The Fast, Affordable, Science and Technology Satellite (FASTSAT) Mission

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ABSTRACT

The Fast Affordable Science and Technology Spacecraft (FASTSAT - HSV01) is a mini-satellite weighing less than 150 kg. FASTSAT was developed as a government-industry collaborative research and development flight project targeting rapid access to space to provide an alternative, low cost platform for a variety of scientific, research, and technology payloads. This initial spacecraft mission carried six instruments and was launched as a secondary "rideshare" payload. The design approach greatly reduced overall mission costs while maximizing the on-board payload accommodations. FASTSAT was designed from the ground up to meet a challenging short schedule using modular components with a flexible, configurable layout to enable a broad range of payloads at a lower cost and shorter timeline than scaling down a more complex spacecraft. The integrated spacecraft along with its payloads were readied for launch in 15 months from authority to proceed. As an Enhanced Expendable Launch Vehicle Secondary Payload Adaptor ESPA-class spacecraft, FASTSAT is compatible with a variety of launch vehicles. These vehicles offer an array of options for launch sites and provide for a variety of rideshare possibilities.

Introduction

Because small satellites are vital to the future of space, the development, launch and operation of FASTSAT and its six payloads showcased an affordable alternative spacecraft in the microsatellite market and with its continued utilization offers expanded opportunities for space flight for the Department of Defense (DoD), NASA, universities, the intelligence community and the aerospace industry. The FASTSAT - HSV01 spacecraft was developed in collaboration among, NASA's Marshall Space Flight Center (MSFC), Dynetics and the Von Braun Center for Science & Innovation (VCSI) in Huntsville, Alabama, for the Department of Defense Space Test Program (DoD STP). FASTSAT - HSV01 carried six science and technology experiment payloads to low Earth orbit on the STP-S26 mission.

Microsatellites such as FASTSAT and Cube/NanoSats represent an emerging core element of NASA, Department of Defense (DoD), and other civil/commercial programs. The agility of these assets provides responsive, persistent and affordable access to space for the end user – from the research scientist to the battlefield, with on-demand space support, augmentation, and reconstitution. The small size of these satellites allows them to be produced affordably and launched on multiple systems – reducing the time from call-up to operation. The FASTSAT mission was a proof of concept that successfully achieved the rapid development of a spacecraft with multiple and complex results driven at an affordable cost to orbit mission cost (*Faster, Better and Cheaper*).

The first FASTSAT spacecraft was managed by NASA's Marshall Space Flight Center (MSFC) and developed in collaboration with Dynetics and the Von Braun Center for Science & Innovation (VCSI) in Huntsville, Alabama.

The spacecraft bus enabled a mission for a fraction of the cost and schedule of other flight options while including the following mission success criteria.

- Space Tests and Experiments
- Technology Demonstrations
- Rapid Response Gap Filler
- Augmenting Large Systems with scalable low complexity solutions
- CubeSat Constellation Deployment
- Earth and Atmospheric Observation
- Space Weather

The FASTSAT project leverages the deep base of space systems development expertise of NASA, an innovative business model through VCSI, and Dynetics' advanced engineering, rapid product development, and manufacturing capabilities. The team executed rapid development processes while applying the rigors for engineering excellence, safety, mission assurance, and manufacturing quality. FASTSAT was designed from the ground up to meet short schedules with modular components and configurable layouts to enable a broad range of payloads at a lower cost and shorter timeline than scaling down more complex spacecraft. This approach enabled the FASTSAT team the ability to rapidly take the spacecraft from design to launch readiness in 15 months.

FASTSAT HSV-01

Aboard STP-S26, FASTSAT-HSV01 launched a total of six instruments approved by the U.S. Department of Defense (DoD) Space Experiments Review Board. STP-S26 was executed by the DoD Space Test Program (STP) at the Space Development and Test Wing (SDTW), Kirtland Air Force Base, N.M., which is a unit of the Air Force Space and Missile Systems Center. The spacecraft was one of four ESPA compatible spacecraft mounted on the Multi-Payload Adaptor, which was developed for the STP to launch up to four ESPA spacecraft on the Minotaur-IV in November 2010. FASTSAT-HSV01 was developed using commercial funding from Dynetics and a unique public-private partnership with the NASA Marshall Space Flight Center, through the Von Braun Center for Science and Innovation. The project rapidly moved through development – going from ATP to space qualification environmental test in 10 months followed by ready-for-flight certification in an additional 5 months. The bus underwent a rigorous development and test process and was certified to both USAF and NASA standards, receiving a NASA Certificate of Flight Readiness. FASTSAT-HSV01 carried a record six SERB experiments on one bus: three technology demonstrations, and three NASA atmospheric research experiments. The technology demonstrations are the Light Detection System (LDS), the NanoSail Demonstration (NanoSail-D), and the Miniature Star Tracker (MST). The Air Force Research Lab sponsored LDS space qualified an advanced detection technology. One capability unique to the FASTSAT microsatellite was the ability to deploy CubeSats from orbit. A separate cubesat was launched by the FASTSAT spacecraft called the NanoSail-D (NSD). This flight experiment was NASA's first successful deployment of a thin film gossamer structure or "sail membrane" via a cubesat spacecraft. Following successful payload ejection the NSD reentered the earth's atmosphere, as planned, within ten months. The remaining NASA atmospheric research experiments are Thermospheric Temperature Imager (TTI), Plasma Impedance Spectrum Analyzer (PISA), and Miniature Imager for Neutral Ionospheric atoms and Magnetospheric Electrons (MINI-ME). TTI's objective was to increase the orbit propagation accuracy of LEO assets during solar and geomagnetic storms by remotely measuring thermospheric temperature and atmospheric atomic oxygen. PISA measured resonance frequencies which depend on electron density, temperature, and magnetic field strength. MINI-ME remotely sensed magnetospheric plasma to improve space weather forecasting. The spacecraft was decommissioned in May 2013 following thirty months of mission operations.

CONCLUSION

Microsatellites such as FASTSAT and Cube/NanoSats are rapidly becoming a core element of Department of Defense (DoD), NASA and other civil/commercial programs. These assets offer the ability to provide responsive, persistent and affordable data for the user. The small size of these satellites enables them to be produced rapidly, affordably and offers the flexibility of multiple launch systems – reducing the time from call-up to operation, thus enabling a broad range of missions for a fraction of the cost and schedule of other options.