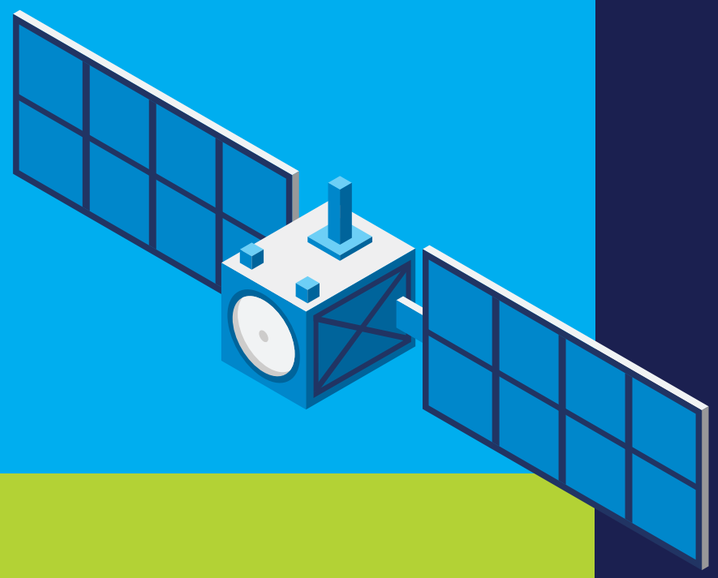
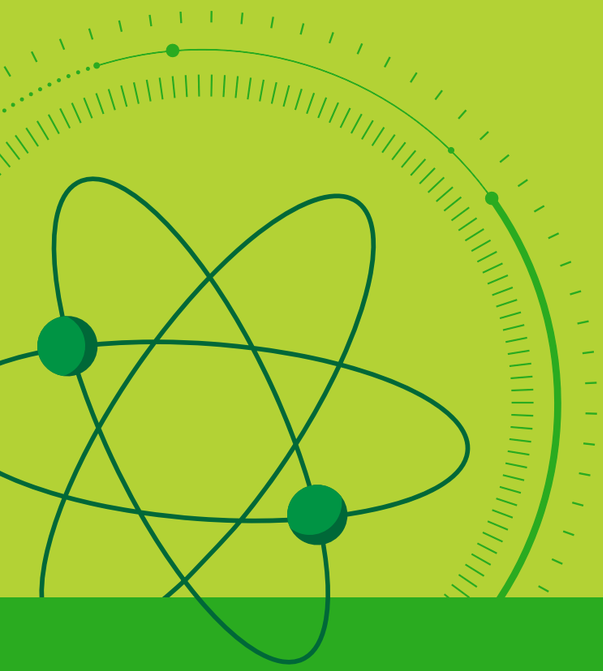
ANNUAL REPORT 2022/23

SMARTSAT
COOPERATIVE RESEARCH CENTRE





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EXECUTIVE SUMMARY

This past twelve months, we have shifted our focus to impact and the tangible outcomes coming from our broad portfolio of research. As we meet the halfway point of our life as a CRC, we have been seeing wonderful outcomes from some of our biggest projects.

It is my firm belief that as an industry, we are stronger together than we are apart, which is why we continue to strengthen our collaborative relationship with a number of international agencies. This past year, we have welcomed Professor Dame Angela McLean, Chief Scientific Advisor for the UK Ministry of Defence, presented to JAXA President Dr Yamakawa Hiroshi, and hosted Daniel L Dumbacher, Executive Director of the American Institute of Aeronautics and Astronautics. We continue to have a strong presence at international events, including the International Astronautical Congress 2022 in Paris and the 37th Space Symposium in Colorado.

November 2022 was highlighted by a visit from NASA Search and Rescue Laboratory Chief, Dr Lisa Mazzuca, and Deputy for National Affairs, Cody Kelly. SmartSat has been working closely with partner company Safety from Space and NASA on the LunaSAR project to develop advanced, low-power emergency radio systems for astronauts, a technology that has been directly adapted from the research completed through the RESARC project.

In February this year, our collaborative venture with the Satellite Applications Catapult and the UK Space Agency was launched at the Avalon Airshow in Melbourne. The supply chain mapping tool, the launch of which marked the second anniversary of the UK-Australia Spacebridge, showcases the capabilities of the space sector spanning across both nations.

On home soil, we continue to cement ourselves as the nation's premier space research center through our extensive partner network. We continue to work alongside the Australian Space Agency to support the Australian Civil Space Strategy. Achieving the goals of the Agency and those of SmartSat requires a 'Team Australia' approach, engaging all areas of the sector to deliver tangible value to our partners and impact for the nation, including knowledge, skills, and technology that will form the basis for Australia's future space systems capability.

In September 2022, we hosted our first in-person SmartSat Annual Conference, welcoming nearly 150 staff, students, researchers, partners and VIPs to the Masonic Centre in Sydney to reflect on our achievements and present our strategic direction as we reach the halfway point of our funding.

In March, CSIRO officially launched their AquaWatch Australia mission, of which SmartSat is a foundation partner, to deliver a ground-to-space water quality monitoring system built on the back of our research. At the 15th Australian Space Forum in May, we were able to unveil our Compact Hybrid Optical-RF User Segment (CHORUS) terminal, a prototype that is creating faster, safer and more secure military satellite communications.

As we move into the new financial year, our Coherent Free-Space Optical Communications project, led by Dr Sasha Schediwy from the University of Western Australia is in preparation to be tested at Talisman Sabre, one of the largest Defence exercises in the southern hemisphere.

Most recently, we were thrilled to announce the launch of the Maya Nula Research Program to develop Australian satellite Earth Observation capability and deliver agricultural intelligence from space. We are thankful to our Board Director, Mikaela Jade, and the Dharug Elders who we consulted with on the pillars of the cornerstone research program to improve our sovereign space capability and provide 'eyes here, there and everywhere' to the Australian agricultural and environmental management sectors.

Of course, the past twelve months has not been without its challenges, and in December we were devastated to learn of the passing of our inaugural chair and much valued colleague, Dr Peter Woodgate. Peter was an inspiring leader, a true strategic thinker, an advocate for the Australian space sector, a Board Chair par excellence, a gentle human being, and most importantly, a good friend.

In March, we were proud to assist in the launch of his legacy project, the 2030 Space + Spatial Industry Growth Roadmap. This document, which was heavily supported by SmartSat, outlined Peter's vision for a conjoined space and spatial industry supporting the national mission. It is this visionary work for which Peter was best known within the industry, and so to honour this SmartSat has worked with the Andy Thomas Space Foundation to establish the Dr Peter Woodgate Earth Observation Scholarship to support young people to pursue a career in the Australian space industry.

It is my hope that SmartSat can sustain Peter's legacy of graciousness, tenacity, and wisdom as we continue to support research and development that results in deliver real-world outcomes.

Professor Andy Koronios
SmartSat CEO & Managing Director

CHAIR'S FOREWORD

This past year has been a testament to SmartSat's resilience, tenacity and ability to adapt to meet the needs of the ever-changing Australian space industry, delivering high quality research and exceeding expectations.

We were deeply saddened by the news that our inaugural Chair, Dr Peter Woodgate, passed away on 23 December 2022. Peter played an integral role in leading the CRC bid for SmartSat, before taking on the role of Chair and lending his expertise and wisdom to the development of the organisations structure and governance framework. Peter was an inspiring leader and a good friend to many of us, and I am honored to have picked up the mantle of SmartSat Chair in his absence in January 2023.

One key piece of Peter's legacy that continues to develop is SmartSat's industry start-up group, the Aurora Space Cluster. The Aurora Board, now under the leadership of Dr Sarah Cannard, is currently examining a review of the organisation's structure to ensure it is operating to provide maximum benefit to its over 40 member companies.

In December, the board met to review SmartSat's strategic direction as we approach the second half of our life as a CRC and beyond. Since this time, the leadership structure has undergone a significant reshuffle. The Nominations and Renumerations Committee and the Diversity, Equity and Inclusion (DEI) Committee have been merged into a single People and Culture Committee chaired by Professor Margaret Harding. This merger will streamline the functions of both groups, reducing administrative process and eliminating unnecessary duplication.

SmartSat maintains its strong commitment to DEI. In September 2022, the Board accepted a Diversity and Inclusion report from Sonali Dsilva at Equality Consulting which has since provided the framework for a revised 2023-2025 DEI Action Plan. This plan cements our commitment to building an inclusive leadership and culture within the organisation, ensuring DEI across all research programs to the best of our ability and growing our First Nations knowledge, capacity, and collaboration.

The cornerstone of this target is the agricultural Earth Observation (EO) intelligence research program, Maya Nula. Developed in consultation with agricultural leaders and First Nations Elders under the guidance of board member Mikaela Jade, this initiative is addressing the increasing need for farmers to reduce risk and increase yield through environmentally sustainable, climate resilient practices, assuring a more stable future for all Australians.

In June 2023, we welcomed Emeritus Professor Roy Green from the University of Technology, Sydney to the board as non-executive director. Professor Green brings to us an extensive background in innovation, having advised – and published widely on – innovation policy and management, as well as trends in business education. We are delighted to welcome him to the board and look forward to his valuable insight and advice.

Reflecting on the last twelve months, I would like to take the opportunity to thank all our partners for their enduring support of our endeavor to drive world leading and world changing satellite research in Australia. I would also like to thank SmartSat and colleagues for welcoming me as the new chair. I have no doubt that together we can continue to build our nation's space research industry.

Dr Michele Allan
SmartSat Chair

HIGHLIGHTS & ACHIEVEMENTS

Highlights and Achievements by the SmartSat team during 2022/23.

RESEARCH

New algorithm product launched from the **Real Time Fire Analytics** project, with ability to provide fire hotspot updates every 10 minutes.

Unveiled the world-first **Compact Hybrid Optical-RF User Segment** prototype terminal for more stable and secure military satellite communications.

Matured technology on **Compact Clock for Small Satellite Applications** and **Coherent Free-Space Optical Communications** projects, which then received Moon to Mars funding from the Australian Space Agency.

Onboard AI for Smoke Detection project produced smoke detection rates of 87% accuracy, with the project's AI model reducing raw data volume and improving downlink speed for crucial fire response information.

Advanced Narrowband Waveform technology developed for terrestrial search & rescue beacons (**RESARC** project) commenced two-phase technology transition:

- The **LunaSAR** project is developing emergency communications for astronaut safety on the moon.
- **ASCEND2LEO** is addressing Defence Space Command's tactical voice communications needs.

GROWING AUSTRALIA'S SPACE HERITAGE

Kanyini, SA Space Services Mission completed design and testing phase.

WARATAH SEED

Supported space technology development for Waratah Seed WS-1 payloads.

BOARD & GOVERNANCE

The 2022/23 SmartSat board consists of:

- **Dr Michele Allan AO** | Chair *FROM JAN 2023
- **Professor Andy Koronios** | CEO, Managing Director
- **Dr Jacqueline Craig AM FTSE** | Director
- **Dr Rosalind Dubs FTSE FAICD** | Director
- **Emeritus Professor Roy Green** | Director *NEW
- **Professor Margaret Harding** | Director
- **Mikaela Jade FTSE** | Director
- **Dr Danielle Wuchenich** | Director
- **Catherine Cooper** | Company Secretary *NEW

The 2022/23 Aurora Space Cluster board consists of:

- **Dr Sarah Cannard** | Chair *NEW
- **Professor Andy Koronios** | Director
- **Dr Tim Parsons** | Director
- **Conrad Pires** | Director

AURORA

PEOPLE & OPERATIONS

- Added University of Technology Sydney as new Supporting Partner
- Staff engagement survey completed with Culture Amp
- Finalised SmartSat DEI Strategic Plan for 2023-2025 and DEI Action Plan for 2023
- Maintained a consolidated employee base with one additional Operations role
- Established People and Culture Committee

New Appointments

Dr Jasmine Muir
Principal Scientist in Earth Observation

Professor Hanna Kurniawati
Professorial Chair for System Autonomy, Intelligence and Decision Making (ANU)

Professor Kirk McKenzie
Professorial Chair of Precision Measurement in Space (ANU)

Professor Craig Smith
Mike Miller Professorial Chair in Telecommunications (UniSA)

COMMUNICATION & EVENTS

14
Media releases issued

729
Media articles published

82M+
Media audience

15
Events *(workshops, distinguished speakers, annual conference)*

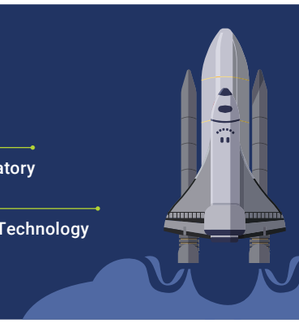
800+
Combined event attendance

EDUCATION & TRAINING

60 current students at various stages of their studies, with 6 already graduated

4 PhD Work Placements

- 2 at NASA Jet Propulsion Laboratory
- 1 at Massachusetts Institute of Technology
- 1 embedded at SmartSat



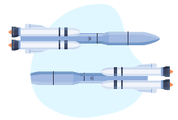
HOSTED MASTERCLASSES

In response to the Australian Space Skills Taxonomy, masterclasses were hosted to address training gaps in:

Space Law | **Mission Design** | **Applied Engineering** | **Radiation in Space**

BROADER EDUCATION SUPPORT & SPONSORSHIP

Established the Peter Woodgate Scholarship for Earth Observation



Supported Australian Youth Aerospace Association student challenge

Launched a scholarship of up to $3,000 for female PhD students to improve gender diversity in STEM

Sponsored South Australian Premier's Reading Challenge (Space Theme)

ENGAGING WITH INDUSTRY AND THE INTERNATIONAL SPACE SECTOR

INTERNATIONAL

NASA ENGAGEMENT

Engagement with NASA continues through the LunaSAR project agreement (NASA Search and Research), supporting astronaut safety on the Moon for the Artemis program. SmartSat also arranged and funded two PhD internships at NASA Jet Propulsion Laboratory.

INTERNATIONAL

UK SPACE BRIDGE

To mark the second anniversary of the UK-AUS Space Bridge, Satellite Applications Catapult, SmartSat Cooperative Research Centre (CRC), and the UK Government launched a new space supply chain mapping tool to showcase the United Kingdom (UK) and Australian space sector capabilities. This mapping tool was built within the existing UK Space Capabilities Catalogue (UKSCC) and extended to develop an International Comparison Dashboard with a current focus on Australia to identify opportunities for collaboration and growth.

INTERNATIONAL

EUROPEAN SPACE AGENCY

The Kanyini team collaborated with Netherlands-based cosine to integrate the HyperScout 2 Flight Model instrument into the satellite. In addition, planning has commenced for collaboration with European Space Agency's Φ-lab on joint research projects relating to the HyperScout 2 data.

INTERNATIONAL

MEETINGS

International meetings were held with DARPA/US Air Force Research Laboratory, Space and Missile Systems; US Consul General; Southwest Research Institute (Texas); Japan Aerospace Exploration Agency; Polish Space Agency; UK Space Agency, UK International Trade and UK Ministry of Defence; and Republic of Korea Agency for Defence.

DOMESTIC

50 + SPACE SMEs

The Aurora Space Cluster supports over 50 space SMEs. The Aurora framework provides members with opportunities to collaborate with research organisations, local and international primes and other Aurora members on commercial ventures to build their capability. In 2023, the Aurora Board undertook a business review to evaluate how to provide more value and significant impact to SMEs in the Australian space sector.

INTERNATIONAL

2023 ROADMAP

SmartSat supported the development and launch of the 2030 Space + Spatial Industry Growth Roadmap, an industry document designed to inform government policymakers to commit to an integrated space and spatial industry to safeguard Australia's future economic success, societal well-being, and national security.

Dr Carl Seubert visiting PhD intern students Emily Ahern and Anne Bettens at NASA Jet Propulsion Laboratory

Launch of the UK Space Capabilities Catalogue International Comparison Dashboard with UK Satellite Applications Catapult

European Space Agency MoU signing

Space + Spatial Industry Growth Roadmap 2030 launch

KEY RESEARCH ACTIVITIES

Coherent Free-Space Optical Communications

Phase Two project Coherent Free-Space Optical Communications, led by University of Western Australia (UWA) has successfully demonstrated the feasibility of high throughput optical communications through adapted astronomy techniques for atmospheric correction. It is on a pathway to deliver fibre like connectivity over free-space channels using a compact, high technology optical ground terminal. UWA has since received $4.4M a Moon to Mars grant to establish TeraNet, a three-node commercial optical communications ground station network. This is an excellent outcome for SmartSat's ongoing major research thrust in advancing satellite communications and, specifically, optical communications.

LunaSAR (Resilient Emergency Search and Rescue Communications)

This Stage Two LunaSAR project, which arose from Resilient Emergency Search and Rescue Communications (both supported by NASA), is developing new search and rescue beacon technology with an aim to support astronauts' safety on the Moon. Transition planning is now underway for the technology, commencing with a third phase project, ASCEND2LEO. This project aims to demonstrate tactical voice and data satellite communication via Fleet Space Technologies' next-generation Centauri satellites, to support a $6.4 million contract they signed with Defence Space Command.

See full case study

Compact Clock for Small Satellite Applications — Engineering Model

SmartSat funded project Compact Clock for Small Satellite Applications – Engineering Model has passed its mission definition, system requirements and preliminary design review with an independent panel. This Phase Two funded project is a great example of SmartSat supporting technology progression to maturation. The clock's intellectual property will be utilised to build a flight model of the clock, with the funded SME QuantX receiving a $3.7 million grant under the Australian Space Agency's Moon to Mars Demonstration program.
This exemplifies SmartSat funded research outputs making a valuable contribution to sovereign end-user needs, with the flight heritage obtained in the mission opening opportunities for commercial use of the technology.

Real Time Fire Analytics

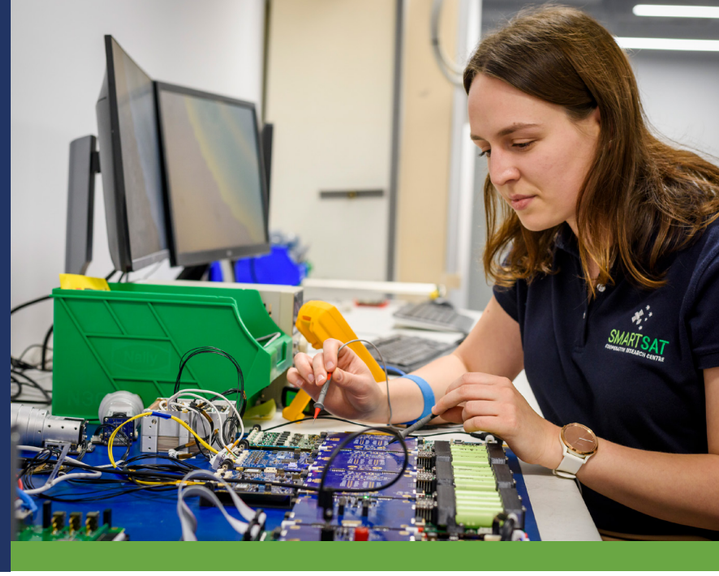
The Real Time Fire Analytics project team launched a new product, an algorithm called BRIGHT/AHI (Biogeographical Region and Individual Geostationary HHMMSS Threshold/ Advanced Himawari Imager).

This uses images from the Japanese Himawari-8 satellite to provide automated, near-continuous and near-real time surveillance of potential fire activity across Australia. Prior to this, polar-orbiting earth observation satellites offered limited daily (or twice daily) images of Australian hotspots. Integrating geostationary satellite data brings new opportunities for fire observation from space to every 10 minutes.

See full case study

Kanyini SA Space Service Mission

The Kanyini mission team completed the integration and testing phase of Kanyini Flat Sat, including the installation of the HyperScout 2 Flight Model delivered from Dutch company cosine. A launch services agreement was signed with ISILaunch, booking Kanyini onboard a SpaceX Transporter mission in 2024. The team selected the Kongsberg Satellite Services (KSAT) based at Antarctica Troll Ground Station to provide data acquisition and Telemetry, Tracking and Command (TT&C).



Compact Hybrid Optical-RF User Segment (CHORUS)

The world-first Compact Hybrid Optical-RF User Segment (CHORUS) prototype terminal has been successfully tested and demonstrated. A hybrid optical/RF terminal, CHORUS integrates an RF antenna and an optical telescope into a system named AntennaScope™. This offers higher bandwidth, lower observability and more secure communications than current RF-only tactical communications technologies across maritime vessels, aircraft and land vehicles. CHORUS can potentially position Australia as a leader in developing and delivering an entirely new class of military satellite communications service for the Australian Defence Force and its allies. It also has commercial applications for shipping and cruise liners. Project partners are Defence Science and Technology Group, EOS Space Systems and EM Solutions, Lyrebird Antenna Research, Shoal Group, ANU and University of South Australia.

CHORUS prototype terminal at demonstration site

Onboard AI for Smoke Detection

The Onboard AI for Smoke Detection project developed AI-based onboard processing strategies to identify fire smoke from HyperScout-2 imagery. The on-board AI model significantly reduces large raw data volumes, which will improve downlink speed for crucial information and lead to earlier detection and response on ground. First results from the project have shown a fire smoke prediction accuracy of 87.8%.

See full case study

Scarlet Laboratory

The flagship project SCARLET-α (Spacecraft Autonomy and Onboard AI for Next Generation Space Systems) is a $7m three-year project engaging eight partners. It forms the first of a suite of projects commenced under the SCARLET laboratory, which aims to develop innovative technologies across spacecraft autonomy, on-board Artificial Intelligence and data analytics.

Maya Nula

The world-first Maya Nula research program was launched in early 2023 with an aim to develop new Earth Observation (EO) capability with space sensor technology to advance Australia's agriculture industry. An initial project helped build a measurement, reporting, and verification (MRV) tool for communicating sustainable practices on soil health, crop conditions, biosecurity, and the environment.

OysterQual

The OysterQual Project developed a Proof-of-Concept and investigated the feasibility of jointly using satellite remote sensing Earth Observation and in-situ data to assist with identification of suitable shellfish growing sites in remote and regional areas of Western Australia, where there is limited telecommunication connectivity.

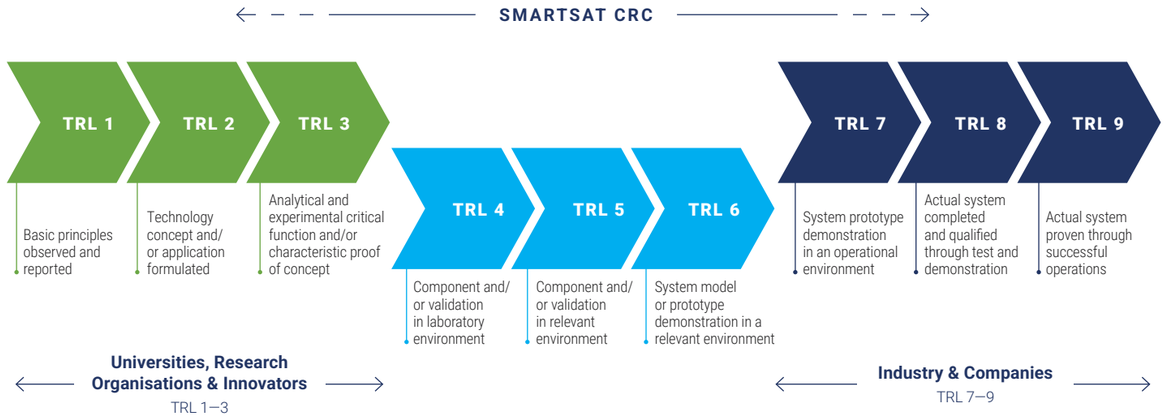
See full case study

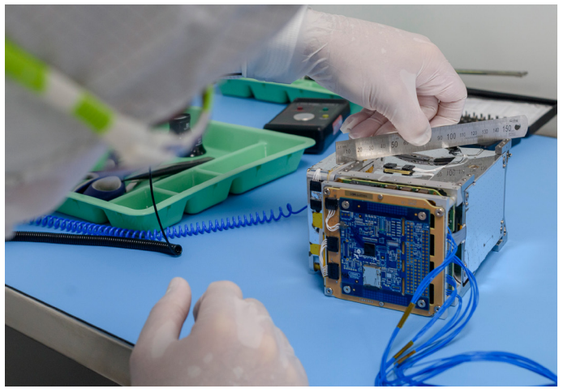
BRIDGING THE TECHNOLOGY READINESS GAP

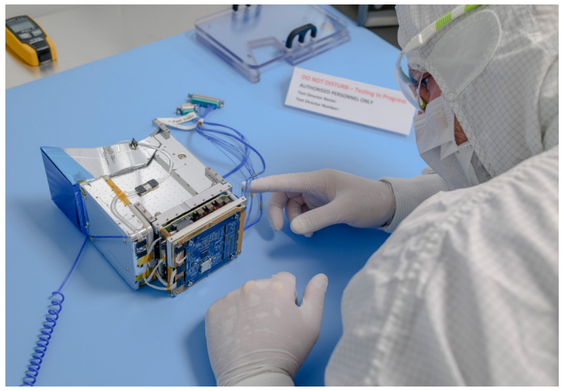
In complex system development, assessing technology maturity and progress is vital. Developed by NASA, the Technology Readiness Level (TRL) framework is a widely accepted method, categorising technology into nine levels of development.

One of the critical challenges discussed is a gap known as the **"Valley of Death,"** referring to the common failure to progress technology from TRL 4 to TRL 7 due to high testing costs, both on the ground and in space. SmartSat aligns it's R&D efforts across this gap, supporting universities, SME innovators and research organisations to progress their technology until it reaches commercial viability and broader industry support.

ALIGNMENT TO TECHNOLOGY READINESS LEVELS



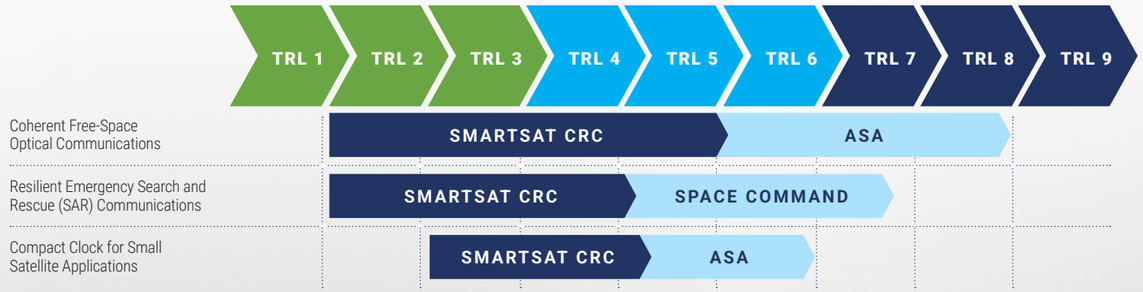




Kanyini's Hyperscout 2 Flight Model Instrument

SmartSat satellite engineers conducting clean room testing of Hyperscout 2 Flight Model Instrument

PROJECT MATURATION PATH



SMARTSAT NODES

16 new node projects
40+ project partners
$10M+ total investment

SmartSat Nodes are a key mechanism to support engagement with SME's, industry partners and our research providers. In the past 12 months SmartSat has funded an additional 16 node projects, expanding the engagement with University and industry partners to over 40, with a significant majority being SMEs.

Node projects have direct alignment to resolving valuable business and industry problems, with the collective total Node investment now **exceeding $10 million.**

QUEENSLAND
$3M total joint investment

QUEENSLAND EARTH OBSERVATION HUB

The Queensland Earth Observation (EO) Hub, a partnership between SmartSat and the Queensland Government was established to accelerate the growth of the earth observation industry throughout Queensland (and Australia) by supporting commercialisation of research, and EO product and service development.

PROJECTS

Localised GNSS IoT networks and Satellite Broadband Communications for Remote Geohazard and Structure Monitoring

With Queensland University of Technology and Monitum Pty Ltd

Aim: the design of a new satellite-IoT system, and prototypes of a GNSS IoT platform end-device, and a baseline processing engine.

Coastal Change Observation and Analytics (Multi-) Scale (Multi-) Technology System (COASTS)

University of the Sunshine Coast, Queensland University, EOMAP Pty Ltd

Aim: to address the lack of available coastal monitoring data using of satellite imagery, drones, numerical modelling, artificial intelligence-based analytics, and cloud-based technology.

Monitum's Kurloo Global Navigation Satellite System

VICTORIA
$2M total joint investment

In partnership with the Victorian Government and RMIT University, the SmartSat Vic Node funded four initial projects to accelerate Victoria's space sector, selected based on their tangible solutions to real-world problems with a clear end-use.

PROJECTS

Advanced Cooperative Tasking and Intelligent Visualisation Environment for Space Domain Awareness (ACTIVE-SDA)

CGI, RMIT University, and Swinburne University of Technology

Aim: to investigate how artificial intelligence and advanced data visualisation techniques can boost Space Domain Awareness technology, which tracks and predicts the motion of satellites and space debris in Earth orbit.

Real-time Online Nutrient Analyser with Adaptive Sampling and Predictive Modelling

La Trobe University and Eco Detection

Aim: to develop a remote nutrient analysis system to provide real-time laboratory-grade analysis of waterway nutrient levels.

HYMS Hyperspectral Microwave Sounder

ESS Earth Sciences, Swinburne University of Technology

Aim: to improve global weather forecasts by developing an advanced, multi-channel, ground-based microwave Sounder to provide high-resolution radiance observations and atmospheric temperature and water profiles.

Investigation into Space-Based Data Streams for Updating & Enriching Victoria's Foundation Spatial Data

FrontierSI, Department of Environment, Land, Water and Planning, VIC (DELWP), RMIT University

Aim: to improve global weather forecasts by developing an advanced, multi-channel, ground-based Microwave Sounder to provide high-resolution radiance observations and atmospheric temperature and water profiles.

NEW SOUTH WALES
$2.2M total joint investment

A significant initiative established under the NSW Node has been the support of the Waratah Seed (WS) mission where SmartSat invested AU$1M to support the development of new space technology that will be tested in space as payloads on the WS-1 spacecraft. Due to take its maiden flight later in 2023, this NSW Government initiative involves SmartSat partners and a consortium of NSW space related SMEs to help provide flight heritage and demonstrate commercial services.

Enabling Resilient Space Computing with Advanced Thermal Management

University of Technology Sydney, Mawson Rovers, Spiral Blue Pty Ltd

As heat management is a significant challenge for Low Earth Orbit satellites, this technology is attracting strong investor and commercial interest worldwide. Developed by an industry-research consortium formed by space startup companies Mawson Rovers Pty Ltd and Spiral Blue Pty Ltd with SmartSat CRC research partner UTS, the technology will demonstrate a novel heat management solution as a vital enabler of space edge computing systems for the current and next generation of Australian and internationally manufactured payloads and satellites.

Heat management system from Mawson Rovers Pty Ltd

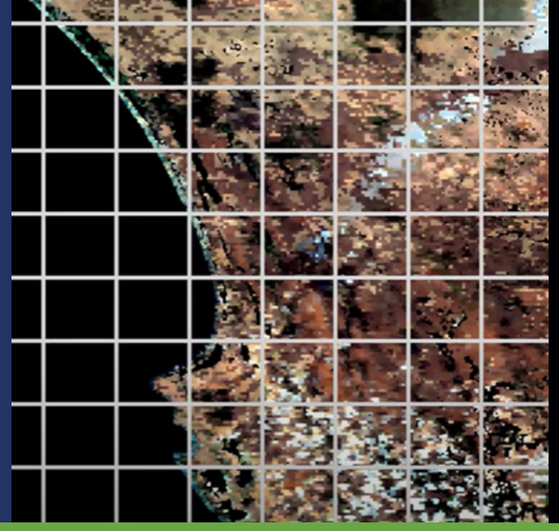
CASE STUDIES

Ongoing and/or completed SmartSat research projects from 2022-23.

CASE STUDY

Small Satellite Energy-Efficient On-Board AI Processing of Hyperspectral Imagery for Early Fire-Smoke Detection

University of South Australia, Swinburne University of Technology, GeoScience Australia, Fireball International
Image (right): An example of the satellite image of South Australia capturing fire smoke, clouds and vegetation separated into tiles.



THE CHALLENGE

This project is addressing the challenge of AI processing of Hyperspectral imagery onboard small satellites for early detection of fire smoke.

When looking from above, smoke is the first obvious indication of a bushfire event. In Australia, and around the world, numerous organisations are currently planning small satellite constellations that will use multi- and hyperspectral sensors to help detect fires. However, due to the time (hours or days) it can take to process and downlink the data imagery, the information is not always useful for early fire response.

For small or cube satellites with advanced EO sensors capturing numerous spectral bands, the amount of raw data generated exceeds what can be transmitted to ground. Onboard processing of imagery could reduce downlink times. However, this requires significant power, which is a challenge for cubesats with limited energy resources.

This project demonstrates an energy-efficient on-board data processing method, which reduces raw data volumes by using AI processing to automatically detect specific results such smoke locations before downlink transfer.

PROJECT DETAILS

The project team simulated images of a past fire event in South Australia, with imagery of clearly visible smoke plume and cloud, as well as burn scars and vegetation. The AI model used these training smoke, cloud and landscape signatures to identify and separate out the presence of smoke only. The imagery was partitioned into tiles and fed into the AI model, with only tiles containing smoke then downlinked to the ground for further processing. This greatly enhanced downlink transfer efficiency, which is crucial for early fire detection.

In summary, the project has achieved:

- Built a fire smoke training dataset based existing satellite imagery.
- Designed and built an energy effective machine learning model for on-board feature and band selection.
- Built an emulation environment/system to replicate on-board processing.
- Tested and evaluated on-board processing capacities, data up/downlink limitations, and timeline restrictions using a ground-based emulation system.
- Measured and reduced energy consumption for the on-board processing tasks.

THE IMPACT

This project is a key stepping stone towards a future operational warning service using satellite-based fire detection, reducing the risk of fire damage across the country.

WHAT'S NEXT

SmartSat is planning a follow-on project to demonstrate the algorithm onboard a mission such as the Kanyini satellite. The research team and SmartSat are actively searching for additional opportunities to deploy the algorithm on other satellites, including commercial and government missions.

CASE STUDY

Visualisation Pilot for Indo-Pacific Connector

University of South Australia, SmartSat CRC, SAAB Australia
Image (right): A simulation of a notional Indo-Pacific Connector constellation.

THE CHALLENGE

A priority focus for the Indo-Pacific Connector is maritime surveillance, supporting offshore patrol vessels, through monitoring and assessing maritime activity for purposes such as national security and illegal fishing.

This project builds on previous research to show how simulation and visualisation tools can help the Indo-Pacific Connector deliver maritime domain awareness through space-based sensors and advanced communication technologies. As such, it is addressing the industry need for a tool to simulate and visualise complex space system technologies without the expense of flying objects in space.

PROJECT DETAILS

This project used readily available satellite trajectory information and shipping traffic data to show how application of "new space" technologies and systems can enhance maritime domain awareness. It developed a new approach to the use of modelling, simulation and visualisations to enhance understanding of the benefits of emerging technology. The project showed the value in decoupling simulation and visualisation to support improved interaction between humans and the computer model of complex systems.

The project examined the impact of intersatellite links between Low Earth Orbit satellites, as well as between satellites in different orbits (Low and Geostationary Earth Orbits). It examined how data transfer rates and end-to-end latency through space systems can effect the command and control of maritime platforms.

It also considered the development of intelligent models of ship motion and signatures, as well as the effects of atmospheric weather (mainly cloud cover) on the performance or sensors and optical communications.

THE IMPACT

This research developed an immersive visualisation environment that enables a responsive interaction. The augmented reality provides a view of the communications satellite constellation, aircraft and shipping, which can be interacted with using a flat screen display or 3D virtual representation of the system. This has demonstrated the value of developing augmented reality tools to simulate and visualise complex space systems to help the Indo-Pacific Connector deliver maritime domain awareness.

WHAT'S NEXT

The project has helped SmartSat and our partners understand how simulation and visualisation can contribute to explaining the utility of emerging space technology. We continue to look for opportunities to implement and extend the tools and techniques developed within this project within a suitable facility that can support ongoing research activities.

"The development of effective Command and Control systems is highly dependent on the ability to distil complex information into an easily digestible situational picture. Saab's partnership with the University of South Australia under the Indo-Pacific Connector Visualisation project simulated the space-based maritime surveillance environment, providing unique insights into factors affecting mission performance. Saab defined the mission environment and provided operational context through their domain-relevant expertise, onto which the University of South Australia developed a user-intuitive interface for representing the operational environment to enhance the effectiveness of a potential mission management system.

Following on from this project, Saab will continue to collaborate with industry and its long term partners, fostering the development of the space ecosystem, whilst continuing to develop and deliver advanced and intuitive Command and Control systems for the space domain."

Brenton Whittington
Space Domain SME, Saab Australia

CASE STUDY

Real-Time Fire Analytics

RMIT University, Geoscience Australia, GA Digital Earth Australia

THE CHALLENGE

Australia urgently requires verified, high quality, real-time information on wildfire location and intensity. Currently, polar-orbiting earth observation satellites are limited to providing new images (and potential hotspots) over Australia once or twice a day, limiting early fire detection and impacting response times.

PROJECT DETAILS

Current fire detection algorithms distinguish hotspots based on the difference between a specific pixel temperature and comparing the potential hotspot to its neighbouring pixels, using fixed threshold values to trigger a detection. As a technique, this can be problematic when fires occur in complex landscapes, or where cloud and/or smoke fully or partially obscure pixel values. For continents as large and diverse as Australia, this poses additional complexity, particularly when relying on satellite images being provided only once or twice a day.

This project had developed a new product, an algorithm called BRIGHT/AHI (Biogeographical Region and Individual Geostationary HHMMSS Threshold/Advanced Himawari Imager). This algorithm uses images from the Himawari-8 satellite from the Japanese Meteorological Agency to provide automated, near-continuous and near-real-time surveillance of potential fire activity across Australia. The BRIGHT/AHI algorithm processes the geostationary earth observation data, detecting fires across Australia using bioregion-specific control values and thresholds based on temperature history. In addition to Himawari-8, satellite sensors that support fire detection include MODIS, VIIRS, Sentinel-2 and DLR's Firebird satellite constellations (Low Earth Orbit satellites). Further to this, in situ and drone and high-altitude-platform based observations provided calibration, validation and accuracy assessment to the algorithm.

The addition of geostationary satellites to the 'toolbox' brings new opportunities for fire observation from space, enhancing the ability for persistent continental monitoring.

The BRIGHT/AHI algorithm delivers near-real-time bushfire information within 45 seconds of receiving satellite imagery and in doing so provides valuable insights into fire activity, impacts, and recovery, contributing to ongoing efforts in wildfire surveillance across Australia.

THE IMPACT

This project produced a new hotspot algorithm that makes observations available every 10 minutes, day and night, customised for Australian conditions. The impact is improved fire information for fire service agencies and land managers across Australia. The current product is deployed with Geoscience Australia's Digital Earth Australia website and provides continuous estimates of fire radiative power day and night, Australia-wide.

WHAT'S NEXT

The system of systems satellite ecosystem (or virtual constellation) developed in this project will support and enhance other projects within the SSCRC Next Generation Earth Observation Data Services program. It is an underpinning and enabling activity. The virtual constellation could be used as an analogue in other application areas:

- Agriculture / Horticulture / Aquaculture,
- Forestry / Mining / Resources,
- Transport / Logistics; and
- Defence,

where multi-temporal and multi-spatial observations are necessary but cannot be accessed from one data source (satellite system). It is being designed to be:

1. incorporated into the GA Digital Earth Australia (DEA) hotspots system; and
2. to be data and platform agnostic i.e. allow for ingestion of spatial data from any satellite source.

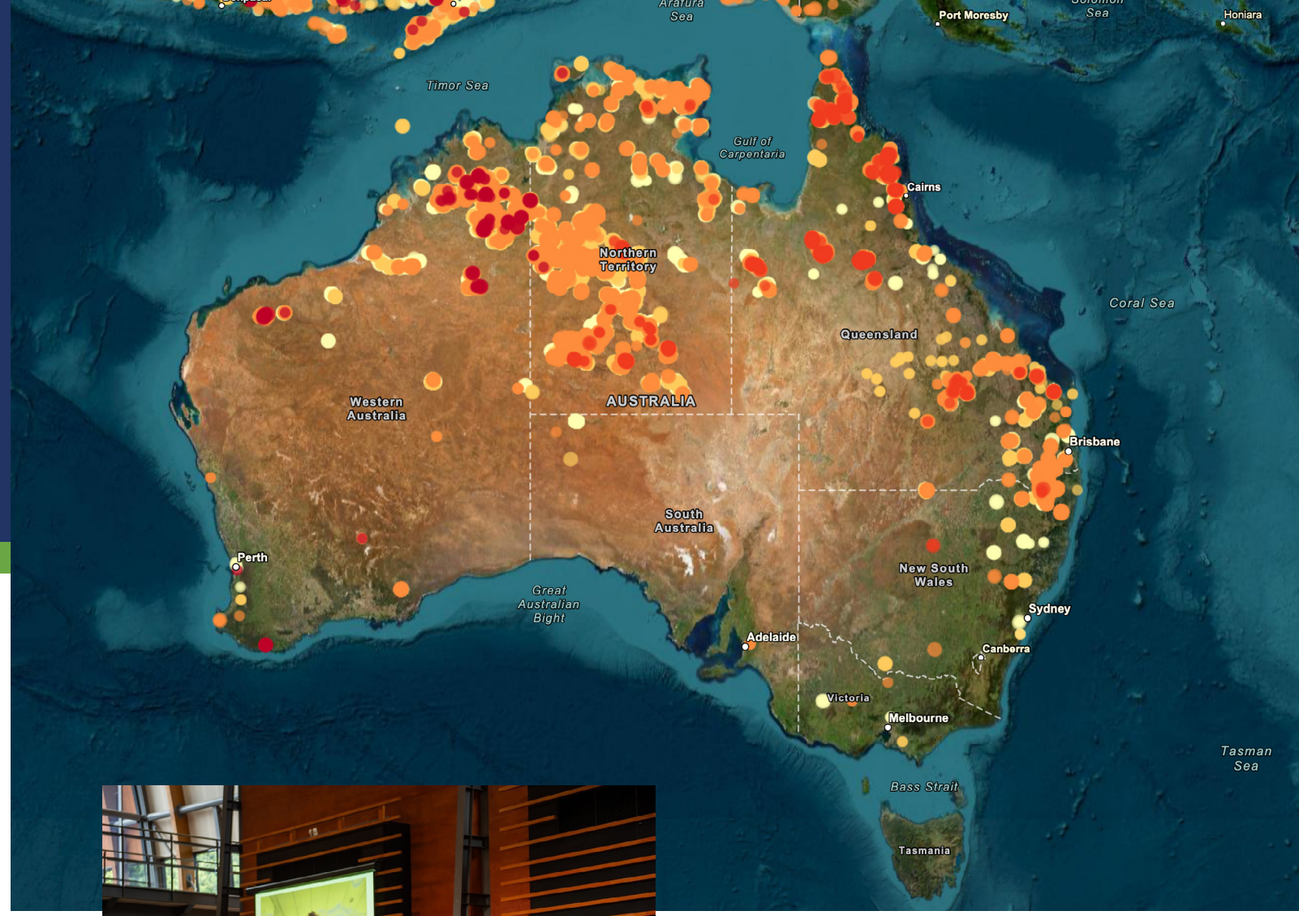


Image (above): Geoscience Australia's web interface 'Digital Earth Australia Hotspots' with the BRIGHT/AHI tool for fire detection, providing automated, near-continuous and near real-time surveillance of fire activity in Australia

Dr Simon Jones, Dr Karen Rienke (RMIT), and Naomi Withers (virtual, Department of Environment, Land Water & Planning Victoria) discussing uses of the BRIGHT/AHI tool

"We've found the RMIT algorithm has made a really big improvement in the accuracy and timeliness of incident detections and it has improved our decision making about knowing when to dispatch resources to remote fires."

Simeon Telfer
Project Manager, Fire Behaviour Intelligence,
South Australian Country Fire Service.

CASE STUDY

Advanced Narrowband Waveforms

Including projects: Resilient Emergency and Search and Rescue Communications (RESARC), LunaSAR and ASCEND2LEO.

RESARC: University of South Australia, Flinders University, Safety from Space, Black Art Technologies, Myriota, Australian Maritime Safety Authority , NASA Search and Rescue Office, Defence Science and Technology Group

LunaSAR: Safety from Space, University of South Australia, Flinders University

ASCEND2LEO: Safety from Space, Fleet Space Technologies, SmartSat CRC

THE CHALLENGE

The initial project in this program of work, RESARC, addressed challenges with existing Search and Rescue (SAR) systems, with an aim to develop an enhanced emergency safety beacon, particularly in remote locations.

A subsequent project, LunaSAR, focused on emergency communications for astronaut suit telemetry and lunar terrain vehicle telemetry, using lunar orbit communication assets for monitoring on Earth, supporting NASA's Artemis program.

A third project, Tactical Waveform Development in support of the ASCEND2LEO Project, is modifying the communications waveform to demonstrate tactical voice communications on Fleet Space Technologies' advanced Low Earth Orbit Centauri satellite.

PROJECT DETAILS

The RESARC Project investigated technology solutions for challenges facing emergency service operators and the public during catastrophic disasters such as bush fires, flooding when communications is compromised or simply unavailable.

A pivotal technology first demonstrated in the RESARC project is the 'Beagle' waveform technology, which meets the needs of next generation satellite-based Search and Rescue. The Beagle processing suite, consisting of software and firmware algorithms, offers a low-power satellite communication system with secure, low-latency messaging and beacon geolocation. It is compatible with the international beacon rescue system, COSPAS-SARSAT, and offers low RF signal power across various frequencies. Beagle also remains robust in 'noisy' and interference-prone environments, ensuring connectivity even when other satellite and terrestrial networks are degraded or unavailable. It is a compact and versatile device with customisable electromagnetic signatures and supports both tactical communications and asset tracking (eg vehicles) with or without GPS, making it ideal for both civilian and military use due to its low detection probability.

The LunaSAR project applied the Beagle technology to the challenging lunar environment, in order to provide astronauts reliable and functional emergency communications. Astronaut safety is paramount and the ability to reliably communicate an emergency incident must be maintained, even if other services are not available. Similar to distress beacons on Earth, this system will provide miniature low power radio beacons mounted on space suits and lunar rover vehicles. The LunaSAR adaptation of the Beagle waveform technology is planned to support SOS and two-way messaging over a lunar orbiting satellite constellation. It will also allow the beacon location to be accurately determined, in the absence of GPS. This information will be provided securely and quickly to both the mission control centre on Earth and the response team on the moon who are able to take immediate action.

In a third project, ASCEND2LEO, a waveform built on Beagle technology will be delivered to Fleet Space Technologies for integration on the Centauri satellite Software Defined Radio (SDR) payload, as part of a $6.4 million contract Fleet Space signed with Defence Space Command. This variant of the Beagle waveform supports low rate voice and data communications, and ASCEND2LEO will demonstrate it's application in LEO satellite communications systems with a focus on tactical communications and data transmission where connectivity is limited. This innovative approach enables Defence to take advantage of Fleet's commercial space technology, primarily used by the mining industry, in combination with the RESARC project IP, to rapidly advance space capabilities.

THE IMPACT

Through these research projects, SmartSat and Safety from Space are adding key features to the Beagle waveform technology that will enable users in the defence and emergency services to access new and emerging SDR solutions for applications in these areas of crucial national importance.

LunaSAR project's outcomes are shaping policies with standard definitions into NASA's international LunaNet specifications document and will see Australia directly contribute sovereign technology to the ARTEMIS program.

A successful demonstration of the Beagle waveform technology in the ASCEN2LEO project has potential to support Defence's needs for sovereign control of key technologies and open licensing opportunities for a future tactical communications system in military environments.

WHAT'S NEXT

Defence Innovation Partnership Collaborative Research is undertaking a project with Flinders University and University of South Australia will see the to development of scalable, secure services in a dual use satellite messaging beacon system for Defence and Emergency Services Personnel.

A related initiative called InfoBuddy to cost effectively connect emergency responders with persons in distress is also now underway through a SmartSat-funded PhD research project at Swinburne University of Technology. InfoBuddy aims to use the Beagle waveform technology to provide messaging services that operate with damaged or unavailable local network infrastructure.

"NASA is delighted to advance technology in this field, which will allow our astronauts exploring the Moon to do so knowing they have a system focused solely on their safety. This is pioneering work that takes such a dedicated international partnership to get to fruition."

Dr Lisa Mazzuca
NASA Search and Rescue Office Chief

"Having had the support of NASA to modernise our second-generation beacon for use on Earth, we are delighted to be entering into an exciting new phase of our development. This agreement will open exciting new opportunities for our technology for users, including emergency management professionals and first responders, as well as helping us to develop important safeguards for astronauts on space missions."

Dr Mark Rice
Safety from Space Co-Founder

"Australia is fortunate to have a talented space industry with an inventive spirit. Space is operationally critical to the achievement of the Defence mission, and this is an example of innovative way to advance our capability and support the development of a sustainable national space enterprise. We look forward to working with Fleet Space Technologies as they bring new approaches to enhance satellite communication capabilities to meet Defence's needs."

Colonel Clifford White
Director Space Services, Defence Space Command

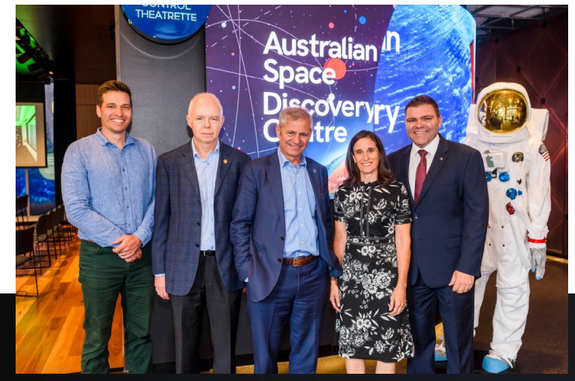
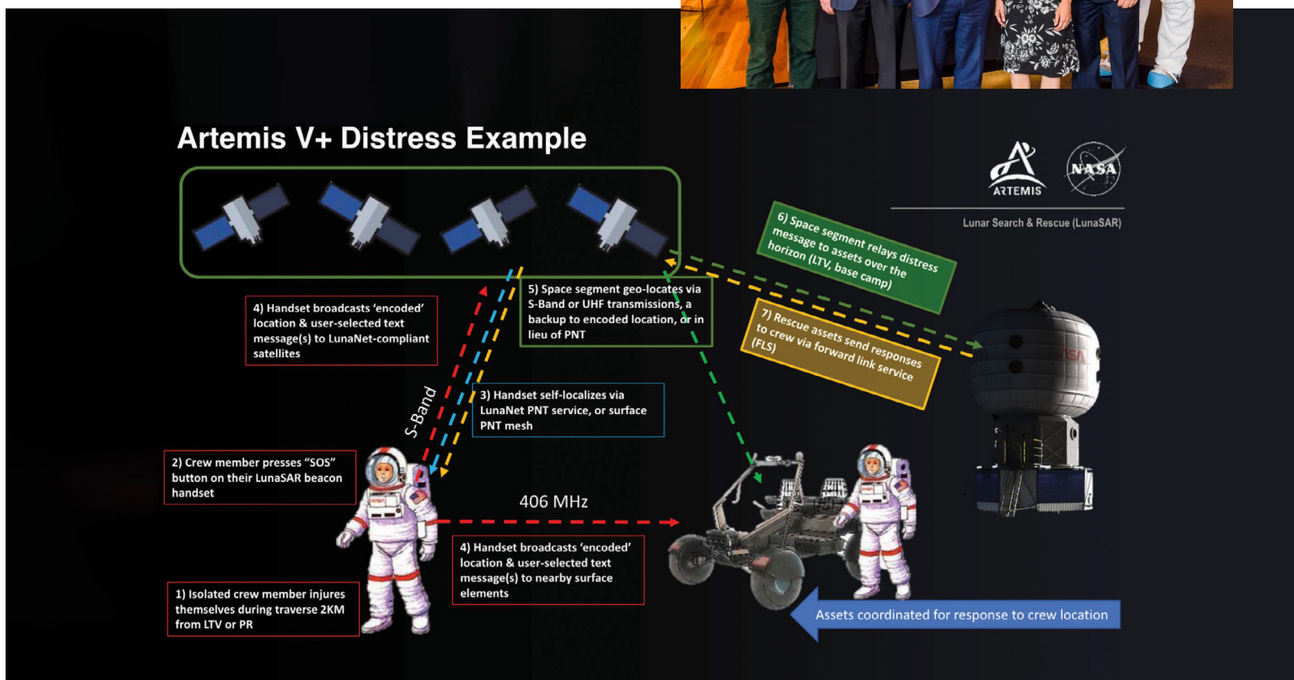


Image (right):L-R SmartSat's Chief Research Officer, Dr Carl Seubert, Safety from Space CEO Dr Mark Rice, SmartSat CEO Prof Andy Koronios, NASA Search and Rescue's Lisa Mazzucca and Cody Kelly



The LunaSAR use case for the Beagle waveform and localisation processing technologies

CASE STUDY

Revolutionizing Aquaculture Site Selection with OysterQual: A Groundbreaking Integration of Earth Observation and IoT for Sustainable Seafood Production in Western Australia

Curtin University, Frontier SI, Geoplex, Maxima Rock Oyster Industries, Myriota, the Department of Primary Industries and Regional Development and Geosciences Australia

THE CHALLENGE

Despite the potential for expansion in Western Australia's aquaculture sector, limited data hampers shellfish farming. Reliable data is vital for identifying optimal farming sites, estimating carrying capacity, and ensuring feasibility. Access to this information helps producers minimise risks and pinpoint ideal development areas.

The OysterQual project is a collaboration of diverse partners - Curtin University, Frontier SI, Geoplex, Maxima Rock Oyster Industries, Myriota, the Department of Primary Industries and Regional Development and Geosciences Australia.

PROJECT DETAILS

The OysterQual project began an innovative investigation into the advantages of merging Internet-of-Things (IoT) based in-situ data acquisition on water quality parameters with satellite-derived Earth Observation data. This was aimed at identifying prime locations for shellfish farming. The goal was to employ the combined power of advanced IoT with remote sensing technologies, to reduce reliance on human personnel visiting remote sites for data collection – a process that can be expensive and logistically challenging.

The required in-situ data was delivered in near-real-time through cost-effective IoT satellite communication technology from Myriota. This innovative approach allowed us to obtain near-real-time data from remote areas with minimal or no conventional telecommunication connectivity, experienced in many regions of Western Australia.

A significant innovation of the OysterQual project lies in its IoT component. The project has melded a range of advanced optical and radiometric sensors with IoT technology, including a chlorophyll fluorometer, turbidity meter, and multi-spectral radiometers. As part of the project, a dashboard prototype was developed that ingested EO, IoT, and model data. The dashboard was trialled by end-users to assess its effectiveness in assisting them in identifying prospective sites. The trial phase concentrated on two remote locations in North Western Australia - the Pilbara and the Kimberley.

THE IMPACT

The OysterQual solution is designed to evolve into a comprehensive IoT and EO based farm site monitoring tool. It demonstrates potential for scalable, farm and regional monitoring of water quality in the Australian aquaculture industry, in both shellfish and fin fish farming. Broader applications could provide critical operational support during the farming process, offering insights into population health, environmental conditions, and disease risk monitoring.

WHAT'S NEXT

As the project nears its conclusion, the focus turns to wrapping up the current phase, with a keen eye on future developments. Our economic feasibility assessment has been completed, producing a comprehensive roadmap for the advancement and operationalisation of the developed solutions. This lays the foundation for a solid business case, driving future development and commercialisation.

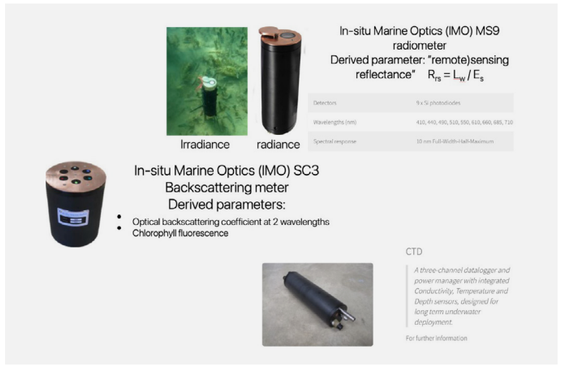
The OysterQual project has accomplished significant milestones, advancing the experimental prototype to Technology Readiness Level (TRL) 3. Some aspects, like the in-situ buoy, have been developed beyond TRL4.

Future work will primarily concentrate on key system elements, such as the optical sensors and the Earth Observation system, which require further validation at new study sites in additional regions of Australia (eg. to deal with variation in local conditions).

Up next is a follow-up workshop with stakeholders to discuss and shape what a potential Phase 2 of the OysterQual project could entail. This collaborative approach will ensure the next steps align with stakeholder needs and expectations.

Image of the deployment sites of the OysterQual project taken from the Copernicus Sentinel2/MSI satellite sensor

Picture taken at deployment of the buoy on the Karratha site



The in-situ sensors deployed on the buoys

By seamlessly integrating IoT technology with satellite Earth Observation imagery, we are looking to help transform the aquaculture industry. At SmartSat, we are enthusiastic about advancing this groundbreaking research into a commercial product that promises to be a game-changer for both the aquaculture industry and government entities.

Dr Jasmine Muir
Principal Scientist in Earth Observation

PHD PROFILES

CHANG LIU
UNSW SYDNEY

Project: Building Damage Estimation After Natural Disaster Using Multi Satellite Source Data Based on Machine Learning

Chang Liu is a PhD candidate in Surveying and Geospatial Engineering at the University of New South Wales (UNSW) Sydney. She completed a Bachelor of Civil Engineering degree at University of Science and Technology Beijing (USTB) and a Master of Philosophy in Built Environment at UNSW Sydney.

Her research is focused on data semantic segmentation for building damage assessment using artificial intelligence methods with 2D satellite images and 3D LiDAR point cloud. In addition to research and teaching at UNSW, she has demonstrated her strong leadership and excellent communication and teamwork skills as the vice-president of Civil and Environment Engineering Research Student Association at UNSW Sydney.

NERMINE HENDY
RMIT UNIVERSITY

Project: Interference modelling, detection, and mitigation for improving spaceborne SAR performance

Nermine Hendy is an Electrical and Electronic Engineering PhD researcher at the RMIT University. Previously, she completed her Masters in Electrical and Electronic Engineering from Alexandria University in Egypt, specialising in emotion recognition using neural networks.

Hendy is currently working on a project to develop a spaceborne RADAR system in the hopes of developing an open-source simulator that will help improve synthetic aperture radar (SAR). She also teaches a number of undergraduate courses in various adjacent research areas, such as network fundamentals and embedded systems.

SABRINA SLIMANI
UNIVERSITY OF ADELAIDE

Project: Using Quantum Entanglement to Remotely Synchronise Clocks

Sabrina Slimani is currently undertaking a PhD with the Institute for Photonics and Advanced Sensing (IPAS) at the University of Adelaide. Sabrina was conferred a Bachelor of Science (Experimental and Theoretical Physics) and subsequently Honours in Bachelor of Science in 2020 at the University of Adelaide.

Her current research involves using quantum mechanics to develop a secure protocol to synchronise clocks.

THOMAS GRAHAM
SWINBURNE UNIVERSITY OF TECHNOLOGY

Project: Responsible Artificial Intelligence in Space

Thomas Graham completed a Bachelor of Science majoring in Physics at the University of Melbourne, before completing his Juris Doctor, also at the University of Melbourne. While completing his Juris Doctor, Graham worked with, and subsequently managed, the regulatory team at the Melbourne Space Program, assisting them in matters such as the launch of their flagship ACRUX-1 satellite in 2019. Graham is now pursuing a PhD at Swinburne University of Technology, focusing on Responsible AI in Space, investigating the need for regulation of automated systems in the space industry. Graham hopes to utilise both his scientific and legal education to bring a multi-disciplinary perspective to the regulation of the Australian space industry as a part of his research supported by SmartSat CRC, Swinburne University of Technology, and Ernst & Young Australia.

SKEVOS KARPATHAKIS
UNIVERSITY OF WESTERN AUSTRALIA

Project: Communications Engineering, Phase- and Spatial-Stabilisation System Development

Skevos Karpathakis is an engineer and PhD candidate at the University of Western Australia. His project contributes to the future of optical ground station networks in Australia by integrating optical communications systems into phase-and-amplitude-stabilised free-space laser ranges. Karpathakis' work is conducted with the Astrophotonics group at the International Centre for Radio Astronomy Research (ICRAR), where he was employed as an electronic engineer prior to commencing his PhD. Before joining ICRAR, Karpathakis worked in product development in the smart city space. He previously completed a Master of Professional Engineering at UWA and led a team of students to participate in the Formula SAE competition.

HARIKESH SINGH
UNIVERSITY OF SUNSHINE COAST

Project: An Empirical and Dynamic Tool for Prediction of Forest Fire Spread Using Remote Sensing and Machine Learning Techniques

Harikesh Singh is a Higher Degree Researcher in the University of the Sunshine Coast School of Science Technology and Engineering studying empirical and dynamic tools for prediction of forest fire spread using remote sensing and Machine Learning techniques, focusing on forest fire spread prediction mapping. Singh completed a Master of Technology in Remote Sensing and geographic information system (GIS) in 2019 at the Indian Institute of Remote Sensing, Indian Space Research Organisation (ISRO) in Dehradun, India.

APPENDIX

SmartSat PhD Students

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SMARTSAT PHD STUDENTS

Student	Commencement — Completion	Research Program	University	Country	Project Title
Benjamin Dix- Mathews	2020 — 2022	RP 1	University of Western Australia	Australia	Phase- and spatial- stabilisation system development
Skevos Karpathakis	2021— 2024	RP 1	University of Western Australia	Australia	Phase- and spatial- stabilisation system development / Coherent Free-Space Optical Communications
Duaa Fatima	2020 — 2023	RP 1	La Trobe University	Pakistan	Physical Layer Security for Satellite based IoT Edge Services with Deep Reinforcement Learning for Energy Efficiency
Zachary Aul	2020 — 2022	RP 1	La Trobe University	Australia	Anomaly Detection in IoT for Satellite Security Using Blockchain
Mohamed Shehata	2021— 2024	RP 1	University of Adelaide	Egypt	Potentials and Limitations of the IEEE 802.15.3d Standard for Terahertz Satellite Communications
Ahsan Waqas	2021— 2024	RP 1	University of South Australia	Pakistan	Distributed Beamforming for Satellite Applications
Kou Tian	2021— 2024	RP 1	University of Sydney	China	Deep Learning for Advanced Physical Layer Communications
Vibhor Thapliyal	2022 —2025	RP 1	La Trobe University	India	Fabrication of 3-D, Wavelength-Tuneable Photonic Crystals for Space-based mm-Wave, Terahertz, and Infrared Communications
Ziwei Wang	2021— 2024	RP 2	Australian National University	China	Event-based attitude estimation for space applications
Anne Bettens	2020 — 2022	RP 2	University of Sydney	Australia	Autonomous navigation of satellites for space exploration
Sam Hilton	2020 — 2022	RP 2	Royal Melbourne Institute of Technology	Australia	Human-Autonomy teaming for intelligent Distributed Satellite Operations
Jordan Plotnek	2020 — 2022	RP 2	University of South Australia	Australia	Measuring Control System Resilience to Cyber-Physical Threat in a Satellite Context
Thomas Graham	2021 — 2024	RP 2	Swinburne University of Technology	Australia	Responsible AI in Space
Sabrina Slimani	2021 — 2024	RP 2	University of Adelaide	Australia	Using quantum entanglement to remotely synchronise clocks
Emily Ahern	2021 — 2024	RP 2	University of Adelaide	Australia	Compact Clock for Small Satellite Applications: Protocol Development for Increased Stability
Kathiravan Thangavel	2021 — 2024	RP 2	Royal Melbourne Institute of Technology	India	AI for Distributed Satellite Systems Autonomous Operations: An Integrated Approach to Space and Control Segments Co-Evolution
Sai Vallapureddy	2021 — 2024	RP 2	Royal Melbourne Institute of Technology	India	A machine learning based solution for Space Situational Awareness and Space sustainability
Artur Medon	2021 — 2024	RP 2	University of South Australia	Australia	Small satellite thermal management with 3D printed metal heat sinks containing phase change material thermal storage
Brandon Victor	2021 — 2024	RP 2	La Trobe University	Australia	Using Satellite Data to Locate and Phenotype Plants from Space
Harikesh Singh	2021 — 2024	RP 2	University of Sunshine Coast	India	An empirical and dynamic tool for prediction of forest fire spread using remote sensing and machine learning techniques
Chang Liu	2021 — 2024	RP 2	University of New South Wales	China	Building damage estimation after natural disaster using multi satellite source data based on machine learning
Jordan Shippard	2022 — 2025	RP 2	Queensland University of Technology	Australia	Efficient Subnets for Scalable Onboard AI in Space
Nermine Handy	2021 — 2024	RP 2	Royal Melbourne Institute of Technology	Australia	Interference modelling, detection, and mitigation for improving spaceborne SAR performance
Trung Dung Nguyen	2022 — 2025	RP 2	La Trobe University	Vietnam	Advances in Long-term Water Quality Monitoring through Data Fusion
Joshua Davis	2022 — 2025	RP 2	La Trobe University	Australia	Attack-resilient CubeSat constellations
Nur Fajar Trihantoro	2021 — 2024	RP 3	Royal Melbourne Institute of Technology	Indonesia	Real Time Fire Analytics
Konstantinos Chatzopoulos Vouzoglanis	2021 — 2024	RP 3	Royal Melbourne Institute of Technology	Greece	Real Time Fire Analytics
Simon Ramsay	2021 — 2024	RP 3	Royal Melbourne Institute of Technology	Australia	Real Time Fire Analytics
Jason Dail	2022 — 2025	RP 3	University of Queensland	USA	Towards effective adaptive monitoring of UN SDG #15 Protect and Sustain Terrestrial Ecosystems using EO Data, Products and Services
Liang Zhao	2021 — 2024	RP 3	University of South Australia	China	Satellite image-based smoke detection for bush fire detection

SMARTSAT PHD STUDENTS

Student	Commencement — Completion Date	Research Program	University	Country	Project Title
Yanli Yu	2021 — 2022	RP 3	Australian National University	China	Monitoring changes in water quality in response to landcover disturbance with Earth Observations in Australia
Alvaro Valenzuela Quinteros	2021— 2024	RP 3	University of Western Australia	Chile	Innovations in spatial response assessment for satellite images
Robert Andriambololonaharisoamalala	2021 — 2024	RP 4	Curtin University	Madagascar	Integration of Earth Observation data and ground-based measurements to accurately map the effect of Urban Heat Islands
Vinícius Guedes	2022 — 2025	RP 2	Flinders University	Brazil	How to preserve national aspirations and promote cyber defence policies
Lucas Tutsui da Silva	2023 — 2026	RP 3	University of New South Wales	Brazil	Semi-Supervised Learning for Automatic Improvement of Onboard Object Detection Models on Small Satellites
Uakomba Uhongora	2022 — 2025	RP 1	University of South Australia	Namibia	Deep Learning Intrusion Detection System for Smart Satellite Networks Based on Software Defined Networking
Xiongren Chen	2022 — 2025	RP 1	University of South Australia	China	Interpretable Machine Learning for the Early Smoke Wild-fire Detection
William Meakin	2022 — 2025	RP 1	University of Adelaide	Australia	Onboard Machine Learning for Intelligent Satellites
Yue Cai	2022 — 2025	RP 2	University of Sydney	China	Deep learning-based Low earth orbit (LEO) satellites task offloading and massive MIMO implementation
Michael Aygur	2023 — 2026	RP 1	Royal Melbourne Institute of Technology	Australia	Cognitive Satellite Radios
Kithmini Weththasinghe	2022 — 2025	RP 1	University of Technology Sydney	Sri Lanka	Cognitive Satellite Radios
Hira Saleem	2023 — 2026	RP 3	University of New South Wales	Pakistan	Natural hazard prediction and damage assessment using multimodal satellite and geospatial data in self-supervised XAI model
William Damario Lukito	2023 — 2026	RP 1	La Trobe University	Indonesia	Machine Learning Approach for The Enhancement of Transmission Capacity and Latency for IoT Satellite Communications Based on Resource Allocation
Cho Hilary	2023 — 2026	RP 1	University of Technology Sydney	Cameroon	Wideband Antennas for Cognitive Satellite Communications.
Gillian Rowan	2023 — 2026	RP 3	University of Queensland	Canada	Using space-based Earth Observation to map Australia's kelp forests for a stronger Blue Carbon economy
Harrison Bennett	2023 — 2026	RP 2	University of Adelaide	Australia	Machine learning-enabled satellites for Agile Space Operations
Franke Agenbag	2023 — 2026	RP 2	University of South Australia	Australia	An automated method of detecting, characterising, and responding to radiation events in space.
Francis Kagai	2023 — 2026	RP 1	Swinburne University of Technology	Kenya	Emergency Buddy System
Than Myint Swe	2023 — 2026	RP 3	University of Queensland	Myanmar	On-ground management of soil health by integrating proximal and remote sensing platforms in northern Australian savannas grazing land
Raja Ram Aryal	2022 — 2025	RP 3	University of Queensland	Nepal	Solar Induced Chlorophyll Fluorescence (SIF) for plant health/stress and productivity remote sensing applications
Elliot Hansen	2023 — 2026	RP 2	University of Adelaide	Australia	Advanced Synthetic Aperture Radar-based Surface and Underwater Object Detection and Classification

SmartSat CRC Ltd and its Controlled Entities

ABN 63 633 923 949

Consolidated Financial Report - 30 June 2023

SmartSat CRC Ltd and its Controlled Entities
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30 June 2023

SmartSat CRC Ltd and its Controlled Entities
Directors' report
30 June 2023

The Directors present their report on SmartSat CRC Ltd (SmartSat) and its Controlled Entities (the 'Group') for the year ended 30 June 2023.

Directors
The following persons were Directors of SmartSat during the whole of the financial year and up to the date of this report, unless otherwise stated:

Director	Position	Date appointed-resigned
Dr. Michele Allan AO	Chair	20/01/2023
	Acting Chair	06/12/2022 - 19/01/2023
Prof. Andy Koronios	CEO & Managing Director	05/08/2019
Dr. Jacqueline Craig AM	Director	27/11/2019
Dr. Rosalind Dubs	Director	27/11/2019
Prof. Margaret Harding	Director	27/11/2019
Dr. Danielle Wuchenich	Director	31/01/2021
Ms. Mikaela Jade	Director	17/02/2022
Prof. Roy Green	Director	23/05/2023
Dr. Peter Woodgate	Chair	05/08/2019 - 06/12/2022

Principal activities
The principal activities of SmartSat during the financial period were to conduct translational research which creates game-changing technologies, generate know-how that will make Australian industries more competitive, and future-proof jobs for the Australian population.

SmartSat is a consortium of universities and other research organisations, partnered with industry that has been funded by the Australian Government to develop know-how technologies in advanced telecommunications and IoT connectivity, intelligent satellite systems and earth observation next generation data services. The impact of this research will be to develop intellectual property and a specialised space industry expertise that will spawn new businesses, create export economic value and generate new high-tech jobs for all Australians.

Short and long term objectives of the Group
SmartSat was established to tackle three major challenges:

1. Lack of universal digital connectivity; (communication and connectivity)
2. Fragmented space ecosystem; (creation of an integrated space R&D ecosystem)
3. Technology-limited earth observation. (earth observation from space)

The strategic objectives of SmartSat are to:

- Forge space systems research
- Drive innovation and transformation
- Develop a space industry
- Foster a space smart nation
- Position Australia as a global player in the space sector

The Group's strategy for achieving its objectives
SmartSat has developed strategic and operational plans that underpin the achievement of its strategic objectives. These include:

- Seeking peer review of SmartSat projects and outcomes from world leaders in space research and development
- Developing a continuous review approach
- Identifying areas of high impact applications in which to develop research programmes relevant to EO needs
- Developing a technology roadmap to align research projects and technology development to selected applications
- Identifying higher degree research (HDR) topics that suggest and augment the research programme
- Conducting a space industry skill needs analysis
- Collaborating with educational providers in mapping all available relevant training programs
- Development of partnerships to share expertise, capabilities and strategies
- Using media tracking services to track media reporting on SmartSat activities and outputs

Key performance indicators used by the Group
Key performance indicators have been developed for each of the Group's objectives including:

- Partners contributing additional funding to CRC approved research projects
- Recognition of excellence in national and international events and activities
- External bench marking of research projects
- Successful completion of at least 70 HDR students
- A percentage of SmartSat students will be employed by the Australian Space Industry

The Group's key performance measures used are the milestones that are set up in the CRC Commonwealth Agreement and SmartSat is required to report against those milestones on a quarterly basis. SmartSat is also required to submit an annual report to the Commonwealth.

Significant changes
There were no significant changes to the operations of the Group.

Operating result
The surplus of the Group for the year amounted to $2,748,786 (2022: $3,368,584).

Dividends
The Group is limited by guarantee and has no share capital. No dividends were paid or declared by SmartSat for the period.

Events after the reporting date
No matters or circumstances have arisen since the end of the financial year which significantly affected or may significantly affect the operations of the Group, the results of those operations or the state of affairs of the Group in future financial years.

Future developments and results
As the Group continues its activities, further expenditure will be incurred on research, educational and other activities and projects established by SmartSat.

Environmental issues
The Group's operations are not regulated by any significant environmental regulations under a law of the Commonwealth or of a state or territory of Australia.

SmartSat CRC Ltd and its Controlled Entities
Directors' report
30 June 2023

Information on Directors
The information on Directors is as follows:

Director	Qualifications
Dr. Michele Allan AO FAICD	B App Sc (Biomedical), DBA, M Mgmt Tech, M Com Law
Prof. Andy Koronios FACS FISEAM GAICD	PhD, MLitt(Comp), GradDip Ed, BE
Dr. Jacqueline Craig AM FTSE	Bsc, MSc, PhD
Dr. Rosalind Dubs FTSE FAICD	BSc, Dr ès SC (Lausanne)
Prof. Margaret Harding FRACI MAICD	BSc (Hons, Chemistry), PhD (Chemistry), DSc (Chemistry)
Dr. Danielle Wuchenich	PhD (Physics), BSc (Physics and Mathematical Studies), BA (Spanish Studies)
Ms. Mikaela Jade	M Applied Cybernetics, BSc (Environmental Biology), Grad Cert Indigenous Land management
Prof. Roy Green FIAM FRSA FCRD FRSNSW	PhD, LLB, BA
Dr. Peter Woodgate GAICD, FSSSI (Hon)	DBA, M App Sci (Remote Sensing), B For Sci, Dip For

Meetings of Directors
The number of meetings of the company's Board of Directors ('the Board') held during the year ended 30 June 2023, and the number of meetings attended by each Director were:

	Full Board	
	Attended	Held
Dr. Michele Allan AO	6	6
Prof. Andy Koronios	6	6
Dr. Jacqueline Craig AM	5	6
Dr. Rosalind Dubs	6	6
Prof. Margaret Harding	6	6
Dr. Danielle Wuchenich	5	6
Ms. Mikaela Jade	6	6
Prof. Roy Green	1	1
Dr. Peter Woodgate	2	2

Held: represents the number of meetings held during the time the Director held office.

Indemnification and insurance of officers and auditors
The Directors and Officers of the Group are covered by a Directors and Officers insurance policy, paid by the Group.

No other indemnities have been given during or since the end of the year for any person who is or has been an officer or auditor of the Group.

Proceedings on behalf of the Group
No proceedings have been entered into on behalf of the Group.

Member's guarantee
SmartSat is a company limited by guarantee. In the event of, and for the purpose of winding up of the company, the amount capable of being called up from each member and any person or association who ceased to be a member in the year prior to the winding up, is limited to $100 for members that are corporations and for all other members, subject to the provisions of the Group's constitution.

At 30 June 2023 the collective liability of members was $1,100 (2022: $1,100).

Auditor's independence declaration
A copy of the auditor's independence declaration in accordance with section 60-40 of the Australian Charities and Not-for-profits Commission (ACNC) Act 2012, for the year ended 30 June 2023, has been received and can be found immediately after this Directors' report.

This report is made in accordance with a resolution of the Board of Directors:

Dr. Michele Allan AO
Chair

Prof. Andy Koronios
CEO & Managing Director

27 September 2023

BDO

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DECLARATION OF INDEPENDENCE

BY JOSH CARVER

TO THE DIRECTORS OF SMARTSAT CRC LTD

As lead auditor of SmartSat CRC Ltd for the year ended 30 June 2023, I declare that, to the best of my knowledge and belief, there have been:

1. No contraventions of the auditor independence requirements of section 60-40 of the *Australian Charities and Not-for-profits Commission Act 2012* in relation to the audit; and
2. No contraventions of any applicable code of professional conduct in relation to the audit.

This declaration is in respect of SmartSat CRC Ltd and the entities it controlled during the period.

Josh Carver
Director

BDO Audit Pty Ltd

Adelaide, 23 October 2023

SmartSat CRC Ltd and its Controlled Entities
Consolidated statement of profit or loss and other comprehensive income
For the year ended 30 June 2023

	Note	Consolidated 2023 $	Consolidated 2022 $
Revenue	4	17,156,611	16,320,883
Other income	5	2,439,222	2,543,452
Total revenue and other income		19,595,833	18,864,335
Programme Costs	6	13,364,373	12,795,427
Business development		341,950	141,545
Conference & seminars		176,436	67,956
Administration fees	7	1,721,447	1,120,427
Governance		467,050	386,832
Information technology		201,910	255,197
Marketing & promotions		323,456	219,723
Office operations		95,428	316,697
Other expenses		154,997	191,947
Total expenses		16,847,047	15,495,751
Surplus for the year attributable to the members of SmartSat CRC Ltd and its Controlled Entities		2,748,786	3,368,584
Other comprehensive income for the year		-	-
Total comprehensive income for the year attributable to the members of SmartSat CRC Ltd and its Controlled Entities		2,748,786	3,368,584

The above consolidated statement of profit or loss and other comprehensive income should be read in conjunction with the accompanying notes

SmartSat CRC Ltd and its Controlled Entities
Consolidated statement of financial position
As at 30 June 2023

	Note	Consolidated 2023 $	Consolidated 2022 $
Assets			
Current assets			
Cash and cash equivalents	8	25,082,360	23,053,641
Trade and other receivables	9	1,027,283	997,150
Other assets		41,817	522
Total current assets		26,151,460	24,051,313
Non-current assets			
Property, plant and equipment	10	188,503	166,587
Right-of-use assets	11	545,962	191,403
Total non-current assets		734,465	357,990
Total assets		26,885,925	24,409,303
Liabilities			
Current liabilities			
Trade and other payables	12	5,710,837	6,444,527
Lease liabilities	13	150,298	78,777
Employee benefits	14	240,634	167,292
Total current liabilities		6,101,769	6,690,596
Non-current liabilities			
Lease liabilities	13	413,499	134,962
Employee benefits	14	65,785	27,659
Total non-current liabilities		479,284	162,621
Total liabilities		6,581,053	6,853,217
Net assets		20,304,872	17,556,086
Equity			
Retained earnings	16	20,304,872	8,080,951
Reserves	15	-	9,475,135
Equity attributable to the members of SmartSat CRC Ltd and its Controlled Entities		20,304,872	17,556,086
Total equity		20,304,872	17,556,086

The above consolidated statement of financial position should be read in conjunction with the accompanying notes

SmartSat CRC Ltd and its Controlled Entities
Consolidated statement of changes in equity
For the year ended 30 June 2023

Consolidated	Research Chairs reserve $	Scholarships reserve $	Node reserve $	Retained earnings $	Total equity $
Balance at 1 July 2021	3,600,000	4,126,416	-	6,461,086	14,187,502
Surplus for the year	-	-	-	3,368,584	3,368,584
Other comprehensive income for the year	-	-	-	-	-
Total comprehensive income for the year	-	-	-	3,368,584	3,368,584
Transfers to/(from) reserves	1,623,077	(474,358)	600,000	(1,748,719)	-
Balance at 30 June 2022	5,223,077	3,652,058	600,000	8,080,951	17,556,086

Consolidated	Research chairs Reserve $	Scholarships reserve $	Node reserve $	Retained earnings $	Total equity $
Balance at 1 July 2022	5,223,077	3,652,058	600,000	8,080,951	17,556,086
Surplus for the year	-	-	-	2,748,786	2,748,786
Other comprehensive income for the year	-	-	-	-	-
Total comprehensive income for the year	-	-	-	2,748,786	2,748,786
Transfer from reserves	(5,223,077)	(3,652,058)	(600,000)	9,475,135	-
Balance at 30 June 2023	-	-	-	20,304,872	20,304,872

The above consolidated statement of changes in equity should be read in conjunction with the accompanying notes

SmartSat CRC Ltd and its Controlled Entities
Consolidated statement of cash flows
For the year ended 30 June 2023

	Note	Consolidated 2023 $	Consolidated 2022 $
Cash flows from operating activities			
Receipts from grants (incl. GST)		8,479,114	8,506,475
Receipts from participants (incl. GST)		7,706,688	9,014,395
Receipts from other operating income (incl. GST)		2,657,429	2,831,383
Payments to suppliers and employees (incl. GST)		(17,270,184)	(15,358,814)
Interest income		722,469	50,526
Interest expense		(29,900)	(20,059)
Net cash provided by operating activities		2,265,616	5,023,906
Cash flows from investing activities			
Payments for property, plant and equipment	10	(79,864)	(190,132)
Net cash used in investing activities		(79,864)	(190,132)
Cash flows from financing activities			
Repayment of lease liabilities (principal)		(157,033)	(100,776)
Net cash used in financing activities		(157,033)	(100,776)
Net increase in cash and cash equivalents		2,028,719	4,732,998
Cash and cash equivalents at the beginning of the financial year		23,053,641	18,320,643
Cash and cash equivalents at the end of the financial year	8	25,082,360	23,053,641

The above consolidated statement of cash flows should be read in conjunction with the accompanying notes

Note 1. General introduction

The consolidated financial statements and notes represent those of SmartSat CRC Ltd (SmartSat) and its Controlled Entities (the 'Group'). SmartSat is a not-for-profit unlisted public company limited by guarantee, incorporated and domiciled in Australia. SmartSat is also a registered charity with the *Australian Charities and Not-for-profits Commission Act 2012*. Aurora Space Cluster Pty Ltd is a wholly owned subsidiary of SmartSat.

The consolidated financial report is measured using the currency of the primary economic environment in which the Group operates in (the 'financial currency'). The financial report is presented in Australian dollars which is the Group's functional and presentation currency.

The financial report was authorised for issue by the Directors on 27 September 2023. The Directors have the power to amend and reissue the financial statements.

Principles of Consolidation
This consolidated financial report has been prepared in accordance with the Australian Accounting Standards - Simplified Disclosures issued by the Australian Accounting Standards Board ('AASB') and the *Australian Charities and Not-for-profits Commission Act 2012*, as appropriate for not-for-profit oriented entities. This includes compliance with the recognition and measurement requirements of all Australian Accounting Standards, Interpretations and other authoritative pronouncements of the Australian Accounting Standards Board and the disclosure requirements of *AASB 1060 General Purpose Financial Statements - Simplified Disclosures for For-profit and Not-for-profit Tier 2 Entities*.

Historical cost convention
The consolidated financial report has been prepared on an accrual basis and under the historical cost convention, unless otherwise stated.

Rounding of amounts
The Group is of a kind referred to in Corporations Instrument 2016/191, issued by the Australian Securities and Investments Commission, relating to 'rounding-off'. Amounts in this report have been rounded off in accordance with that Corporations Instrument to the nearest dollar.

Critical accounting estimates
The preparation of the consolidated financial report requires the use of certain critical accounting estimates. It also requires management to exercise its judgement in the process of applying the Group's accounting policies. The areas involving a higher degree of judgement or complexity, or areas where assumptions and estimates are significant to the financial statements, are disclosed in note 3.

Note 2. Significant Accounting Policies

The principal accounting policies adopted in the preparation of the consolidated financial report are set out below. These policies have been consistently applied to all the years presented, unless otherwise stated.

(a) New or amended Accounting Standards and Interpretations adopted
The Group has adopted all of the new or amended Accounting Standards and Interpretations issued by the Australian Accounting Standards Board ('AASB') that are mandatory for the current reporting period.

Any new or amended Accounting Standards or Interpretations that are not yet mandatory have not been early adopted.

Note 2. Significant Accounting Policies (continued)

(b) Principles of Consolidation
This consolidated financial report incorporates the assets and liabilities of all subsidiaries of SmartSat as at 30 June 2023 and the results of all subsidiaries for the year then ended. SmartSat and its subsidiaries together are referred to in this consolidated financial report as the 'Group'.

Subsidiaries are all those entities over which the Group has control. The Group controls an entity when the Group is exposed to, or has rights to, variable returns from its involvement with the entity and has the ability to affect those returns through its power to direct the activities of the entity. Subsidiaries are fully consolidated from the date on which control is transferred to the Group. They are de-consolidated from the date that control ceases.

(c) Revenue Recognition
Income for Not-for-profit Entities
The consolidated entity considers the applicability of AASB 15 *Revenue from contracts with customers* to each significant income stream.

Where AASB 15 is determined to apply to an income stream, the consolidated entity recognises revenue at an amount that reflects the consideration to which the company is expected to be entitled in exchange for transferring goods or services to a customer. For each contract with a customer, the company: identifies the contract with a customer; identifies the performance obligations in the contract; determines the transaction price which takes into account estimates of variable consideration and the time value of money; allocates the transaction price to the separate performance obligations on the basis of the relative stand-alone selling price of each distinct good or service to be delivered; and recognises revenue when or as each performance obligation is satisfied in a manner that depicts the transfer to the customer of the goods or services promised, which may involve the recognition of contract assets and / or liabilities.

Contract assets are recognised when the company has transferred goods or services to the customer but where the company is yet to establish an unconditional right to consideration. Contract liabilities represent an obligation to transfer goods or services to a customer and are recognised when a customer pays consideration, or when the company recognises a receivable to reflect its unconditional right to consideration (whichever is earlier) before the company has transferred the goods or services to the customer.

AASB 15 *Revenue from contracts with customers* is only applicable to agreements with customers that contain:
1. 'Enforceable' rights and obligations; and
2. 'Sufficiently specific' performance obligations.

An agreement is typically enforceable by another party through legal or equivalent means if the agreement is in writing and includes sufficiently specific requirements of the parties.

Judgement is exercised in assessing whether promises within an agreement are ‘sufficiently specific’, taking into account any conditions specified in the arrangement (whether explicit or implicit) regarding the promised goods or services, including conditions regarding:
- the nature or type of the goods or services;
- the cost or value of the goods or services;
- the quantity of the goods or services; and
- the period over which the goods or services must be transferred.

Where the consolidated entity determines agreements with customers do not contain “enforceable” rights and obligations, or “sufficiently specific” performance obligations, the consolidated entity applies AASB 1058 *Income of Not-for-Profit Entities* and recognises income in full, either upon receipt, or when the unconditional right to receive payment is established (whichever comes earlier), and it is probable that the economic benefits comprising the contribution will flow to the consolidated entity.

Note 2. Significant Accounting Policies (continued)

For the below listed revenue streams, the Group recognises revenue as follows:

Contributions from Participants
Contributions from Participants are recognised as revenue in the Statement of Profit or Loss and Other Comprehensive Income as they are received, or when the Group has an unconditional right to receive payment.

Government Grants
Government grants (including monetary grants at fair value) are recognised as revenue in the Statement of Profit or Loss and Other Comprehensive Income as they are received, or when the Group has a conditional right to receive payment. If conditions are attached to the grant which must be satisfied before the Group is eligible to retain the contributions, the grant will be recognised in the Statement of Financial Position as a liability until those conditions are satisfied.

Third Party Contributions
Contributions from other third parties are assessed on a case-by-case basis, with the Group evaluating whether sufficiently specific performance obligations are attached to the funding. Where sufficiently specific performance obligations are determined to exist, revenue is recognised in profit or loss when the Group satisfies the performance obligations. When the Group determines there are no sufficiently specific performance obligations, contributions are recognised as revenue in the Statement of Profit or Loss and Other Comprehensive Income as they are received, or when the Group has an unconditional right to receive payment.

Interest
Interest revenue is recognised as interest accrues using the effective interest method. This is a method of calculating the amortised cost of a financial asset and allocating the interest income over the relevant period using the effective interest rate, which is the rate that exactly discounts estimated future cash receipts through the expected life of the financial asset to the net carrying amount of the financial asset.

Volunteer services and other in-kind contributions
The Group has elected not to recognise volunteer services as either revenue or other form of contribution received in line with AASB 1058. As such any related consumption or capitalisation of such resources received is also not recognised.

Other revenue
Other revenue is recognised when it is received or when the right to receive payment is established.

(d) Financial Instruments
Financial instruments are recognised initially on the date that the Group becomes party to the contractual provisions of the instrument.

On initial recognition, all financial instruments are measured at fair value plus transaction costs (except for instruments measured at fair value through profit or loss where transaction costs are expensed as incurred).

Note 2. Significant Accounting Policies (continued)

(e) Financial Assets
All recognised financial assets are subsequently measured in their entirety at either amortised cost or fair value, depending on the classification of the financial assets.

Classification

On initial recognition, the Group classifies its financial assets into the following categories, those measured at:

- amortised cost
- fair value through profit or loss - FVTPL
- fair value through other comprehensive income - equity instrument (FVOCI - equity)
- fair value through other comprehensive income - debt investments (FVOCI - debt)

Financial assets are not reclassified subsequent to their initial recognition unless the Group changes its business model for managing financial assets.

Amortised Cost

Assets measured at amortised cost are financial assets where:

- the business model is to hold assets to collect contractual cash flows; and
- the contractual terms give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

The Group's financial assets measured at amortised cost comprise trade and other receivables and cash and cash equivalents in the Statement of Financial Position.

Subsequent to initial recognition, these assets are carried at amortised cost using the effective interest rate method less provision for impairment.

Interest income, foreign exchange gains or losses and impairment are recognised in the Statement of Profit or Loss and Other Comprehensive Income. Gain or loss on derecognition is recognised in the Statement of Profit or Loss and Other Comprehensive Income.

Note 2. Significant Accounting Policies (continued)

(f) Impairment of Financial Assets
Impairment of financial assets measured at amortised cost is calculated using an expected credit loss (ECL) approach which requires lifetime expected credit losses to be recognised from initial recognition of the financial assets.

When determining whether the credit risk of a financial asset has increased significantly since initial recognition and when estimating ECL, the Group considers reasonable and supportable information that is relevant and available without undue cost or effort. This includes both quantitative and qualitative information and analysis based on the Group's historical experience and informed credit assessment and including forward looking information.

The Group uses the presumption that an asset which is more than 90 days past due has seen a significant increase in credit risk.

The Group uses the presumption that a financial asset is in default when:

• the other party is unlikely to pay its credit obligations to the Group in full, without recourse to the Group to actions such as realising security (if any is held); or
• the financial assets is more than 120 days past due date.

Credit losses are measured as the present value of the difference between the cash flows due to the Group in accordance with the contract and the cash flows expected to be received. This is applied using a probability weighted approach.

(g) Income Tax
The Group's subsidiary, Aurora Space Cluster Pty Ltd is a for-profit unlisted company, limited by shares and is liable for income tax.

As SmartSat is a charitable institution in terms of subsection 50-5 of the *Income Tax Assessment Act 1997*, as amended, it is exempt from paying income tax.

(h) Current and Non-current Classification
Assets and liabilities are presented in the consolidated Statement of Financial Position based on current and non-current classification.

An asset is classified as current when: it is either expected to be realised or intended to be sold or consumed in the Group's normal operating cycle; it is held primarily for the purpose of trading; it is expected to be realised within 12 months after the reporting period; or the asset is cash or cash equivalent unless restricted from being exchanged or used to settle a liability for at least 12 months after the reporting period. All other assets are classified as non-current.

A liability is classified as current when: it is either expected to be settled in the Group's normal operating cycle; it is held primarily for the purpose of trading; it is due to be settled within 12 months after the reporting period; or there is no unconditional right to defer the settlement of the liability for at least 12 months after the reporting period. All other liabilities are classified as non-current.

(i) Cash and Cash Equivalents
Cash and cash equivalents includes cash on hand, deposits held at call with financial institutions, other short-term, highly liquid investments with original maturities of three months or less that are readily convertible to known amounts of cash and which are subject to an insignificant risk of changes in value.

SmartSat CRC Ltd and its Controlled Entities
Notes to the Consolidated Financial Statements
30 June 2023

Note 2. Significant Accounting Policies (continued)

(j) Trade and Other Receivables
Trade receivables are initially recognised at fair value and subsequently measured at amortised cost using the effective interest method, less any allowance for expected credit losses. Trade receivables are generally due for settlement within 30 days.

The Group has applied the simplified approach in AASB 9 to measure expected credit losses, which uses a lifetime expected loss allowance. The Group has determined the probability of non-payment of the receivables and multiplied this by the amount of the expected loss arising from default.

The amount of the impairment is recorded in a separate allowance account with the loss being recognised in other expenses. Once the receivable is determined to be uncollectable then the gross carrying amount is written off against the associated allowance.

Where the Group renegotiates the terms of trade receivables due from certain customers, the new expected cash flows are discounted at the original effective interest rate and any resulting difference to the carrying value is recognised in the Statement of Profit or Loss and Other Comprehensive Income.

(k) Other Financial Assets Measured at Amortised Cost
Impairment of other financial assets measured at amortised cost are determined using the expected credit loss model in AASB 9. On initial recognition of the asset, an estimate of the expected credit losses for the next 12 months is recognised. Where the asset has experienced a significant increase in credit risk then the lifetime losses are estimated and recognised.

(l) Financial Liabilities
The Group measures all financial liabilities initially at fair value less transaction costs, subsequently financial liabilities are measured at amortised cost using the effective interest rate (EIR) method. Gains and losses are recognised in the Statement of Profit or Loss and Other Comprehensive Income when the liabilities are derecognised as well as through the effective interest rate amortisation process.

Amortised cost is calculated by taking into account any discount or premium on acquisition and fees or costs that are an integral part of the EIR. The EIR amortisation is included as finance costs in the Statement of Profit or Loss and Other Comprehensive Income.

The financial liabilities of the Group comprise trade and other payables.

(m) Property, Plant and Equipment
Property, plant and equipment is stated at historical cost less accumulated depreciation and impairment. Historical cost includes expenditure that is directly attributable to the acquisition of the items.

Depreciation is calculated on a straight-line basis to write off the net cost of each item of property, plant and equipment over their expected useful lives as follows:

Leasehold improvements are depreciated over the unexpired period of the lease or the estimated useful life of the assets, whichever is shorter.

Asset class	Depreciation rate
Leasehold improvements	5 years

The residual values, useful lives and depreciation methods are reviewed, and adjusted if appropriate, at each reporting date.

Note 2. Significant Accounting Policies (continued)

An item of property, plant and equipment is derecognised upon disposal or when there is no future economic benefit to the Group. Gains and losses between the carrying amount and the disposal proceeds are taken to profit or loss.

Minor asset purchases of less than $3,000 are expensed as incurred.

(n) Right-of-use Assets
A right-of-use asset is recognised at the commencement date of a lease. The right-of-use asset is measured at cost, which comprises the initial amount of the lease liability, adjusted for, as applicable, any lease payments made at or before the commencement date net of any lease incentives received, any initial direct costs incurred, and, except where included in the cost of inventories, an estimate of costs expected to be incurred for dismantling and removing the underlying asset, and restoring the site or asset.

Right-of-use assets are depreciated on a straight-line basis over the unexpired period of the lease or the estimated useful life of the asset, whichever is the shorter. Where the Group expects to obtain ownership of the leased asset at the end of the lease term, the depreciation is over its estimated useful life. Right-of use assets are subject to impairment or adjusted for any remeasurement of lease liabilities.

(o) Impairment of Non-financial Assets
Non-financial assets are reviewed for impairment whenever events or changes in circumstances indicate that the carrying amount may not be recoverable. An impairment loss is recognised for the amount by which the asset's carrying amount exceeds its recoverable amount.

Recoverable amount is the higher of an asset's fair value less costs of disposal and value-in-use. The value-in-use is the present value of the estimated future cash flows relating to the asset using a pre-tax discount rate specific to the asset or cash-generating unit to which the asset belongs. Assets that do not have independent cash flows are grouped together to form a cash-generating unit.

(p) Trade and Other Payables
These amounts represent liabilities for goods and services provided to the Group prior to the end of the financial year and which are unpaid. Due to their short-term nature they are measured at amortised cost and are not discounted. The amounts are unsecured and are usually paid within 30 days of recognition.

(q) Leases
Finance leases are leases of fixed assets where substantially all of the risks and benefits incidental to the ownership of the asset are transferred to the Group, but the legal ownership is not transferred to the Group.

Finance leases are capitalised by recording a right-of-use asset and a corresponding liability at the lower of the amounts equal to the fair value of the leased asset, or the minimum lease payments measured at present value including any residual values.

Leased assets are depreciated on a straight-line basis over the shorter of their estimated useful lives or the lease term.

Short-term leases (remaining lease term of 12 months or less) or low value leases are charged to the Statement of Profit or Loss and Other Comprehensive Income on a straight-line basis over the term of the lease.

The Group has tested the right-of-use asset for impairment on the date of application and has concluded that there is no indication that the right-of-use asset is impaired.

SmartSat CRC Ltd and its Controlled Entities
Notes to the Consolidated Financial Statements
30 June 2023

Note 2. Significant Accounting Policies (continued)

(r) Employee Benefits

Short-term Employee Benefits
Liabilities for wages and salaries, including non-monetary benefits, annual leave and long service leave expected to be settled wholly within 12 months of the reporting date are measured at the amounts expected to be paid when the liabilities are settled.

Other Long-term Employee Benefits
The liability for annual leave and long service leave not expected to be settled within 12 months of the reporting date are measured at the present value of expected future payments to be made in respect of services provided by employees up to the reporting date using the projected unit credit method. Consideration is given to expected future wage and salary levels, experience of employee departures and periods of service. Expected future payments are discounted using market yields at the reporting date on national government bonds with terms to maturity and currency that match, as closely as possible, the estimated future cash outflows.

(s) Provisions
Provisions are recognised when the Group has a legal or constructive obligation resulting from past events, for which it is probable that there will be an outflow of economic benefits and that outflow can be reliably measured. Provisions are measured using the best estimate available of the amounts required to settle the obligation at the end of the reporting period.

(t) Comparatives
Where necessary, comparative information has been reclassified and repositioned for consistency with current year disclosures.

(u) Goods and Services Tax ('GST') and Other Similar Taxes
Revenues, expenses and assets are recognised net of the amount of associated GST, unless the GST incurred is not recoverable from the tax authority. In this case it is recognised as part of the cost of the acquisition of the asset or as part of the expense.

Receivables and payables are stated inclusive of the amount of GST receivable or payable. The net amount of GST recoverable from, or payable to, the tax authority is included in other receivables or other payables in the consolidated Statement of Financial Position.

Cash flows are presented on a gross basis. The GST components of cash flows arising from investing or financing activities which are recoverable from, or payable to the tax authority, are presented as operating cash flows.

(v) Going Concern Assumption
The financial report has been prepared on a going concern basis which contemplates continuity of normal business activities and the realisation of assets and the settlement of liabilities in the ordinary course of business.

Note 3. Critical accounting judgements, estimates and assumptions

The preparation of the financial report requires management to make judgements, estimates and assumptions that affect the reported amounts in the financial statements. Management continually evaluates its judgements and estimates in relation to assets, liabilities, contingent liabilities, revenue and expenses. Management bases its judgements, estimates and assumptions on historical experience and on other various factors, including expectations of future events, management believes to be reasonable under the circumstances. The resulting accounting judgements and estimates will seldom equal the related actual results. The judgements, estimates and assumptions that have a significant risk of causing a material adjustment to the carrying amounts of assets and liabilities (refer to the respective notes) within the next financial year are discussed below.

Note 3. Critical accounting judgements, estimates and assumptions (continued)

Revenue recognition
The Group was required to assess whether government grants and contributions from participants fell under the scope of AASB 15 or AASB 1058. Specifically, the Group had to determine whether the Agreements contained performance obligations that meet the 'sufficiently specific' criteria in sections F20-F26 of AASB 15. Judgement is necessary to assess whether a promise is 'sufficiently specific', which takes into account any conditions specified in the Agreements regarding the following aspects:

a) the nature or type of the goods or service;
b) the cost or value of the goods or services;
c) the quantity of the goods and services; and
d) the period over which goods or services must be transferred.

The Directors have determined that the Commonwealth and participant agreements in place do not contain performance obligations that meet the 'sufficiently specific' criteria as per sections F20-F26 of the AASB 15. Therefore, Grant Income has been recognised in accordance with AASB 1058: in full upon receipt or when the Group has the unconditional right to receive the contribution, and it is probable that the economic benefits comprising the contribution will flow to the Group.

Estimation of useful lives of assets
The Group determines the estimated useful lives and related depreciation and amortisation charges for its property, plant and equipment and finite life intangible assets. The useful lives could change significantly as a result of technical innovations or some other event. The depreciation and amortisation charge will increase where the useful lives are less than previously estimated lives, or technically obsolete or non-strategic assets that have been abandoned or sold will be written off or written down.

Employee benefits provision
As discussed in note 2, the liability for employee benefits expected to be settled more than 12 months from the reporting date are recognised and measured at the present value of the estimated future cash flows to be made in respect of all employees at the reporting date. In determining the present value of the liability, estimates of attrition rates and pay increases through promotion and inflation have been taken into account.

Note 4. Revenue

	Consolidated 2023 $	Consolidated 2022 $
Contributions	7,736,821	5,510,359
Government grants	8,479,114	7,733,159
Node funding	242,624	2,719,000
Third party contributions	698,052	358,365
Revenue	17,156,611	16,320,883

Note 5. Other income

	Consolidated 2023 $	Consolidated 2022 $
Interest income	722,469	50,526
Consultancy work	247,991	181,250
Office space	12,086	36,190
Other income - Aurora	8,376	6,850
Space services mission	1,448,300	2,268,636
Other income	2,439,222	2,543,452

Note 6. Programme Costs

	Consolidated 2023 $	Consolidated 2022 $
Research expenditure	12,509,337	11,884,391
Education expenditure	825,274	781,576
Outreach	29,762	129,460
	13,364,373	12,795,427

Note 7. Administration expenses

	Consolidated 2023 $	Consolidated 2022 $
Depreciation expenses		
Depreciation expense - Right of use assets	152,532	104,577
Depreciation expense - leasehold improvements	57,948	23,545
	210,480	128,122
Employee benefits expenses		
Wages & salaries	1,126,358	802,171
Superannuation	133,503	95,783
Workcover	7,975	6,416
Leave expenses	111,469	87,935
Payroll tax	161,513	-
	1,540,818	992,305
	1,751,298	1,120,427

Note 8. Cash and cash equivalents

	Consolidated 2023 $	Consolidated 2022 $
Current assets		
Aurora Space Cluster Pty Ltd	25,608	18,515
SmartSat CRC Ltd	4,834,531	5,988,896
SmartSat CRC Ltd (NAB TD #10713840)	4,151,034	4,015,794
SmartSat CRC Ltd (MyStateBank TD1)	4,657,885	4,515,793
SmartSat CRC Ltd (MyStateBank TD2)	3,602,435	3,514,643
SmartSat CRC Ltd (NAB TD #10792853)	5,168,453	5,000,000
SmartSat CRC Ltd (NAB #1128 - ACT Node)	1,030,962	-
SmartSat CRC Ltd (NAB #1814 QLD Node)	1,611,452	-
	25,082,360	23,053,641

Reconciliation to cash and cash equivalents at the end of the financial year
The above figures are reconciled to cash and cash equivalents at the end of the financial year as shown in the consolidated statement of cash flows as follows:

Balances as above	25,082,360	23,053,641
Balance as per consolidated statement of cash flows	25,082,360	23,053,641

Note 9. Trade and other receivables

	Consolidated 2023 $	Consolidated 2022 $
Current assets		
Accounts receivable	1,027,283	997,150
Less: Allowance for expected credit losses	-	-
	1,027,283	997,150

The carrying value of trade and other receivables is considered a reasonable approximation of fair value due to the short-term nature of the balances. The maximum exposure to credit risk at the reporting date is the fair value of each class of receivable in the financial report.

Note 10. Property, plant and equipment

	Consolidated 2023 $	Consolidated 2022 $
Non-current assets		
Leasehold improvements - at cost	269,996	190,132
Less: Accumulated depreciation	(81,493)	(23,545)
	188,503	166,587

Note 10. Property, plant and equipment (continued)

Reconciliations
Reconciliations of the written down values at the beginning and end of the current financial year are set out below:

Consolidated	Leasehold improvements $	Total $
Balance at 1 July 2022	166,587	166,587
Additions	79,864	79,864
Depreciation expense	(57,948)	(57,948)
Balance at 30 June 2023	188,503	188,503

Note 11. Right-of-use assets

	Consolidated 2023 $	Consolidated 2022 $
Non-current assets		
Office lease	702,310	413,802
Less: Accumulated amortisation	(156,348)	(222,399)
	545,962	191,403

Reconciliations
Reconciliations of the written down values at the beginning and end of the current financial year are set out below:

Consolidated	$	Total $
Balance at 1 July 2022	191,403	191,403
Additions	507,091	507,091
Depreciation expense	(152,532)	(152,532)
Balance at 30 June 2023	545,962	545,962

Note 12. Trade and other payables

	Consolidated 2023 $	2022 $
Current liabilities		
Accounts payables	391,115	484,384
Accrued expenses	5,188,791	5,669,360
Credit card	2,314	51
GST	33,026	204,168
Income tax payable	6,396	2,600
Fringe benefits tax payable	(7,340)	11,743
PAYG withholdings payable	70,447	51,541
Superannuation payable	26,088	20,680
	5,710,837	6,444,527

Trade and other payables are unsecured, non-interest bearing and are normally settled within 30 days. The carrying value of trade and other payables is considered a reasonable approximation of fair value due to the short-term nature of the balances.

Note 13. Lease liabilities

	Consolidated 2023 $	2022 $
Current liabilities		
Lease liability - office premises	150,298	78,777
Non-current liabilities		
Lease liability - office premises	413,499	134,962

The Group has entered into a new finance lease during the financial year for office premises located at Level 2, McEwin Building, Lot Fourteen, North Terrace, Adelaide, South Australia, 5000. The lease has a duration of 4 years and is due to end in October 2026 with a right of renewal for a further 5 years with no purchase option or escalation clauses.

The Group has an existing finance lease for office premises located at Level 3, McEwin Building, Lot Fourteen, North Terrace, Adelaide, South Australia, 5000. The lease has a duration of 5 years and is due to end in October 2026 with terms to extend the lease period of use past the end date but no purchase option or escalation clauses.

Reconciliation
Reconciliation of the lease liabilities at the beginning and end of the current financial year are set out below:

Note 13. Lease liabilities (continued)

Consolidated	Office premises $	Total $
Balance as at 1 July 2022	213,739	213,739
Additions	507,091	507,091
Principal repayments	(186,933)	(186,933)
Interest	29,900	29,900
Balance at 30 June 2023	563,797	563,797

Note 14. Employee benefits

	Consolidated 2023 $	2022 $
Current liabilities		
Annual leave	240,634	167,292
Non-current liabilities		
Long service leave	65,785	27,659

Note 15. Reserves

	Consolidated 2023 $	2022 $
Node reserve	-	600,000
Research chairs reserve	-	5,223,077
Scholarships reserve	-	3,652,058
	-	9,475,135

Node reserves
The nodes reserve has been setup for the specific purpose of quarantining future commitments for the payment of the specific node during the term of SmartSat.

Research chairs reserve
The research chairs reserve has been setup for the specific purpose of quarantining future commitments for the payment of Research Chairs during the term of SmartSat and ensures that sufficient funds are available to meet these obligations once the positions have been rectified.

Note 15. Reserves (continued)

Scholarships reserve
The scholarships reserve was setup for the specific purpose of quarantining future commitments for the payment of PhD scholarships during the term of SmartSat. Supporting the PhD programme is considered a high priority and is a commitment in the education and training milestones in the Commonwealth agreement.

The Board resolved to transfer all reserves to retained earnings during the period, noting that the forward commitments on the three reserves are now very well understood and committed.

Note 16. Retained earnings

	Consolidated 2023 $	Consolidated 2022 $
Retained earnings at the beginning of the financial year	8,080,951	4,712,367
Surplus for the year	2,748,786	3,368,584
Transfer from Research chairs reserve	5,223,077	-
Transfer from Node reserve	600,000	-
Transfer from Scholarships reserve	3,652,058	-
Retained earnings at the end of the financial year	20,304,872	8,080,951

Note 17. Key management personnel disclosures

Compensation
The aggregate compensation made to key management personnel of the Group is set out below. Key management positions included in this value are the Chair, Non-Executive Directors, CEO and COO.

	Consolidated 2023 $	Consolidated 2022 $
Aggregate compensation	1,171,026	955,085

Note 18. Remuneration of auditors

During the financial year the following fees were paid or payable for services provided by BDO Australia - Adelaide, the auditor of the Group:

	Consolidated 2023 $	Consolidated 2022 $
Audit services - BDO Australia - Adelaide		
Audit of the financial report	21,580	21,500

Note 19. Contingent liabilities

In the opinion of the Directors, the Group did not have any contingent liabilities as at 30 June 2023 (2022: nil).

Note 20. Related party transactions

Key management personnel
Disclosures relating to key management personnel are set out in note 17.

Other related parties include close family members of key management personnel and entities that are controlled or significantly influenced by those key management personnel or their close family members.

Transactions with related parties
There were no related party transactions during the financial year (2022: nil).

Note 21. Events after the reporting period

No matter or circumstance has arisen since 30 June 2023 that has significantly affected, or may significantly affect the Group's operations, the results of those operations, or the Group's state of affairs in future financial years.

Note 22. Group information

The registered office and principal place of business of the Group is:

SmartSat CRC Ltd
Level 3, McEwin Building
Lot Fourteen, North Terrace
Adelaide, SA, 5000

SmartSat CRC Ltd and its Controlled Entities
Directors' declaration
30 June 2023

In the Directors' opinion:

- the consolidated financial statements and notes are in accordance with the Australian Accounting Standards - Simplified Disclosures, the *Australian Charities and Not-for-profits Commission Act 2012*, the *Australian Charities and Not-for-profits Commission Regulations 2022* and other mandatory professional reporting requirements;
- the attached financial statements and notes give a true and fair view of the Group's financial position as at 30 June 2023 and of its performance for the financial year ended on that date; and
- there are reasonable grounds to believe that the Group will be able to pay its debts as and when they become due and payable.

Signed in accordance with a resolution of the Board of Directors:

Dr. Michele Allan AO
Chair

Prof. Andy Koronios
CEO & Managing Director

27 September 2023

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INDEPENDENT AUDITOR'S REPORT
TO THE MEMBERS OF SMARTSAT CRC LTD

Report on the Audit of the Financial Report

Opinion

We have audited the financial report of SmartSat CRC Ltd (the registered entity) and its subsidiaries (the Group), which comprises the consolidated statement of financial position as at 30 June 2023, the consolidated statement of profit or loss and other comprehensive income, the consolidated statement of changes in equity and the consolidated statement of cash flows for the year then ended, and notes to the financial report, including a summary of significant accounting policies, and the responsible entities' declaration.

In our opinion the accompanying financial report of SmartSat CRC Ltd, is in accordance with Division 60 of the *Australian Charities and Not-for-profits Commission Act 2012*, including:

(i) Giving a true and fair view of the Group's financial position as at 30 June 2023 and of its financial performance for the year then ended; and

(ii) Complying with Australian Accounting Standards – Simplified Disclosures and Division 60 of the *Australian Charities and Not-for-profits Commission Regulations 2022*.

Basis for opinion

We conducted our audit in accordance with Australian Auditing Standards. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the Financial Report* section of our report. We are independent of the Group in accordance with the auditor independence requirements of the *Australian Charities and Not-for-profits Commission Act 2012* (ACNC Act) and the ethical requirements of the Accounting Professional and Ethical Standards Board's APES 110 *Code of Ethics for Professional Accountants (including Independence Standards)* (the Code) that are relevant to our audit of the financial report in Australia. We have also fulfilled our other ethical responsibilities in accordance with the Code.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Other information

The responsible entities of the registered entity are responsible for the other information. The other information obtained at the date of this auditor's report is information included in the registered entity's annual report, but does not include the financial report and our auditor's report thereon.

Our opinion on the financial report does not cover the other information and accordingly we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial report, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial report or our knowledge obtained in the audit or otherwise appears to be materially misstated.

If, based on the work we have performed on the other information obtained prior to the date of this auditor's report, we conclude that there is a material misstatement of this other information, we are required to report that fact. We have nothing to report in this regard.

Responsibilities of responsible entities for the Financial Report

The responsible entities of the registered entity are responsible for the preparation and fair presentation of the financial report in accordance with Australian Accounting Standards – Simplified Disclosures and the ACNC Act, and for such internal control as the responsible entities determine is necessary to enable the preparation of the financial report that is free from material misstatement, whether due to fraud or error.

In preparing the financial report, responsible entities are responsible for assessing the Group's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the responsible entities either intends to liquidate the Group or to cease operations, or has no realistic alternative but to do so.

The responsible entities of the registered entity are responsible for overseeing the Group's financial reporting process.

Auditor's responsibilities for the audit of the Financial Report

Our objectives are to obtain reasonable assurance about whether the financial report as a whole is free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with the Australian Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of this financial report.

A further description of our responsibilities for the audit of the financial report is located at the Auditing and Assurance Standards Board website (http://www.auasb.gov.au/Home.aspx) at: http://www.auasb.gov.au/auditors_responsibilities/ar3.pdf

This description forms part of our auditor's report.

BDO

BDO Audit Pty Ltd

JDCarver

Josh Carver
Director

Adelaide, 23 October 2023

SMARTSAT
COOPERATIVE RESEARCH CENTRE

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North Terrace, Adelaide, SA 5000

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program