Team launches world's first ZigBee-based inter-satellite communication system

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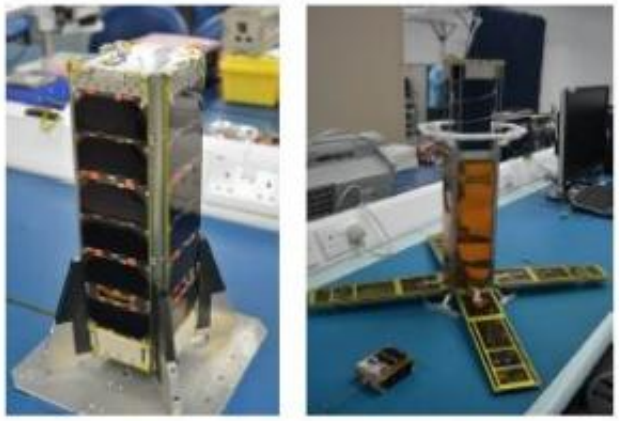

(a) (b)

Fig. 1. VELOX-I in (a) launch configuration and (b) after deployment.

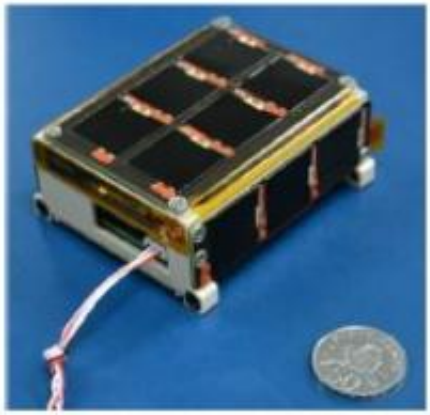

Fig. 2. P-Sat picosatellite.

VELOX-I before and after deployment and a picosatellite. Credit: Shuanglong Xie, Guo Xiong Lee, Kay-Soon Low, Erry Gunawan, 2014

Engineers at the Nanyang Technological University in Singapore have successfully piloted the world's first ZigBee-based inter-satellite communication system.

The team at the Satellite Research Centre launched the VELOX-I, which consists of a nanosatellite weighing 3.5 kg and a piggyback picosatellite weighing 1.5 kg, from the two highest points on campus. Both miniature satellites were configured with a ZigBee wireless network and equipped with small sensor nodes that perform functions such as local sensing, distributed computing and data-gathering.

Designed to evaluate the performance of wireless sensor networks (WSNs) in space, the experiment marks a breakthrough in aeronautical engineering. After conducting Received Signal Strength Indicator tests on the satellites' radio frequency modules, a maximum range of 1 km was found to be achievable for inter-satellite communication in the campus environment. An even longer communication range can be expected in free space, due to the absence of signal attenuation caused by fading and diffraction.

To estimate the range of inter-satellite communication in free space, the team applied a link budget analysis based on the Friis transmission equation, deriving an average theoretical distance of 4.186 km and a maximum of 15.552 km. Published in the special issue of *Unmanned Systems*, these findings present a compelling case for further studies into inter-satellite communication systems with more complex designs.

In addition to their high performance in inter-satellite communication, WSNs are also remarkably suitable for intra-satellite communication. The team found that by replacing internally wired connections with wireless links, a satellite's mass could be reduced by as much as 10%. With the twin pressures of minimising development costs and maximising risk diversification imposing major constraints on satellite

design, the production of comprehensive yet lightweight systems could benefit significantly from WSNs.

Although WSNs have been used in a wide range of applications in recent years, their use in space applications has, until now, remained limited. The Singaporean team's data-driven survey has established a sound platform for future formation-flying satellite missions, and seems poised to create subsequent revolutions in space.

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