SMARTSAT
COOPERATIVE RESEARCH CENTRE

Compact Hybrid Optical/RF User Segment

Enhancing defence communication capabilities

Mission Goal: Integrating laser-based optical and radio frequency (RF) communications technologies in a single satellite communications (SATCOM user terminal.

High data rate communications to and from small aperture satellite earth terminals are reaching the limits of Radio Frequency (RF) technology due to regulations that control spectrum access and spectrum sharing between systems. This has meant that satellite communications keep moving to higher frequencies, including optical frequencies to deliver greater data transfer capabilities for users. The problem is that optical frequencies suffer availability impacts due to atmospheric phenomena such as rain and clouds. Users want high data rates and high availability.

Furthermore, current generation military communications from mobile platforms operate in contested electronic warfare environments (jamming, geo-location and interception) where smaller terminals are at greater disadvantage. This is likely to get worse in the future unless new approaches to the provision of communications are developed.

To address these challenges, the **C**ompact **H**ybrid **O**ptical-**RF** **U**ser **S**egment Project (known as CHORUS) has commenced as Defence Science and Technology Group 's (DSTG) first collaborative project with SmartSat. The project will see a cross-disciplinary team exploring ways of integrating both laser-based optical and radio frequency communications technologies in a single SATCOM user terminal. Previous research has shown that improved performance and link availability can be delivered by exploiting the diversity offered from simultaneous use of radio and optical frequencies.

The end result will be the development of innovative technology options for integrating hybrid optical-RF SATCOM terminals into military aircraft, land vehicles and maritime platforms. This research has the potential to create new market opportunities for Australian industry to compete globally in what is expected to be a growing segment of the satellite communications enterprise.

The project has been established to develop world-leading Australian technologies that will improve the resilience of military satellite communications, and potentially provide leapfrog technology for commercial markets.

IN COLLABORATION WITH:

Australian Government
Department of Defence
Science and Technology

EM SOLUTIONS
Radio waves at work

EOS SPACE SYSTEMS

University of South Australia

LYREBIRD ANTENNA RESEARCH

SHOAL™

Australian National University

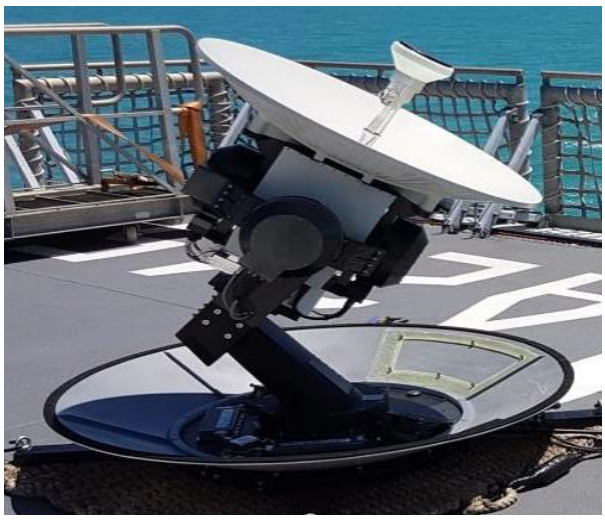
The research effort brings together experts from DST, industry partners EOS Space Systems and EM Solutions, Lyrebird Antenna Research and Shoal Group, and academic partners the Australian National University and the University of South Australia. DST is a core SmartSat partner and will collaborate on research projects that address Australia's need for sovereign space capabilities or explore disruptive approaches to delivering space-enabled services for the Australian Defence Force.

DST has leveraged previous research activities in multi-band RF design, compact on-the-move terminals and optical communications to bring together a team within SmartSat CRC drawing on industry and academia. Australia has a small but active manufacturing base for advanced SATCOM terminals and optical systems. CHORUS aims to develop world leading hybrid Optical/RF communications technology to grow this industry base and position Australia as a leader in advanced satellite communications systems. Optical SATCOM is an emerging application and CHORUS plans to open a new market for mobile users on land, in the air and on the sea. It is hoped that this technology will create game-changing benefits for military and non-military customers.

By combining optical and RF communications, satellite operators will have more options to provide high-availability, high-capacity and high-resilience satellite communications services without requiring additional access to scarce and expensive radio spectrum.

High data rate communications to and from small aperture satellite earth terminals are reaching the limits of Radio Frequency (RF) technology due to a number of factors. These include fixed spectrum allocations and increasingly challenging spectrum coordination to mitigate cross-system interference; available satellite power, both DC power and RF power; physical limits on directivity from space-based antennas at currently assigned bands (Ka band and below); and information theoretic limits of modulated RF carriers.

Optical communications and E-Band (73/83 GHz) / Terahertz (>100 GHz) frequencies have the potential to



overcome some of these limitations and vulnerabilities but questions remain about their suitability to meet commercial quality of service requirements and military reliability/survivability requirements.

Other research programs are addressing the fixed infrastructure optical terminal for deep space communication and for data highway backbones (ESA, NASA, JAXA) but a gap exists in looking at performance limits for tactical terminals. This project proposes to initiate Australian research to address this gap.

The project aims to utilise digital engineering approaches to seek answers to these questions and to underpin the research and development activities. The "digital twin" will allow system optimisation and design trade studies to occur concurrently with research activities. This iterative approach allows for faster development and enable nuanced approaches to risk management in what is acknowledged to be a high-risk activity. If the project enters a technology demonstration and prototyping phase, the digital engineering will also reduce costs.

Phase 1 of the project is due to complete in March 2021 and will develop concepts for integration of optical and RF apertures and associated systems. The plan is to develop a proof of concept demonstration terminal within a subsequent phase and if this proves feasible from a performance and manufacturing perspective, move rapidly to demonstrate a working system for military and non-military applications. The team will also look to integrate outputs from other SmartSat CRC optical communications project to further enhance the CHORUS technology.

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Business Cooperative Research Centres Program