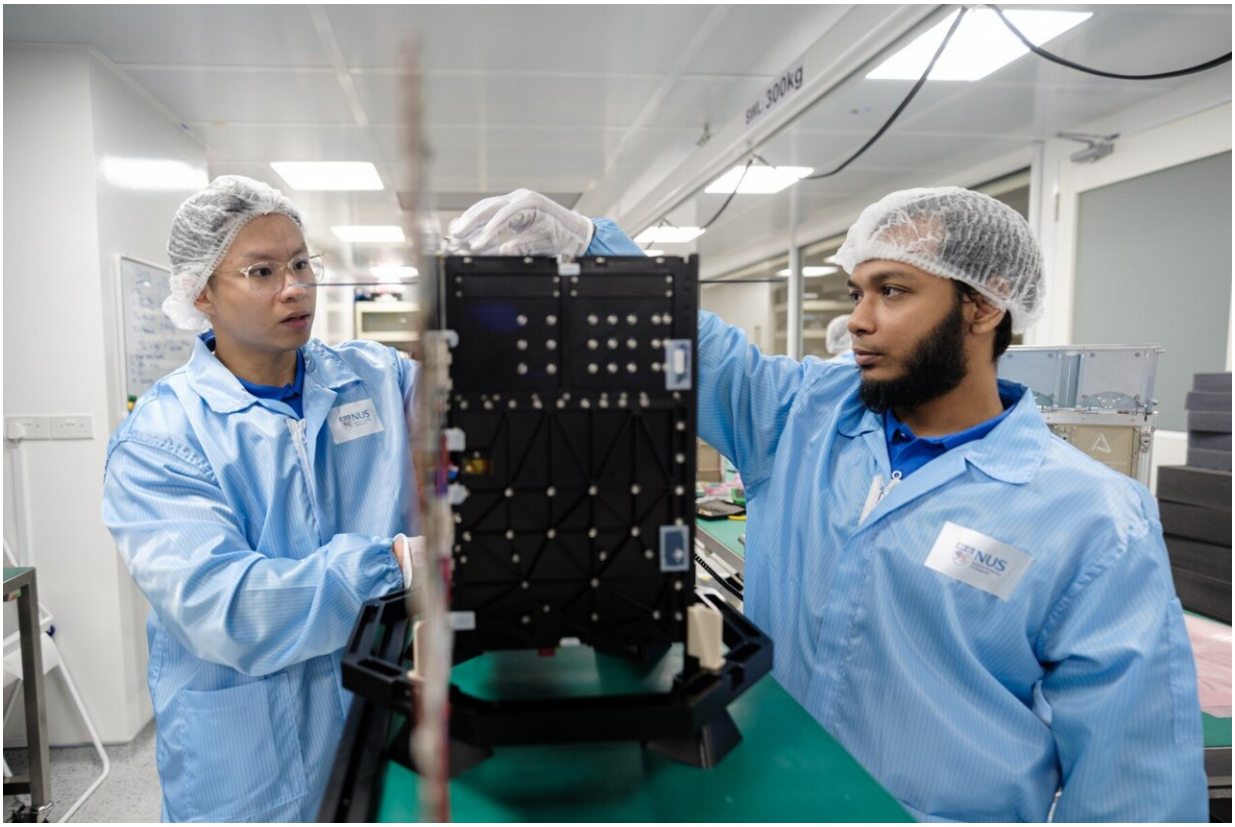
Successful launch of Lumelite-4 to enhance maritime communications

April 24 2023



Students from NUS College of Design and Engineering worked closely with research staff at STAR to develop Lumelite-4. Credit: National University of Singapore

A microsatellite for maritime communications developed by the Satellite

Technology And Research Center (STAR) under the National University of Singapore's College of Design and Engineering (NUS CDE), and A*STAR's Institute for Infocomm Research (I2R), has been successfully launched from the Satish Dhawan Space Center in Sriharikotta, India, on Saturday, 22 April 2023 at 4:50pm (Singapore time).

NUS' STAR designed and built the Lumelite-4 microsatellite using the university's patented modular and scalable satellite's bus system with fault tolerant features, while A*STAR's I2R developed the experimental satellite-based communication hardware. This collaboration between NUS and A*STAR signifies the pioneering effort by Singapore researchers to develop a satellite-based high-performance VHF Data Exchange System (VDES), which will significantly improve maritime communications as well as traffic management and analytics. This is also the first demonstration of satellite-based VDES for maritime applications in Southeast Asia.

Currently, international voyaging ships are fitted with the Automatic Identification System (AIS), which is an automatic tracking system that uses transceivers on ships for collision avoidance by allowing the maritime authorities to track and monitor vessel movements using broadcast information on identification, location, course and speed.

The VDES payload which Lumelite-4 is carrying has several advantages over the current AIS system, such as greater bandwidth, range, accuracy, capacity, security, flexibility, and global coverage, making it an attractive solution for maritime operators seeking to enhance communication and operational efficiency. The successful launch will allow A*STAR's I2R to demonstrate the satellite VDES technology, and validate potential applications of VDES including real-time maritime traffic and asset tracking as well as two-way messaging, in contrast to the one-way reporting supported by AIS. Designed by A*STAR's I2R, the VDES payload can reduce signal interference and increase tracking

capability in an anticipated dense environment and low-complexity radio resource management.

A*STAR's I2R and ST Engineering had previously developed the VDES Mobile Station, which can achieve up to 32 times higher data rate than the current AIS system. Supported by terrestrial VDES, the VDES Mobile Station enables higher data throughput as well as higher quality data delivery among ship-to-ship and ship-to-shore two-way communications.

The latest satellite VDES complements the terrestrial VDES to enable a more robust maritime communications service, allowing the tracking of vessels not just in coastal areas but also in high seas and in areas without terrestrial network.

The NUS and A*STAR team started working on the Lumelite-4 project in December 2018, and recently completed the design, assembly, integration and testing of Lumelite-4 with VDES payload.

The Singapore microsatellite, Lumelite-4, was deployed by the Polar Satellite Launch Vehicle (PSLV) of the Indian Space Research Organization, and it is flying at 586 kilometers above the sea level on an orbital plane known as the near-equatorial orbit. This is the third satellite from NUS that has been successfully delivered to space—the first two satellites, namely Galassia and Kent Ridge 1, were launched in 2015.

Lumelite-4 weighs 16 kilograms and has a compact size of about 20 centimeters in length and breadth and 30 centimeters tall (similar to the size of a laser printer). This is one of four microsatellites that STAR is developing.

Professor Low Kay Soon, Director of STAR, said, "The successful launch of Lumelite-4 marks a new chapter in NUS' journey into space,

and STAR is excited to leverage our knowledge and expertise in satellite technologies in this collaboration with A*STAR's I2R. Over the next few months, the team aims to demonstrate the space-based implementation of high performance VDES on a small satellite for maritime applications. The success of this mission will further strengthen Singapore's position as an innovative space technology hub for small satellites."

"With the Lumelite-4 launch, we are closing the gap to showcase the full operational capability of the VHF Data Exchange System (VDES) with both terrestrial and satellite components, advancing from our earlier development of the VDES Mobile Station. The experimental microsatellite in orbit will allow A*STAR to test and validate key technologies of the VDES satellite mode, which includes helping maritime operators to monitor and analyze real-time traffic thus enhancing navigational safety and port efficiencies, even in areas without terrestrial network. We look forward to exploring further applications of A*STAR's technology with NUS and our partners in the ecosystem, to better support the maritime industry," said Dr. Sun Sumei, Acting Executive Director of A*STAR's I^2R.

Further development of satellite capabilities in NUS and A*STAR

Under STAR's satellite road map until 2027, the NUS satellite team is working on a series of small satellites for distributed space system comprising a number of small satellites flying in tandem for formation and constellation mission that would be useful for environmental monitoring and more timely maritime and aviation traffic management.

Following the successful launch of the Lumelite-4, A*STAR's I^2R will carry out extensive in-orbit testing of satellite payload with their VDES

Mobile Station on ground to demonstrate the two-way data communication and vessel tracking capability, coupled with maritime traffic analytics, modeling and optimization capabilities by A*STAR's Institute of High Performance Computing (IHPC).

A*STAR's I2R will continue to leverage capabilities in radio frequency and antenna designs to meet the requirements for compact satellite payloads and ground terminals. Through close partnerships with local and global ecosystem partners, A*STAR's I2R will develop further applications and integrated capabilities to improve e-navigation, port efficiency and shipping operations for maritime safety.

Nurturing talent for the space sector

Lumelite-4 also offered invaluable learning opportunities for students to put engineering concepts into practice. Twelve students from the NUS CDE worked closely with four research staff at STAR to develop the microsatellite, under the mentorship of Prof Low.

"I am very heartened that many of our undergraduate students who had participated enthusiastically in this highly challenging project have chosen to continue to work in STAR as full-time research engineers upon graduation," added Prof Low.

One of these students is Kelvin Ng, who joined STAR in 2019 after completing his Bachelor of Engineering (Computer Engineering) degree program and is now a Research Associate. "I pursued my interest and participated in a satellite program as my Final Year Project. The practical hands-on experience gave me greater confidence to tackle real-world problems with my engineering training. It is a great achievement to see our satellite successfully placed in orbit."

Another student is Marcus Tay, who graduated with a Mechanical

Engineering degree, and has been a Research Engineer with STAR since 2022. He said, "Being involved in this project has been an eye-opener. It's simply exhilarating to witness our satellite being deployed in space. Being able to apply my knowledge and skills in a real-world product and make a tangible impact is every engineer's dream come true."

Provided by National University of Singapore