National Aeronautics and Space Administration

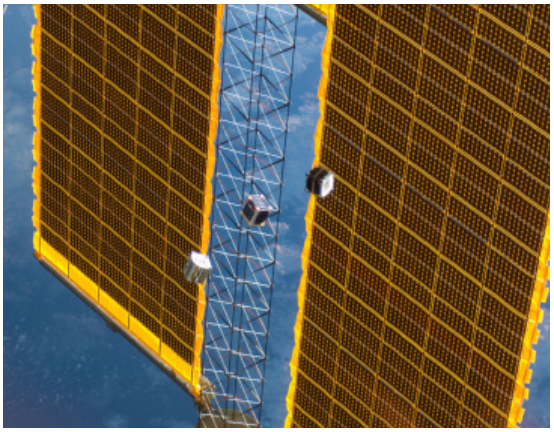
NASAfacts

TechEdSat-4: Nano-Satellite Series

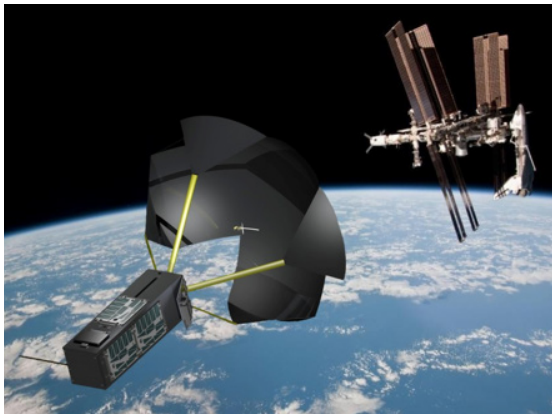
Technologies for Passive Reentry, Future Sample Return and Mars Missions

Technology Educational Satellite-4 (TechEdSat-4) is the fourth generation in the continuing TechEdSat Series. The TechEdSat-4 (TES) builds upon the success of TES-1, 2, and 3 by continuing to demonstrate increasing capability for CubeSats in the areas of communications and satellite reentry. On March 3, 2015 the TES-4 became the first NASA satellite to jettison into orbit from the International Space Station (ISS) via the Nanoracks CubeSat Deployer. TES-4 was launched to the ISS on board Orbital Sciences Corporation's Antares-120 launch vehicle on July 13, 2014 as a secondary payload on the Cygnus Commercial Resupply Services (CRS) Orbital (Orb) -2 ISS resupply mission from the Mid-Atlantic Regional Spaceport (MARS), Wallops Island, VA.

The TES Series uses the CubeSat standards established by the California Polytechnic State University (CalPoly), San Luis Obispo, which are defined in 1-unit (1U = 10x10x10 cm) increments. The TES-4 has a 3U volume (10X10X30 cm) and weighs 2.68kg. The TES project uniquely pairs advanced university students with NASA Ames researchers in a rapid design-to-flight experience over the course of 1-2 semesters. The TES Series not only provides a rapid platform for testing technologies for future NASA Earth and planetary missions, but also provides students early exposure to flight hardware development and management.



Photograph of TechEdSat-1 (far left) – the 1st US CubeSat jettisoned from ISS



Rendering of TechEdSat-3p post-jettison from the ISS

The objective of the TES-4 mission is to demonstrate two new technologies: satellite-to-satellite communications that also provides information about the spacecraft's health, and an upgraded Exo-Brake, which is a passive de-orbiting system capable of accurately allowing the spacecraft to reenter Earth's atmosphere. The Exo-Brake is an exo-atmospheric passive braking device, like a specially designed parachute that operates at extremely low pressures, the technology for which will eventually enable small samples to be returned from the ISS or other orbital platforms. In addition, this technology is intended to help enable future small or nanosatellite missions to the surface of Mars and other planetary bodies in the solar system.

TES-4 further develops the capability of the Exo-Brake passive de-orbiting system by adding an incremental development step to controlled de-orbit technique for

Photograph of TechEdSat-3p (bottom) installed in the JSSOD on ISS

accurate de-orbit and eventual re-entry control. TES-4's demonstration of a satellite-to-satellite communications system allows for more frequent communication sessions with the satellite that lead to a higher accuracy of satellite altitude and position predictions which are important for the operation of the Exo-Brake. The satellite's structure, avionics, and payload are custom-designed by the TES-4 team to utilize the 3U volume most efficiently while providing ample space for the Exo-Brake. The TES-4 hardware consists mostly of off-the-shelf components available to anyone. This allows for easily reproducible future flight variations as well as accessible to the education community.

The TES-1, a 1U and the first in the series, successfully demonstrated the use of a radiation-tolerant nano-Remove Terminal Unit (nanoRTU) to control a StenSat radio that provided basic TES housekeeping and space environmental data. It was the first U.S. CubeSat to be deployed from the ISS on October 4, 2012. TES-1 deployed from the Japanese Experiment Module (JEM, or "Kibo") utilizing the Small Satellite Orbital Deployer (J-SSOD) and the JEM Remote Manipulator System (JEMRMS). It functioned for 7 months until it re-entered Earth's atmosphere. The TES-2 mission followed and was launched on the first Antares-1 launch vehicle on August 21, 2013, successfully demonstrating the use of an Iridium Short-Burst Data (SBD) modem for greatly improved satellite communication. TES-3 was carried to the ISS by the Japanese vehicle HTV-4 launched from Tanegashima, Japan. It was deployed from the JEM utilizing the J-SSOD and the JEMRMS on November 20, 2013 and successfully performed the first passive Exo-Brake flight test.

The overarching goals of the TES series are twofold: develop the requisite technologies for on-demand sample return capability from the ISS, and perform reentry test flights and hardware validation for future nano-satellite missions to the Martian surface. Based on the current state of nano-satellite technology, these missions are proposed for the 2016-2020 timeframe. These planned missions are anticipated to offer tremendous education and research opportunities as an extension of the TES Series.

The TES Team is currently working on the TES-5, due for delivery later this year. TES-5 builds on TES-4, and has a novel device to modify the drag coefficient in what is referred to as 'drag-modulation.' This is the next step in improving the accuracy of the controlled de-orbit process permitted by the Modulated Exo-Brake.

The TES-4 mission is supported by the NASA Ames Engineering Directorate, the NASA Engineering and Safety Center, the Safety and Mission Assurance Directorate, the Ames Chief Technologist Office Center Innovation Fund, and the Space Technology Mission Directorate / Entry Systems Modeling Project.

For more information about the Ames Engineering Directorate, visit:
http://www.nasa.gov/centers/ames/engineering/

For more information on the TES Series, please visit:
http://www.nasa.gov/centers/ames/engineering/techedsat/

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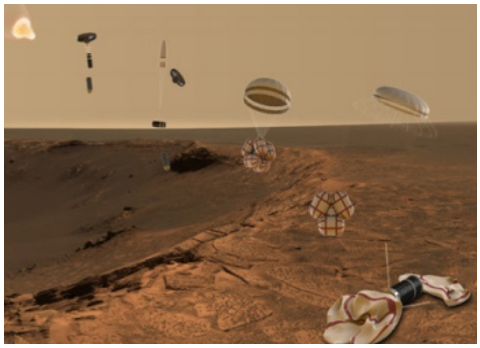

Future step: Building the elements for nano-satellite technology to be placed on the surface of Mars.

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