart of quantum machines.

- **ARC CoE for Quantum Computation & Communication Technology (CQC2T):**

Based at the University of NSW and partnering with the University of Sydney, CQC2T is an international research effort to develop the science and technology of a global quantum computing information network, encompassing ultra-fast quantum computation, absolutely secure quantum communication and distributed quantum information processing.

Sydney Quantum Academy

The Sydney Quantum Academy dedicated to postgraduate training and research is being established in Sydney through a partnership between the University of Sydney, Macquarie University, UNSW and the University of Technology Sydney. Sydney has one of the greatest concentrations of quantum researchers in the world. This expertise will be brought together to cement Sydney as a global centre of excellence for quantum technology.

Centre for Medical Radiation Physics

Based at the University of Wollongong, the centre is the largest research body of its kind in the Asia-Pacific region. It is a world leader in silicon microdosimetry, which provides a new metric for the estimation of hazards from ionizing radiation in the mixed radiation fields. It makes an essential contribution to radiation protection in space, where the radiation environment is not easy to predict.

Centres of research for AI

- **The Centre for Artificial Intelligence at the University of Technology Sydney** is a world-leading research centre with a vision to develop theoretical foundations and advanced algorithms for artificial intelligence and to drive significant progress in related areas such as computational intelligence, business intelligence, computer vision, data science, machine learning, brain-computer interface, social robotics and information systems.

- **The UBTECH Sydney Artificial Intelligence Centre at the University of Sydney** aims to establish, analyse and evaluate models that can learn and make predictions in data, create prototypes or applications to investigate autonomous agent actions, and identify patterns and apply logic.

- **The AI & Robotics Research Group at the University of NSW** focuses on applying AI to robots. Its areas of research include software architecture for autonomous robots, learning robot behaviours, robot control and reasoning, and autonomous adaptation and trust.

NSW Smart Sensing Network

The NSW Smart Sensing Network brings together smart sensing expertise from six NSW universities, industry and government in a collaborative network to conduct innovative research in sensors, and to develop commercially viable sensor and related technologies for challenges facing industry and government.

Research infrastructure

NSW research infrastructure can support other space sector activities, including capabilities for materials science, imaging and data storage. Examples include:

- Australian National Fabrication Facility
- National Imaging Facility
- Australian Microscopy and Microanalysis Research Facility
- Australia's Nuclear Science and Technology Organisation (ANSTO) facilities.

Growing the NSW space industry

National Space Industry Hub

The NSW Government has signed a memorandum of understanding with Australian space businesses, accelerators, research organisations and science, technology, engineering and mathematics (STEM) education providers to develop the National Space Industry Hub in Sydney. The hub will support the growth of the space industry in NSW through:

- co-location of space startups, accelerators, incubators and related research at the Sydney-based hub
- shared testing and small-scale manufacturing facilities
- facilitating connections between primes, researchers, customers and startups/SMEs
- supporting programs aimed at developing the required workforce skills to support the growing space industry
- promotion and advocacy of the NSW space industry at a national and international level.

Western Sydney Aerotropolis

The Western Sydney Aerotropolis, being developed adjoining the future Western Sydney Airport, will be a hub of aerospace activity, including research and development, manufacturing and training. The Western Sydney Aerotropolis is a greenfield opportunity for businesses to build and foster a sustainable cluster of industry, R&D and educational space industry activities.

The precinct will focus on building and accessing global supply chains within the aviation, space and defence industries. It will create opportunities for startups and SMEs to leverage university research and development facilities, and incubate their cutting-edge ideas. The precinct will encourage expansion into other industry sectors and provide access to industry networks across NSW.

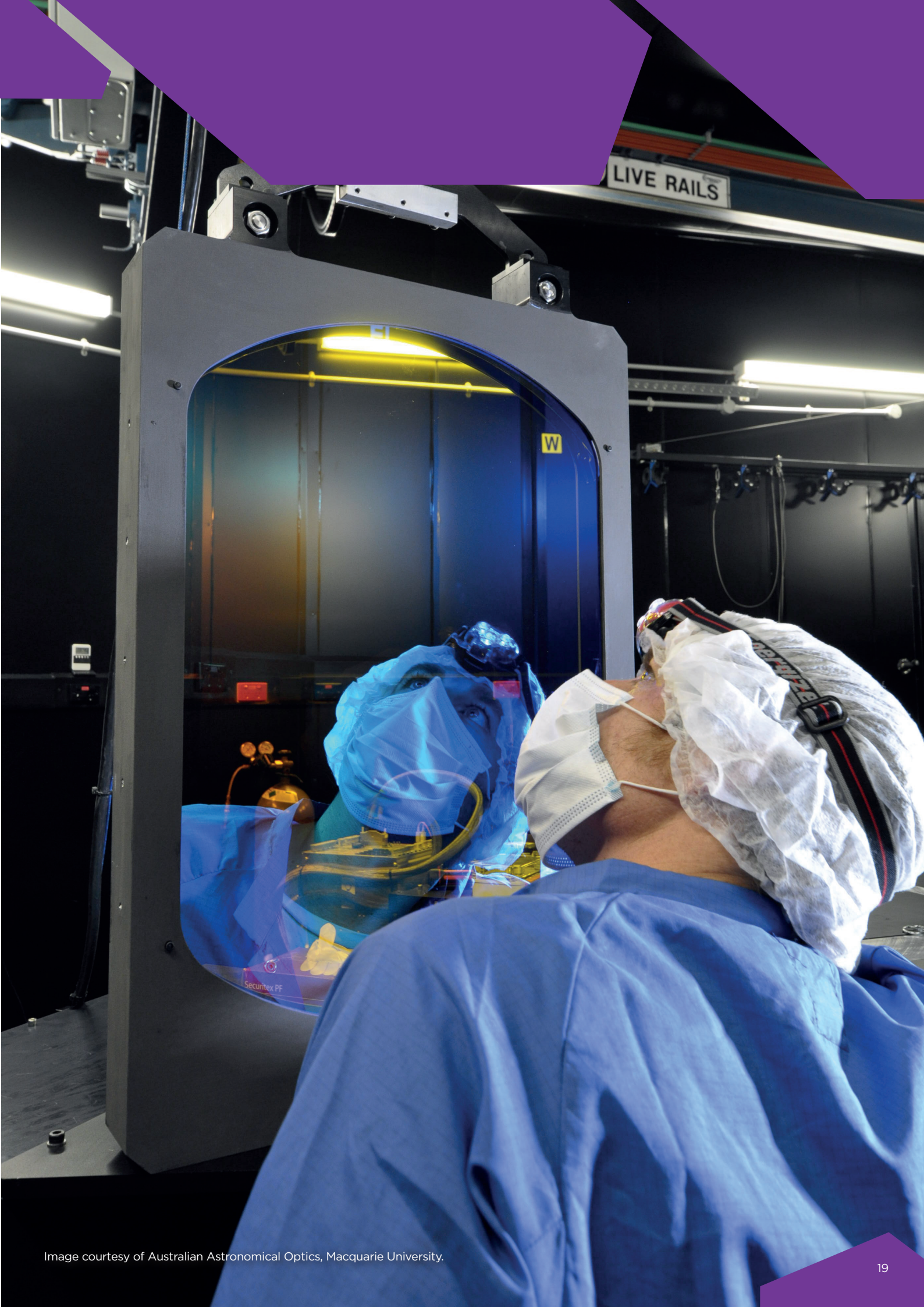


Image courtesy of Australian Astronomical Optics, Macquarie University.

How we can help

The NSW Government's Industry, Trade & Investment Team can help you establish, innovate and grow your business in Sydney and NSW. Our dedicated team works with experts across all levels of government (local, state and federal) and business networks to provide customised information for businesses. This service is free and confidential.

We can provide:

- market intelligence and investment opportunities
- support for business case development
- identification of suitable investment locations and facilitation of familiarisation visits to NSW
- advice on NSW government programs and approval processes
- connections with partners.

Contact us

The NSW Government is here to help you. If you need assistance, or have any questions, please contact NSW Government's Industry, Trade & Investment team.

NSW Department of Industry, Trade & Investment team:

T: +61 2 8222 4888

W: invest.nsw.gov.au

Unless otherwise referenced, all NSW space sector figures are from Asia Pacific Aerospace Consultants (2017), *Briefing Paper to the NSW Government on NSW Space Capabilities and the Review of Australia's Space Industry*.



The Future Made Here

T: +61 2 8222 4888

W: invest.nsw.gov.au

© State of New South Wales through Department of Industry 2019.

The information contained in this publication is based on knowledge and understanding at the time of writing (February 2019). However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of the Department of Industry or the user's independent adviser.

PUB19/76

