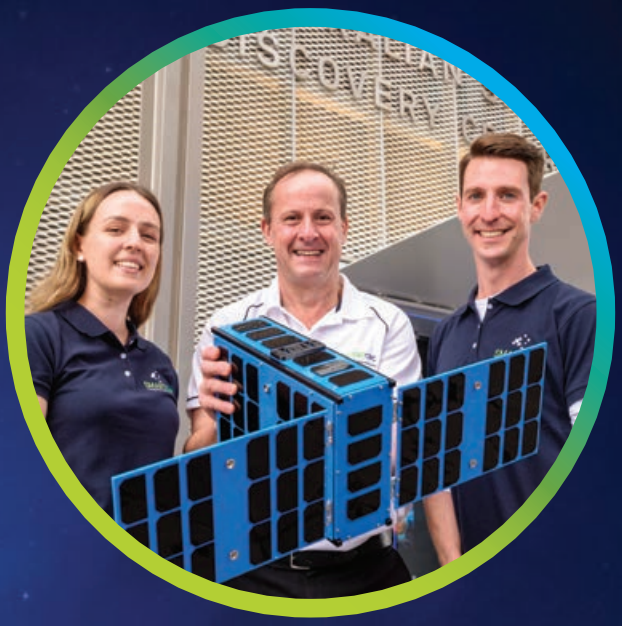
ANNUAL REPORT 2021/22



SMARTSAT
COOPERATIVE RESEARCH CENTRE

CONTENTS

EXECUTIVE SUMMARY

Well, what a momentous year it has been for SmartSat!

The SmartSat research portfolio has grown substantially. Projects are starting to deliver significant milestones with some concluding and others transitioning to next phases of development and maturation. For example, the project 'On-Board Processing for Advanced Tactical Communications' will enhance the networking functionality of existing state of the art military satellite communications. Such projects are strongly supported by Defence. Another example is the 'Onboard Hyperspectral AI' which is developing brand new capabilities for onboard Artificial Intelligence processing and analysis of hyperspectral imagery on smart satellite platforms. Such novel capabilities in these areas will transform the ability of a satellite to automatically make sense of the rich and multidimensional spectral modalities in an end-to-end manner onboard the satellite itself.

SmartSat continues to drive the research program toward the Capability Demonstrator concepts, as this lays the foundations for a thriving space ecosystem. This is building Australian capability - having our academic researchers be innovative on the world space stage, placing industry to uplift technologies, and ultimately deliver sovereign content to enable future missions of national importance to our Civil and Defence pursuits.

One of the highlights this year was a program to fund five collaborative research projects in partnership with the UK based Satellite Applications Catapult and the UK Science Innovation Network. This program was supported by Austrade, the Australian Space Agency, the UK Government and UK Space Agency under the UK-Australia Space Bridge framework. The five projects explored advanced satellite technologies with partners from both countries and demonstrated the untapped R&D and commercial opportunities that can be created from collaborating with the international space community.

Our team continues to work with industry partners Myriota and Inovor Technologies to progress the build of South Australia's state satellite, Kanyini, which is designed to rapidly build Australian space heritage. Over the past twelve months, the Kanyini project team successfully completed the Critical Design Review (CDR), a very significant milestone for the spacecraft. Kanyini will integrate an IoT sensor that will collect data from ground-based sensors using the HyperScout 2 imager – a three-in-one instrument that combines hyperspectral and thermal imaging with high-level data processing and Artificial Intelligence (AI) capabilities to support a wide array of applications.

The SatCom IoT-enabled Automatic Ground Water Collection and Aggregation Pilot (known as the SIG Water project) won the Environment and Sustainability Award at the Asia-Pacific Spatial Excellence Awards. This project was a collaboration with the South Australian Department for Environment and Water, SmartSat, FrontierSI, Myriota, the University of South Australia and NGIS. It developed a demonstrator system to collect data from more than 60 ground water bores scattered throughout South Australia, transmitted to nanosatellites several times per day, aggregated and then sent to the SA Department of Environment & Water data collection centre. This project has demonstrated proof of concept for use of advanced IoT's in remote and harsh locations providing a reliable stream of data and supporting the management of water, one of our most precious resources.

To support the growth of the space sector nationally, SmartSat has established State Nodes in NSW, Victoria, and Queensland. An agreement was also reached with the ACT Government for a Node in that State in late June, bringing the total combined investment to $2.5M. The NSW, Victoria and Queensland Nodes have developed grant programs to drive industry-research teaming and collaboration within their local space ecosystems.

I am increasingly proud of SmartSat's contribution to the research and development of satellite technologies for the benefit to our national space community and beyond. I cannot wait to see what the next twelve months will bring.

Professor Andy Koronios
Chief Executive Officer & Managing Director

CHAIR'S FOREWORD

Over the past twelve months the Board and the Executive team have continued our strong focus on the deployment of resources to the highest priority space research challenges for the nation in this our third full year of operation of SmartSat.

SmartSat has undergone a substantial expansion in the number of organisations with which it has collaborative research projects. These now number more than 130 partnering organisations, representing the most powerful space research collaboration in our nation's history.

SmartSat has also laid the groundwork for the next stage of the development of its industry start-up cluster, Aurora, to further benefit its 40+ members.

SmartSat has used the past twelve months to consolidate its position as Australia's space ecosystem 'catalyst', helping transform the sector by shepherding innovation from conception to operational technology. This involves the bringing together of many moving parts within the space sector to give critical mass to 'Team Australia'. This approach supports our partners achieve more together than they would be able to individually and drives partnerships that deliver the space technology innovation Australia needs to build sovereign capabilities.

We continued to work closely with the Australian Space Agency to support their strategy and programs. We have also worked to build a strong relationship with the new Australian Government following the election of March.

The Australian Government has placed increased emphasis and priority on regional engagement covering disaster response, security and economic assistance for neighbouring nations across the Indo-Pacific. In addition, the 2020 Defence Strategic Update notes the region is undergoing a strategic realignment, making the region more contested and apprehensive. Our catalogue of Australian developed space technologies across the three SmartSat research programs aim to contribute to regional diplomacy and security partnership through enhanced collaboration. The Defence Space Strategy, released in March 2022, prioritises a line of effort to deliver military effects that promote regional security. These effects will be enabled by space systems that integrate all levels of Australian Government along with allies and regional partners. Furthermore, space will be included as part of regular engagement with regional countries.

SmartSat research aims to position Australian industry to identify and develop technologies that can underpin a resilient space architecture. One such mechanism to demonstrate the application of our research is through the Defence Resilient Multi-mission Space Science and Technology Shot (RMS STaR Shot). SmartSat views the STaR Shot as a critical vehicle to mature and demonstrate the results of our research program and will continue to work closely with Defence to identify realistic utilisation pathways for our technology.

On behalf of the Board, I would like to acknowledge the fine service of retiring founding Board member, Mr Michael Davis AO. The Board also warmly welcomed new member, Ms Mikaela Jade, a proud Cabrogal woman who brings to us a wealth of First Nations knowledge, together with an expertise in cybernetics and augmented reality. The Board sincerely thanks our Managing Director, Professor Andy Koronios, for another year of great leadership, as well as our dedicated Management Team for their hard work to make our strategic goals a reality. I would also like to thank all my fellow Board members for their strong service on the Board and its committees. SmartSat acknowledges with gratitude the Commonwealth Government's Cooperative Research Centre Program for its on-going support of SmartSat.

Finally, I would like to thank each and every one of our partners for their continued collaboration in what is a nation building endeavour.

Peter Woodgate
Chair

HIGHLIGHTS & ACHIEVEMENTS

GOVERNANCE

- Regular Board meetings and two Strategic Planning sessions
- Conducted an Annual General Meeting and Extraordinary General Meeting
- Appointed a new director to the Board, Ms Mikaela Jade, proud Cabrogal woman and CEO of Indigital
- Farewelled founding board member Mr Michael Davis AO from the SmartSat Board in May 2022

PEOPLE & OPERATIONS

- Maintained a consolidated employee base with key additional appointments including:
  - Kanyini Satellite Engineer
  - Marketing and Communications Coordinator
  - Research Support Officer
- Launched online project management system, mySmartSat, to project leaders and extended partner network
- Added high-precision timing company QuantX Labs to Supporting Partner network
- Grew SmartSat State Nodes from original $1.1M for the NSW Node to a combined $2.5M co-investment supporting local space industry growth:
  - Established Queensland Earth Observation Hub (incorporating the SmartSat Queensland Node) with initial funding agreement
  - Project funding agreements announced in NSW and Victoria Nodes

EDUCATION & TRAINING

- Approved 47 PhD scholarships and a further two in-kind scholarships
- Completed Australian Space Industry Skills Gap Analysis Phase 2 and development of the Australian Space Skills Database in partnership with the Australian Space Agency
- Conducted a series of industry webinars to provide training supporting the Australian Space Agency's Demonstrator Program

RESEARCH & INDUSTRY

- Approved and commenced 28 new research projects across the research portfolio
- Funded five projects as the first collaborative research activity under the Australia-UK Space Bridge framework
- Funded 12 research projects through State Nodes
- Addressed critical milestones in research capability development in technologies including: cognitive networks, quantum communications, autonomy and onboard Artificial Intelligence
- Successfully completed Critical Design Review phase for Kanyini satellite mission
- Hosted Defence and National Security Showcase to discuss alignment of research activities with Defence's RMS STaR Shot program
- Aligned research strategy with the Australian Space Agency's Earth Observation Roadmap and assisted in the development of the Communications Technologies and Services Roadmap

MARKETING & COMMUNICATIONS

- Issued 10 media releases announcing projects, partnerships and appointments resulting in 190 articles in print, online, TV and radio, with an audience reach of over 10 million
- Published quarterly newsletters and monthly electronic direct mailouts providing updates on research and industry activities
- Hosted the first virtual SmartSat conference for over 150 delegates spanning industry, academia, and government
- Launched official brand identity of the SA Space Mission satellite, Kanyini, developed in conjunction with students from Findon High School, representatives from the APY Lands and members of the mission team
- Attended major industry conferences and exhibitions including:
  - International Astronautical Congress 2021 in Dubai
  - 37th Space Symposium in Colorado
  - Australian Defence, Science Technology and Research Summit
  - 12th and 13th Australian Space Forums
- Hosted over 30 events including workshops, webinars and project briefings.
- Hosted several VIP and special guest visits from Federal and State Ministers of Parliament and international delegations

RESEARCH

RESEARCH FRAMEWORK

SmartSat continues to drive its research program toward the Capability Demonstrator concepts, as they lay the foundation for a sound space ecosystem. This is building Australian capability, giving our academic researchers the opportunity to innovate on the world space stage, placing industry to uplift technologies, and ultimately deliver sovereign content to enable future missions of national importance to our Civil and Defence pursuits.

Over the last year we have strengthened the architecture and technology needs of the Capability Demonstrators. SmartSat's research activities have become increasingly focused on missions that align with national programs and are required to meet some of Australia's major challenges including water and land management, Defence and national security, and supporting emergency management services to combat increasingly frequent natural disasters and climate change impact. This focused and applied approach aims to provide opportunities for our partners to ultimately deliver capabilities that may be translated into operational adoption by end-users as fully fledged missions.

This research framework has resulted in the gradual development and approval of larger and more focused research projects. These projects have brought together the best research capability in our partner network to address critical milestones, including cognitive networks, quantum communications, autonomy and onboard AI.

Over the next year there will be even greater emphasis on the strategic development of major, multi-partner projects producing outputs that will be positioned for uptake by key industry end users including Defence Science and Technology Group's (DSTG) Resilient Multi-Mission STaR Shot. As the SmartSat research program matures, there will be a gradual move towards technology deployment, driven by strong industry involvement and effective end user engagement.

MAJOR PROJECTS APPROVED 2021/22

Cognitive Satellite Radios
P1-27

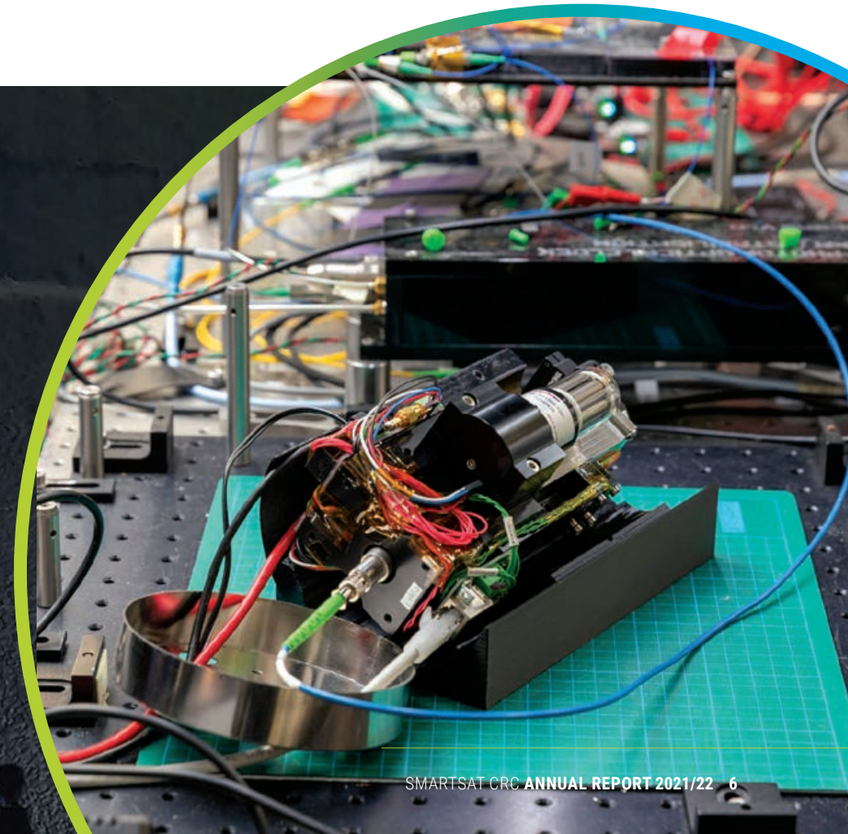
Partners: Airbus Defence and Space Limited (UK), Deakin University, Defence Science and Technology Group, Macquarie University, Royal Melbourne Institute of Technology, University of Technology Sydney

This project aims to develop and adopt advanced cognitive radio techniques for satellite communications to make satellite communication system intelligent and adaptive. This will improve the spectral efficiency of commercial satellite systems and maximise the throughput and availability of critical communication systems in congested and contested environments. The project will make important contributions to future, intelligent space networks that underpin Command and Control and Situational Awareness relating to Defence (including RMS STaRShot) interests.

Compact Clock for Small Satellite Applications Engineering Model
P2-31

Partners: QuantX Labs, The University of Adelaide, Defence Science and Technology Group

This project aims to develop Position, Navigation and Timing (PNT) precision timing technologies, which is essential for the development of a sovereign timing capability for Australia. As PNT services derived from Global Navigation Satellite Systems (GNSS) underpins so many of the technologies we currently depend upon in both civilian and Defence arenas, it is a significant vulnerability if such information were no longer available through accidental damage or malicious attacks on the network. Australia currently relies on GNSS from other countries such as the US (GPS) and Europe (Galileo) and has no sovereign capabilities in this area and this will make a contribution to the development of future PNT systems for GPS denied environments.



MAJOR PROJECTS APPROVED 2021/22

Adaptive Analytical Tool for Better Understanding and Reducing Future Bushfire Risk
P3-23

Partners: The University of Adelaide, Shoal Engineering, Royal Melbourne Institute of Technology, The University of Adelaide, Shoal Engineering, Royal Melbourne Institute of Technology, South Australian Department of Environment and Water, Department of Fire and Emergency Services.

The core aim of this project is to demonstrate how the use of EO data can assist with identifying how bushfire likelihood can change in space and time, allowing more informed and transparent decision-making for reducing bushfire risk. The project will develop an analytical tool – the Adaptive Analytical Bushfire Likelihood (AABL) Tool – that utilises EO data such as vegetation, soil moisture, meteorological and climatic variables as inputs to a model to map the spatial and temporal distribution of bushfire likelihood. Working with our end users – the SA and WA government – the tool will deliver a new suite of analytical and modelling capabilities and information dashboards that can integrate with and support these State Governments' Bushfire planning strategy.

OzFuel (Australian Fuel Monitoring from Space) Phase A
P3-24

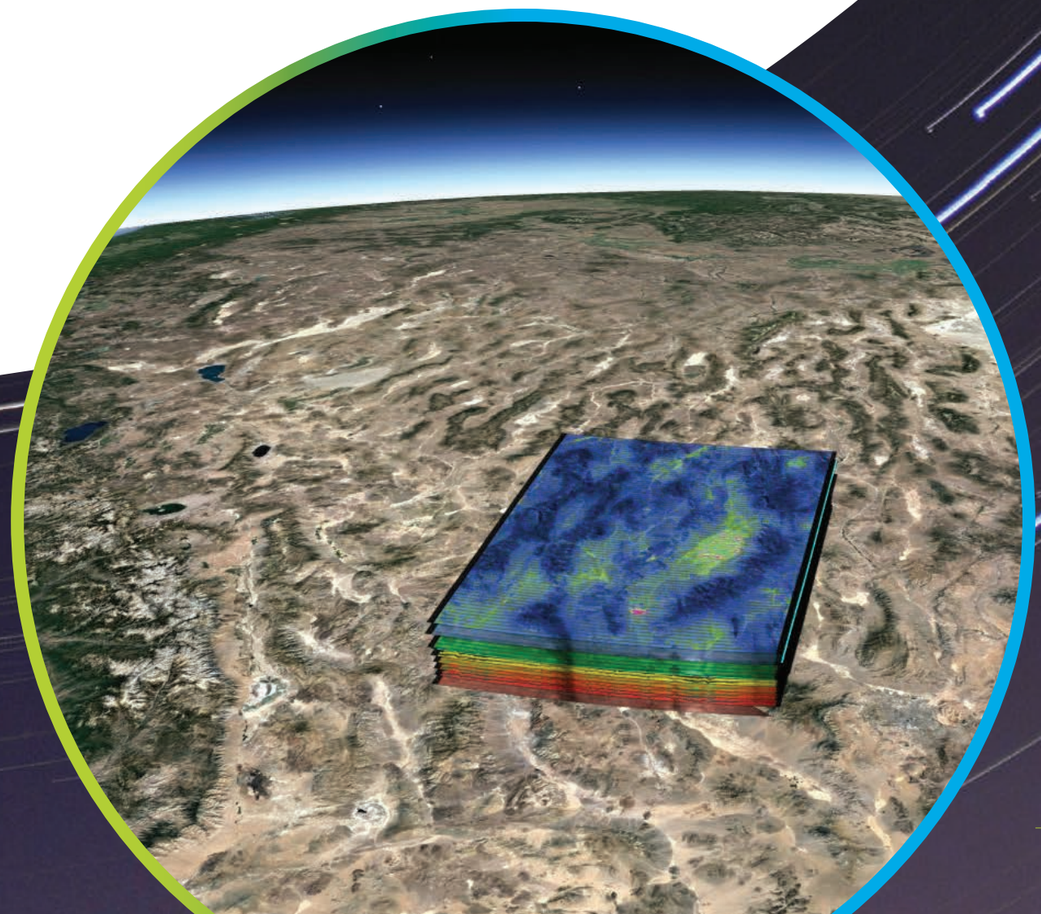
Partners: The Australian National University, The University of New South Wales, Skykraft, LatConnect 60, Spiral Blue, GeoScience Australia

OzFuel is a bushfire mitigation satellite mission aimed at delivering fuel hazard remote sensing data for downstream Earth Observation data analytics services, with the goal of improving Australia's pre-fire monitoring, prediction, preparation, response and resilience. From Low Earth Orbit (LEO), OzFuel will acquire spatial data on fuel conditions such as dry mass and moisture content, tuned specifically to Australia's Eucalypt-dominant forests. This data will be tested within data services such as the Australian Flammability Monitoring System, which is used by agencies for pre-season planning (identifying areas in the landscape where a fire may ignite and spread for prescribed burns) and response (deciding what areas should be prioritised when sending resources and equipment).

Onboard Hyperspectral AI: Cal, Panoptic Segmentation, Estimation
P2-34

Partners: Queensland University of Technology, Airbus Defence and Space Limited (UK), Nova Systems

This project will develop a Panoptic Segmentation network featuring brand new capabilities for onboard Artificial Intelligence processing and analysis of hyperspectral imagery on smart satellite platforms. New capabilities in these areas will transform the ability of a satellite to automatically make sense of the rich and multidimensional spectral modalities in an end-to-end manner onboard the satellite itself. This will create new opportunities to enable accurate, efficient, and reliable automated detection and classification of natural phenomena and human activities over a wide area on Earth. The project will also explore joint learning between satellite and ground-based sensors, and develop a proof-of-concept demonstrator system to run on-board Kanyini, Australia's first state-based satellite.



SUPPORTING THE AUSTRALIAN SPACE AGENCY'S ROADMAPS

The Australian Space Agency's Roadmaps address priority areas in the Advancing Space: Australian Civil Space Strategy 2019/28. These Roadmaps are designed to assist industry to coordinate and build world-leading capabilities and technologies that support jobs and critical services into the future.

Earth Observation Roadmap

SmartSat has invested in and supported research projects aligning with the Earth Observation Roadmap, which has identified five focus segments. SmartSat has developed research projects to align with goals of the focus areas of:

- EO Missions and Payloads
- Data Quality Assurance and Integrity monitoring
- Enhanced Data Management
- International EO Partnership and Leadership
- Access to International Data and Missions

FOCUS SEGMENTS	SMARTSAT ALIGNED PROJECTS	
Australian EO Missions and Payloads	**Kanyini hyperspectral and IoT satellite** This mission is designed to help foster a sovereign satellite manufacturing and support industry with partners Myriota and Inovor Technologies. Myriota are developing the IoT communications device and supporting the cosine Hyperspectral sensor integration work. Inovor are building the satellite 6U bus for the mission. **The OzFuel (Australian Fuel Monitoring from Space)** satellite mission will make use of sovereign technologies to deliver fuel hazard data, specifically tested for monitoring fuel conditions in Australia's eucalypt-dominant bushland, with the goal of improving Australia's pre-fire monitoring, prediction, preparation, response and resilience. **AquaWatch Misson** This project aims to build an extensive network of purpose-designed Earth observation satellites and ground-based sensors to monitor the quality of Australia's rivers and coastal and inland waterways with real-time data and predictive analysis.
Data Quality Assurance and Integrity Monitoring	**Next Generation Testbed Design for Earth Observation (Calibration/Validation)** This project aims to engage with satellite image producers, providers and users to prototype a next generation testbed platform to calibrate and validate earth observation satellite imagery. **Aquawatch Pathfinder EO Sensor Design testbed** This project will develop a simulation suite for Earth Observation Sensor Design as well as VAI algorithm development and testing to enable simulation of satellite EO sensors and subsequent simulation of at-earth-surface image products.
Enhanced Data Management	**The Kanyini mission with onboard AI processing** The onboard processing capability of the Kanyini satellite makes it possible to develop AI routines to pre-process data collected providing more value-added products to end-users. **AquaWatch** planned satellite data management and data integration to existing systems. **Real Time Fire Analytics** using historic data and new data to provide up to date fire data to emergency service agencies.
International EO Partnership and Leadership	**Five projects under UK-Australia Space Bridge** • Cal/Val Space Bridge: An Earth Observation Partnership • Modelling novel radio spectrum bands for next generation satellite networks • IceCube: Monitoring Antarctic sea-ice with small satellites • Australia's Quantum Leap: to satellite quantum encryption • Harvesting hyperspectral satellite data to improve crop production

Communications Technologies and Services Roadmap

SmartSat and a number of its academic and government partners were also involved in the development of the Communications Technologies and Services Roadmap. This close involvement has helped align SmartSat research with priorities identified by the space agency, including:

- LEO Satellite Services
- Optical Ground Stations
- Hybrid RF-Optical Communications
- Reconfigurable Networks, Radios, Modems and Waveform
- Satellite Communication Network Management tools
- Quantum Enabled Communications

FOCUS SEGMENTS	SMARTSAT ALIGNED PROJECTS	
Low Earth Orbit (LEO) Satellite Services	**Development of an Evil Digital Twin for LEO Small Satellite Constellations** Develop a proof of concept Evil Digital Twin framework for satellite related cyber security testing projects.	**Kanyini Misson** A planned three-year mission in Low Earth Orbit (LEO) to further develop capability in manufacturing and technologies associated with CubeSat production.
Optical Ground Stations	**Coherent Free-Space Optical Communications** Aims to demonstrate a system that will enable optical fibre-like data transfer rates for atmospheric free-space communication links, including over 10 km+ ground-to-ground links, as well as space-to-ground links.	**Lunar Ground Station Feasibility Study** Determining the feasibility to design, build, and place an optical communications terminal on the lunar surface.
Hybrid RF-Optical Communications	**Compact Hybrid Optical/RF User Segment (CHORUS)** Developing a full size engineering model of one a highly integrated hybrid Optical-RF tactical terminal.	**Modem Development for Optical and Hybrid RF/Optical Communications** Developing a modem for these optical and hybrid RF/optical communication links.
Reconfigurable Networks, Radios, Modems and Waveforms	**MIMO and Cooperative Communications for New Space** Investigating novel communications technologies towards achieving a resilient communications architecture between satellites flying in formation, the ground network and users.	**On-Board Processing for Advanced Tactical Communications** Developing technology for advanced tactical satellite communications as a long-term option to augment or replace current High Mobility satellite communications services provided by Ultra High Frequency (UHF) SATCOM.
Satellite Communication Network Management Tools	**The applications of AI for Satellite Enterprise Management** Investigating existing SATCOM enterprise architectures to quantify the	performance gains achievable through the incorporation of Artificial Intelligence techniques.
Quantum Enabled Communications	**Q Pathfinder – Quantum Enhanced Secure Comms for Small Sats and IoT** Defining Quantum Enhanced Secure Communications (QComms) system architecture(s).	**Evaluation of rare-earth quantum communication technology for space-based applications** Evaluating key issues in operating rare-earth quantum technology on a satellite platform and gauge its suitability for potential future space missions.

CAPABILITY DEMONSTRATOR MISSIONS

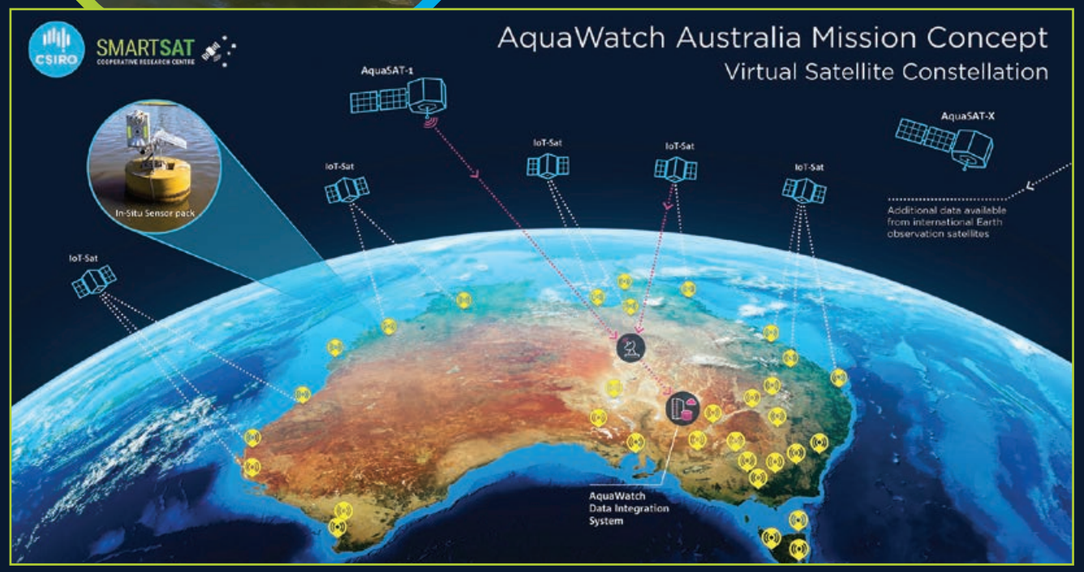
SmartSat continues to focus research on the three Capability Demonstrator (CD) missions established in 2020/21. This goal-orientated research and innovation method aims to address some of Australia's major challenges, including water and land management (Aquawatch Australia), Defence and national security (Indo-Pacific Connector), and natural disaster management (I-in-the-Sky). Research outputs from these CDs may be translated for operational adoption by end-users as fully fledged missions.

AquaWatch Australia

Knowledge of water quality information from inland rivers, reservoirs and coastal zones is a critical requirement for the effective monitoring and management of this essential resource. Freshwater quality can be adversely affected by natural or man-made low river flows, warm temperatures, toxic algae blooms, hypoxic blackwater from floodplain inundation, bushfires, sediment and nutrients transport. Similarly, coastal water quality is a key factor for fishing, ecosystem health, aquaculture, recreation, and tourism. Preventing poor water quality across all these areas requires improved monitoring, forecasting and management responses.

The AquaWatch Australia mission, a partnership lead by CSIRO and SmartSat, commenced in 2020/21 with a 'Phase-0' project. The mission commenced with a suite of three pilot projects were approved to study the water quality of inland and coastal waters, with another focusing on water quality associated with aquaculture farming. The results of these pilots will inform the next generation of satellites and sensors being designed for Australian applications.

- AquaWatch Coastal Water Quality Pilot: Integration of satellite and in situ observations with ecosystem modelling data streams for water quality understanding in two Australian coastal ecosystems
- AquaWatch Inland Water Quality Pilot: Application of Earth Observation and Modelling for Forecasting of Inland Water Quality (Lake Hume, Lake Tuggeranong and Darling River)
- AquaWatch Pilot Project: Aquaculture in Spencer Gulf, South Australia.

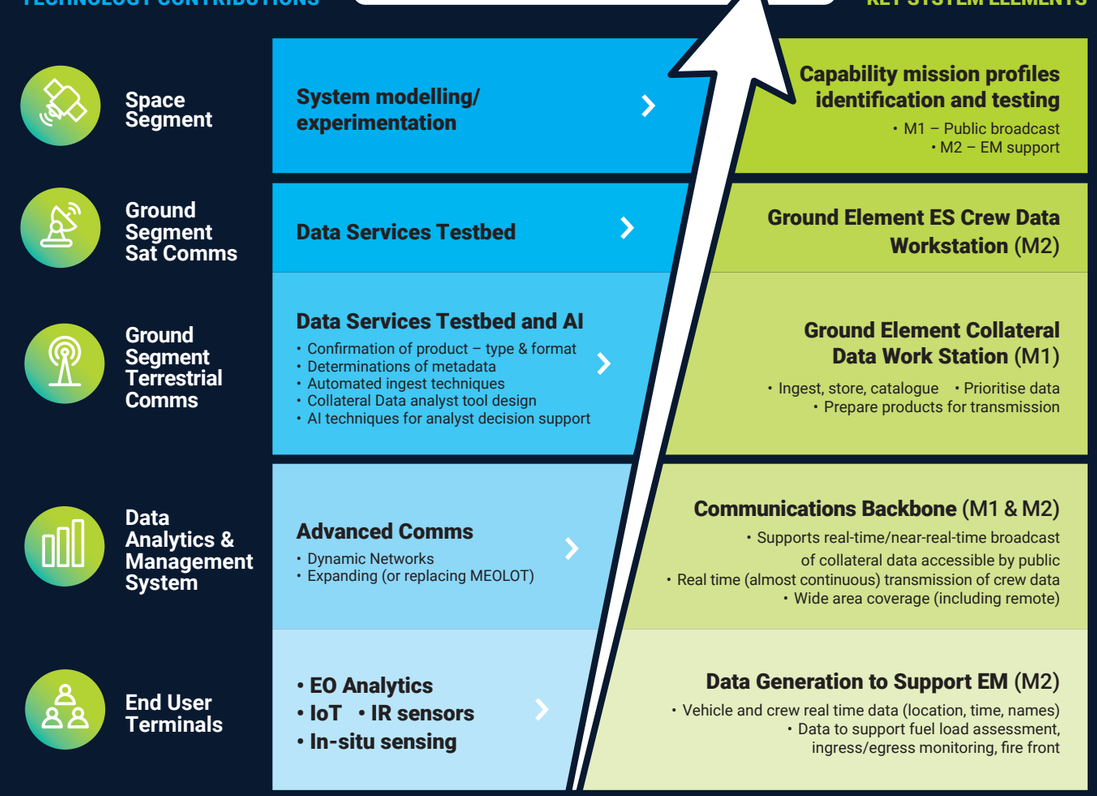


I-in-the-Sky

Natural disasters have always been part of the fabric of the Australian experience, however in recent years phenomena such as bushfires, floods, and droughts have been occurring with increasing frequency and severity. The Disaster Resilience mission (Intelligence-in-the-Sky, or I-in-theSky) seeks to focus research projects on significant gaps in all phases of disaster management to enhance decision-ready information and develop resilience capabilities for disaster operations. Through strategic international partnerships SmartSat is expanding project applications and drawing on overlapping interests to accelerate native capabilities.

In the 2021/22 period, I-in-the-Sky has focused on addressing technology and capability gaps in disaster response and climate change resilience using space through two core areas: communication and Earth Observation. The program supports an assemblage of research initiatives that address key phases of disaster management:

- Preparation – understanding how a changing climate affects and influences disasters through cutting-edge sensors to monitor fuel loads and landscapes
- Identification and Response – using AI and Machine Learning (ML) for real-time, on-board computing and decision making and preparing for Australian led hyperspectral satellite missions
- Developing novel, resilient communication solutions to better equip State Emergency Services (SES) as they respond.



Indo-Pacific Connector

The Indo-Pacific Connector Capability Demonstrator (IPC-CD) aligns closely to the Defence Science and Technology Group's (DSTG) RMS STaR Shot program and aims to create options to increase Australian industry contributions to payload development and capability experimentation within the STaR Shot. During the 2021/22 period, SmartSat has worked closely with DSTG with a goal to use the IPC-CD architecture to highlight the art of the possible in building resilient and capable future space systems that enable decision superiority across the entire spectrum of conflict.

IPC-CD is providing thought leadership on how Australia might move from being a consumer of space services to a contributor by evolving the building blocks of our national security space architecture from the 'large, complex and few' towards the 'small, smart and many'. Such space architecture will support the evolution of concepts that mirror terrestrial cloud computing. The ability to provide effective and reliable access to a distributed resource of sensors, processors and storage in space will seed the development and demonstration of a 'space cloud' that facilitates rapid innovation in space service delivery by exploiting the rich information environment it will create.

In the 2021/22 period, a number of key projects aligned with the IPC-CD progressed from the initial scoping phase to more advanced phases which further develop and demonstrate the technologies including:

- Coherent Free Space Optical Communications (Phase 2)
- Compact Hybrid Optical RF (CHORUS) (Phase 2)
- Compact Clock for Small Satellite Applications – Engineering Model

Additionally, a number of new projects were commenced in the period to address capabilities, which were identified in the technology roadmap as being critical for the IPC-CD, including:

- Spectrum Sensing from Space
- On-board Processing (OBP) for Advanced Tactical Communications
- Hybrid Optical/E-Band Correlated Channel Model
- Cognitive Satellite Radios
- Space Jeopardy and Response (S-JAR)
- Cyber Security and Resilient LEO Satellite Operations: Development of Cyberworthiness using a Digital Twin Approach (CY-JAR)
- Satellite Proximity Surveillance System (SatProx)

Many of the projects initiated over the past 12 months will support SmartSat and Defence in building an understanding of how Australian industry can contribute to future space capabilities providing new services and enhanced resilience. Our goal is to support Defence in realising its vision for "assured Australian civil and military access in space, integrated across Government, and in concert with allies, international partners and industry".

Distributed, Fractioned, Resilient C2/SA for Regional Security

Southern Indian/Pacific Ocean Priority Coverage

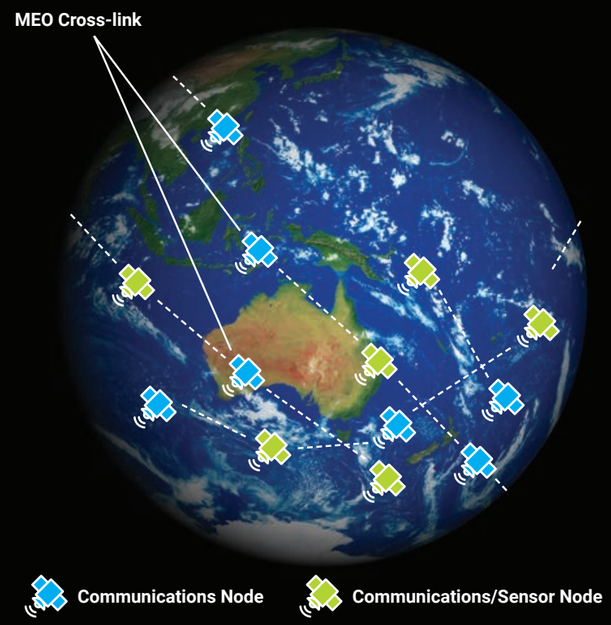
Hybrid LEO-MEO-GEO constellation
- Highly autonomous satellites
- Proliferated, distributed constellation design

Sensors optimised for Maritime and Littoral Domain Awareness
- Spectral, spatial and temporal resolution

LEO Service Delivery through agile, resilient networking capabilities
- User interface exploits API for evolved cloud services across the network

Networked Infrastructure Nodes
- Optical/THz LEO crosslinks
- V/E band ISL between LEO/MEO
- S band/X band user access

Integrated Space and Ground Nodes
- Fractioned service provision
- Secure but flexible access control
- Supports fixed and mobile network access
- Distributed intelligence through space and ground nodes – including user access terminals



PROJECTS APPROVED 2021/22

No.	Project Title	Project Parties
P1-22	Hybrid Optical/E-Band Correlated Channel Model	The University of Adelaide Defence Science and Technology Group
P1-23	On-board Processing (OBP) for Advanced Tactical Communications	Airbus Defence and Space Limited (UK) Defence Science and Technology Group Fleet Space Technologies Macquarie University University of South Australia LatConnect 60
P1-24	Spectrum Sensing from Space	Flinders University Defence Science and Technology Group
P1-26	Emergency Communications for LunaSAR (RESARC Phase 2)	University of South Australia Flinders University
P1-27	Cognitive Satellite Radios	Airbus Defence and Space Limited (UK) Deakin University Defence Science and Technology Group Macquarie University Royal Melbourne Institute of Technology University of Technology Sydney
P2-28	Pulsed Cathodic Arc Thruster Cathode Spot Motion and Erosion Pattern Quantification	Neumann Space University of Sydney
P2-31	Compact Clock for Small Satellite Applications Engineering Model	QuantX Labs The University of Adelaide Defence Science and Technology Group
P2-33	A Success Factor-based Framework for undertaking small satellite missions: SASAT-1	University of South Australia
P2-34	Onboard Hyperspectral AI: Cal, Panoptic segmentation, estimation	Queensland University of Technology Airbus Defence and Space Limited (UK) Nova Systems
P2-35	Space Jeopardy & Response (S-JAR)	Defence Science and Technology Group The Australian National University Royal Melbourne Institute of Technology The University of Adelaide University of Sydney
P2-36	Satellite Proximity Surveillance System (SatProx)	The University of Adelaide Inovor Technologies Defence Science and Technology Group
P2-37	Cyber Security and Resilient Low Earth Orbit Satellite Operations: Development of Cyberworthiness using a Digital Twin Approach (CY-JAR)	Defence Science and Technology Group The University of New South Wales University of South Australia
P2-38	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
P2-39	Assessing and enhancing multi-spacecraft mission simulation and visualisation	Swinburne University of Technology

No.	Project Title	Project Parties
P2-40	Cybersecurity of space infrastructure: a multidisciplinary approach	Flinders University CyberOps
P2-46	IPC Visualisation Task	University of South Australia Saab Australia
P3-15	AquaWatch Coastal Water Quality Pilot: Integration of satellite and in-situ observations with ecosystem modelling data streams for water quality understanding in two Australian coastal ecosystems	CSIRO WA Department of of Water and Environmental Regulation QLD Department of Agriculture and Fisheries
P3-16	AquaWatch Inland Water Quality Pilot: Application of Earth Observation and Modelling for Forecasting of Inland Water Quality (Lake Hume, Lake Tuggeranong and Darling River)	CSIRO
P3-17	AquaWatch Pilot Project: Aquaculture in Spencer Gulf, South Australia	CSIRO The University of Adelaide
P3-19	All-weather, near real-time monitoring of bushfire with satellite SAR	The University of New South Wales Nova Systems
P3-23	Adaptive Analytical Tool for Better Understanding and Reducing Future Bushfire Risk	The University of Adelaide Shoal Engineering Royal Melbourne Institute of Technology The South Australian Minister for Environment and Water (through the Department of Environment and Water (DEW)) Department of Fire and Emergency Services
P3-24	OzFuel (Australian Fuel Monitoring from Space) Phase A	The Australian National University The University of New South Wales Skykraft LatConnect 60 Spiral Blue GeoScience Australia
P3-25	Can satellites monitor crop and pasture quality across Australia?	CSIRO Grain Research and Development Corporation
P3-26	Quantifying the Past and Current Major Australian Floods with SAR and Other Satellites	University of New South Wales - Canberra Geoplex Department of Planning and Environment
P3-27	Fusion of multi-platform Earth observation data for mapping of fire progression and post-fire vegetation recovery	Macquarie University The University of Queensland NSW Department of Planning, Industry and Environment NSW Department of Primary Industries
P3-28	WildFireSat Mission and Australian Bushfire Management	MDA Corporation The Australian National University
P3-29	Machine learning for AquaWatch WQ parameter mapping: Dynamic Machine Learning Model to Estimate Water Quality Parameters in Complex Coastal Waters using Satellite Ocean Colour Observations	La Trobe University CSIRO
P4-20	Skills Gap Analysis Stage #2	La Trobe University

INTERNATIONAL COLLABORATIONS

UK-Australia Space Bridge Research Collaboration.

SmartSat led a program to fund five collaborative research projects in collaboration UK based Satellite Applications Catapult and the UK Science Innovation Network. This program was supported by Austrade, the Australian Space Agency, the UK Government and UK Space Agency as the first activity under the UK-Australia Space Bridge framework. Each project included partners from the UK and Australia to advance satellite technologies in the topics of:

- Earth Observation and Climate Resilience;
- Agriculture and Land Management from Space;
- Enabling Connectivity and Innovative Space Communications; and
- Quantum Technologies for Space

Cal/Val Space Bridge: An Earth Observation Partnership

Symbios Communications, Frontier SI and Assimila Ltd, The National Physical Laboratory

This project explored opportunities and identified commercial opportunities for collaboration between the United Kingdom and Australia on the calibration and validation aspects of Earth Observation satellite missions.

V-Band Radio Channel Prediction for Next Generation LEO Constellations

Royal Melbourne Institute of Technology and OneWeb

This project developed a novel time-series modelling approach for V-band satellite channel for space-to-Earth communication links. This will allow more accurate link performance prediction and aims to enhance network service availability, which is an essential component for OneWeb's next generation satellite system.

IceCube: Monitoring Antarctic sea-ice with small satellites

UNSW Sydney, University of Tasmania (Australia Australian Centre of Excellence in Antarctic Science, Australian Antarctic Program Partnership) and Spire Global UK, British Antarctic Survey

The IceCube project aimed to develop and validate new methods for sea-ice detection and classification harnessing Low Earth Orbit nanosatellites and artificial intelligence. The main outcome of the project was a demonstration of a more accurate classification of Antarctic sea ice using novel nanosatellite sea ice detection and deep learning classification methods that have been trained and validated with in-situ and remote sensing data of known ice conditions.

"I am delighted to see this exciting step which brings the Space Bridge partnership to life. It demonstrates the capacity for UK-Australian collaboration that will advance technology for the strategic benefit of both our nations. I congratulate all who took part and particularly the selected projects which were of an extremely high calibre. This is a concrete example of our shared focus and investment in scientific innovation."

British High Commissioner to Australia
Vicki Treadell

Australia's Quantum Leap: to satellite quantum encryption

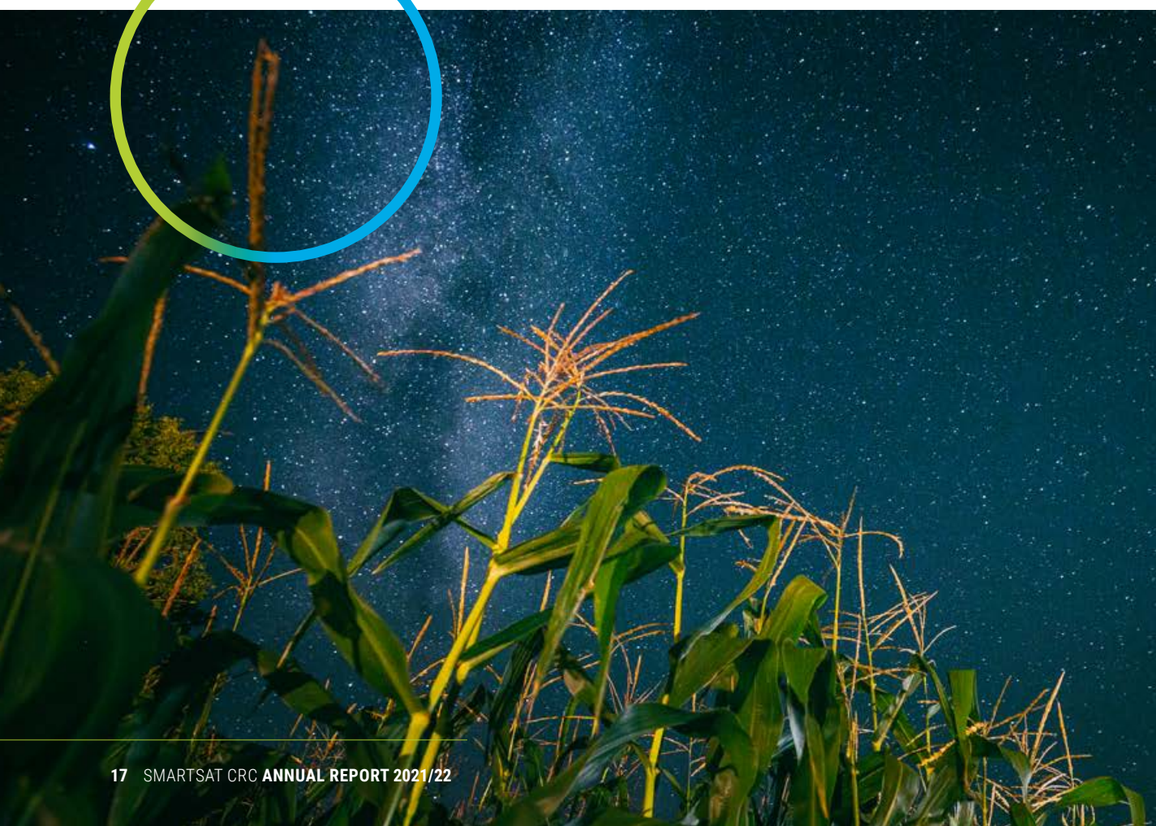
Arqit Limited and Australian National University

Advances in quantum computing threaten the methods of encryption upon which the world's digital economy depends. This proposed project built on work underway by Arqit to establish a Federated Quantum key distribution Satellite constellation (FQS) for use by government customers, protecting critical infrastructure against cyber-attacks, with the goal for Australia to become a partner in the construction of the system.

Harvesting hyperspectral satellite data to improve crop production

Digital Content Analysis Technology Ltd, InterGrain, and The Plant Accelerator, Australian Plant Phenomics Facility, The University of Adelaide

This project focused on demonstrating the ability for hyperspectral imaging to measure important grain quality traits, potentially useful for both helping breeders develop new varieties, and growers optimise crop quality.



INDUSTRY DEVELOPMENT

SmartSat's industry partners are at the heart of its projects and a key driver for ensuring strong end-user support and commercialisation pathways for its research. SmartSat has been working hard to ensure projects and PhD students have significant industry commitment and play a key role in their success. Strong industry involvement during initial project formulation phase is a critical success factor in maximising commercial opportunities. A positive indication of this engagement is many instances of industry partners supporting commercial pathways and considering intellectual property utilisation as projects wrap up or move onto subsequent phases.

Industry and End-User Engagement

Over the last three years, the SmartSat End User Advisory Boards have been critical in achieving the aims of 'Industry Lead, Research Driven' projects. SmartSat continues to utilise the End-User Sector Priorities published in 2021 and 2022 to inform the research program and have developed several sector specific projects based on these inputs.

The End User Advisory Boards met on a regular basis in 2021/22, providing invaluable advice and insight into the industry needs and challenges. Going forwards, the Agriculture and Natural Resources and Mining and Energy Advisory Boards will be utilised on an ad-hoc basis with members forming part of our extended advisory network rather than formal quarterly meetings.

Partner Feedback and Capability Map

During the year, a revamped Partner Survey was released to provide valuable information allowing SmartSat to map its partner capabilities and interests against the Technology Roadmap and strategies. This 'SmartSat Ecosystem Map' will significantly help us to bring Industry and Research partners together to build strong partnerships and projects.

INDUSTRY ENGAGEMENT

Moon to Mars Feasibility Showcase

This event, hosted by the NSW Node, highlighted the capabilities of successful Moon to Mars grant recipients, Australian Space Agency staff and SmartSat researchers covering Deep Space Communications, Space Robotics and Orbit Control, including propulsion and formation flight. This event provided an opportunity for successful grant recipients and key stakeholders to share valuable information on the program for potential future applicants.

Industry Webinar with Airbus: Harnessing Market and Competitor Intelligence for Growth

In order to provide start-ups, SMEs and entrepreneurs in the SmartSat community with industry-ready training, SmartSat hosted a webinar with Head of Strategy and Market Intelligence at Airbus Defence and Space, Steve Rooney. This webinar looked at the value of tracking market and competitor intelligence, how to understand the stakeholder ecosystem and business development best practice.

Kanyini End User Workshop – Earth Observation Applications

Hosted in conjunction with the 13th Australian Space Forum, SmartSat and Dutch company cosine collaborated on a briefing of the HyperScout 2 Flight Model Instrument and its integration onto South Australian state satellite Kanyini. Attendees received a comprehensive overview of the capability of the hyperspectral camera and its potential applications, including cloud detection, fire hazard monitoring, change detection and flooding delineation.

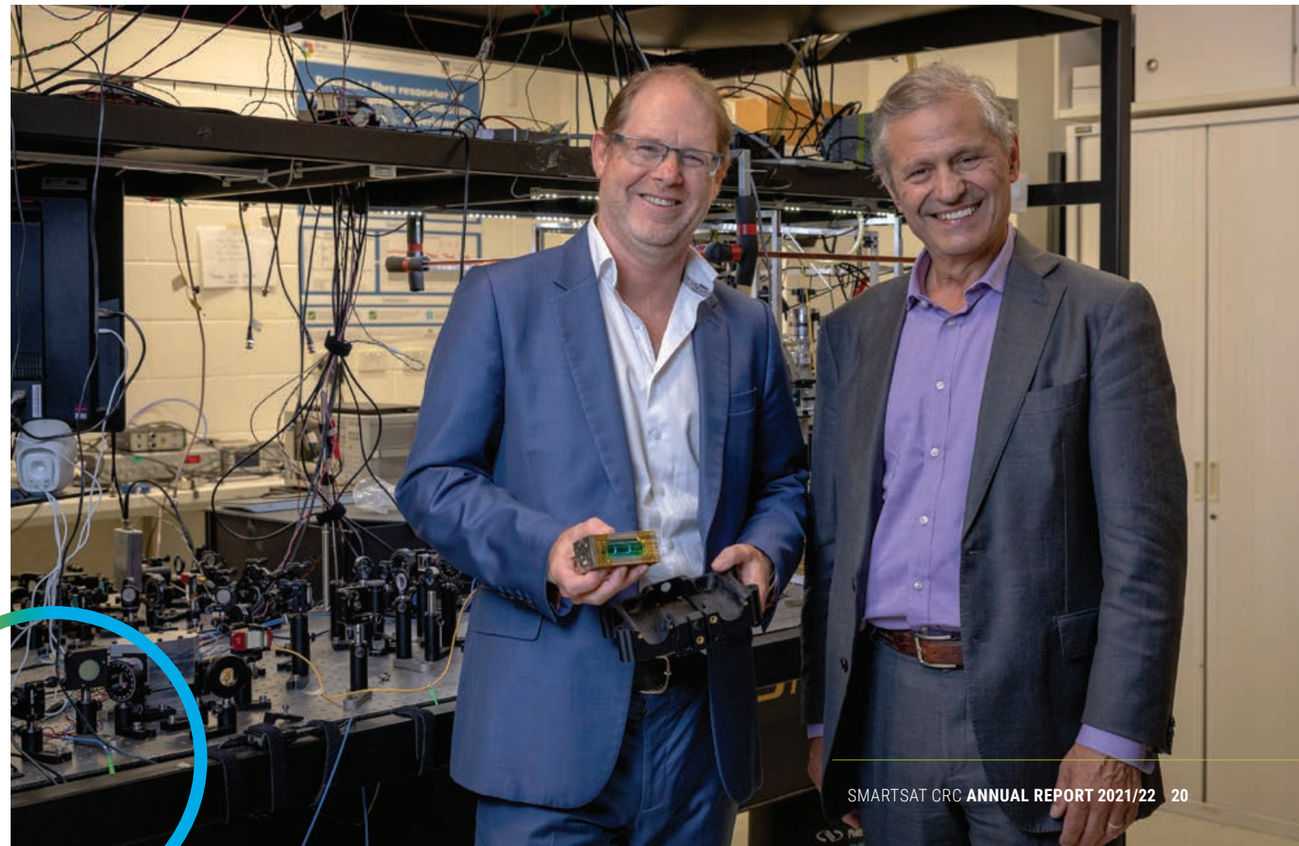
NEW MEMBERS

Supporting Partner

During the year, SmartSat welcomed new industry partner, QuantX Labs (formerly Cryoclock) as a Supporting Partner. Based at Lot Fourteen in South Australia, QuantX is a world-leader in high-precision timing and quantum sensor technologies with its flagship product, Cryoclock, a key element of the AIR2025 JORN Phase 6 Defence upgrade program. SmartSat has committed $1 million to assist QuantX in the development of its optical atomic clock satellite payload that will deliver the heart of a future Australian sovereign navigation and timing capability. QuantX's clock delivers a quantum leap in timing performance by using high-precision lasers to interrogate a specially prepared vapour of Rubidium atoms. Precision timing is of vital importance to modern society and is utilised daily though the Global Navigation Satellite Systems (GNSS), such as GPS, which generates trillions of dollars each year in economic benefits around the globe.

"This latest project with SmartSat CRC is crucial to accelerate progress as we plan to trial the Compact Optical Clock in space within the next 24 months. This latest funding builds on SmartSat's ongoing support, having supported the research and development through the Aurora Space Cluster, as well as facilitating connections with industry and government partners to help us bring the space clock to market."

QuantX Labs Founder and Managing Director
Andre Luiten



SUPPORTING THE GROWTH OF AUSTRALIA'S SPACE INDUSTRY

To support the growth of the space industry nationally, SmartSat has established State Nodes in New South Wales, Victoria and Queensland. An agreement was also reached with the Australian Capital Territory Government for a Node in that State in late June.

Victoria

The Victoria Node, supported by the Royal Melbourne Institute of Technology (RMIT) is continuing to strongly assist local industry and academia to develop technologies in telecommunications, IoT connectivity and intelligent satellite systems. The open project call offers up to $300,000 co-funding to local demonstrator projects that fit within SmartSat's key research areas. The Victoria Node hosted a research and development workshop to provide an overview of the first round of Demonstrator Grants and to bring together representatives from the local industry.

Queensland Earth Observation Hub

In conjunction with the Queensland Government, SmartSat established the Queensland Earth Observation (EO) Hub, which aims to generate opportunities for data analytics businesses and researchers, downstream industry, and upstream service providers of EO imagery. The Partnering Program supports industry-led projects with potential for commercialisation with co-funding of up to $300,000, with the following activities:

- The Calibration and Validation program supporting industry-led projects relevant to calibration and/or validation of EO data, projects, applications, or services
- Similar to the NSW Node, the Mobility Scheme encourages collaborative initiatives between Queensland-based universities and local industry

The Queensland EO Hub also hosted an initial workshop, focused on partnership within the local space sector and the opportunities available through the Hub.

New South Wales

Since its launch in March 2021, the New South Wales Node has run three grant programs to drive industry-research teaming and collaboration within the local space ecosystem. These programs are:

- The Space Demonstrator Program provides co-funding of up to $300,000 for industry-led demonstrator projects
- The Space Sector Mobility program funds placements of up to six-months for industry representatives to work within NSW universities, or for university researchers to work within NSW companies, to facilitate the transfer of expertise, training and skills
- The Infrastructure Access Scheme provides companies with access to R&D equipment, laboratory space and other research infrastructure on a rolling basis

The Node also hosted its first teaming design workshop in conjunction with the ACSER CUBESAT 2021: CubeSat Innovation Workshop at University of New South Wales Sydney.

NSW Node Projects approved in 2021/22

No.	Project Title	Project Parties
P7-01	Extra-terrestrial Radiation Tolerant Silicon Solar Cells	The University of New South Wales, Extra-terrestrial Power, New South Innovations
P7-02	Hybrid Space-Based Cameras for Target Uncertainty	High Earth Orbit Robotics, Infinity Avionics, The Australian National University, The University of New South Wales
P7-03	Very Low Earth Orbit Spacecraft Design for Remote Sensing Missions	Space Ops Australia, University of Sydney
P7-04	Automated Instant High Resolution Imagery Procurement and Integration	CSIRO, Arlula

Aurora Space Start-Up Cluster

SmartSat continued to demonstrate a commitment to supporting Australia's space SME and start-up ecosystem through the Aurora Space Start-Up Cluster. Aurora provides it's 40+ members with a framework to grow while providing opportunities for companies to collaborate with research organisations, local and international primes and with each other on commercial ventures and to build their capability. In its first full year of operation, a number of Aurora members collaborated on projects, including member companies AI Craft and Antaris, who signed a Memorandum of Understanding to test new Artificial Intelligence and Machine Learning models in space.

Due to COVID-19 restrictions, the first Aurora Town Hall meetings were hosted online, as were a number of exclusive member-only site tours of GPC Electronics, the University of Wollongong and TRICEP. As restrictions have eased, member companies have been showcasing their achievements at various space conferences across Australia and the world, including the Australian Space Forum in Adelaide and the Space Symposium in Colorado, USA.

The Aurora Board will have a number of positions up for re-election going in the 2022/23 financial year, as well as a review of the constitution that will allow committee members to have a greater impact and input into the running of the cluster.

AURORA

KANYINI

KANYINI (SA SPACE SERVICES MISSION SASAT-1)

The Kanyini mission is aimed at promoting and developing the South Australian space industry through the launch of a CubeSat nanosatellite with Earth observation and Internet of Things (IoT) payloads. Kanyini, which will be South Australia's first state satellite, is a collaboration among SmartSat and its partners Myriota and Inovor Technologies, with funding from the South Australia State Government.

Kanyini comprises the spacecraft bus, designed and built by Inovor Technologies and provides the vital functions for the spacecraft including power, attitude control and communications to the ground. The bus also supports the Myriota IoT payload and cosine Hyperspectral Imaging payload (HyperScout 2). HyperScout 2, developed under a European Space Agency (ESA) program, is a three-in-one instrument that combines hyperspectral and thermal imaging with high-level data processing and Artificial Intelligence (AI) capabilities. This will benefit research into crop health, forests, inland water and coasts, while the thermal infrared imager will provide vital information on heat generators in South Australia. In parallel with the development phase, a research program is being formulated with SmartSat's partners to make the best use of the systems once in orbit.

During the year, the Kanyini project team successfully completed the Critical Design Review (CDR), a highly significant milestone for the spacecraft. The CDR finalised the design of the 6U spacecraft with integrated payloads and initiated the start of the manufacture and test phase. The CDR team consisted of almost 30 members, including experienced independent reviewers from the Australian Space Agency, CSIRO and Mews, who have extensive ESA experience. A large portion of design team is made up of young engineers, the future of our space industry.

As part of the Kanyini project, Findon High School students were invited to the Myriota facility for a tour of their labs and presentations from the Inovor and Myriota design teams on the wide variety of exciting space career opportunities. Findon High School was the winner of satellite naming competition, suggesting the name Kanyini which means responsibility and unconditional love for all of creation and encompasses the key principles of Aboriginal life including, creation, soul, family and land.

EDUCATION AND TRAINING

AUSTRALIAN SPACE INDUSTRY SKILLS GAP ANALYSIS REPORT

The second Phase of the Skills Gap Analysis tested the skills gap findings with the lived experience of the space industry and training providers, capturing more qualitative information about skills needs pressure points. This developed a Space Skills Database which maps skills to courses, occupations, and education providers, offering greater insights into the skills gaps in different industry domains and the identification of capability and capacity of training providers and available courses.

It is recognised that many roles within the industry require multi-year qualifications and thus have long lead times. This means employers must proactively plan for future workforce needs. In a nascent industry, many of the offerings do not currently exist and there are barriers facing course development in terms of time, human capacity, and financial resources.

SmartSat is working with its partner network to look at innovative and collaborative programs as a means to reduce the barriers for training providers to develop courses and bring greater clarity on training and education market demands.

In collaboration with SmartSat's national and international networks, efforts have commenced to fill some of the knowledge and skills gaps identified with the development and roll-out of various Master Classes and short courses that directly align to gaps identified, including in the areas of:

- Space Law
- Radiation Protection for Space
- Designing Space Missions and Systems; and
- Applied Space Systems Engineering

MOON TO MARS PROGRAM DEMONSTRATOR WEBINARS

Following the Australian Space Agency's Moon to Mars Demonstrator Feasibility Grant, SmartSat offered a series of webinars to support organisations preparing for the challenges and requirements involved in developing space ready capabilities. These commenced in 2020/21 and concluded in 2021/22 with sessions on:

- Systems engineering and spacecraft operations
- Launch regulations
- Space environmental challenges

STEM INITIATIVES

South Australian Premier's Reading Challenge

SmartSat affirmed a commitment to support the future space workforce through sponsoringa space-themed challenge in the South Australian Premier's Reading Challenge. The Premier's Reading Challenge is a literacy engagement program introduced by the Premier in 2004 to encourage students to read more books and enjoy reading and improve literacy levels. The space themed category received 463 entries from Reception to Year 9, with winners receiving a package including SmartSat merchandise, a book voucher and a selection of specially selected space books as a prize.

Australian Youth Aerospace Association Astra Program

During the year, SmartSat sponsored the Australian Youth Aerospace Association (AYAA) Astra program, which provides tertiary students and young professionals of all disciplines an opportunity to learn about important issues in the Australian space industry. Astra participants are divided into three teams to address three different space issues. SmartSat provided sponsorship and mentorship into the team tackling the question "How can Australia use satellite technologies for the benefit of the earth and environment?"

SmartSat offers congratulations to team member Jennifer Williams, who was identified as an emerging leader by the ATSRA team and her fellow participants, and was awarded a scholarship of $1,200 to attend the Australian Space Forum.

The Andy Thomas Space Foundation

The Andy Thomas Space Foundation supports space education and inspires youth to pursue careers in the space sector. The Foundation, which is supported by SmartSat, has committed to use its funding to work alongside the Australian Space Discovery Centre to inspire the next generation of the space workforce, as well as to provide scholarships and in-kind support to increase resources for space education and outreach.

The Andy Thomas Space Foundation has also been appointed to take over the running of the biannual Australian Space Forum, one of Australia's premier space industry events. SmartSat is a major sponsor of this event and participates in the event both as an exhibitor and presenters.

R-2
RUNNER UP
SPACE

DAMANPREET
ARORA
YEAR 1

3-5
RUNNER UP
SPACE

LOGAN
BUCKINGHAM
YEAR 4

HIGHER DEGREE BY RESEARCH

SmartSat's Education and Training College guides matters relating to the recruitment, assessment, and training of PhD students. SmartSat also has a PhD Scholarship Committee which assesses all PhD scholarship applications. Other PhD related initiatives include:

- Two PhD professional development sessions, followed by PhD student presentations at the SmartSat Conference 2021
- Updated the priority areas for Higher Degree Research (HDR) scholarship applications in accordance with the priority areas of SmartSat's research programs
- A HDR Recruitment Strategy Paper and Research Progress Reporting procedure

By the conclusion of 2020/21, SmartSat offered 47 PhD scholarships with a further 2 PhD students are engaged in SmartSat projects on an in-kind basis from partner universities. These scholarships are a mix of full or top-up funding and include 'stand-alone' PhD research projects or PhD students 'embedded' in larger SmartSat research projects. Below is a profile of four of the PhD students and their projects.

Trung Dung (Alex) Nguyen, La Trobe University

Project Title: Advances in Long-term Water Quality Monitoring through Data Fusion

Trung Dung (Alex) Nguyen is a PhD candidate at La Trobe University, supervised by Professor Wei Xiang. Nguyen's project aims to develop a Machine Learning (ML) model that fuses satellite imagery and in-situ data for water monitoring and analysis for the benefit of water and environmental management. The result of this study will enable national monitoring of water bodies by using data fusion from satellite images and in-situ data; thus, limiting the risk of bushfires damaging ground-based water monitoring infrastructure. This research aligns well with the AquaWatch Demonstrator as it develops artificial intelligence (AI) algorithm that will provide accurate forecasting of water degradation in Australia. The AI will map major environmental events such as algae blooms, bushfires, and other meteorological events to the degradation of Australian reservoirs, waterways and coastal environments.

Jordan Shipard, Queensland University of Technology

Project Title: Efficient Subnets for Scalable Onboard AI in Space

Jordan is a PhD candidate at Queensland University of Technology, supervised by Professor Clinton Fookes. This project aims to develop state of the art methods and approaches for implementing efficient onboard space AI in the context of Earth Observation nanosatellite constellations. This research will focus on the onboard AI problems within the context of Earth Observation, making its potential applications as diverse as Earth Observation applications. Notable applications include, agricultural monitoring, disaster warning systems, and environmental system monitoring and management.

Robert Andriambololonaharisoamalala, Curtin University

Project Title: Integration of Earth Observation data and ground-based measurements to accurately map the effect of Urban Heat Islands

Robert is a PhD candidate from Curtin University, supervised by Dr Petra Helmholz. The aim of this project is to review how existing and future EO data can be used in combination with data capture with terrestrial methods in a joint data fusion architecture. To create the architecture, standards of the terrestrial and satellite data will be investigated and when required, recommendations for standards' improvement will be suggested. The proposed architecture will be designed as general, applicable in multiple spatial information areas, the study will focus especially on Urban Heat Islands (UHIs). Approaches to efficient data and information visualisation will be part of the investigation in this research with professionals from different areas than spatial information science as target audience. Urban Heat Islands impact the quality of life in many urban centres. Metropolitan areas of Australian cities and urbanised regional centres show vulnerability towards UHIs due to challenging climatic conditions.

Uakomba Uhongora, University of South Australia

Project Title: Deep Learning Intrusion Detection System for Smart Satellite Networks Based on Software Defined Networking

Uakomba Uhongora is a PhD candidate at the University of South Australia, supervised by SmartSat Professorial Chair, Jill Slay. Uhongora's project will focus on detecting anomalous traffic within SDN-based smart satellite networks using Deep Learning (DL). The project will contribute to SmartSat's focus areas of Advanced Satellite Systems, Sensors and Intelligence specifically the data security of satellite systems, and the Security of Satellite-based IoT services with Deep Reinforcement Learning and is in close association with SmartSat CRC's Project P2-36, Cyber Jeopardy and Response (CY-JAR).

DIVERSITY & INCLUSION (D&I)

The Diversity and Inclusion (D&I) Committee met four times during the 2021/22 period. The committee welcomed Eva Rodriguez Rodriguez, Space Lead at FrontierSI and Cinthia Perez, Assistant Manager at the Australian Space Agency, as new members.

During the year, and in alignment with the SmartSat D&I Action Plan, SmartSat policies and procedures were continually reviewed and updated to ensure that they were reflective of the organisation's continuing commitment to D&I. SmartSat added a Parental Level Policy and Flexible Work Arrangements procedure during the term to provide greater certainty in these areas. SmartSat also maintained its membership of the Diversity Council Australia.

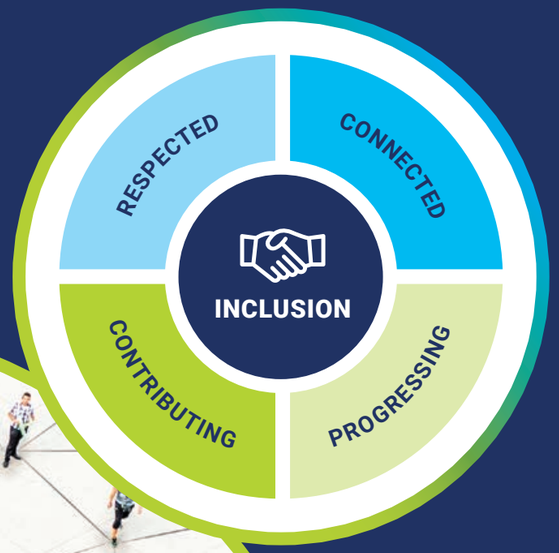
D&I recruitment principles are considered considered during the recruitment and appointment process for all new positions. For existing staff, D&I principles, targets and initiatives continue to be communicated across the organisation.

SmartSat is focused on ways to improve the data collection from its partners to ensure that the development of baseline strategies to improve gender balance in the space ecosystem. To this end, during the term, research project teams were requested to report on diversity and inclusion in their quarterly project reports, including progress, challenges and any barriers that may exist. This information will be reviewed across all projects, and progress/trends will be reported to the D&I Committee. It is hoped that this information can be used by SmartSat to look more broadly within the sector and how SmartSat can position itself as a leader in terms of recruitment demographics, including in its funded research projects.

In late 2021, all female staff were invited to participate in a survey to support a response to the Women in STEM Decadal Plan. In parallel with this activity, Equality Consulting was engaged to assist SmartSat in providing expert advice and support towards SmartSat learning more about potential issues relating to gender equity within and external to the organisation, to allow SmartSat to identify areas of opportunity for positive influence.

To align our communications and marketing approach with D&I principles, a review is currently underway to ensure that our communication platforms, including our website, newsletters and publications, adhere to best practice in terms of accessibility.

Through the D&I Committee, SmartSat is also looking to develop mechanisms to provide greater incentive and support to increase the number of female PhD students. It is intended that SmartSat will engage with current female PhD students to seek feedback on their experience to date and seek input regarding female-only PhD incentives. It is expected that SmartSat will look to implement these mechanisms in Quarter One of 2022/23.



CASE STUDIES

SPACE JEOPARDY & RESPONSE (S-JAR)
P2-35

Project Participants:

Defence Science and Technology Group , University of Adelaide , Royal Melbourne Institute of Technology, University of Sydney, Australian National University

This project aims to advance the concept of a small, system independent suite of sensors and processors feeding information into an Artificial Intelligence (AI) based interpreter that will identify the potential jeopardy of the platform as well as propose an appropriate response.

Project Overview

When a satellite stops communicating it is difficult for an operator to determine the cause or nature of the failure and to determine an appropriate response. Failures can be caused by many events including space based sub-system failures, impaired access to communication spectrum or spacecraft loss due to a collision with space debris.

This first phase S-JAR project focused on the threats posed by space debris and space weather in particular. The proposed system would respond to those threats by:

- Near real-time attribution of satellite anomalies and failures, particularly when operating in an increasingly congested space environment. When communication abruptly stops, or operation is unexpectedly and severely degraded, it is important for operators to be credibly able to determine the root causes of the problem.
- In-orbit jeopardy assessment for high-value space assets, leveraging state-of-the-art sensing and AI technologies to provide timely situation awareness to operators.
- Resilience and risk mitigation through autonomous maneuvering of a satellite which may be initiated by the S-JAR AIMC as a response. This capability is also known as 'Sense and Avoid', required by most emerging autonomous systems.

The sensor suite of S-JAR can also contribute Space-based Space Domain Awareness (SDA) by timely adding new entries and refining the information in the space object catalogues. The sensors currently under investigation for debris detection are radar, LiDAR, and Event-Based Camera (EBC). A suite of sensors for space weather are also being considered.

The envisioned future deployment of S-JAR could be in any one of these configurations:

1. A module or subsystem on a larger host satellite, or
2. A wingman CubeSat orbiting in close proximity (within a few kilometres) to a larger satellite requiring its support, or
3. A 'swarm' of wingman S-JAR CubeSat's orbiting in close proximity to a larger satellite.

The S-JAR system must also stay within the size, weight and power (SWAP) constraints of the specific use case and deployment configuration.

This work is an important precursor to the development of cognitive satellites – satellites that are 'context aware' of their operating environment and are able to independently self-configure to achieve increased mission resilience in a hazardous environment. Opportunities exist for orbital data collection and flight demonstration, at various development stages of S-JAR in Defence's Resilient Multi-mission (RMS) STaR Shot.

The longer term outcome goal from the project is envisioned to be the Australian development of a generic S-JAR capability that could be applied to future missions as a low cost, low space weight and power sub-system, which could be considered as a type 'satellite black box' that would autonomously assess the jeopardy state and transmit useful information to operators prior to loss of the asset.

The project team involved four universities working under the technical leadership of DST-G. The team aim to onboard industry partners for the relevant subsystems to continue the work in a Phase 2 project.

ON-BOARD PROCESSING FOR ADVANCED TACTICAL COMMUNICATIONS

Project Participants:

Defence Science and Technology Group, Airbus Defence and Space, Macquarie University, Fleet Space Technologies, University of South Australia, LatConnect 60

This project aims to explore whether and how the networking functionality of existing state of the art of military satellite communications (MILSATCOM) for tactical use cases can be provided via a LEO small-satellite (under 200kg) constellation at lower cost, taking advantage of advanced onboard processing techniques.

Project Overview

The use of Software Defined Radio (SDR) technology and On-Board Processing (OBP) of the communications waveform in space offer significant performance benefits compared to existing 'bent-pipe' solutions, but at the cost of increased complexity.

For the purposes of this project, tactical communications is described as supporting terminal mobility which often leads to the need to use very small aperture terminals and operate over complex RF propagation channels. The current state of the art in provision of high mobility MILSATCOM is delivered by the US Department of Defense Mobile User Objective System (MUOS). MUOS is a constellation of five (four operational, one spare) geosynchronous satellites offering communications services at Ultra High Frequency (UHF). It is desirable for Australia to have a sovereign option for these crucial functions and there are also opportunities to leverage the strong research capabilities in the country to develop advanced new technologies and communications solutions.

To begin this project, the research team defined key network design goals and scoped the requirements for an eventual operational network. The team examined five use case scenarios of increasing scope and complexity. These include both single beam and multi-beam scenarios. One of the more complex scenarios investigated is a humanitarian/disaster relief operation in the Indo-Pacific region where a Defence Task Force is supported by broader government agencies, contributing to a multi-national effort supporting a regional partner following a large-scale natural disaster such as an earthquake, cyclone or tsunami.

In each scenario the research involved working with end-users to define the service and traffic scenario that will allow a greater detail in our analysis of resource allocation and priority setting for the various communication.

The research is considering a broad range of technical aspects, including:

- Different types of user terminals including handheld and on-the-move ground stations
- Frequency band options
- Link quality including path loss due to atmospheric and foliage effects
- Network traffic load analysis including simultaneous voice and data
- Different network topologies including point-to-point, multi-cast, hub-spoke and mesh
- The geographic spread of the users
- The types and geographic spread of base stations
- Satellite backhaul
- Multi-access schemes
- Antenna specifications
- Beam steering and beam allocations
- Security consideration including encryption and cyber resilience
- Satellite constellation design including orbits, coverage and capacity
- Waveform design
- Multi-channel emulator hardware testbed

The current project is focused on requirements and performance specifications. Also delivered will be an implementation plan for future phases, which can then be executed by either the same project team and/or by additional partners. This project intends to align its outcomes on the needs of Defence (JP9102) but there are also credible pathways to future demonstrations through Defence's RMS STaRShot missions.

It is envisioned that the follow-on research and development after this project will lead to a sovereign and high-performance advanced communication capability that is desired by Defence as an augmentation or future replacement to legacy UHF satcom.

Whilst the core focus is on military and other government users, this project is also exploring the potential demand for this class of service by commercial users, in the agriculture, mining and transport sectors.

ALL-WEATHER MONITORING OF BUSHFIRE WITH SYNTHETIC APERTURE RADAR

Participants:

Defence Science and Technology Group, Department of Defence, Airbus Defence and Space, Lat Connect 60, Fleet Space Technologies, Macquarie University, University of South Australia

This project is aiming to provide an all-weather monitoring of bushfires with Synthetic Aperture Radar systems to provide better emergency response to bushfire. The project concept was developed in conjunction between UNSW and Nova Systems as an additional tool to be provided to Nova Systems existing clients in the emergency services sector.

Project Overview

Bushfires present a constant threat to Australia which has been exacerbated by climate change. For example, the 2019/20 Australian bushfire season, colloquially known as the Black Summer, was a period of unusually intense bushfires in many parts of Australia, started in June 2019 and continued through to May 2020. In total, more than 9,352 buildings were destroyed with 34 direct deaths and 417 indirect deaths due to bushfire smoke inhalation.

The need for an all-weather and 24/7 bushfire monitoring system has been known widely and has become more urgent because of the devastating 2019/20 Black Summer Bushfire. For example, an inquiry into the disaster recommended – "That, in order to improve capability to detect ignitions and monitor accurately all fire edge intensity and progression automatically across the State in near real-time, Government establish a spatial technology acceleration program to maximise the information available from the various remote sensing technologies currently in use and to plan for inclusion of new remote sensing systems that can sense precisely and rapidly through heavy smoke, cloud, fog and dust. This will require work within the State and with partners nationally and internationally." (Final Report of the NSW Bushfire Inquiry, Page VII, 31 July 2020).

The aim of this project is to exploit interferometric coherence of high-resolution satellite Synthetic Aperture Radar (SAR) imagery to detect bushfire early and reliably, monitor its spread day and night and in all weather conditions, and hence greatly improve our bushfire management capabilities. Project activities include not only the development of a robust satellite SAR based 'production line' to convert remote sensing imagery to fire intelligence, but also several comprehensive bushfire case studies across states.

The expected outcomes are:

- An innovative tool based on satellite SAR (e.g. three meter resolution Sentinel-1A, 1B and NovaSAR) ready to be integrated into the existing bushfire information systems such as the Digital Earth Australia Hotspot (DEAH) system, which complements its planned upgrade through the addition of shortwave infrared information from geostationary satellites (e.g. Himawari-8);
- Technical reports on several case studies of using the new tool to detect and monitor bushfires which may occur in the 2021/22 and 2022/23 fire seasons; and
- A report detailing recommendations for future follow-on project phases by a group of workshop attendees of industry-gathered emergency services clients.

It is impossible for the current bushfire information systems based on satellite short-wave infrared imagery (SWIR) data to detect and monitor bushfires in the presence of cloud cover, as demonstrated in the 2009 Victorian Bushfire. Further, hot air plumes carried by strong wind may also mislead locating bushfires.

This work will complement the current systems using advanced InSAR coherence techniques, which can penetrate cloud and smoke and reveal what occurs on the ground in all weather conditions, day and night.

End-users such as the NSW Rural Fire Services (RFS) may not have in-house SAR remote sensing specialists to address bushfire applications, taking advantage of the rapid development of SAR missions globally. This project will develop powerful software tools to automatically access and process SAR imagery from multiple missions to deliver bushfire intelligence.

Project outcomes have the potential to be readily utilised and commercialised in Australia and across the globe. This will be reviewed directly with potential future end users and collated into a report recommending a pathway for future phases. Further, multiple high profile case studies will also inform larger Phase 2 activities such as InSAR coherence processing on-board satellites and even Australian SAR satellite missions for disaster monitoring.

OZFUEL (AUSTRALIAN FUEL MONITORING FROM SPACE) PHASE A

Participants:

Australian National University , Skykraft, University of New South Wales Canberra, LatConnect60, Spiral Blue

This project is the first stage in developing a sovereign satellite capability for assessing fire fuel loads in Australia to better manage, predict and respond to bushfire hazards.

Project Overview

The spectral and radiometric resolution in existing satellite data is insufficient for eucalypt-dominant bushland. The OzFuel (Australian Fuel Monitoring from Space) satellite mission will make use of sovereign technologies to deliver fuel hazard data, with the goal of improving pre-fire monitoring, prediction, preparation, response and resilience. Led by ANU, the 12-month project will deliver OzFuel Phase A with partners Skykraft, University of New South Wales Canberra, Spiral Blue and LatConnect 60. The project involves end-to-end mission design at the ANCDF, verification of fuel biochemical properties to be sensed from space, and market analysis on the commercial potential of shortwave infrared data in parallel industry sectors. The project will accelerate development of critical sovereign Earth observation space technologies including advanced sensors, edge processing and small satellite capabilities.

The OzFuel mission is the first step in the creation of an EO early warning system for natural disaster mitigation, with adequate spatial and spectral resolutions and revisit times that may complement existing Earth observation satellites. While there are high profile Australia and international missions targeting active fire/smoke detection for bushfire mitigation (i.e. during fire activities), OzFuel is unique in that it will measure fuel properties as opposed to fire detection, for pre-fire mitigation and preparedness. These properties are nevertheless also critical for planning response (e.g. during fire activities) as OzFuel will provide fuel variables that are input into fire behaviour models and therefore will enhance the capability to predict where and how quick an active fire will spread. By targeting the specific wavelengths, the chemical components that make Australian forests more flammable, OzFuel will provide a comprehensive characterisation of fuel loads at a continental scale. Its fire prevention function will be the first of its kind in the world, complementing an array of commercial and government initiatives for active fire detection.

The OzFuel pathfinder is proposed to be of significant relevance to the SmartSat I-In-The-Sky Capability Demonstrator. OzFuel Phase A will highlight a concept of operations from data acquisition and edge processing to data distribution via the Australian Flammability Monitoring System web service. Architectures and lessons learned from OzFuel-1 would help de-risk design concepts for SmartSat's disaster resilience program.

At an international level, OzFuel will contribute to ongoing Wildfire Pilot Project lead through the Committee on Earth Observation Satellites (www.ceos.org) where countries will collaborate to deliver satellite earth observation systems for fire: prediction, monitoring and postfire assessment. Australia will lead the work on fire prediction by building a satellite system that will deliver the data to continue to drive Australian Flammability Monitoring System (AFMS).

This project represents a significant collaboration of industry and research to study the feasibility to develop a new Australian sovereign satellite system and sensor tailored specifically to Australian vegetation needs for the assessment of fire fuel loads. The project has a well-established end-user and a platform for the system to deliver data to. The collaboration of Skykraft, LatConnect60 and Spiral Blue brings together significant experience in the technical and engineering development of space systems and the research team led by Marta Yebra at the Australian National University, will add the missing piece of knowledge on spectral characteristics of Australian vegetation required to understand the data from the satellite.

QUANTIFYING THE PAST AND CURRENT MAJOR AUSTRALIAN FLOODS WITH SAR AND OTHER SATELLITES

Participants:

University of New South Wales, Department of Planning and Environment, Nova Systems (Geoplex)

This project aims to develop an all-weather system using Synthetic Aperture Radar (SAR) and optical satellite imagery data to map flood extents and manage floodplain water harvesting.

Project Overview

Flooding is a common and extremely impactful event within Australia and around the world. For example, the March 2021 Australian floods are a series of floods that began from 18 March 2021 which have affected New South Wales, from the North Coast to the Sydney metropolitan area in the south, in a disaster described as a 'one-in-100-year event'. Additionally, far-south and far-southeast communities in Queensland were also greatly affected by flooding and heavy rainfall.

The aim of this project is to develop and operationalise smart analysis of SAR and optical satellite imagery (primarily NovaSAR and Sentinel missions) to address time-critical applications such as flood mapping (2D) and floodplain water harvesting (3D), based on many years of research in this area by the project team since 2009. Project activities include feasibility studies, remote sensing software development (analytic toolbox) and extensive case studies.

The expected outcomes are:

- a suite of near real-time, cross platform, scalable and operational tools for mapping floods with satellite remote sensing, ready for flood management agencies to takeover and/or private sector to commercialise, and improve volume estimate during the floodplain harvesting event for the Murray-Darling Basin states;
- a comprehensive report on feasibility studies to inform a Phase 2 project; and
- a comprehensive report on the case studies, targeting a range of users.

The project brings together core partners such as Univeristy of New South Wales, the New South Wales Department of Planning and Environment (DPE), and Geoplex through Nova Systems – an ideal mix of academia, end user and geospatial service provider. The proposed project has also attracted strong support from the Federal Department of Agriculture, Water and Environment (DAWE) because of its significant national benefits, as well as other key players such as Airbus and Geospatial Intelligence Pty Ltd.

Project outcomes will inform a larger Phase 2 activity and be readily commercialised and utilised. The larger Phase 2 activity could implement the same smart analysis in space on the satellite and broadcast the flood information globally. On the other hand, the outcomes can be used to improve flood management, flood modelling, infrastructure and residential planning, floodplain water harvesting, and the better management of Murray Darling Basin.

Deliverables from this project consist of a highly efficient software tool and extensive case studies for satellite SAR, altimeter and optical sensors-based flood detection and monitoring. There are two different pathways for adoption of these outcomes by the end user and industry partner.

For the end users such as the State Emergency Services (SES), they might use the software tool as a 'black box' through the loose-integration approach and hence it is important that the final product from this tool is fully compatible with the flood information system used by SES.

For industry partners such as Nova Systems or DPE, they might take over the source codes for the tool and embed the new SAR capability in their systems through the tight-integration approach. Hence, it is important to ensure the tool's cross-platform compatibility and easy-to-follow documentation.

FUSION OF MULTI-PLATFORM EARTH OBSERVATION DATA FOR MAPPING OF FIRE PROGRESSION AND POST-FIRE VEGETATION RECOVERY

Participants:

University of Queensland, Macquarie University, Department of Planning and Environment , New South Wales Department of Primary Industries.

The project aims to develop a reliable all-weather system for near-real time tracking and mapping of fire progression, extent and recovery using multiple sources of data.

Project Overview

The project aims to develop remote sensing methods that will be integrated into an operational framework for monitoring the impact of fire on vegetation. The project will address two research areas for novel methods for rapid fire extent mapping and understanding recovery potential.

The key innovation of this project is the development of robust methods for the integration of radar-based Earth Observation (EO) data into current and emerging systems for monitoring the impact of fire on vegetation. Rapid fire extent mapping, including fire progression of large wildfires, will be based on dense time-series of synthetic aperture radar (SAR), optical data and machine learning. The research will also explore the capabilities of SAR and LiDAR data, integrated with optical data, for distinguishing structural characteristics of post-fire recovery dynamics.

The overarching focus of the research is on the integration of multi-sensor EO data to fill key gaps in operational monitoring of the impacts of wildfire. The project aims to support land and fire managers to make more informed decisions, by developing more accurate and timely measures of burnt area extent and tools for monitoring post-fire recovery.

A range of sensors will be utilised for this research including SAR data from Sentinel 1 and ALOS-2 with potential for NovaSAR 1 data to be added when available and optical data from at least Sentinel 2.

The key outcomes of the project are:

- robust all-weather methods for rapid mapping of burnt area;
- improved methods for using satellite time-series to assess vegetation recovery by integrating structural metrics from radar with spectral metrics from optical sensors; and
- building capacity and knowledge in the sector by publishing in peer reviewed journals and engaging with Government and Industry stakeholders.

The measure of success of the research will be in the adoption of new methods into the operational workflows of our government partners. The research will determine whether the integration of SAR and optical data provides a robust means of rapid fire-extent mapping, including for certain vegetation types (heath, grassland). Methods will be tested on DPE's high performance computing environment (SDC), will leverage existing workflows (FESM) or be coded into new workflows and be available for immediate use following project completion. The research on recovery potential will build on a prototype post-fire recovery monitoring system currently under development by DPE that integrates with FESM.

Our strong collaborative partnerships with end users and key stakeholders including NPWS, RFS and the NRC, will be tapped to support the development of operationally ready products. Research outcomes will be demonstrated at a stakeholder workshop to be held in the last couple of months prior to project completion. The uptake of methods developed in this project by key stakeholders will be an effective measure of the success of the research.

The use of radar has long proven challenging due to cost, limited time-series, sensitivity to moisture and topography, and often a need for multiple frequencies and polarizations. With free availability of dense time-series of C-band SAR observations from Sentinel-1A (2014-) and Sentinel-1B (2016-), the research will unlock the potential of multi-temporal C-band SAR for fire extent and recovery monitoring. New ways of integrating SAR and multi-platform data will be discovered, which will lead to advances in the application of SAR in natural resource/disaster management. Exploring the potential of next generation EO sensors (BIOMASS, NovaSAR, GEDI) will open the door to new applications development.

INTELLECTUAL PROPERTY MANAGEMENT

As outlined under the SmartSat Core Participants Agreement, the SmartSat Board will be responsible for determining protocols relating to the ownership of project Intellectual Property (IP), and utilisation of project IP, which will be agreed in Project Agreements by SmartSat on a fair and consistent basis.

SmartSat's IP management is guided by two principles, namely:

- Preference for utilisation rights to be given to those (Core and Supporting) participants who have played a lead role in the research and development phase, and
- The flow of benefits from outcomes of utilisation must be in the overall best interests of all SmartSat participants, including the immediate and long-term national interest.

Supporting the implementation and operationalization of these is an IP assessment decision making framework, underpinned with internal policies and templates.

SmartSat Management has identified the three main steps in assessing the Project IP are as follows:

- Step One deals with IP Ownership, Utilisation Agents and Retained rights. These are largely agreed in the Project Agreement, but can be revised / added to / adjusted if a project party submits a Utilisation Plan.
- Step Two is a staged assessment process for different types of SmartSat projects, where the outcome and mechanism for dealing with the Project IP may require Board approval under the delegations policy.
- Finally, Step Three considers the mechanisms for how to deal with Project IP (i.e. Hold, Develop, Assign, License, etc.), for any Project IP that is developed.

This process and framework were endorsed by the SmartSat Industry Advisory Board during the term, who had previously asked SmartSat to consider additional project attributes, such as: TRL increase, commercial potential, and overall contributions to project (i.e. Background IP) versus cash received, and the total value of SmartSat cash investment, within its framework.

SmartSat maintains the position that, given the complexity of some of these arrangements, it will continue to review and manage these on a case-by-case basis, including entering into separate agreements with Utilisation Agents to ensure the rights and requirements for the utilisation of project IP are documents and adhered to.

SmartSat continues to maintain a register of Background IP, and Project IP, in its project management system, mySmartSat. SmartSat and project parties have the ability to add and review this on an ongoing basis to ensure the records remain accurate and up to date.

COOPERATIVE RESEARCH CENTRE FUTURE PLANS AND TRANSITION ARRANGEMENTS

SmartSat Participants have agreed in principle to work towards the establishment of a permanent space research entity at the completion of the seven-year term.

During the term, the SmartSat Board and management completed two strategic planning sessions that focused both on maximizing the impact and delivery against the SmartSat Strategic Plan and discussed options for positioning SmartSat for an ongoing role in the Australian Space ecosystem.

The Board and Management continue to hold the view that through successful delivery against the Strategic Plan, SmartSat will aim to create a sustainable presence of a national, collaborative, innovation driven, research and development organisation, that will succeed through its enduring partnerships.

SmartSat has continued ongoing discussions with key partners in relation to the role that SmartSat can play in the space ecosystem, including:

- SmartSat's uniquely capable of bringing industry, researchers and universities together to help Australia build a viable and thriving space sector.
- SmartSat's unique position as an independent, impartial broker, to enable effective collaboration with the industry that delivers projects at speed and at scale.
- SmartSat's strong track record of creating next generation technologies and innovative projects that can contribute to the government's goal of tripling the size of the space sector, generating new opportunities for all Australians, and supporting Australia's defence and national security.
- SmartSat's unparalleled space industry and research network that can be harnessed to deliver the space technology innovation Australia needs to build sovereign capabilities.

APPENDIX
EDUCATION AND TRAINING: PhD STUDENTS

Student's Name	Date Commenced	Completion Due	Research Program	Project Title	University	Country
Benjamin Dix-Mathews	2020	2022	RP 1	Phase and spatial stabilisation system development *	The University of Western Australia	Australia
Skevos Karpathakis	2021	2024	RP 1	Phase and spatial stabilisation system development / Coherent Free-Space Optical Communications	The University of Western Australia	Australia
Duaa Fatima	2020	2023	RP 1	Physical Layer Security for Satellite based IoT Edge Services with Deep Reinforcement Learning for Energy Efficiency	La Trobe University	Australia
Zachary Aul	2020	2022	RP 1	Anomaly Detection in IoT for Satellite Security Using Blockchain	La Trobe University	Australia
Mohamed Sheta	2021	2024	RP 1	Potentials and Limitations of the IEEE 802.15.3d Standard for Terahertz Satellite Communications	University of Adelaide	Egypt
Ahsan Waqas	2021	2024	RP 1	Distributed Beamforimng for Satellite Applications	University of South Australia	Pakistan
Kou Tian	2021	2024	RP 1	Deep Learning for Advanced Physical Layer Communications	University of Sydney	China
Vibhor Thapliyal	2022	2025	RP 1	Vibhor Thapliyal	La Trobe University	India
Ziwei Wang	2021	2024	RP 2	Event-based attitude estimation for space applications	The Australian National University	China
Anne Bettens	2020	2022	RP 2	Autonomous navigation of satellites for space exploration	University of Sydney	Australia
Sam Hilton	2020	2022	RP 2	Human-Autonomy teaming for intelligent Distributed Satellite Operations	RMIT	Australia
Jordan Plotnek	2020	2022	RP 2	Measuring Control System Resilience to Cyber-Physical Threat in a Satellite Context	University of South Australia	Australia
Thomas Graham	2021	2024	RP 2	Responsible AI in Space	Swinburne University	Australia
Sabrina Slimani	2021	2024	RP 2	Using quantum entanglement to remotely synchronise clocks	University of Adelaide	Australia
Emily Ahern	2021	2024	RP 2	Compact Clock for Small Satellite Applications: Protocol Development for Increased Stability	University of Adelaide	Australia
Kathiravan Thangavel	2021	2024	RP 2	Artificial Intelligence for Distributed Satellite Systems Autonomous Operations: An Integrated Approach to Space and Control Segments Co-Evolution	RMIT	India
Sai Vallapureddy	2021	2024	RP 2	A machine learning based solution for Space Situational Awareness and Space sustainability	RMIT	India
Artur Medon	2021	2024	RP 2	Small satellite thermal management with 3D printed metal heat sinks containing phase change material thermal storage	University of South Australia	Australia
Brandon Victor	2021	2024	RP 2	Using Satellite Data to Locate and Phenotype Plants from Space	La Trobe University	Australia
Harikesh Singh	2021	2024	RP 2	An empirical and dynamic tool for prediction of forest fire spread using remote sensing and machine learning techniques	University of Sunshine Coast	India
Chang Liu	2021	2024	RP 2	Building damage estimation after natural disaster using multi satellite source data based on machine learning	University of New South Wales	China
Jordan Shipard	2022	2025	RP 2	Efficient Subnets for Scalable Onboard AI in Space	Queensland University of Technology	Australia
Nermine Hendy	2021	2024	RP 2	Interference modelling, detection, and mitigation for improving spaceborne SAR performance	RMIT	Australia
Trung Dung Nguyen	2022	2025	RP 2	Advances in Long-term Water Quality Monitoring through Data Fusion	La Trobe University	Vietnam
Joshua Davis	2022	2025	RP 2	Attack-resilient CubeSat constellations	University of South Australia	Australia
Nur Fajar Trihantoro	2021	2024	RP3	Real Time Fire Analytics	RMIT	Indonesia
Konstantinos Chatzopoulos Vouzoglanis	2021	2024	RP3	Real Time Fire Analytics	RMIT	Greece
Simon Ramsey	2021	2024	RP3	Real Time Fire Analytics	RMIT	Australia
Jason Dail	2022	2025	RP3	Towards effective adaptive monitoring of UN SDG #15 Protect and Sustain Terrestrial Ecosystems using EO Data, Products and Services	University of Queensland	USA
Liang Zhao	2021	2024	RP3	Satellite image-based smoke detection for bush fire detection	University of South Australia	China
Alvaro Valenzuela Quinteros	2021	2024	RP3	Innovations in spatial response assessment for satellite imagers	RMIT	Chile
Robert Andriambololon-aharisoamalala	2021	2024	RP3	Integration of Earth Observation data and ground-based measurements to accurately map the effect of Urban Heat Islands	Curtin University	Madagascar
Vinícius Guedes	2022	2025	Other	How to preserve national aspirations and promote cyber defence policies	Flinders University	Brazil

FINANCIAL STATEMENTS

SMARTSAT CRC LTD

ABN 63 633 923 949
ACN 633 923 949
For the year ended 30 June 2022

Contents

Directors' Report

SmartSat CRC Ltd
For the year ended 30 June 2022

Directors' Report

The directors present their report on SmartSat CRC Ltd for the year ended 30 June 2022.

Information on directors

The names of each person who has been a director during the year and to the date of this report are:

Directors	Position	Date appointed/resigned
Dr. Peter Woodgate	Chair	05/08/2019
Prof. Andy Koronios	CEO & Managing Director	05/08/2019
Dr. Jacqueline Craig AM	Director	27/11/2019
Mr. Michael Davis AO	Director	27/11/2019 - resigned 04/05/2022
Dr. Rosalind Dubs	Director	27/11/2019
Prof. Margaret Harding	Director	27/11/2019
Dr. Michele Allan	Director	27/11/2019
Dr. Danielle Wuchenich	Director	31/01/2021
Ms. Mikaela Jade	Director	17/02/2022

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 and 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 specialist 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; (communications 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 operations 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 support 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 strategic 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 $3,368,584. (Prior period: $2,534,619)

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.

Information on directors

The information on directors is as follows:

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

Meetings of directors

Directors	Number eligible to attend	Number attended
Dr Peter Woodgate	4	4
Prof. Andy Koronios	4	4
Dr. Jacqueline Craig AM	4	3
Mr. Michael Davis AO	3	3
Dr. Rosalind Dubs	4	4
Prof. Margaret Harding	4	4
Dr. Michele Allan	4	4
Dr. Danielle Wuchenich	4	4
Ms. Mikaela Jade	2	0

Indemnification and insurance of officers and auditors

The directors and officers of the Group are covered by a directors and officers insurance policy, paid for 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.

Members' guarantee

SmartSat CRC Ltd 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 company's constitution.

At 30 June 2022 the collective liability of members was $1,100. (2021: $800)

Auditor's independence declaration

The lead 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 2022, has been received and can be found on the following page.

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

Dr. Peter Woodgate
Director

Prof. Andy Koronios
Director

28 September 2022

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GPO Box 2018 Adelaide SA 5001
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DECLARATION OF INDEPENDENCE
BY ANDREW TICKLE
TO THE DIRECTORS OF SMARTSAT CRC LTD

As lead auditor of Smartsat CRC Ltd for the year ended 30 June 2022, 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-profit 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.

Andrew Tickle
Director

BDO Audit Pty Ltd

Adelaide, 28 September 2022

Consolidated Statement of Profit or Loss and Other Comprehensive Income

SmartSat CRC Ltd
For the year ended 30 June 2022

	NOTES	2022	2021
Revenue			
Contributions		5,510,359	5,155,305
Government Grants		7,733,159	7,065,312
Node Funding		2,719,000	-
Third Party Contributions		358,365	550,000
Total Revenue		16,320,883	12,770,617
Other Income			
Other Income	5	2,543,452	615,301
Total Other Income		2,543,452	615,301
Total Revenue and Other Income		18,864,335	13,385,918
Programme Costs			
Education Expenditure		781,576	440,234
Outreach		129,460	142,525
Research Expenditure		11,884,391	8,099,495
Total Programme Costs		12,795,427	8,682,254
Expenses			
Business Development		141,545	126,304
Conferences & Seminars		67,956	(11,136)
Administration Expenses	6	1,120,427	988,429
Governance		386,832	330,841
Information Technology		255,197	216,516
Marketing & Promotion		219,723	157,792
Office Operations		316,697	199,038
Other Expenses		191,947	161,261
Total Expenses		2,700,324	2,169,045
Surplus/(Deficit)		3,368,584	2,534,619
Other Comprehensive Income			
Other Comprehensive Income		-	-
Total Other Comprehensive Income		-	-
Total Comprehensive Income		3,368,584	2,534,619

The accompanying notes form part of these financial statements.

Consolidated Statement of Financial Position

SmartSat CRC Ltd
As at 30 June 2022

	NOTES	30 JUN 2022	30 JUN 2021
Assets			
Current Assets			
Cash at Bank	7	23,053,641	18,320,643
Trade and Other Receivables	8	997,150	704,213
Prepayments		-	23,430
Other Current Assets		522	522
Total Current Assets		24,051,313	19,048,808
Non-Current Assets			
Property, Plant and Equipment	9	166,587	-
Right-of-use Asset	10	191,403	274,920
Total Non-Current Assets		357,990	274,920
Total Assets		24,409,303	19,323,728
Liabilities			
Current Liabilities			
Trade and Other Payables	11	6,444,527	4,735,756
Employee Benefit Liabilities	12	167,292	100,543
Lease Liabilities	13	78,777	76,262
Total Current Liabilities		6,690,596	4,912,561
Non-Current Liabilities			
Lease Liabilities	13	134,962	217,192
Employee Benefit Liabilities	12	27,659	6,473
Total Non-Current Liabilities		162,621	223,665
Total Liabilities		6,853,217	5,136,226
Net Assets		17,556,086	14,187,502
Equity			
Reserves	19	9,475,135	7,726,416
Retained Earnings		8,080,951	6,461,086
Total Equity		17,556,086	14,187,502

The accompanying notes form part of these financial statements.

Consolidated Statement of Changes in Equity

SmartSat CRC Ltd
For the year ended 30 June 2022

Equity

	Research Chairs Reserve Note 19	Scholarships Reserve Note 19	Node Reserve Note 19	Retained Earnings	Total Equity
Balance at 1 July 2020	**-**	**4,321,500**	**-**	**7,331,383**	**11,652,883**
Net Profit for the Period	-	-	-	2,534,619	2,534,619
Other Comprehensive Income for the Period	-	-	-	-	-
Total Comprehensive Income for the Period	**-**	**-**	**-**	**2,534,619**	**2,534,619**
Transfers to Reserves	3,600,000	(195,084)	-	(3,404,916)	-
Balance at 30 June 2021	**3,600,000**	**4,126,416**	**-**	**6,461,086**	**14,187,502**
Balance at 1 July 2021	**3,600,000**	**4,126,416**	**-**	**6,461,086**	**14,187,502**
Net Profit for the Period	-	-	-	3,368,584	3,368,584
Other Comprehensive Income for the Period	-	-	-	-	-
Total Comprehensive Income for the Period	**-**	**-**	**-**	**3,368,584**	**3,368,584**
Transfers to 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**

The accompanying notes form part of these financial statements.

Consolidated Statement of Cash Flows

SmartSat CRC Ltd
For the year ended 30 June 2022

	NOTES	2022	2021
Statement of Cash Flows			
Cash flows from operating activities			
Receipts from Grants		8,506,475	7,821,843
Receipts from Participants		9,014,395	6,424,049
Receipts from Other Operating Activities		2,831,383	985,930
Payments to suppliers and employees		(15,358,814)	(7,957,724)
Interest Income		50,526	45,307
Interest Expense	14	(20,059)	(18,883)
Net Cash flows from operating activities		5,023,906	7,300,522
Net cashflows from investing activities			
Purchase of Leasehold Improvements		(190,132)	-
Total Net cashflows from investing activities		(190,132)	-
Net cash flows used in financing activities			
Repayment of lease liabilities (principal)	14	(100,776)	(67,595)
Net Cash flows from financing activities		(100,776)	(67,595)
Net increase in cash and cash equivalents		4,732,998	7,232,927
Cash and Cash Equivalents at the beginning of the period		18,320,643	11,087,716
Cash and Cash Equivalents at the end of the period	7	23,053,641	18,320,643

The accompanying notes form part of these financial statements.

Notes to the Financial Statements

SmartSat CRC Ltd
For the year ended 30 June 2022

The consolidated financial statements and notes represent those of SmartSat CRC Ltd & Controlled Entities. SmartSat CRC Ltd (SmartSat) is a Company limited by guarantee, incorporated and domiciled in Australia. Aurora Space Cluster Pty Ltd is a wholly owned subsidiary of SmartSat CRC Ltd.

SmartSat is a not-for-profit entity for the purpose of preparing the financial statements. The functional and presentation currency of SmartSat is Australian dollars.

A description of the nature of the Group's operations and its principal activities are included in the directors' report, which is not a part of the financial statements.

The financial report was authorised for issue by the Directors on 28 September 2022. The directors have the power to amend and reissue the financial statements.

Principles of Consolidation

The consolidated financial statements incorporate the assets and liabilities of all subsidiaries of SmartSat CRC Ltd ('company') as at 30 June 2022 and the results of all subsidiaries for the year then ended. SmartSat CRC Ltd and its subsidiaries together are referred to in these financial statements as the 'Group'.

1. **Basis of Preparation**

The financial statements are general purpose financial statements that have 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.*

The financial report has been prepared on an accrual basis, and is based on the historical cost method unless otherwise stated.

The Company is an entity to which ASIC Corporations (Rounding in Financial/Directors' Reports) Instrument 2016/191 applies and, accordingly amounts in the financial statements and Directors' Report have been rounded to the nearest dollar.

2. **New Australian Accounting Standards**

The Company 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.

The adoption of these Accounting Standards and Interpretations did not have any significant impact on the financial performance or position of the consolidated entity.

The following Accounting Standards and Interpretations are most relevant to the Group:

AASB 1060 General Purpose Financial Statements - Simplified Disclosures for For-Profit and Not-for-Profit Tier 2 Entities

The Group has adopted AASB 1060 from 1 July 2021. The standard provides a new Tier 2 reporting framework with simplified disclosures that are based on the requirements of IFRS for SMEs. As a result, there is increased disclosure in these financial statements for key management personnel and related parties.

Conceptual Framework for Financial Reporting (Conceptual Framework)

The Group has adopted the revised Conceptual Framework from 1 July 2021. The Conceptual Framework contains new definition and recognition criteria as well as new guidance on measurement that affects several Accounting Standards, but it has not had a material impact on the company's financial statements.

3. Statement of Significant Accounting Policies

The accounting policies that have been adopted in the preparation of these statements are as follows:

Revenue Recognition

Income for Not-for-Profit Entities

The Group applies AASB 1058 Income of Not-for-Profit Entities. The timing of income recognition under AASB 1058 is dependent upon whether the transaction gives rise to a liability or other performance obligation at the time of receipt. Income under the standard is recognised where: an asset is received in a transaction, such as by way of grant, bequest or donation; there has either been no consideration transferred, or the consideration paid is significantly less than the asset's fair value; and where the intention is to principally enable the entity to further its objectives. For transfers of financial assets to the entity which enable it to acquire or construct a recognisable non-financial asset, the entity must recognise a liability amounting to the excess of the fair value of the transfer received over any related amounts recognised. Related amounts recognised may relate to contributions by owners, AASB 15 revenue or contract liability recognised, lease liabilities in accordance with AASB 16, financial instruments in accordance with AASB 9, or provisions in accordance with AASB 137. The liability is brought to account as income over the period in which the entity satisfies its performance obligation. If the transaction does not enable the entity to acquire or construct a recognisable non-financial asset to be controlled by the entity, then any excess of the initial carrying amount of the recognised asset over the related amounts is recognised as income immediately. Where the fair value of volunteer services received can be measured, a private sector not-for-profit entity can elect to recognise the value of those services as an asset where asset recognition criteria are met or otherwise recognise the value as an expense.

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 non-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 an unconditional right to receive payment. If conditions are attached to the grant which must be satisfied before the Group is eligible to retain the contribution, 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 evaluation 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.

Other revenue

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

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.

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).

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.

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 (excluding land) over their expected useful lives as follows:

Leasehold improvements 5 years

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

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

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. Any revaluation surplus reserve relating to the item disposed of is transferred directly to retained surpluses.

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

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.

Trade Receivables

Impairment of trade receivables and contract assets have been determined using the simplified approach in AASB 9 which uses an estimation of lifetime expected credit losses. The Group has determined the probability of non payment of the receivable and contract asset 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.

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.

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.

Impairment of non-financial assets

At the end of each reporting period the Group determines whether there is any evidence of an impairment indicator for non financial assets.

Where an indicator exists and regardless for indefinite life intangible assets and intangible assets not yet available for use, the recoverable amount of the asset is estimated.

Where assets do not operate independently of other assets, the recoverable amount of the relevant cash generating unit (CGU) is estimated.

The recoverable amount of an asset or CGU is the higher of the fair value less costs of disposal and the value in use. Value in use is the present value of the future cash flows expected to be derived from an asset or cash generating unit.

Where the recoverable amount is less than the carrying amount, an impairment loss is recognised in the Statement of Profit or Loss and Other Comprehensive Income.

Reversal indicators are considered in subsequent periods for all assets which have suffered an impairment loss.

Cash and Cash Equivalents

Cash and cash equivalents include cash on hand, deposits held on call with banks, other short-term highly liquid investments with original maturities of three months or less, and bank overdrafts.

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.

Employee Benefits

Provision is made for the liability for employee entitlements arising from services rendered by employees to 30 June 2022. Provision in respect of wages and salaries, annual leave and long service leave is recognised when it is probable that settlement will be required and they are capable of being measured reliably.

Provisions made in respect of employee benefits expected to be settled within 12 months are measured at their nominal values using the remuneration rate expected to apply at the time of settlement.

Provisions made in respect of employee benefits which are not expected to be settled within 12 months are measured at the present value of the estimated future cash outflows to be made by the Group in respect of services provided by employees up to reporting date.

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 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.

Goods and Services Tax (GST)

Revenue, expenses and assets are recognised net of the amount of goods and services tax (GST), except where the amount of GST incurred is not recoverable from the Australian Taxation Office (ATO).

Receivables and payable are stated inclusive of GST.

Cashflows in the statement of cash flows are included on a gross basis and the GST component of cash flows arising from investing and financing activities which is recoverable from, or payable to, the ATO is classified as operating cash flows.

Income Tax

Aurora Space Cluster Pty Ltd is a for profit company and liable for income tax. SmartSat CRC Ltd is income tax exempt under Subsection 50-5 of the Income Tax Assessment Act 1997.

4. Critical Accounting Estimates and Judgements

When determining the nature, timing and amount of revenue to be recognised, the following critical estimates and judgments were applied and are considered to be those that have the most significant effect on revenue recognition.

The directors make estimates and judgements during the preparation of these financial statements regarding assumptions about current and future events affecting transactions and balances. These estimates and judgements are based on the best information available at the time of preparing the financial statements, however, as additional information is known then the actual results may differ from the estimates.

The significant estimates and judgements made have been described below.

Key estimates - 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 services;

b) the cost or value of the goods or services;

c) the quantity of the goods or services; and

d) the period over which goods or services must be transferred.

No specific number or combination of the conditions noted above needs to be specified in an agreement for the promise to be 'sufficiently specific'. There may be other conditions that need to be taken into account in applying the judgement that may indicate the promise is 'sufficiently specific'.

A condition that a not-for-profit entity must transfer unspecified goods or services within a particular period does not, of itself, meet the 'sufficiently specific' criterion.

Where entities receive a transfer to be used over a particular time period for specified services, such a transfer could meet the 'sufficiently specific' criterion. It is unlikely that transfers directed at promoting or progressing an entity's charter or stated objectives alone would be specific enough. If the transfer does not specify measurable services to be provided, the entity would not meet the 'sufficiently specific' criterion because it would be unable to determine when it meets the performance obligations.

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.

5. Other Income

	2022	2021
Consultancy Work	181,250	93,750
Interest Income	50,526	45,307
Office Space	36,190	19,880
Other Income - Aurora	6,850	-
Space and Spatial Industry Road Map	-	40,000
Space Services Mission - SASAT1	2,268,636	416,364
Total Other Income	2,543,452	615,301

6. Administration Expenses

	2022	2021
Depreciation Expenses		
Depreciation Expense - Right of Use Assets	104,577	78,548
Depreciation Expense - Leasehold Improvements	23,545	-
Total Depreciation Expenses	128,122	78,548
Employee Expenses		
Wages & Salaries	802,171	743,170
Superannuation	95,783	83,714
Workcover	6,416	1,106
Annual Leave Expense	66,749	76,063
Long Service Leave Expense	21,186	5,828
Total Employee Expenses	992,305	909,881
Total Administration Expenses	1,120,427	988,429

7. Cash and Cash Equivalents

Aurora Space Cluster Pty Ltd	18,515	11,000
SmartSat CRC Ltd	5,988,896	9,792,695
SmartSat CRC Ltd (NAB TD #10713840)	4,015,794	3,507,331
SmartSat CRC Ltd (MyStateBank TD1)	4,515,794	1,505,071
SmartSat CRC Ltd (MyStateBank TD2)	3,514,643	3,504,546
SmartSat CRC Ltd (NAB TD #10792853)	5,000,000	-
Total Cash and Cash Equivalents	23,053,641	18,320,643

Reconciliation of Cash

Cash and Cash equivalents reported in the statement of cash flows are reconciled to the equivalent items in the statement of financial position as follows

	2022	2021
Balance as per Statement of Cash Flows		
Cash and Cash Equivalents	23,053,641	18,320,643
Balance as per Statement of Cash Flows	23,053,641	18,320,643

8. Trade and Other Receivables

	2022	2021
Accounts Receivable	997,150	704,213
Total Trade and Other Receivables	997,150	704,213

The carrying value of trade 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 statements.

9. Property, Plant & Equipment

The changes in the Group's property, plant & equipment is classified as follows:

	Leasehold Improvements
Balance at 1 July 2021	-
- Additions	190,132
- Depreciation	(23,545)
- Disposals	-
Balance at 30 June 2022	**166,587**

10. Right of Use Asset

	2022	2021
Office Lease	413,802	392,742
Accumulated Depreciation	(222,399)	(117,822)
Total Right of Use Asset	191,403	274,920

Additions to the right of use assets during the year were $195,219, remeasurement adjustments were ($174,159) and depreciation charged to the profit and loss was $104,577

11. Trade and Other Payables

Current

Accounts Payable	484,384	642,435
Accrued Expenses	5,669,360	3,876,132
Credit Card	51	1,962
GST	204,168	149,156
Income Tax Payable	2,600	2,600
Fringe Benefits Tax Payable	11,743	
PAYG Withholdings Payable	51,541	45,257
Superannuation Payable	20,680	18,214
Total Current	6,444,527	4,735,756
Total Trade and Other Payables	6,444,527	4,735,756

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.

12. Employee Benefit Liabilities

	2022	2021
Employee Benefits Liability - Current	167,292	100,543
Employee Benefits Liability – Non-Current	27,659	6,473
Total Employee Benefit Liabilities	194,951	107,016

13. Lease Liabilities

	2022	2021
Lease Liability Current	78,777	76,262
Lease Liability Non-Current	134,962	217,192
Total Lease Liabilities	213,739	293,454

SmartSat has two finance leases. The lease of Level 3, McEwin Building has a duration of 5 years and has terms to extend the period of use past the end date but no purchase option or escalation clauses. The lease of Level 2, McEwin Building is due to end October 2022 and a new lease is currently being negotiated.

14. Reconciliation of liabilities arising from financing activities

The changes in the Group's liabilities arising from financing activities can be classified as follows:

	Lease Liability
Balance at 1 July 2020	**361,049**
- Repayments	(86,478)
- Interest	18,883
Balance at 30 June 2021	**293,454**
Balance at 1 July 2021	293,454
- Additions	195,219
- Repayments	(120,835)
- Interest	20,059
- Remeasurement Adjustments	(174,159)
Balance at 30 June 2022	**213,738**

15.Remuneration of auditors

During the financial year, the following fees were paid or payable for services provided by BDO, the auditor of the Group.

	2022	2021
Audit Services - BDO		
Audit Fees	21,500	21,000
Non-Audit Services	-	-
Total Audit & Non-Audit Services - BDO	21,500	21,000

16. Contingencies

In the opinion of the Directors, the Group did not have any contingencies at 30 June 2022 (2021: none).

17. Cash Flow Information

Reconciliation of results for the period to cashflows from operating activities

	2022	2021
Surplus for the period	$3,368,585	$2,534,619
Depreciation	$128,122	$78,548
(Increase) / decrease in trade and other receivables	($342,937)	$557,151
(Increase) / decrease in prepayments and other assets	$23,430	($4,339)
Increase / (decrease) in trade and other payables	$1,758,771	$4,052,652
Increase / (decrease) in provisions	$87,935	$81,891
Cashflow from operations	$5,023,906	$7,300,522

18. Related Parties

The Group's main related parties are as follows:

- Key management personnel refer to Note 20.
- 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 between related parties are on normal commercial terms and conditions no more favourable than those available to other parties unless otherwise stated.

19. Reserves

	2022	2021
Node Reserve	600,000	-
Research Chairs Reserve	5,223,077	3,600,000
Scholarships Reserve	3,652,058	4,126,416
Total Reserves	9,475,135	7,726,416

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

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 recruited.

The scholarships reserve has been set up 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 amounts have been identified through the budgeting process and ensures that sufficient funds are available to meet these obligations. A statement of movement and balances will be provided for monthly financial reporting to the Executive and Board.

20. Key Management Personnel Remuneration

The totals of remuneration paid to the key management personnel of SmartSat during the year are as follows:

The total remuneration paid to key management personnel of the Group is $955,085 (2021: 810,399). Key management positions included in this value are the Chair, Non-Executive Directors, CEO and COO.

21. Events after the end of the Reporting Period

The financial report was authorised for issue on 28 September 2022 by the Board of Directors.

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

22. Statutory Information

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

SmartSat CRC Ltd

Level 3, McEwin Building

Lot Fourteen, Frome Road

ADELAIDE SA 5000

Directors' Declaration

SmartSat CRC Ltd
For the year ended 30 June 2022

The directors of the Group declare that:

1. The financial statements and notes, as set out on pages 8 to 21, are in accordance with the *Australian Charities and Not-for-Profit Commissions Act 2012* and:

a. comply with Australian Accounting Standards - Simplified Disclosures; Australian Charities and Not-for-profits Commission Regulation 2013 and other mandatory professional reporting requirements, and

b. give a true and fair view of the financial position of the Group as at 30 June 2022 and of the performance for the year ended on that date.

2. In the Directors' opinion, there are reasonable grounds to believe that the Group will be able to pay its debts as and when they become due and payable.

This declaration is made in accordance with a resolution of the Board of Directors.

Dr. Peter Woodgate

Director

Prof. Andy Koronios

Director

28 September 2022

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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 2022, 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 the *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 2022 and of its financial performance for the year ended on that date; and

(ii) Complying with Australian Accounting Standards – Simplified Disclosures and Division 60 of the *Australian Charities and Not-for-profits Commission Regulation 2013*.

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 Regulation 2013* (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

Those charged with governance 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 the directors 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 intend to liquidate the Group or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the registered entity'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 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 Audit Pty Ltd

Andrew Tickle
Director

Adelaide, 30 September 2022

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