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★Commentary | Business

Commentary: How Singapore can be a space power, with small satellites

The space race of the Cold War may be long over, but the time is now for Singapore to fight for a slice of the satellite industry pie, says National University of Singapore's Low Kay Soon.

The world's smallest rocket SS-520 carrying a mini satellite for observation of the Earth's surface is launched from the Japan Aerospace Exploration Agency's Uchinoura Space Center in Kagoshima Prefecture, on Jan 15, 2017. (Photo: AFP/Jiji Press)

SINGAPORE: In 1957, the first man-made satellite was launched into space by the Soviet Union. Since mankind's first foray into space, we have not looked back.

Today, there are more than 6,000 satellites in space.

In the earlier decades of satellite development, the key players were governments, especially those of large countries, whose use for satellites were primarily for weather monitoring, remote sensing of environmental conditions and surveillance.

In recent years, many commercial applications have emerged, such as the use of Global Positioning System (GPS) satellites for asset tracking, and the provision of satellite television programmes, telecommunication services and internet services.

With its many applications, the annual market revenue for the satellite industry stands around US$260 billion.

THE REVOLUTION OF THE INDUSTRY

Back in the early days, satellites weighed a few thousand kilogrammes and were huge, with a height of several storeys. Such satellites took years to build, and were typically very expensive.

The majority of them were owned by a monopoly of governments or large organisations.

Over the last two decades, however, miniaturised satellites have been gaining popularity.

Such satellites typically weigh from a few to tens of kilogrammes, with a volume similar to that of a bar fridge.

While initially built by universities as technology demonstrators, the functionality of such small satellites following rapid advancements in technology has garnered interest from government space agencies and commercial companies.

While the space industry has traditionally been dominated by a few large countries such as Russia, more, and smaller countries have shown growing interest in entering it. (Photo: Reuters)

For example, the US National Aeronautics and Space Administration (NASA) is planning to launch two briefcase-sized miniaturised satellites of 10kg each to Mars next year. These two satellites will help NASA monitor the Insight mission when it first lands by relaying information about the landing to ground controllers back on earth.

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THE ADVANTAGE OF BEING SMALL

The key advantage of miniaturised satellites, particularly those with a mass less than 20kg, is the low cost of building and launching them into space. Building time is also significantly cut as these can be mass produced.

Their lower cost and smaller mass mean such satellites can potentially be built and launched in fleets of tens or hundreds. Having such large numbers of small satellites in space enables up-to-date monitoring of the earth across wide areas, for uses such as earth imaging and the collection of weather data.

For instance, a typical low Earth orbit satellite flies at a height of 500km above sea level at a speed of 26,000 kmh. These satellites go around the earth about 14 to 15 times a day, requiring only 100 minutes to make one complete orbit.

If there are 10 of them in space, the same spot can be monitored every 10 minutes.

Commercial interest in miniaturised satellites has been growing since 2013, particularly in those that weigh less than 5kg. In total, there are more than 500 miniaturised satellites in space, and just about half of them are from the space industry.

In February this year, the Indian Space Research Organisation launched a total of 104 satellites, with 103 of them weighing less than 10kg each. Among them, 96 belong to two commercial companies, an indication of the private sector's increasing interest and capability to enter the space market.

SINGAPORE'S SPACE JOURNEY

Singapore has space dreams too. Our first programme to develop a locally-built satellite was in 2003.

The satellite, named X-SAT (eXperimental SATellite), involved DSO National Laboratories, Nanyang Technological University and the National University of Singapore. It was completed in 2009, and launched on Apr 20, 2011.

Associate Professor Low Kay Soon, research engineer Chin Shi Tong, NTU undergraduate A Saravanan, and PhD student Charlie Soon at the NTU Mission Control Room, where satellite operations are controlled daily. (Photo: NTU)

The X-SAT allows us to perform remote sensing to monitor environmental change and detect forest fires, among other things. The programme's other important objective was to build local capabilities in satellite engineering.

Its success led to the formation of a new satellite company ST Electronics (Satellite Systems) in 2011, which subsequently built and launched Singapore's first commercial satellite TeLEOS-1 in December 2015.

This satellite is capable of imaging the earth with a resolution of 1m, meaning to say that it can tell objects that are 1m apart from space, and its average revisit time, the time between observations of the same spot on earth, is around 12 to 16 hours.

With these capabilities, the satellite can facilitate quick response to maritime situations and disaster monitoring.

TeLEOS-1 has a mean revisit time of 12-16 hours and its coverage of the equatorial belt includes many major shipping routes, disaster prone and forest fire regions. (Photo: ST Electronics)

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Between 2011 and 2015, a number of miniaturised satellites have also been built in Singapore and launched into orbit.

The first was a 1kg satellite named VELOX-PII whose hardware and software were built by my undergraduate students and research staff in 2013, during my time as the Director of the Satellite Research Centre of NTU.

This was followed by the 5kg VELOX-I, launched in 2014. It was the world's first miniaturised satellite to demonstrate a short-range wireless communication technology known as zigbee, as well as an extendable telescopic mechanism.

These technologies allow multiple satellites to communicate with each other if they come within range, and achieve a higher imaging resolution of earth, compared to older design.

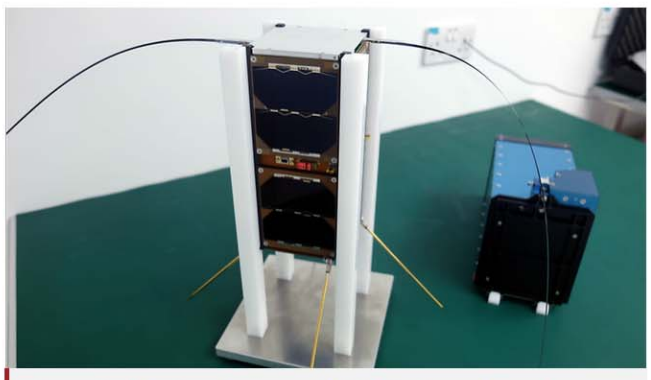
In 2015, we launched VELOX-II in collaboration with Addvalue Technologies. It validated the world's first satellite-to-satellite communication technology which allowed the VELOX-II to communicate with commercial geosynchronous satellites anytime and anywhere in space.

The two miniaturised satellites NASA will be sending to Mars next year are of the same class of satellites.

NUS launched the Galassia in December 2015. Developed by NUS Faculty of Engineering, the 2kg nanosatellite carried the first quantum science payload that was designed by the Centre for Quantum Technologies at NUS.

The mission of this payload was to test a quantum-based communication concept using Small Photon-Entangling Quantum System.

The experiment conducted from this satellite validated the viability of quantum technology for secure communications over long distances between satellite and earth.



Pictured is the Galassia flight model. Galassia was launched on Dec 16, 2015 as the first nano-satellite of NUS developed by undergraduate students.

WHAT IS TO COME

These multiple successful launches make it clear that Singapore has established a strong track record in building different classes of satellites, ranging from 1kg to 400kg.

Moreover, local university students have been involved in the building of these satellites, demonstrating that the space related courses and projects our engineering students undergo are not classroom exercises, but truly cultivate the requisite skills and experiences to build the next generation of engineers for Singapore's space industry.

For any overseas satellite company keen to set up operations here, Singapore evidently has the infrastructural capability and manpower to meet their needs.

The new trend towards miniaturised satellites plays to Singapore's advantage especially, since we do not need to enter into direct competition with space veterans of large satellites.

Instead, Singapore can focus on carving out a place for itself, as a key player in the miniaturised satellite industry.

To that end, NUS has recently set up the Satellite Technology and Research Centre (STAR) to deepen the local base of expertise in space and satellite technologies.

STAR aspires to become a leading centre for advanced distributed satellite systems - such systems involve the deployment of a fleet of miniaturised satellites flying in formation, swarm or constellation.

We also intend to build and demonstrate the use of miniaturised satellites for various applications.

These could include aeroplane or ship detection and monitoring that could enhance our position as an aerospace or maritime hub, since data on their positions and velocities could help increase efficiency in operations.

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Growing Singapore's space industry could benefit its position as a maritime hub. (Photo: AFP/Roslan Rahman)

As we debate Singapore's strengths in an uncertain world economy, the space industry will be of strategic importance to staying ahead of the competition, both in leveraging space technology for use in other sectors of our economy, and in attracting foreign firms to move here.

The various space-related institutes, including STAR, will contribute by advancing research in satellite technologies and training the next generation of engineers for Singapore's space industry.

Partnerships with local companies to commercialise Singapore's expertise in space-related technologies will also be critical in building a vibrant indigenous high-tech satellite industry.

Singapore's size may lead some to think that we should leave space technology to the "big boys", but as we have seen, being small has its strengths.

With foresight, investment in human capital and technology and some fortunate timing, we have a good shot at creating space for ourselves in this industry.

Low Kay Soon is professor at the faculty of engineering and the director of the Satellite Technology and Research Centre (STAR) at the National University of Singapore.

Read also: a commentary on why Singapore should look to space for more economic opportunities.

Source: CNA/sl