



## Technology Educational Satellite Series: TechEdSat-6

Technologies for Passive Re-entry, Future Sample Return and Mars Missions

Big results can come from small satellites, and the latest in the productive TechEdSat series of CubeSats continues development of multiple key technologies for small sats – controlled de-orbit and re-entry; wireless sensors; and ISM-band communications links.

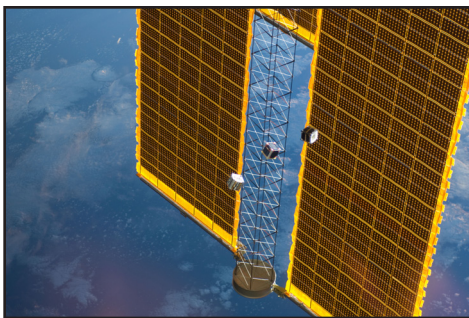
Launched November 12, 2017 on the Orbital ATK-8 crew supply mission from the NASA Wallops Flight Facility in Virginia, the Technology Educational Satellite-6 or TechEdSat-6 nanosatellite is the sixth mission in the continuing TechEdSat Series.

### About TechEdSat

TechEdSat is a STEM collaborative project that pairs advanced university students with NASA Ames researchers, providing not only a platform for testing planetary mission concepts and developing state-of-the-art technology but also engineering and management experience for NASA early-career employees, interns and students from several universities including San Jose State University, University of Idaho, University of California at Riverside, and California Polytechnic State University, San Luis Obispo, University of Georgia and Smith College.

### Goals of TES-6

The overarching goals of the TES series are to develop the requisite technologies for entry, descent and landing capabilities for small payloads and for on-demand sample return capabilities from orbit.



Photograph of TechEdSat-1 (far left), the first US CubeSat jettisoned from the International Space Station.



Illustration of TechEdSat-5 post-jettison from the International Space Station.

TechEdSat-6, with the updated Exo-Brake and Modulation control, sets the stage for even more accurate de-orbit and the automation planned for future TES flights.

TES-6, with a 3.5U (40 x 10 x 10 cm) volume and mass of 3.51 kg, further tested improvement to Exo-Brake, a tension-based, flexible braking device resembling a cross-parachute. Exo-Brake deploys from the rear of the satellite to increase drag and enable guided controlled re-entry of small spacecraft and eventual return of science experiments.

In addition, TechEdSat-6 will set the foundation for future autonomous de-orbit and target capability through unique use of the upgraded avionics, microprocessor set, and communication capability. The wireless sensor experiments onboard will also be the first self-powered tests, permitting an augmentation of sensor networks for future ascent or re-entry systems.

Although the goal of returning samples from the space station or other orbiting platforms is integral to the project, NASA seeks to develop “building blocks” for larger scale systems that might enable future small or nanosatellite missions to reach the surface of Mars and other planetary bodies in our solar system.

### Past TechEdSat Missions

The TES-1, a 1U and the first in the series, successfully demonstrated the use of a radiation-tolerant nano-Remote

NASAfacts

Terminal Unit (nanoRTU) to control a StenSat radio that provided basic TES housekeeping data. TES-1 deployed October 4, 2012 from the International Space Station's Japanese Experiment Module (JEM, or "Kibo") utilizing the Small Satellite Orbital Deployer (J-SSOD) and the JEM Remote Manipulator System (JEMRMS). It functioned for seven months until burning up upon re-entering Earth's atmosphere.

The TES-2 mission was launched on the first Antares-1 launch vehicle on August 21, 2013, successfully demonstrating the use of an Iridium Short-Burst Data modem for greatly improved satellite communication.

TES-3 was deployed from the JEM utilizing the J-SSOD and the JEMRMS on Nov. 20, 2013, and successfully performed the first passive Exo-Brake flight test.

TES-4 further developed the capability of the Exo-Brake de-orbiting system and laid the groundwork for controlling the Exo-Brake in orbit. TES-4's demonstration of a satellite-to-satellite communications system allowed for more frequent communication with the satellite, leading to more accurate satellite altitude and position predictions, which are important for the optimal operation of the Exo-Brake. The satellite's structure, avionics and payload were custom-designed by the TES-4 team to utilize its 3U volume. The TES-4 hardware consisted mostly of off-the-shelf components, allowing for easily reproducible future flight variations.



The TechEdSat team at NASA Ames Research Center.

## Partners in TechEdSat

The TechEdSat mission is supported by the Ames Engineering Directorate, the Ames Safety and Mission Assurance Directorate, and the Ames Chief Technologist Office Center Innovation Fund. Both TechEdSat and the Exo-Brake are funded by the Entry Systems Modeling project within the Space Technology Mission Directorate's Game Changing Development program and the NASA Engineering and Safety Center.



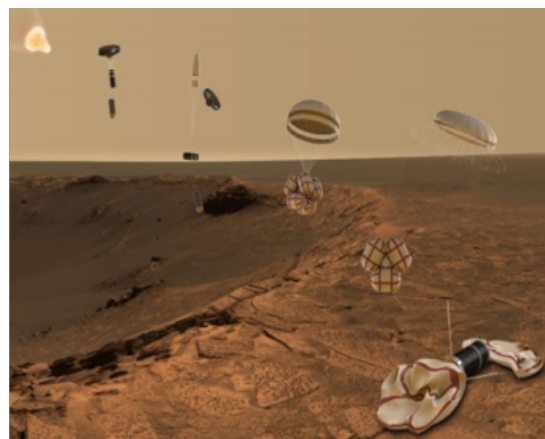
Engineers pack TechEdSat-5 with Exo-Brake payload.

TES-5 launched December 9, 2016, on Japan's H-II Transfer Vehicle from Tanegashima Space Center in Japan. TES-5 focused on demonstrating capabilities of several technologies in addition to the Exo-Brake:

- The Cricket wireless sensor modules, which use a mesh wireless network that supports multiple wireless sensors to provide real-time data for TES-5.
- Use of the commercial off-the-shelf (COTS) Intel Edison microprocessor imbedded in the TES-5 bus element's avionics board.
- Use of an ISM-band "Wi-Fi" communications link to send data to a ground station.
- Two-way communications using an Iridium L-band transceiver for data and control.

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Future step: Building the elements for nanosatellite technology to be placed on the surface of Mars

## For more information about the Ames Engineering Directorate, visit:

<http://www.nasa.gov/centers/ames/engineering/>

## For more information on TES, please visit:

<http://www.nasa.gov/centers/ames/engineering/techedsat/>

## For more information on the Game Changing Development program, please visit:

[http://www.nasa.gov/directorates/spacetech/game\\_changing\\_development/index.html](http://www.nasa.gov/directorates/spacetech/game_changing_development/index.html)

## For more information on NASA's small satellite missions, please visit:

<http://www.nasa.gov/smallsats>