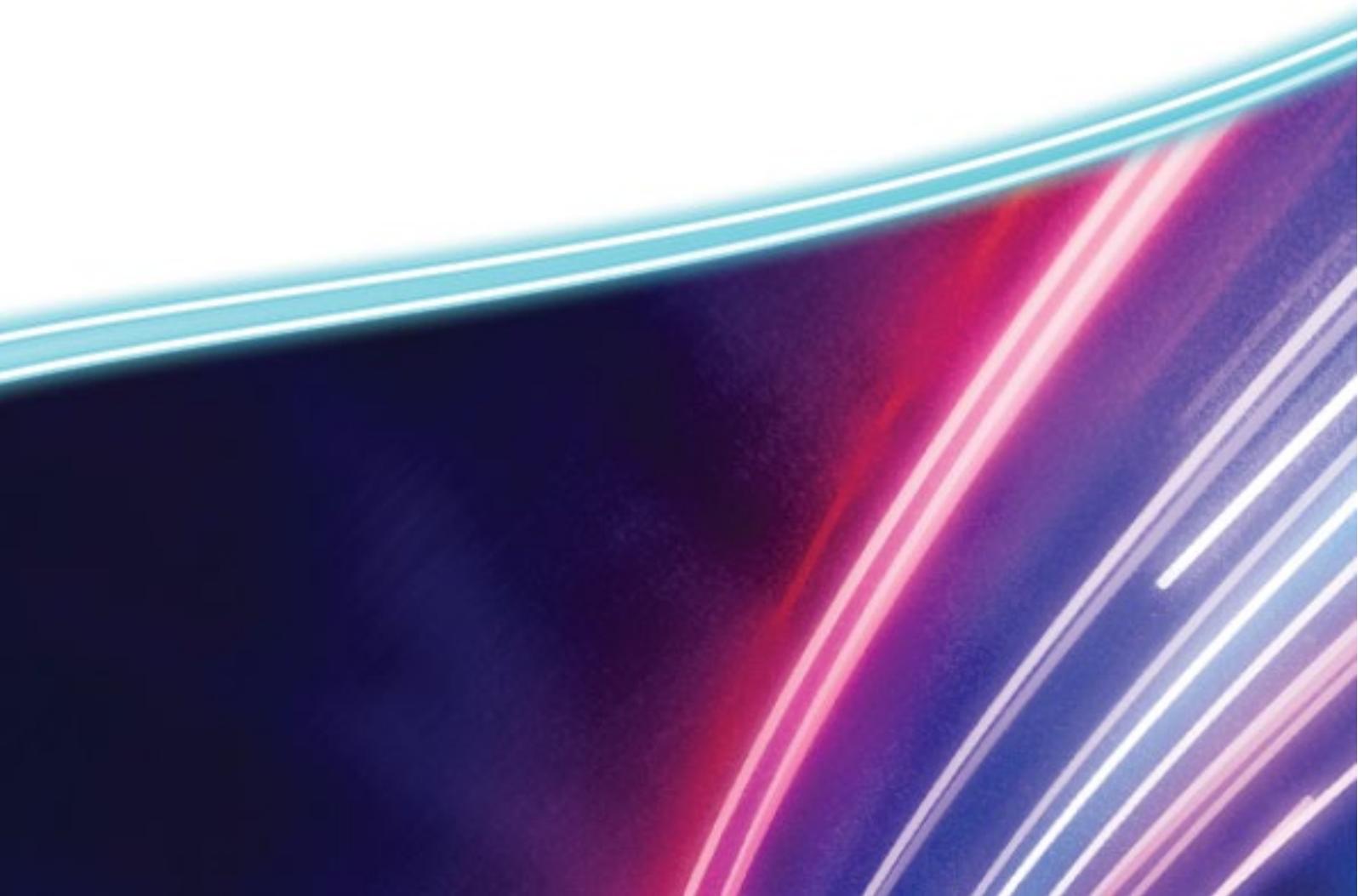




Department of
**Jobs, Tourism, Science
and Innovation**

Western Australian Space Sector Overview

August 2022





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1. Overview

Western Australia has more than 60 years' experience in the space industry with its geographic location, dry environmental conditions, radio quiet zones and clear skies providing an attractive setting for major space projects since the late 1950s. From 1961 to 1975, ground stations in Western Australia played key roles in NASA's Mercury, Gemini and Apollo missions.

Today, Western Australia is involved in a range of space operations, hosts significant space infrastructure for both civil and defence applications and is home to more than 100 international and Australian organisations operating space and space-related services. Significant areas of activity and capability include ground-based satellite and deep space communications; space situational awareness; data processing and analysis; and world-leading remote operations automation and robotics. Additionally, Western Australia has emerging capabilities in space mission operations, optical communications, satellite development and launch.

Western Australia is also home to five universities and various research institutions with established expertise in the space industry and related fields, feeding into a vibrant R&D and innovation ecosystem. The Western Australian workforce is highly skilled and diverse, with a pipeline of skilled workers in space and space related fields.

Western Australian organisations also have strong collaborations with international space and defence companies and international space agencies including NASA, European Space Agency (ESA) and Japan Aerospace Exploration Agency (JAXA).

Building on these strengths and utilising the State's current and expanding space infrastructure, capabilities and geographic advantage for the global coverage of space assets, Western Australia will continue to increase activities in providing critical space mission and remote operation services to international space agencies and private space companies.

With a diverse and strong economy, Western Australia also has a significant market for space technology and space data within its mining, oil and gas, agriculture, defence, energy, and maritime industry sectors.



Image: NASA Robonaut testing at Woodside Energy's robotics lab, Perth



2. Capabilities

Western Australia has significant activity and capabilities in all of [Australian Space Agency's Civil Space Strategy](#) Priority Areas including the following advantages and opportunities:

- Southern hemisphere location and longitude are ideal for space situational awareness and facilities that contribute to the global coverage of space assets, including tracking of launches.
- Ideal environmental conditions: geographically stable with clear skies (low rainfall and cloud cover), large arid areas with minimal radio interference and radio-quiet zones.
- Significant communications, computational infrastructure and local access to technical expertise across the State.
- Substantial capabilities in space systems, ground stations, astronomy and planetary research.
- World leading capabilities in remote operations, automation and robotics in remote and harsh environments utilising ultra-low bandwidth satellite communications.
- Partnerships and extensive activity with international space agencies and private space companies.
- Emerging capabilities in optical communications; satellite design, construction and operation; and launch facilities.
- Established innovation ecosystem and technology transfer between terrestrial (mining, oil and gas, agriculture, energy) and space sectors.
- Diverse and highly-skilled workforce with more than 100 international and Australian companies operating in space and space-related services.



Image: CSIRO's Australian Square Kilometre Array Pathfinder telescope in Western Australia



3. Current Focus Areas

3.1. Space mission and remote operations, robotics and automation

Robotics, automation and AI underpin much of the space industry and will be critical to all future manned and unmanned deep space missions. Western Australia is the world-leader in remote operations, with expertise in remote asset management, autonomous operations, robotics, AI, remote sensing and systems integration.



Image: Rio Tinto remote operations centre, Perth

Key infrastructure, research and activities include:

- The Australian [Space Automation, AI and Robotics Control Complex](#) (SpAARC) in Perth is a world-class facility for space missions and remote operations in space and other harsh environments. The multi-user facility operated by Fugro, will also provide infrastructure to support software simulation of space vehicles, space robotic systems, and planetary exploration systems, including orbital mechanics and simulated communication links with time delays. SpAARC will support a number of upcoming national and international space (including lunar) missions.
- The Perth headquartered [Australian Remote Operations for Space and Earth](#) (AROSE) entity is a not-for-profit, industry-led consortium that transfers technology from the resources sector into the international space sector. AROSE's aim is to position Western Australia as the trusted leader of remote operations for terrestrial and space sectors. AROSE is rapidly expanding and members include research organisations Curtin University, UWA, QUT, UNSW; industry, Nova Group, Perenti, Rio Tinto, Woodside; and space companies such as [First Mode](#), [Gilmore Space](#) and [MDA](#).
- [Woodside has partnered with NASA](#) to explore automation, remote operation and the robot-human interface and has one of eight NASA Robonaut 2 anthropomorphic systems in the world for testing.
- State-of-the-art remote operation facilities, which enable companies such as BHP, FMG, Fugro, Rio Tinto, Roy Hill and others operate robotic mines, ports, rail systems, submersibles and marine vessels thousands of kilometres away from Perth. Companies such as [Harvest Technology Group](#) provide state-of-the-art remote operations connectivity utilising ultra-low bandwidth satellite communications
- Remote operations training, development and testing facilities include the [Australian Automation and Robotics Precinct](#) in Perth and [Caterpillar Autonomous Training Facility](#) in Collie, one of only two Caterpillar Autonomous Training Facilities in the world.
- Key robotics and AI companies include [Chironix](#), [Nexis](#), [SAFE AI](#), [Stealth Technologies](#), [Blue Ocean Marine Tech Systems](#) and [Total Marine Technology](#)
- Companies such as [CADwalk](#) and [Sentient](#) provide designs, VR and test labs for space and terrestrial mission control centres and lunar habitats.



3.2. Space communications and situational awareness

3.2.1 Space communications

Western Australia, with its clear skies and large arid areas with minimal radio interference is particularly well placed for space communication; space situational awareness; positioning, navigation and timing; and facilities that contribute to global coverage of space assets.



Image: *ESA Tracking Station in New Norcia*

Current space communication infrastructure and activity in Western Australia:

- ESA's [New Norcia Deep Space Ground Station](#) is part of ESA's global tracking station network. The site contains one of only three ESA deep space antenna's in the world with a second deep space antenna currently under construction. CSIRO manages the New Norcia site.
- Mingenew Space Precinct is sited within a 300 km radio frequency Earth Station Protection Zone established by the Australian Communications and Media Authority to support the development of space communications facilities in the area. The area is also a no-fly zone to allow laser communication and ranging activities. Current operators in the Precinct include:
 - [Australian Maritime Safety Authority](#) - satellite tracking station for the regional detection and location of emergency distress beacon activations.
 - [Capricorn Space](#) which also hosts [ATLAS Space Operations](#), [Infostellar](#), and [Leaf Space Srl](#)
 - [Geosciences Australia – operates NASA's Yarragadee Geodetic Observatory](#)
 - [Goonhilly Earth Station](#) - WA Deep Space Ground Station (under construction)
 - [Swedish Space Corporation](#) (SSC) - Western Australia Space Centre
- The [Western Australian Optical Ground Station](#) (WAOGS) at The University of Western Australia (UWA), Perth is the first optical ground station in the southern hemisphere. WAOGS utilises UWA's world-leading atmospheric turbulence mitigation optical laser communication technology and also has PNT and SSA capability.
- The [Australian Defence Satellite Communications Station](#) (ADSCS), located at Kojarena is part of the US signals intelligence and analysis network ECHELON.
- CSIRO manages a network of ground-based satellite calibration and validation sites across Australia used by international space agencies to ensure the accuracy of data collected by satellites. This includes the Pinnacles Desert site, ~200 km north of Perth. This network will grow as part of the [National Space Mission for Earth Observation](#) which will see new ground-based satellite calibration and validation sites developed across Australia. This infrastructure network will support domestic and international operators to calibrate their satellites and verify the data they collect. This is vital to ensuring the accuracy of data collected by satellites.
- Western Australia also hosts ground stations for national and international communication companies such as [Cingulan Space](#), [Inmarsat](#), NBN, Optus, [Orion Space Systems](#), Speedcast, ViaSat, ITC Global, SES, Starlink and Telstra.
- Companies such as [Blacktree Technology](#) design, engineer, procure, manufacture, install, commission and maintain mission critical satellite-based communication systems.



3.2.2 Space Situational Awareness

Western Australia hosts a variety of space infrastructure providing space situational awareness and is a part of the US surveillance network for space debris. Western Australia also has international collaborations and research focused on technologies to detect, track and monitor objects in space.



Image: US-Aust. Space Surveillance Telescope

Key infrastructure and activities include:

- World-leading joint [US-Australian Space Surveillance Telescope](#) and [C-Band Space Surveillance Radar System](#) (operated by [Raytheon Australia](#)) located at the Naval Communications Station Harold E. Holt in Exmouth.
- LeoLabs' [West Australian Space Radar](#) near Bunbury is a part of [LeoLabs'](#) global network of ground-based, phased array radars producing high-resolution data on objects in low Earth orbit.
- EOS Space Systems, in partnership with Lockheed Martin, has constructed a new facility for Low Earth Orbit and deep space [Optical Space Surveillance](#) at Learmonth.
- Curtin University's [FireOpal](#) is a world-class optical space tracking system developed in partnership with Lockheed Martin.
- Royal Australian Air Force [Jindalee Operational Radar Network](#) near Laverton is a state-of-the-art defence system that provides wide area surveillance.
- The [MWA telescope](#) at the MRO Observatory has undertaken passive radar detection of space debris in Earth orbit. Curtin University is working with the Defence Science and Technology Group and the US Air Force on a number of projects to expand these capabilities.
- [Learmonth Solar Observatory](#), jointly operated by Bureau of Meteorology - Space Weather Services and the US Air Force. The observatory is the site of one of six solar velocity imagers in the world-wide Global Oscillation Network Group network.
- NASA/Geoscience Australia's [MOBLAS 5 Satellite Laser Ranging Station](#) is sited at the MSP.
- SSC is currently [installing a SSA facility](#) at the MSP due to be operational in mid-2022.
- [UWA's Zadko Observatory](#) is located 70 kilometres north of Perth and hosts the following Space Situational Awareness (SSA) ground infrastructure:
 - [UWA Zadko Telescope](#) for SSA, astronomy, gravitational wave research and tracking launch
 - French based ArianeGroup two SSA optical telescopes
 - US based [Numerica](#) SSA optical telescope
 - Polish Space Agency SSA optical telescope
 - JAXA optical telescope
 - [United States Air Force Academy - Falcon telescope](#) for SSA research and STEM.
- US company [Slingshot Aerospace](#) uses advanced analytics, machine learning, computer vision, and collaborative tools for commercial SSA and has an Australian base in Geraldton.
- [ExoAnalytic Solutions](#) has two SSA telescope sites situated near Perth.



3.3. Satellites and payloads

Western Australia has emerging capabilities in the design, manufacturing and operation of satellites and satellite payload systems and sensors. This includes:

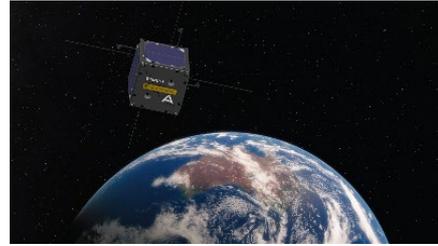


Image: Curtin University *Binar 1*

- Curtin University's Space Science and Technology Centre has developed the [Binar CubeSat](#), the first spacecraft to be fully designed and manufactured in Australia utilises Curtin University's innovated integrated sub-system printed circuit board. Using cost-effective manufacturing, it provides an accessible sovereign platform, enabling easy access to space for students, researchers and industry. The satellite can be used for a range of applications such as remote sensing, imaging, communications and defence, and represents a lower barrier of entry for start-ups to develop and test their technology in space. The first satellite was launched into space in August 2021 with a further six due to be launched in 2023, forming Australia's first home-grown constellation of satellites. Curtin University is also collaborating with Sitael and Fugro to undertake a geophysical survey mission to identify lunar resources from orbit ([Binar Prospector](#)).
- In May 2021, Perth based Australian satellite company [LatConnect 60 \(LC60\)](#), entered into a partnership with UK-based Surrey Satellite Technology Ltd (SSTL) to have exclusive rights and tasking of their SSTL S1-4 observation satellite over Australia, Asia Pacific and Middle East. This agreement supports LC60's expansion across the South East Asia region as it scales up its satellite constellation and product applications. In April 2022, LC60 [announced](#) a collaboration with Gilmore Space for the Australian manufacture and launch of eight hyperspectral microsats. The constellation will be able to scan locations in Australia, Asia, South America and Africa hourly.
- Through its Western Australian office, CSIRO, manages Australia's share in [NovaSAR-1](#), an Earth observation (EO) satellite capable of observing through cloud, smoke and at night. Australian researchers and industry can request to task the satellite and access the image archive free of charge via CSIRO's NovaSAR-1 data hub.
- The Western Australian Government, Curtin University, UWA and a number of SMEs are all partners of the [SmartSat Cooperative Research Centre](#) (CRC). SmartSat CRC develops technologies in advanced telecommunications and IoT connectivity, intelligent satellite systems and EO next generation data services.
- [Australian National Fabrication Facility Western Australian node](#), based at UWA, runs a complete, vertically integrated facility, from materials growth, through to device design, fabrication and testing. The node incorporates [UWA's Microelectronics Research Group](#) which is one of Australia's largest and most respected semiconductor electronics research groups and is leading the world in the innovative combination of micro-electromechanical system with infrared (IR) sensor technologies for fourth generation IR systems suitable for satellite use.
- Other Western Australian satellite and payload system/sensor companies include [Exodus Space Systems](#), [Picosat Systems](#), [QL Space](#), [Sky and Space Company](#).
- Companies such as [Calytrix Technologies](#) provide training solutions for satellite operations.



3.4. Space data analytics, supercomputing and cybersecurity

Western Australia has significant computing infrastructure and capability in data science, analytics and cybersecurity. Key Western Australian infrastructure and activities include:



Image: Pawsey's Setonix supercomputer

- The Perth-based [Australian Space Data Analysis Facility](#) (ASDAF) has been established to assist Australian SMEs and researchers in enhancing their ability to leverage space data, particularly EO data, through a multi-pathway strategy.
- [Landgate](#), the Western Australian Land Information Authority, is at the leading-edge of research and development in remote sensing and its applications, providing a full range of remote sensing services: from direct acquisition of satellite data, to processing of data and then delivering that data to government and business via their products and services.
- Other key space data analytics and EO organisations include [Astron](#), [Fastwave](#), [FrontierSI](#), [Gaia Resources](#), [Geospatial Intelligence](#), [In Situ Marine Optics](#), [Maptaskr](#), [NGIS](#), and [Soar](#).
- The Perth-based [Pawsey Supercomputing Research Centre](#) (Pawsey) is the lead Tier 1 supercomputing research facility in Australia. Pawsey provides a range of supercomputing, data storage and data visualisation services, as well as key expertise, training and support. Pawsey is also installing the world's first market-ready diamond quantum accelerator (quantum computer) which will operate without the requirement of near absolute zero temperature or complex laser systems.
- Perth-based [DUG Technology](#) is at the forefront of high-performance computing (HPC) and currently operates the most powerful supercomputer in the Southern Hemisphere. DUG recently announced plans to build the world's first carbon-free HPC campus powered by renewable energy in Geraldton. The facility will have a capacity in excess of 200 petaflops, with plans for expansion to multi-exaflop scale. DUG Technologies have established partnerships with Curtin University in the areas of radio astronomy and astrophysics and the development of algorithms that can detect and monitor space junk and satellites in Earth orbit.
- [WA Data Science Innovation Hub](#) provides access to specialised data science capabilities in universities and trained graduates, upskilling programs for industry, the translation of data science capabilities from the resources sector to emerging sectors.
- Edith Cowan University (ECU) is a world-leader in cyber security research and cyber security education and is recognised by the Australian Government as an Academic Centre of Cyber Security Excellence. ECU is home to the [ECU Security Research Institute](#), [Western Australian AusCyber Innovation Hub](#) and the [Cyber Security Cooperative Research Centre](#). ECU recently opened the largest university Security Operations Centre in the Southern Hemisphere to provide students real world training in monitoring, detecting and responding to cyber security threats.



3.5. Research, training and education

Western Australia has significant capability in space research, training and education including:



Image: Curtin University robotics laboratory

- CSIRO in Western Australia undertakes research in satellite design and control, EO, signal processing and radio astronomy. CSIRO has 100 personnel working in space and space-related projects in the State.
- Curtin University's [Space Science and Technology Centre \(SSTC\)](#) is home to the largest planetary research group in the Southern Hemisphere. Key strengths include SSA, space engineering (CubeSats) and machine learning in planetary geology. Curtin University's [Remote Sensing and Satellite Research Group](#) undertakes research related to calibration and validation of satellite remote sensing observations. Curtin University's [GNSS Satellite Positioning and Navigation Group](#) develops theory, models, and methods to provide the high accuracy and high-integrity requirements for future GNSSs. Curtin University annually graduates dozens of science and engineering students in spacecraft design, space missions, EO and GNSS. SSTC also runs a major outreach program for high school students to design and prototype satellite payloads ([BinarX](#)).
- UWA's [International Space Centre \(ISC\)](#) combines leading space science, research and teaching capabilities, with the mission of advancing our ability to operate from space and enabling the development of innovative technology to enhance and sustain life on Earth and beyond. ISC is a multi-disciplinary team that includes more than 12 research nodes and 150 researchers. ISC specialises in (space) optical communications, SSA, batteries, propulsion systems, health, agriculture, engineering, information technology, and social studies. UWA graduates dozens of science and engineering students trained in these space sectors. UWA also runs a Space Boot Camp for Year 9 and 10 students. UWA also hosts the [Defence and Security Institute](#) with expertise in space, AI, automation and quantum technologies.
- Perth is home to the [International Centre for Radio Astronomy Research \(ICRAR\)](#), a joint venture between Curtin University and UWA. ICRAR is an internationally renowned, multi-disciplinary research centre for science, engineering and data intensive astronomy which has played an integral role in the development of the SKA project and translation of radio astronomy technologies and expertise to other industry sectors. Curtin University's [Curtin Institute of Radio Astronomy](#), a world-class radio astronomy institute supports ICRAR and a number of international projects. Both groups undertake training of dozens of undergraduates, MSc and PhD students annually.
- The Western Australian Government also supports [Joseph Banks Secondary College Space Science Education Centre](#). The Centre provides students with a simulated lunar surface, specialist facilities for space science experiments and technology for remote operation and mission control experience.
- STEM and space outreach programs, with Western Australian Government support, are also undertaken by AROSE, ASDAF, [Gravity Discovery Centre](#), ICRAR, Pawsey, [Perth Observatory](#), [Scitech](#), SpAARC and the [Western Australian Museum](#).



3.6. Launch

Western Australia has significant advantages and opportunities for the establishment of new launch facilities.



Image: *Western Australian Spaceport*

Mainland Western Australia is the largest State in Australia and spans latitudes from -14°S to -35°S . Christmas Island (-10°N) and Cocos (Keeling) Islands (-12°N), south of Java and Sumatra are also governed by the Western Australian Government. Western Australia has a land area of 2,527,013 square kilometres and is very sparsely populated (2.7 million people).

Thus, there is an opportunity for launch to equatorial, polar and sun synchronous orbits from Western Australia. Interest in establishing launch capabilities in the State has increased significantly in recent years and a number of national and international organisations are working with the State Government to establish launch sites. Western Australia has significant experience in establishing major facilities in remote areas through its massive resources industry. There is also significant opportunity to decarbonise launch activities through the use of renewable power at facilities and green fuels for propulsion.

Current companies operating or establishing launch facilities include:

- Airbus Defence and Space have established the [world's first High Altitude Pseudo-Satellite \(HAPS\) flight base](#) and launch site in Wyndham for its Zephyr Unmanned Aerial Vehicle.
- The [Western Australian Spaceport](#) (WA Spaceport) is establishing a launch site in Albany for small to medium sized launch vehicles for polar and sun synchronous orbits. WA Spaceport anticipates being operational in 2025. Launch facilities are to include clean room, gas services, communications, building services, lifting equipment, workstations, propellants, in-door staging, common launch pad, propellant loading-offloading, in-door launch control centre, downrange RF facilities, medical supplies and fire-fighting equipment. WA Spaceport experiences temperate weather conditions year-round with clear ocean southwards launching into azimuths up to 50° eastwards from south and $85-90^{\circ}$ westwards from south. WA Spaceport partners include Telesat and Norman Disney & Young.
- [Space Angel](#) has executed a MoU with Indian based [Skyroot Aerospace](#) focused on space technology collaborations on launch opportunities for IoT-satellite constellations and establishing a launch facility in Western Australia. Space Angel also aims to develop a Digital Space Port to provide a strong platform for companies requiring cost-effective access to space.



4. Related Capabilities

4.1. Defence Science

The [Defence Science Centre](#) (DSC) is the Western Australian contribution to the Australian Defence Science and Universities Network. This network supports the national Defence enterprise through collaboration between state university researchers, industry, Defence Science and Technology Group, and Defence end-users. This facilitates the engagement of Australia's best research and development capabilities to apply their research to real-world Defence needs and challenges. The DSC also supports the commercialisation of defence-related research.

4.2. Radio astronomy infrastructure

CSIRO's [Murchison Radio-astronomy Observatory](#) (MRO) is a world-class site for radio astronomy and hosts the Australian SKA Pathfinder radio telescope, Murchison Widefield Array and will host the [SKA-Low Telescope](#).

Western Australia will also host the SKA-associated Australian Science Operations Centre, Australian Science Processing Centre, [Australian SKA Regional Centre](#), MRO Support Facility and Engineering Operations Centre.

4.3. SME support and training

The State Government supports Atomic Sky's [Quantum Technology Exchange program](#) which grows (through accelerator and incubator services) emerging business and capability by facilitating collaboration across space, resources, agriculture and defence sectors.

Perth also hosts a number of Start-up and SME innovation hubs that support the space sector including the [Centre for Entrepreneurial Research and Innovation](#), [CORE Innovation Hub](#), [ERDi Testlab](#), [Innovation Central Perth](#), [Spacecubed](#), [WA Austcyber Innovation Hub](#) and [WA Data Science Innovation Hub](#).

4.4. Funding

The Western Australian Government's \$180 million [Investment Attraction Fund](#) was established to attract further investment to Western Australia that will create local jobs in new and emerging industries including the space industry. The Investment Attraction Fund presents an exciting opportunity for businesses looking to establish and grow their operations in Western Australia by accessing support and financial assistance of up to \$5 million.

The State Government also supports innovation through the [New Industries Fund](#) which includes a variety of funding programs to support the acceleration of new and emerging businesses in Western Australia, to diversify the economy and create new jobs and industries.



Contact Details:

This document was prepared by the Department of Jobs, Tourism, Science and Innovation to provide an overview of Western Australia's space capability and activities. It is supplemented by the more detailed review of [Western Australian Space Industry Capability undertaken by ACIL Allen in 2018](#).

Website: www.jtsi.wa.gov.au/what-we-do/science-and-innovation/science-and-innovation-overview/space

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