CSIR C3
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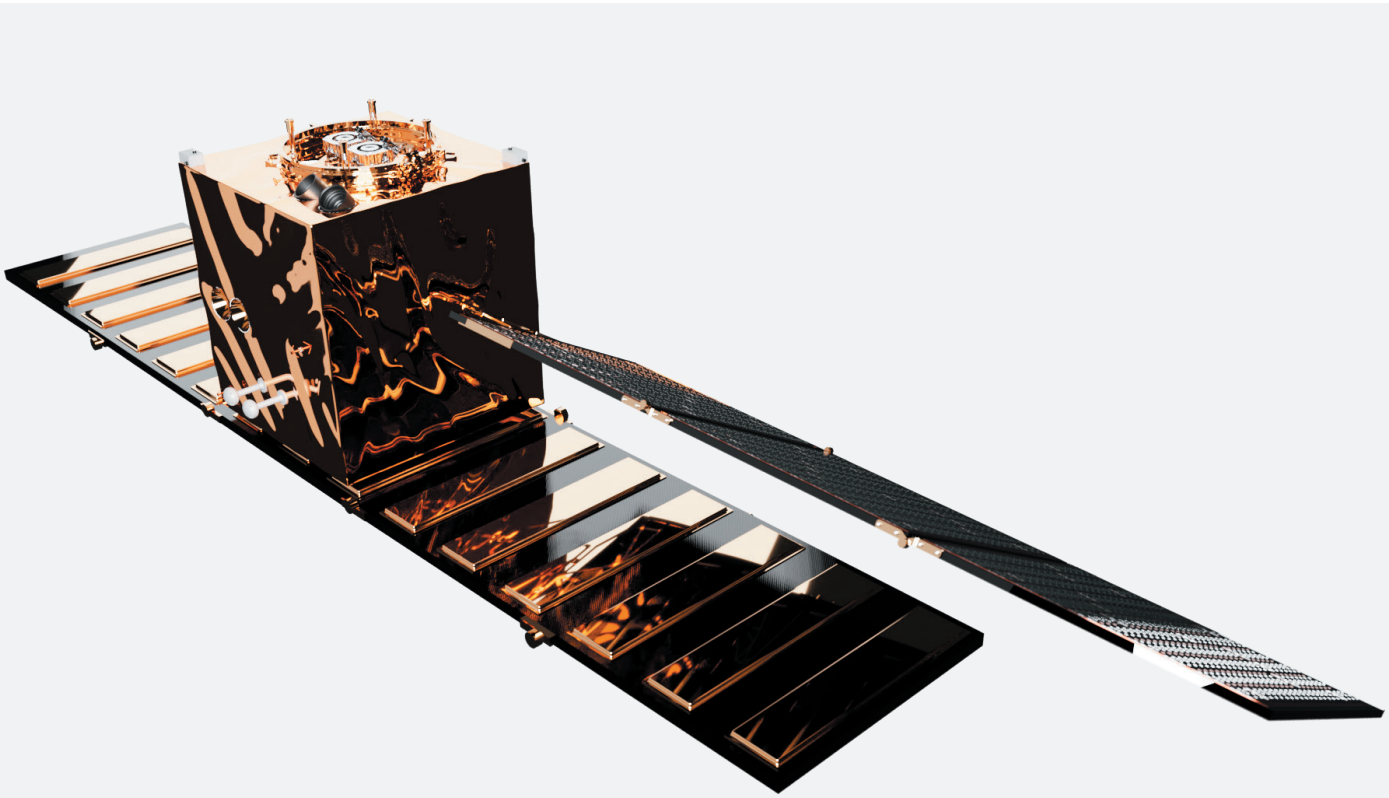


A computer-aided design model of the DragonFly-C synthetic aperture radar (SAR) satellite utilising the Dragonfly satellite bus and a SAR-C payload (deployed configuration) as designed by the CSIR.

RADAR-BASED PAYLOADS FOR EARTH OBSERVATION: PRECISE AND PRICED RIGHT

The next generation of Earth observation technology with all-weather, day and night capability

Addressing a problem and fulfilling a market demand

Understanding and closely observing our planet

Remote sensing of the Earth has become of critical importance to ensure a sustainable future for the planet. At all scales and across many sectors – from government departments to local municipalities, and from multinational insurance businesses to small-scale farmers – remote sensing data are used for improved decision-making, better logistics and better planning.

Spaceborne synthetic aperture radar (SAR) systems can deliver remotely sensed data in all weather conditions and during day and night, due to the active microwave sensor modality. As such, SAR is fast becoming a crucial complementary technology to the more traditional optical observation of the Earth. In particular, SAR sensors provide the ability to monitor the Earth at all times (even during severe storms) and extract information that is difficult to extract through other sensor modalities. This includes detecting fine-scale surface deformation after earthquakes, monitoring large swaths of the ocean for oil spills, detecting crop health and crop yield, monitoring infrastructure development, providing information during floods or detecting military targets of interest – even in foliage.

The technology on offer

C-band SAR satellite payloads

The CSIR has developed C-band phased-array radar technology to a sufficient level of maturity for use in surveillance radar products and airborne SAR demonstrators. These array antennas provide wide-band capability that allows fine-resolution SAR imaging – as demonstrated on the airborne C-Owl SAR technology demonstrator. The team has also demonstrated real-time processing capabilities and fine-resolution (sub-metric) imaging capability – taking the technology closer to readiness for space-borne radar application. Through research and development funded by the Department of Science and Innovation, portions of the technology have also been radiation tested and the design and development of the first space-capable sub-array which, in production, can be used to realise a full SAR satellite payload, is well underway.

Coupled with the significant capability in imaging radar system design, development, integration and test capability, the opportunity exists to now scale the technology from the lab to develop custom SAR payloads for missions aimed at particular sectors and user needs, such as serving African markets yet untapped by the international commercial SAR industry.

The CSIR C-band SAR technology enables fine-resolution SAR imaging at range resolutions as fine as 25cm with advanced digital beamforming modes to enable high-resolution wide-swath imaging. The technology was developed to be scalable, modular and highly manufacturable to enable constellation deployment. Firmware and software for the control of the key subsystem elements are completed and current developments are focusing on the development of the system-level embedded software and system-level verification of the SAR payload designs.

Value proposition and competitive advantage

The C-band spaceborne SAR market

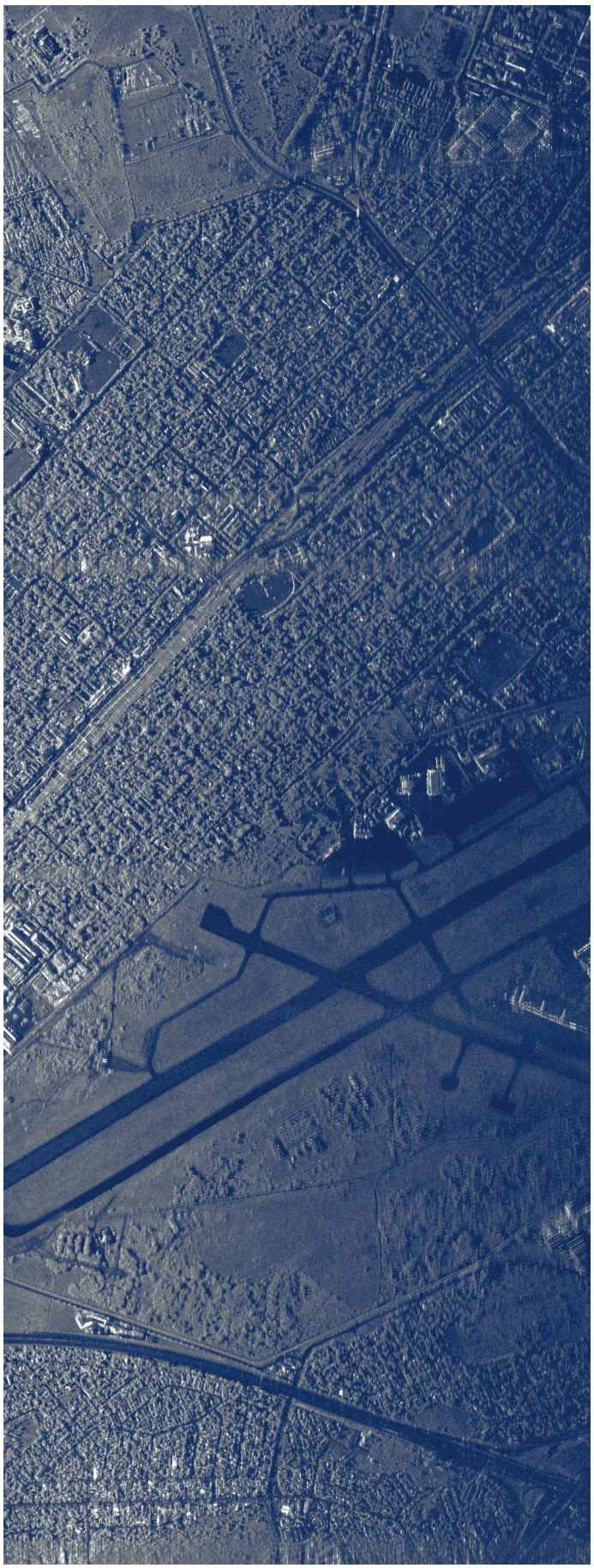
Other players in the field of commercial spaceborne SAR largely make use of X-band payloads and satellites which, although powerful, focus primarily on the level of resolution. SAR applications, however, especially in agriculture, ocean monitoring and subsidence monitoring, require lower frequencies such as L- and C-band to provide longer coherence times and the required physical interactions to measure the information needed.

The CSIR solution, which uses low-cost C-band components but provides high-performance outputs, targets a niche market by achieving commercial-grade cost points and near X-band resolution with the benefits of C-band coherence and information content. Also, the CSIR and the local space industry have combined efforts to achieve higher ratios of satellite utilisation, enabling larger area coverage rates than typical commercial competitor satellites.

All this will enable cost-effective missions in the areas of agriculture, maritime domain awareness, subsidence monitoring, mining, security and defence applications – applications that can address requirements in the international, African and local markets.

Strong partnerships with local satellite industry

The CSIR has formed strong partnerships with the local satellite industry in South Africa to enable the design of the full satellite solution, including the design of the powerful buses required to host a SAR payload.



C-band synthetic aperture radar image created over Centurion, Gauteng, in 2022, using CSIR C-band (5.5GHz) radar technology.

The CSIR synthetic aperture radar airborne test facility ready for flight tests aboard a Cessna 208 light manned aircraft.

The South African satellite industry has a strong heritage in using commercial off-the-shelf components to achieve satellite mission success. This track record, combined with the CSIR's radar capability, provides a unique opportunity to create SAR missions that deliver high-quality data at affordable and competitive prices globally.

Market opportunity

C-band SAR satellites and the international market

The global Earth observation market is expected to double over the next decade. The global revenue across Earth observation data and value-added services was estimated at €2.8 billion in 2021 and is expected to reach €5.5 billion (EUSPA, 2022). Revenue generated from data within the African and Middle Eastern markets was approximately €29 million, with revenue generated from value-added services estimated at €156 million.

Commercial SAR satellite use has been one of the fastest growing market segments within this low Earth orbit Earth observation market – aside from communication satellites. In particular, the number of SAR satellites globally has grown nearly exponentially over the last five years.

Being an active sensor, the work rate of SAR satellites is typically only a few minutes per orbit, limited both by data download rate and satellite power budget. The saturation point of the market is deemed to be a long way away. To achieve global coverage at a temporal rate of interest, one would require thousands of SAR satellites.

Almost all of the current commercial satellites are X-band and as such the CSIR-developed C-band solution addresses a clear market niche.

Investment and return on investment

Significant return on investment potential through the sale of SAR payloads

The project requires approximately R200 million to create the first SAR-C payload flight model, fully qualified and ready for launch. This compares well with the investments needed by other satellite producers.

Once the first payload has been developed and proven, there is scope to achieve considerable profit from the sale of future payloads, with figures of R25 million profit per payload possible in certain scenarios. Significant return on investment is, therefore, possible through the sale of SAR payloads once more than 10 payloads are sold. For example, the sale of a modest but effective constellation of 16 satellites developed over five years (for which the CSIR has already identified potential clients) would yield an estimated R150 million profit. This excludes other forms of income that might also be generated from the technology base of the SAR payloads.

In addition to the payload business case, the business could further be extended around creating a company that owns and operates the satellites and sells the data and applications on the global market.

Milestone and timelines

Development of the first payload will take approximately two years. Thereafter, payloads can be produced and integrated at a rate of roughly four to six per year. The production and sale of 10 payloads to achieve breakeven will thus roughly take four years and a constellation of 16 satellites can be developed within five years.

A seasoned team of radar and sensor experts

The C-band SAR satellite payloads developed are rooted in nearly eight decades of CSIR radar innovation. The CSIR team comprises electronic engineers with vast capabilities in the field and a clientele around the globe who are using CSIR-developed cutting-edge radar systems. The team is further bolstered by access to sophisticated software and simulation suites, and world-class facilities.

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