

INTRODUCING



OFFICE FOR SPACE TECHNOLOGY & INDUSTRY



## CONTENT

Singapore's Leap into the Space Industry

1

2

3

4

5

6

Spearheading the Exciting Growth of Singapore's Space Industry

The Singapore Space Ecosystem

Singapore Satellite Missions

Key Highlights

Join Singapore's Space Journey As a small and open economy, Singapore has always recognised the need to stay ahead of global trends and developments, to adapt and position ourselves for future growth...

Singapore's effort to develop ourspace industry is an example of how we are doing so.

- Mr S Iswaran, then Minister for Trade and Industry (Industry), Global Space and Technology Convention (GSTC) 2017

Satellite image of Singapore Sports Hub, Singapore from TeLEOS-1 Courtesy of ST Engineering

# Singapore's Leap into the Space Industry

Space is a growing industry filled with exciting potential.

To capture the economic opportunities and build a thriving space industry for Singapore, the Singapore Economic Development Board (EDB), together with other participating ministries and agencies, established the Office for Space Technology and Industry (OSTIn) in 2013.

OSTIn serves as a national office to grow a globally competitive space industry in Singapore. We collaborate closely with local and international satellite industry players to realise their business and innovation initiatives for the Asian markets. With a strong focus on driving innovation, OSTIn also works closely with partners within and beyond the Singapore's space ecosystem to develop key research capabilities and talent to enable sustainable growth of the satellite industry in Singapore.

In addition, OSTIn operates as the national focal point to plan for all civil space matters in Singapore. As a responsible actor in space, Singapore is committed to the peaceful and sustainable use of space resources, and is currently registering its membership for the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS).

# "

To better support innovation in our space industry, we will refine our approach to ensure greater alignment with industry as well as deepen capabilities within public sector research performers.

05TIN

For the past 3 years, EDB's Office for Space Technology and Industry (OSTIn) ran open thematic grant calls to select and award research proposals on satellite-related technologies ranging from software and algorithms, to various satellite subsystems. 2

# Spearheading the Exciting Growth of Singapore's Space Industry

### NATIONAL SPACE OFFICE

National space office established in 2013 to grow a globally competitive space industry for Singapore

2013

215 researchers, engineers and scientists trained for Singapore's satellite industry



Established to expand the space business activities of the companies in Singapore





#### SATELLITE INDUSTRY DEVELOPMENT FUND

To drive the development of national small satellite capabilities and development of new sensor technologies for small satellite platforms through the management of the \$90 million Satellite Industry Development Fund (2013 – 2018)



Funded 4 satellite missions in local universities and research institutes to build local manpower capabilities in advanced space technologies

New satellite technology development projects funded

# **3** The Singapore Space Ecosystem

Our journey began in 1992.

With the concerted efforts and support from industry players, academia and government agencies, the Singapore space ecosystem has grown significantly and is now home to space companies across the satellite value chain. This includes new and upcoming players like Addvalue Technologies and ST GeoInsights, and established space companies such as iDirect, Thales and Eutelsat. The Singapore Space and Technology Association (SSTA) has also been playing a active role by organising the annual Global Space and Technology Convention (GSTC) that brings together local and foreign space industry players from across the world to exchange ideas and establish partnerships to further develop innovative ideas and solutions.



Satellite image of Poás Volcano Lake in Botos, Costa Rica from TeLEOS-1 Courtesy of ST Engineering



# Singapore Satellite Missions



X-SAT High-resolution imaging satellite built by NTU



VELOX-PII Satellite to space-qualify new satellite components built by NTU



2013

0

Ň

inter-satellite communications



VELOX-PIII Satellite to test components built by NTU



POPSAT-HIP 1 High-resolution imaging satellite built by Microspace Rapid



4

0

Ň



Tropical environment monitoring satellite built by NTU



GALASSIA Demonstration satellite for quantum encryption technologies built by NUS



VELOX-II Demonstration satellite for inter-satellite data relay system built by NTU in collaboration with Addvalue Technologies



TeLEOS-1 High-resolution commercial EO . satellite built by ST Engineering



KENT-RIDGE 1 Hyperspectral imaging satellite built by NUS



ATHENOXAT-1 Night-vision optical imaging satellite built by Microspace Rapid





AOBA VELOX-IV Demonstration satellite to observe lunar horizon glow built by NTU and KIT



Formation Flying Nanosatellite Mission Built by NUS and to be launched in 2021

**TeLEOS-2** SAR mini-satellite built by ST Engineering and to be launched in 2021/2022

#### NeuSAR

SAR microsatellite built by DSO National Laboratories and to be launched in 2021/2022

#### QKD Qubesat

Demonstration satellite for quantum key distribution (QKD), built by NUS CQT and RAL Space and targeted to be operational in late 2021

going

2

0

**NTU**: Nanyang Technological University **KIT**: Kyushu Institute of Technology

**NUS**: National University of Singapore **CQT**: Centre for Quantum Technologies

# Key Highlights

## NeuSAR

It is fully polarimetric (Synthetic Aperture Radar), capable of land and maritime applications, and incorporates a unique capability that detects minute changes in the scene between two passes. Designed to achieve a revisit time of less than 60 minutes for six satellites in constellation, NeuSAR is also able to provide day and night, all weather and through-cloud imaging possibilities.

Designed and developed by Nanyang Technological University (NTU), in collaboration with Singaporean company Addvalue Innovation Pte Ltd, VELOX-II is an advanced 6U nano-satellite carrying Addvalue's experimental payload for inter-satellite communications.

Launched in 2015, this satellite enabled Addvalue to test its proprietary LEO-GEO data relay system in space. With this system, LEO satellites are able to communicate with other satellites in higher geostationary orbits, thus providing near real-time connectivity between the LEO satellites and ground stations. Following the success of this experimental payload, Addvalue was able to formalise a worldwide agreement with Inmarsat in 2017 to jointly offer the world's first commercial on-demand communications service for LEO satellites.

Launched on 16 December 2015, TeLEOS-1 is Singapore's first commercial Near Equatorial Orbit (NEqO) Earth Observation satellite.

Designed and developed locally, it operates at an altitude of 550km, and offer 1m high resolution satellite imagery. With an orbital period of 96 minutes in a near-equatorial orbit, it provides greater imaging opportunities throughout the day with up to 6 daylight passes per day. This allows convenient access to high temporal imagery and geospatial solutions to respond to time sensitive events. Apart from reliable and rapid collection, TeLEOS-1 also offers direct tasking, imaging and downloading throughout the day.

Satellite image of surface mi Courtesy of ST Engineering ace mining in Kolwezi, Democratic Republic of Congo from TeLEOS-1



ELOX-II

m



While our space industry has made progress, is it important that we continue to innovate and chart new frontiers.

- Mr S Iswaran, then Minister for Trade and Industry (Industry), GSTC 2017

#### In pursuing the next frontier in space, NeuSAR will be Singapore's first small satellite Pathfinder developed for commercial constellation deployment due for launch in 2022.





#### Satellite Research Centre (SaRC)

The "Birthplace" of Singapore's first satellite programme, NTU's SaRC is a centre of excellence that provides an exciting and dynamic research environment for aspiring satellite and space enthusiasts.

Over the past two decades, NTU SaRC has launched 9 satellites successfully. This includes Singapore's first locally designed and developed micro-satellite, X-SAT. Its VELOX series of satellites also demonstrated the centre's capabilities in the design and operation of pico and nano satellites. VELOX-II is one of the world's first LEO-GEO satellite communication on a 6U nanosatellite, and VELOX-CI was able to demonstrate radio occultation using a COT GNSS receiver. Its latest satellite, AOBA-VELOX-IV, a collaboration with the Kyushu Institute of Technology, was also launched earlier this year to demonstrate propulsion and low light camera capabilities for small satellites to carry out future lunar missions.

# Research Centre (STAR) Technology and Satellite

Established in 2018, the STAR@National University of Singapore (NUS) is a state-of-the-art centre that aims to be a leader in advanced distributed small satellite systems with a focus on flying multiple small satellites in formation or constellation.

It comprises a state-of-the-art clean room facility for satellite testing and assembly works, electrostatic discharge controlled laboratories for research and student projects, as well as environmental testing facilities such as a thermal chamber and a vacuum chamber. Through its satellite mission programme, STAR will develop scalable small satellites of various sizes and weights for different applications. It aims to develop a fleet of 20kg satellites that can be deployed in space by 2022, for applications such as maritime and aerospace security. The small satellites can also be equipped with other instruments for remote sensing to monitor environmental change and detect forest fires.





### **Exploiting Disruptive Space Technologies**

Satellite-based Quantum Key Distribution (QKD) is emerging as an unbreakable encryption technology, and is more secure than any existing encryption techniques.

NUS Centre for Quantum Technologies (CQT) and its spin-off company, SpeQtral, have been leveraging quantum cryptography to explore commercial applications of QKD in secure communications of sensitive data for telecoms and financial industries. They also aim to provide QKD hardware and other quantum-safe solutions, and are collaborating with telecommunications companies to bring QKD communication technologies into market. CQT is also partnering UK's RAL Space to co-develop a 'QKD Qubesat', a Cubesat-standard satellite carrying QKD technology. Expected to be operational in 2021, the satellite will use a pioneering QKD technology from CQT to test the secure distribution of cryptographic keys over globe-spanning distances.

## Join Singapore's Space Journey

industry. Today, the industry is witnessing new technological developments that are opening up new possibilities and opportunities that will transform and grow the industry even further.

OSTIn will continue to play a central role and take a whole of nation approach to develop a robust Singapore space ecosystem. If you would like to partner Singapore in growing your space business in the region, or would like to partner us in any other way, please feel free to reach out to us.

# "

Moving forward, Singapore will continue to invest in small satellite R&D, but channel our resources to build deep and differentiated capabilities in a few selected areas.

Under this new approach, OSTIn will work with various technology stakeholders to identify technology areas and establish national satellite R&D programmes."

- Mr S Iswaran, then Minister for Trade and Industry (Industry), GSTC 2017

## **Contact Us**



www.edb.gov.sg







