



JOINT NEWS RELEASE

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Singapore consortium to launch an advanced small satellite at very low earth orbit to trial new technologies

- *Project supported by Singapore's national space office, the Office for Space Technology & Industry (OSTIn)*

Singapore will seek to tackle new frontiers in space, using advanced space technology in a consortium project led by **Nanyang Technological University, Singapore (NTU Singapore)**.

This pioneering project was announced today by **Minister for Trade and Industry Mr Gan Kim Yong** at the Global Space and Technology Convention (GSTC) held at Sheraton Towers.

It was followed by a signing ceremony for the Research Collaboration Agreement between **NTU Singapore, Aliena, LightHaus Photonics, ST Engineering** and **NUS Temasek Laboratories**, witnessed by **Office for Space Technology & Industry (OSTIn) Executive Director Mr David Tan**.

Led by **NTU's Satellite Research Centre**, the consortium will build a 100-kilogramme remote sensing microsatellite – the size of a mini-fridge. Advising on the systems development and manufacturing of the satellite will be **ST Engineering Satellite Systems**, a joint venture between ST Engineering, DSO National Laboratories and NTU.

This new microsatellite will fly at a Very Low Earth Orbit (VLEO), some 250 kilometres above Earth. This is at least half of the Low Earth Orbit altitudes (500 to 800 km) commonly used by conventional satellites, such as the X-SAT, Singapore's first locally built satellite developed by NTU and DSO National Laboratories, launched in 2011.

Flying at VLEO brings with it the promise of differentiated capabilities, such as instruments being able to perform better as they are closer to Earth.

However, the challenges of flying at VLEO include satellites de-orbiting and re-entering Earth's atmosphere in just a few days, if the satellites are not equipped with a suitable propulsion system.

A unique, fuel-efficient engine built by **Aliena**, a spin-off company from NTU Singapore, has been designed to overcome this issue. The engine will ionise and accelerate inert propellant, generating thrust at low power that will maintain the satellite's orbit.

The microsatellite will also house the nation's first locally-designed space camera by tech firm **LightHaus Photonics**, which can take high-resolution images of objects as small as 0.5 metres – about the size of a delivery parcel – 20 times more powerful than X-SAT's camera. It is useful for industrial applications, such as supply chain monitoring, agriculture and mining, and real estate analytics.

In addition, NTU researchers will be developing a predictive aerodynamic model to optimise the satellite design for reduced drag, evaluating different materials that can protect against atomic oxygen corrosion, and measuring the plasma concentration, velocity and temperature in the ionosphere to enhance the understanding of spacecraft charging.

Spacecraft charging is a phenomenon where a negative charge starts to build on a satellite's surface due to hot electrons found in space (similar to how static electricity builds up when humans walk across carpets) which can cause damage to electronic systems onboard the satellites. (See Annex A)

The satellite will also collect valuable data to enable the development of the next generation of commercial VLEO satellites with multiple applications, from communications and imaging to climate and weather monitoring, which will help to position Singapore as a VLEO solutions hub.

This new satellite is also designed to be sustainable. At the end of its operational life, its engine can be turned off and the satellite will de-orbit and descend to Earth within a few days. It will eventually burn up in the atmosphere during re-entry, leaving no debris in space.

This "passive clean-up" will help to minimise risk of collisions in future for VLEO spacecrafts, in contrast to operating at Low Earth Orbits where it is increasingly getting overcrowded.

Led by **NTU's Satellite Research Centre**, the consortium also includes **Temasek Laboratories at NUS and NTU**, and **ST Engineering Satellite Systems** – a joint venture between ST Engineering, DSO National Laboratories and NTU – which serves as the lead advisor on the systems development and manufacturing of the satellite.

Professor Lam Khin Yong, Senior Vice President (Research), NTU Singapore, said the new microsatellite will be yet another milestone for Singapore and the University, which has spearheaded Singapore's satellite research efforts in the last 22 years. NTU has successfully launched and operated nine satellites that has space-proven various novel made-in-Singapore technologies (See Annex B).

"Satellite technologies are always multidisciplinary and complex, requiring the best minds in various fields, from power systems engineering to aerodynamics and software design, to work together as a team to develop new solutions that do not exist today. NTU is also proud to partner our own spin-off company Aliena and joint venture company ST Engineering Satellite Systems, both great examples of how NTU's space technologies have successfully made it from lab to market, contributing to the nation's rising reputation in the global space industry," Prof Lam said.

Mr David Tan, Executive Director, OSTIn, said "The establishment of a new consortium to develop solutions that will enable satellites to operate at very low earth orbit is testament to the diverse capabilities of Singapore's industry and academia in developing disruptive technologies for space. OSTIn is pleased to support this collaboration which showcases the advanced capabilities of our local space industry ecosystem, with more than 50 companies employing over 1,800 professionals, complemented by several research centres of excellence."

Dr Lim Jian Wei Mark, CEO of Aliena, said that the company's involvement in this project is aligned with its corporate vision of providing high resolution images through enabling future satellite constellations to orbit closer to the Earth, "At the heart of any Very Low Earth Orbit (VLEO) mission are the engines that enable extended operations in such a challenging domain, to make future opportunities commercially viable. Aliena is proud to contribute towards the deployment of our MUSIC engines on such a satellite platform in VLEO, and to showcase that the VLEO domain in space can now be accessible even to smaller satellites with the systems we are bringing to market."

This sets the stage for the deployment of Aliena's VLEO microsatellite imaging constellation that will begin to be populated by 2027, thereby illustrating the seamless translation of technologies that can address new business segments through market capture and creation."

LightHaus Photonics Chief Technology Officer Dr Phua Poh Boon said: “Our LightHaus team is excited to be part of this special satellite mission and become the first Singaporean company to build a space optical payload. Our unique approach will give a cost-effective solution to high resolution space imaging.”

Mr Goh Ing Nam, General Manager, ST Engineering Satellite Systems said, “Ecosystem partnerships like this are crucial to push the boundaries of space technology innovations to meet real-world needs and for the continued advancement of Singapore’s space industry. We are pleased to lend our expertise in end-to-end satellite services and to partner our local tech start-ups and institutes on this exciting pioneering project.”

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About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Humanities, Arts, & Social Sciences, and Graduate colleges. It also has a medical school, the Lee Kong Chian School of Medicine, established jointly with Imperial College London.

NTU is also home to world-renowned autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Ranked amongst the world’s top universities by QS, NTU has also been named the world’s top young university for the last seven years. The University’s main campus is frequently listed among the Top 15 most beautiful university campuses in the world and it has 57 Green Mark-certified (equivalent to LEED-certified) building projects, of which 95% are certified Green Mark Platinum. Apart from its main campus, NTU also has a campus in Singapore’s healthcare district.

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources. For more information, visit www.ntu.edu.sg

About Aliena

Aliena Pte Ltd is a Singapore based space propulsion provider that aims to bring space closer to home for satellite operators and terrestrial businesses through high resolution datasets acquired from their constellation of very-low-Earth-orbiting microsattellites. Their novel propulsion systems aim to equip disruptive next-generation satellites with advanced manoeuvring capabilities that can empower satellite operations of tomorrow including operations at VLEO for their own microsatellite constellation. A technology spin-off from Singapore's Nanyang Technological University (NTU), Aliena currently operates out of a privately-owned jet propulsion test facility that gives the R&D and manufacturing environment to provide their systems to the most demanding of customers internationally.

For more information visit <https://www.aliena.sg/>

About Lighthaus Photonics

LightHaus Photonics Pte Ltd is a high-tech company founded in 2011. It has a team of experts specialising in Optics/Photonics, Imaging, Electronics and System Integration. Their core business is in R&D and customized solutions for their clients, which include government agencies, institutions, statutory boards as well as MNCs. LightHaus has also developed several new technologies towards high resolution imaging payload and spectral imaging. These imaging payload inventions give unique functionalities, compactness and cost advantages as compared to existing imaging cameras in the market

About NUS Temasek Laboratories

Temasek Laboratories@NUS is a partnership established between the Ministry of Defence and the National University of Singapore to undertake cutting-edge research and development for potential defence applications, while building up both technical capabilities and human talent in critical research areas such as aerodynamics, flight sciences, electromagnetics and cryptography.

For more information visit <http://temasek-labs.nus.edu.sg/>

About ST Engineering

ST Engineering is a global technology, defence and engineering group with a diverse portfolio of businesses across the aerospace, smart city, defence and public security

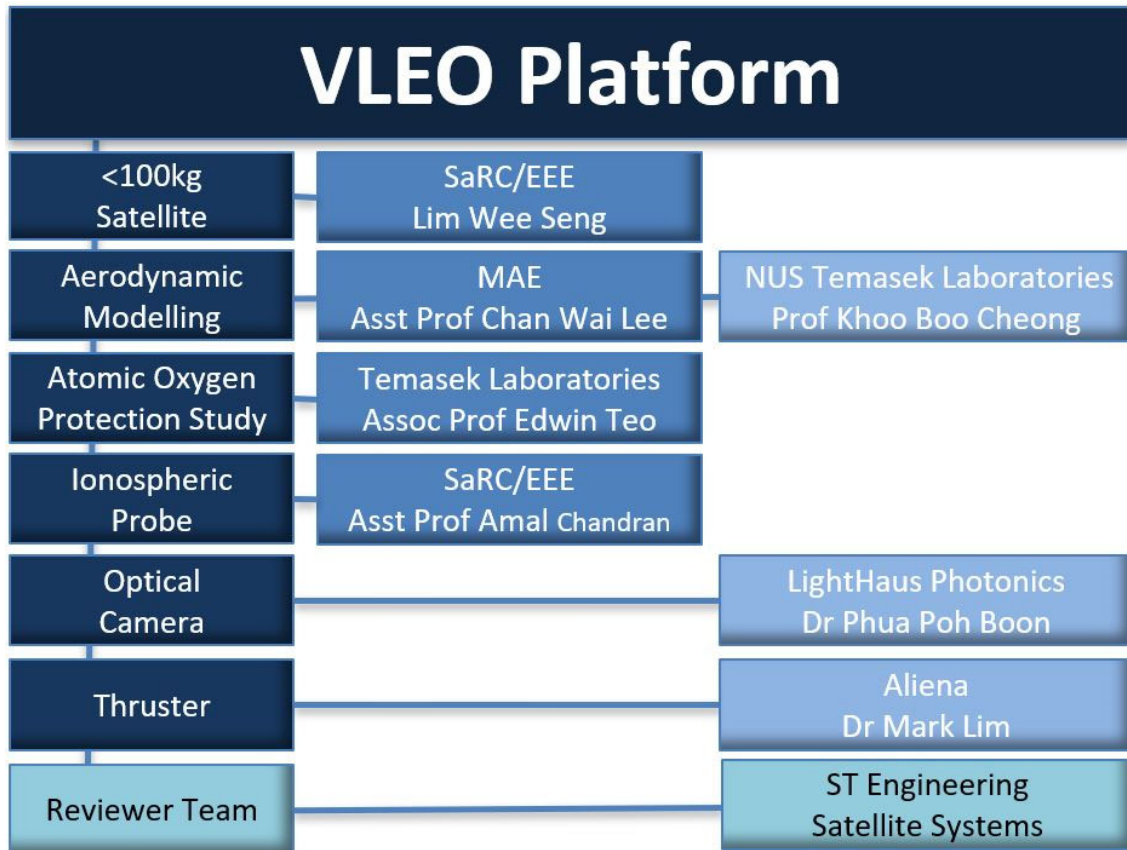
segments. The Group harnesses technology and innovation to solve real-world problems, enabling a more secure and sustainable world. Headquartered in Singapore, it has operations spanning across Asia, Europe, the Middle East and the U.S., serving customers in more than 100 countries. ST Engineering reported revenue of \$7.2b in FY2020 and ranks among the largest companies listed on the Singapore Exchange. It is a component stock of the FTSE Straits Times Index, MSCI Singapore, iEdge SG ESG Transparency Index and iEdge SG ESG Leaders Index.

About OSTIn

The Office for Space Technology & Industry (OSTIn) is Singapore's national space office. OSTIn is responsible for nurturing the development of space technologies to serve national needs and growing a globally competitive space industry in Singapore. To support these objectives, OSTIn seeks to foster an enabling regulatory environment for Singapore's space activities, build international partnerships and contribute to the development of multilateral norms on space.

Annex A

Project Team:



Key missions and experiments:

As one of the pioneering satellites globally to operate at Very Low Earth Orbit (VLEO), the joint research team will have multiple challenges to overcome which will be classified into different technologies and missions.

A key enabler of the satellite mission will be Aliena's highly-efficient engine, a low-power Hall effect thruster known as "MUSIC", which has a high thrust to power ratio and a small and compact form factor. The MUSIC thruster ionises and accelerates inert propellant, generating thrusts at low power that can maintain the spacecraft's orbit by compensating for the effects of atmospheric drag. This is one of the key requirements for a small spacecraft (below 100 kg) operating at VLEO.

On the imaging front, local SME LightHaus Photonics will be piloting its LEOCAM (short for LightHaus Earth Orbit CAMera). It is the first space camera design in Singapore and uses all reflective mirrors instead of refractive optical lenses. It also has a self-compensating mechanism to prevent blurring of images due to the wide

temperature variation in space. It can produce high full-colour images of objects 0.5m and larger, such as small vehicles, buildings and changes in landscapes.

The satellite will also be a platform to study other phenomena at VLEO which are not feasibly replicable or measurable on Earth.

Among them is the drag effect that will slow down the satellite and corrosion caused by atomic oxygen. A joint team from NTU and NUS Temasek Labs will be developing a predictive aerodynamic model to optimise the satellite design for reduced drag. **NTU Temasek Laboratories Director Associate Professor Edwin Teo** will be evaluating different materials that can protect against atomic oxygen corrosion and benchmarking them in space.

NTU School of Mechanical and Aerospace Engineering Asst Prof Chan Wai Lee will be working with **NUS Temasek Laboratories Director Professor Khoo Boo Cheong** to develop predictive aerodynamic models for satellites operating VLEO. Their findings will facilitate the optimal aerodynamic design of future VLEO spacecrafts they have minimum drag and sufficient stability. Such qualities will reduce the amount of thruster fuel needed, which in turn can prolong the operational lifespan of VLEO satellites, as well as increasing their payload capacity.

NTU School of Electrical and Electronic Engineering and Satellite Research Centre Director (Space Science & Technology) Asst Prof Amal Chandran will be measuring the plasma concentration, velocity and temperature in the ionosphere (part of Earth's upper atmosphere. This study will enhance the understanding of the spacecraft's charging – a phenomenon where a negative charge starts to build on its surface due to hot electrons found in space, similar to how static electricity builds up when humans walk across carpets – and atmospheric drag effect at VLEO.

These technologies and experiments will be integrated into a single VLEO microsatellite at NTU. The integration is led by **NTU Satellite Research Centre Director Mr Lim Wee Seng** in consultation with **ST Engineering Satellite Systems**, which will help to ensure that the eventual satellite system is compliant with space standards and accepted by key industry players, leading the way towards a feasible commercialisation plan for future satellite constellations.

Annex B

About NTU Satellite Research Centre (SaRC)

- **Birthplace of Singapore's space and satellite programmes**
- **22 years of satellite expertise**

NTU Singapore made its first foray into space more than 20 years ago, with a communication payload codenamed Merlion, which was mounted on a main satellite body developed by the University of Surrey. It was launched in 1999, making this year the 22nd year anniversary milestone since NTU begun its space mission.

Since then, NTU has designed, built and sent nine out of 13 Singapore satellites into Earth's orbit. In 2011, NTU launched Singapore's first locally built satellite into space. Named the X-SAT, it was a 106kg microsatellite that NTU had built in collaboration with DSO National Laboratories.

The success of X-SAT had resulted in a joint venture between ST Engineering, DSO National Laboratories and NTU, to form ST Engineering Satellite Systems, as it is known today.

In 2015, ST Engineering Satellite Systems launched TeLEOS-1, Singapore's first commercial earth observation satellite along with five other satellites from the nation including VELOX-II, NTU's first satellite to carry a commercial payload that could communicate with other satellites and VELOX-CI, a 123kg micro satellite used to study the tropical climate.

Since 2009, NTU has also been running Singapore's first and leading satellite programme for undergraduates and postgraduates, where student-built pico-satellites (the size of a small cube) was successfully launched and tested to operate well.

Previously launched NTU satellites include:

- **X-SAT**, Singapore's first locally built satellite launched in April 2011. The fridge-sized micro-satellite weighing 105kg is built by NTU and DSO National Laboratories.
- **VELOX-P11**, an NTU student-built nano-satellite satellite launched in November 2013. It is the size of a 10cm cubic box weighing 1.3kg.
- **VELOX-I**, a 4.5-kilogramme satellite built by students and research staff to demonstrate advanced satellite technologies designed by NTU. It tested an inter-satellite communication system that could communicate with the 193-grams **VELOX-P111** satellite which it piggybacked. These two satellites were launched in June 2014.

- **VELOX-II**, a 12kg nano-satellite that demonstrated Inter-Satellite Data relay System (IDRS) which is owned and developed by Addvalue Innovation Pte Ltd. It was launched in 16th Dec 2015 and is NTU's first satellite to carry a commercial payload.
- **VELOX-CI**, a 123-kg microsatellite, supported by Singapore's EDB, is designed to evaluate a new precise navigation system and to measure atmospheric parameters for studying the tropical climate. It was launched in 16th Dec 2015 together with VELOX-II and four other satellites on a rocket from India.
- **AOBA VELOX-III**, a 2kg nanosatellite built with Japan's Kyushu Institute of Technology (Kyutech). This was launched in 9th Dec 2016 and released from International Space Station 16th Jan 2017. The satellite demonstrated the first pulsed plasma micro-propulsion system for nanosatellites.
- **SPATIUM-1** was the first nanosatellite that demonstrated a chip-scale atomic clock working in Low Earth Orbit. The 2.6kg nanosatellite is a joint program with Japan's Kyushu Institute of Technology (Kyutech). The launch was in 23rd Sep 2018 and it was deployed from International Space Station on 6th Oct 2018.
- **AOBA VELOX-IV**, a 2.9kg nanosatellite built with Japan's Kyushu Institute of Technology (Kyutech). This was launched in 18th Jan 2019. The main objective of this mission is the technological demonstration of taking earth glow images in Low Earth Orbit by using a low-light camera and pulsed plasma thruster (PPT) towards observation of the lunar horizon glow in future moon missions.

For more information, visit

<https://www.ntu.edu.sg/sarc/research-capabilities/satellites>
