Compact Hybrid Optical/ RF User Segment (CHORUS) Phase 2

Project Case Study

Project Partners

Defence Science and Technology Group, EOS Space Systems, EM Solutions, Shoal Group, Australian National University, University of South Australia, Lyrebird Antenna Research

Project Overview

Satellite optical communications is an emerging capability that potentially offers significantly higher communications bandwidths and lower probability of intercept when compared with standard civilian and military satellite communications. There remains however, some significant limitations to the technology that have and continue to create barriers to the widespread uptake (commercialisation) of the technology.

The CHORUS Project aims to address some of these limitations by using an RF beacon to establish an optical link, re-use existing RF terminal infrastructure and improve availability by using a hybrid optical/RF system. The research will significantly mature the technology and open the way to mainstream take-up of the capability. The project aims to develop an integrated satellite ground terminal that exploits diversity within RF and optical communications bearers, enabling the development of an entirely new class of satellite communications terminal.

In the first phase, the project team delivered a range of design options and are now proceeding to build a full-scale engineering model of the preferred option. The ability to get to this point within 12 months while working through the COVID-19 pandemic shows the benefits of having a strong, multi-disciplinary team with a range of complementary skills and enthusiasm for collaborative research. The research builds on long standing investment in Australia by Defence and industry in both small tactical SATCOM on the move terminals and laser communications.

A novel part of Project CHORUS has been the application of Model-based Systems Engineering (MBSE) methods and tools since the beginning of the project. Shoal Group has helped guide and expedite the R&D effort by capturing the system design, improving design analysis and supporting decision making. This MBSE model is a reusable template for specifying future iterations and variants of the CHORUS terminal, as well as a specification for interfacing systems including the modems and satellite terminals.

Utilisation

Current generation military communications from "disadvantaged platforms" are highly vulnerable to electronic warfare (jamming, geo-location and interception) and this is likely to get worse in the future unless new approaches to the provision of communications are developed.

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

The research program aims to prove the technical viability of a small aperture, hybrid Optical-RF terminal that exploits diversity in electromagnetic wave propagation to provide high data rate and high availability from a single low-cost terminal.

Successful delivery of this project would create impact by enabling Australian developed technology solutions to provide a viable acquisition pathway for new SATCOM capabilities. If successful, CHORUS will position Australian industry to lead in the development and delivery of an entirely new class of military satellite communications service for the Australian Defence Force and its allies, including the ability to develop optical comms to provide higher bandwidth, lower observability and more secure communications than current RF technologies for tactical communications between ships, aircraft and even ground vehicles. It is believed there are additional commercial applications of this technology as well, e.g., for commercial shipping and cruise liners.

Members of the project team are well positioned to support the path to adoption of the outcomes of the project and the team has become a significant participant in the Defence, Government and Commercial satellite communications sector.

For Australian military communications satellites the nearest opportunity to place optical transponders on orbit rest in the Defence project JP9102 (Next Generation Defence Satellite Communications). SmartSat does not have the resources to progress this technology to TRL-8/9. The plan is to partner with Defence and demonstrate a viable hybrid RF/Optical SATCOM link through the Resilient Multi-mission Space STaR Shot mission series. SmartSat is working with DST Group to help define a potential "Advanced Communications Experimentation" mission supporting demonstration, experimentation and concept development for a number of SmartSat projects including CHORUS.

Collaboration

The cross-disciplinary team is drawn from across Australia and includes EOS, EM Solutions, Shoal Group, Lyrebird Antenna Research, Defence Science and Technology Group (DSTG), the Australian National University and the University of South Australia. The team were employed to create innovative technology options to address Australia's need for sovereign space capabilities to provide a secure, high data rate and high availability satellite link from a single low-cost terminal.

SmartSat is playing a key role in overcoming the 'risk hump' for potentially game-changing technologies such as free space optical communications. The ability of SmartSat to rapidly deliver a phased approach to research has helped manage risks and deliver outcomes. We are also keen to try new approaches to risk mitigation including model-based systems engineering (MBSE) in order to focus research efforts on the project elements that should deliver the best results.

Dr Gerald Bolding, DST Group

Project CHORUS is a great example of a true collaboration between Defence, industry and academia. This isn't a project the industry partners would have contemplated alone, and the leadership provided by Defence and SmartSat have been a critical element in the success to date. Bringing together the RF and optical communities has been eye-opening to see what can be achieved when all partners adopt a truly collaborative approach.

Prof Craig Smith, CEO of EOS Space Systems