

Breaking (Space) Barriers for 50 Years: The Past, Present, and Future of the DoD Space Test Program

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ABSTRACT

2017 marks the 50th anniversary of the Department of Defense Space Test Program's (STP) first launch. STP's predecessor, the Space Experiments Support Program (SESP), launched its first mission in June of 1967; it used a Thor Burner II to launch an Army and a Navy satellite carrying geodesy and aurora experiments. The SESP was renamed to the Space Test Program in July 1971, and has flown over 568 experiments on over 251 missions to date. Today the STP is managed under the Air Force's Space and Missile Systems Center (SMC) Advanced Systems and Development Directorate (SMC/AD), and continues to provide access to space for DoD-sponsored research and development missions. It relies heavily on small satellites, small launch vehicles, and innovative approaches to space access to perform its mission.

INTRODUCTION

Since space first became a viable theater of operations for the Department of Defense (DoD), space technologies have developed at a rapid rate. Yet while advanced technologies and instruments can enable the DoD to use space more effectively, it is risky to use unproven technology for critical systems. In the 1960s, the DoD realized that before developing and deploying space systems for operational use, it needed to test such systems in space. At that time no organization or funds were readily available to provide timely spaceflight for experiments and demonstrations with military relevance. It was out of this need that the DoD Space Test Program (STP) was born.

Over the five decades of its existence, STP has contributed to the advancement of space technologies in many fields, including satellite development, launch system development, and ground system development. Missions flown by STP have been at the forefront of navigation, surveillance, nuclear detection, communication, weather observation, and ground radar calibration. Other payloads flown by STP have collected data that furthered the knowledge of the space environment, including composition, radiation, and solar effects.

Today STP continues to provide access to space for DoD-sponsored research and development missions, relying heavily on small satellites, small launch vehicles, and innovative approaches to space access. The following sections describe STP's past, present, and future. It will also discuss how small experimental satellites and payloads can make use of STP's services. STP provides access to space for experiments built by universities and private entities, as well as those built by DoD agencies; for an experiment to be flown by STP, it need only be sponsored by a DoD organization. Once DoD sponsorship is obtained, the payload is briefed through a series of review boards until it reaches the DoD level. The DoD Space Experiments Review Board (SERB) meets annually to evaluate the experiments on military relevance and technical merit, and provides STP with a new ranked list each year. Then it is STP's job to break down as many barriers as it can, to fly as many space experiments as it can, from that list - just as it has done for the past 50 years.

THE PAST

The early days of STP

The DoD Space Test Program was created by a memo in 1966 from the Director of Defense, Research and

Engineering, to the Assistant Secretary of the Air Force. The program was then called the Space Experiments Support Program (SESP) and was meant to serve advanced development programs. SESP would ultimately be responsible for payload integration and launch services, and starting in 1970 with identifying “piggyback” space on large boosters which could be used for DoD Research and Development (R&D) experiments. Any military agency could sponsor experiments to SESP, but since SESP operated with R&D funds, sponsors of non-R&D payloads were expected to finance their own integration and launch costs. The budget requested for SESP in the FY1969 budget was \$16.5 million (or approximately \$120 million in 2017 dollars).

The first SESP mission was launched on 29 June 1967 and was truly a joint DoD effort. The mission was an Air Force launch that flew an Army satellite (Sequential Collation of Range, or SECOR 9) and a Navy satellite (Aurora 1). The objective of SECOR 9 was to improve geodetic survey accuracy worldwide; the objective of Aurora 1 was to obtain data on background radiation in the UV wavelength. Both experiments were 100% successful. Data from SECOR 9 was used for military target location and mapping while data from Aurora 1 was used in the background radiation database for surveillance satellites.

Involvement with the Space Shuttle

In 1978, the Under Secretary of Defense for Research and Engineering issued a new policy memo revising STP’s marching orders. This memo directed STP to investigate the use of the Space Shuttle as a “laboratory in space” for DoD experiments. STP first flew a suite of seven DoD experiments on STS-4. The experiments, which spanned a range of science areas (navigation, environmental data collection, plasma contamination, and solar data), were mounted on a structure in the Shuttle cargo bay. This first suite of experiments was followed by more, and STP ultimately flew 242 experiments on 109 Shuttle missions over the lifetime of the Shuttle.

Following the retirement of the Shuttle, STP has continued to fly experiments on manned missions to the International Space Station (ISS). STP has the distinction of flying the first internal science payload on the ISS - the Air Force Research Laboratory’s (AFRL’s) Middeck Active Control Experiment II (MACE II) - and the first external ISS science payload - AFRL’s Materials on International Space Station Experiment 1 and 2 (MISSE 1 and MISSE 2). Another series of experiments, started on the Space Shuttle and continuing today on the ISS involve rodent, cell-culture, and tissue research to improve battlefield



Figure 1: The STP-1 payload stack, with the ESPA ring on the bottom

medicine for the Army. One such experiment led to the development of a deployable intravenous infusion pump.¹

Recent missions

Since 2000, STP has launched 88 missions, flying 157 experiments. Some of the major experiments are discussed below.

Coriolis. In 2003, the Coriolis mission was launched with two experiments: the Navy’s Windsat experiment², which measured ocean surface wind speed and direction, and the AFRL Solar Mass Ejection Imager (SMEI), which detected solar mass ejections moving towards the earth.³ The satellite is still in operation today and data from Windsat is used operationally. The technology demonstrated in the Windsat experiment is the basis for several planned follow-on missions.⁴

STP-1. In 2007, STP launched one of its larger missions, STP-1.^{5,6} This mission marked the first flight of the Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA),⁷ which spawned a new class of small satellite weighing up to 180kg and compatible with the ESPA ring. To this day such satellites are still known as “ESPA Class” satellites. STP-1 deployed six satellites into a low earth orbit: the Defense Advanced Research Projects Agency’s (DARPA’s) Orbital Express (a two-satellite stack),⁸ Los Alamos National Laboratory’s Cibola Flight

Experiment satellite (CFESat), The Naval Academy's MidStar-1, STP's STPSat-1, and the Air Force Academy's FalconSat-3. There were nine individual SERB payloads on the mission conducting a variety of experiments. The integrated payload stack is shown in Figure 1.

C/NOFS. The Communications Navigation Outage Forecasting System (C/NOFS)⁹ was launched in 2008. C/NOFS's mission was to forecast scintillations in the earth's ionosphere to help the DoD predict the effects of ionospheric activity on signals from communication and navigation satellites. C/NOFS flew a suite of six AFRL experiments, developed by agencies as diverse as the University of Texas at Dallas and National Aeronautics and Space Administration's (NASA's) Goddard Space Flight Center.

STP-S26 and the Standard Interface Vehicle. The STP-S26 mission, so named because it represented the 26th small launch managed by STP, was launched in 2010 and included six small satellites mounted to a flat plate adapter.¹⁰ The satellites included two Formation Autonomy Spacecraft with Thrust, Relav, Attitude and Crosslink (FASTRAC) satellites from the AFRL University Nanosats Program, the Fast Affordable Science and Technology (FASTSAT) satellite from NASA (which contained a 3U CubeSat called Nanosail-D), the FalconSat-5 satellite built by the Air Force Academy, and STPSat-2.

STPSat-2 represented STP's first use of a Standardized Interface Vehicle (SIV).¹¹ The SIV, developed by STP as an enabler, is a "generic" 180kg satellite that can accommodate 70kg of payloads and provide 200 watts of power. The SIV was designed to accommodate a majority of the experiments on the SERB list that needed a satellite bus. While STP only bought and flew two SIVs (a later mission, called STPSat-3, was also based on the SIV), the bus has now become a standard bus in the Ball Aerospace catalog (the Ball



Figure 2: The Standard Interface Vehicle (SIV)



Figure 3: The ISS Express Logistics Carrier (ELC) Configurable Platform 100, or BCP-100).

The STP-S26 mission also launched two 3U cubesats off of the launch vehicle: the Organism/Organic Exposure to Orbital Stresses (O/OREOS) CubeSat from NASA, and the Radio Aurora Explorer (RAX) CubeSat from The University of Michigan.

Houston missions. During this timeframe the STP office in Houston saw the end of the Space Shuttle program, and the transition to the ISS. STP flew the PicoSat Solar Cell (PSSC-2) experiment on the last Shuttle flight, STS-135, in 2011. But even prior to the last flight of the Shuttle, STP had already established its presence on the ISS. Anticipating the need for a standardized external platform on the ISS, STP worked with NASA on the Express Logistics Carrier (ELC) as a platform for external ISS payloads; STP has since used the ELC to fly several suites of experiments on the ISS. The first such ELC mission, the Naval Research Laboratory's (NRL's) MISSE-7 launched in 2009; STP-H3 and MISSE-8 (also from NRL) followed in 2011.¹²

STP has also flown several internal experiments on the ISS. One of the more popular is the SPHERES experiment (sponsored to STP by AFRL).¹³ SPHERES, which stands for Synchronized Position, Hold, Engage, and Re-orient Experiment Satellites, consists of three free-floating testbeds approximately 22cm in diameter that float within the pressurized living areas of the ISS. They are used to demonstrate control and maneuvering algorithms in the weightlessness of space, and are a favorite of the ISS astronauts.

The "zombie year" and recovery

From a FY1969 budget of \$16.5 million (approximately \$120 million 2017 dollars), STP's budget declined over time, until it totaled approximately \$50M per year prior to 2012. In 2012, the President's budget for FY13 was submitted with a request of only \$10M for STP. The

Table 1: STP “Firsts”

Mission	Milestone
SOLWIND	First satellite to discover a comet
STS-4	First DoD payloads on a shuttle mission
STEP-M0	First flight of the Taurus launch vehicle
STEP-M1	First flight of the Pegasus XL launch vehicle
FalconSat	First flight of the Minotaur 1 launch vehicle
MACE II	First science experiment internal to the ISS
MISSE 1&2	First science experiment external on the ISS
PICOSat	First satellite bought through the Foreign Comparative Test Program
Kodiak Star	First orbital launch from the Kodiak Launch Complex
Nanosats II	First launch of the Delta IV Heavy launch vehicle
STP-1	First Air Force Atlas V launch vehicle First flight of the Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) First dual orbit trajectory for EELV
STP-S26	First use of a [Expand Acronym] HAPS to obtain dual orbit First Minotaur IV CubeSat deployment First Minotaur launch from Kodiak Launch Complex
GEARRSat	First duplex Space-to-Ground communications over Globalstar

Air Force planned to cancel the program and this amount was meant to assist the program in shutting down. There was no plan to request funds for STP after FY13.

With Congressional involvement and advocacy,¹⁴ and the action of leaders in the Office of the Secretary of

Defense (OSD), the Air Force was convinced not to cancel the program. The “zombie year” of 2013 took its toll, however; news of STP’s cancellation reached many customer agencies, and some still do not realize that the program was spared. Also, STP’s reinstatement came with significant budget cuts: the Air Force has submitted budget requests of roughly \$26M annually for STP since 2013. This cut represents a 50% reduction in annual funding, and STP has had to learn to execute its program with far fewer resources. This has included executing fewer flagship missions, and relying more heavily on partnerships to launch its experiments – including its significant partnership with NASA and the ISS.

Statistics and “firsts”

Since that first flight in 1967 STP has flown 568 experiments on 251 missions, as of April 2017. In addition to flying experiments that have contributed to the advancement of technology, STP has been involved in many “firsts” in its history. Table 1 lists some of these firsts.

THE PRESENT

Despite budget cuts, STP currently has a full plate of missions deep in development, awaiting launch, or already on orbit. These include dedicated spacecraft development efforts carrying SERB experiments (STPSat-4 and STPSat-5), multi-manifest rideshare missions (STP-2 and EAGLE), and missions from the STP Houston office that launch to the ISS (STP-H5, the Rodent Research series of experiments, the Roll Out Solar Array experiment, and deployable CubeSats).

Dedicated STP Spacecraft Development Efforts

The STPSat-5 Mission. Following the success of the SIV used for STPSat-2 and STPSat-3, STP set out to develop a smaller, less-expensive standard interface vehicle. This was necessitated by the cuts to STP’s budget following the “zombie year.” With an approximately \$25M annual budget, STP could no longer afford to purchase a \$50M bus to fly SERB experiments; instead, STP ultimately contracted with Sierra Nevada Corporation to build a \$15-\$20M bus based on CubeSat parts.¹⁵ STPSat-5 hosts five SERB experiments. The High Bandwidth Anti-Jam LPI/LPD Optical Network (HALO-Net) is designed to improve understanding of space based optical communications, and is being built by the Navy’s Space and Naval Warfare Systems Command (SPAWAR). NRL is providing the Ram Angle and Magnetic field Sensor (RAMS) and the Strontium Iodide Radiation Instrumentation (SIRI) experiment. The Rad Hard Electronic Memory Experiment (RHEME) is being built by AFRL. STPSat-5 also hosts the Integrated

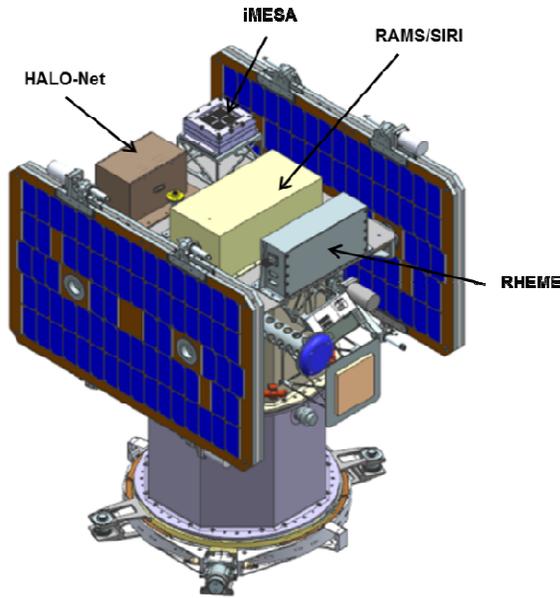


Figure 4: The STPSat-5 satellite

Miniaturized ElectroStatic Analyzer (iMESA), from the US Air Force Academy, which makes in-situ measurements of the low energy component of the plasma energy spectrum.

The STPSat-4 Mission. The STPSat-4 mission is a new paradigm for STP's ISS involvement. In 2014, STP brokered the launch of NRL's SpinSat satellite from the Cyclops deployment system on the ISS. Developed by NASA in partnership with STP, the Cyclops system allows satellites larger than CubeSats to pass through the Japanese Experiment Module airlock on the ISS,

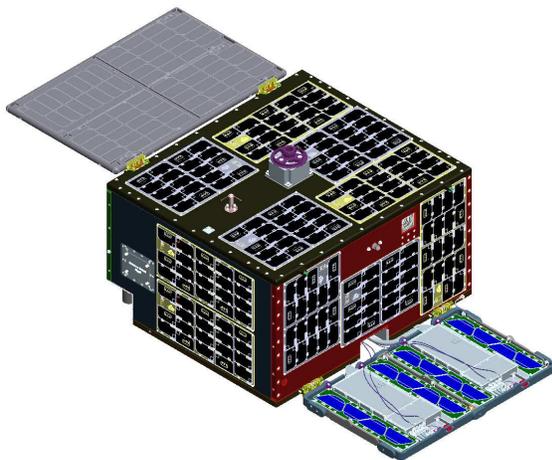


Figure 6: The STPSat-4 Satellite



Figure 5: The SpinSat deployment from Cyclops (photo courtesy of NASA)

and be deployed from the ISS robotic arm.¹⁶ Figure 5 shows the SpinSat deployment. STP is planning to use the same approach to deploy a spacecraft bus carrying five SERB experiments in 2018. Called STPSat-4, this free-flying spacecraft will carry experiments from AFRL, the Air Force Academy, and the Navy into low-earth orbit at extremely reduced development and launch costs. Figure 6 shows the STPSat-4 satellite.

Multi-Manifest Rideshare Missions

The STP-2 Mission. The STP-2 mission is one of STP's current flagship missions. Slated to be the first DoD use of the SpaceX Falcon Heavy¹⁷, STP-2 will launch 13 science and technology satellites and 12 CubeSats into three different orbits. STP is responsible for the stack integration, and for the "Do No Harm" mission assurance¹⁸ for the entire stack. STP is flying several SERB experiments as hosted payloads on the satellites being launched. Included in the manifest is the Taiwanese COSMIC-2 (Constellation Observing System for Meteorology, Ionosphere, and Climate) constellation,¹⁹ a group of six weather satellites which carry, among other instruments, three Space and Missile Systems Center (SMC) space and terrestrial weather payloads. STP-2 will also launch AFRL's Demonstration and Science Experiment (DSX),²⁰ which researches technologies needed to operate spacecraft in the harsh radiation environment of medium-earth orbits (MEO). STP-2 is also launching six auxiliary payloads: the Air Force Academy's FalconSat-6; the Naval Postgraduate School's NPSAT1; NASA's Green Propellant Infusion Mission (GPIM), hosting three SERB payloads; the AFRL University Nanosat Program satellites Oculus-ASR (Oculus Attitude and Shape Recognition Satellite) and Prox-1 (Automated Proximity Satellite #1); and Surrey's Orbital Test Bed

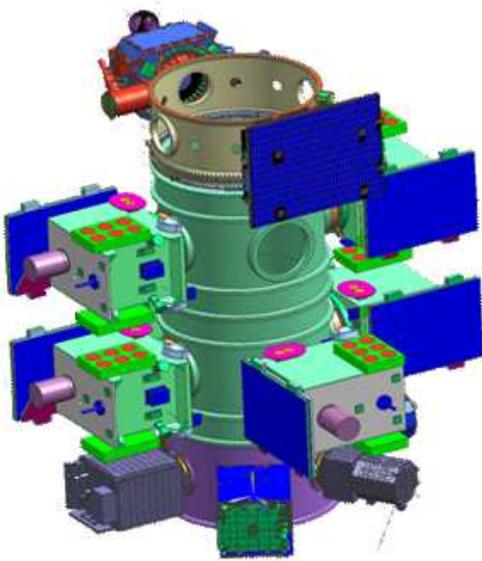


Figure 7: The STP-2 Integrated Payload Stack

(OTB), hosting a NASA payload and two SERB payloads.

EAGLE. STP is also overseeing the stack integration of the ESPA Augmented Geostationary Laboratory Experiment (EAGLE) satellite onto an upcoming Air Force Space Command mission. EAGLE, built by AFRL, is a propulsive ESPA ring hosting multiple experiments demonstrating Air Force technology concepts. It is flying several SERB experiments on separating and non-separating spacecraft. EAGLE will launch to geosynchronous orbit in 2018. STP is responsible for certifying Do No Harm mission assurance for EAGLE.

Houston Missions

STP-H5. STP-H5 is the fifth of STP’s flagship “pallet” missions to use the ELC on the ISS. Launched in February 2017 on the SpaceX-10 Commercial Resupply mission.^{17,21} STP-H5 was removed from the SpaceX Dragon trunk, installed on the exterior of the ISS, and is currently operating 13 experiments for the DoD and NASA. The suite of experiments tests new technologies in space situational awareness, rendezvous and proximity operations, space environment and weather, and spacecraft subsystem capabilities.

Rodent Research. The Rodent Research 4 project is the 4th in a series of experiments studying bone and wound healing in a microgravity environment. A collaborative effort between NASA’s Ames Research Center, the

Army, and the University of Indiana, Rodent Research 4 launched on the same SpaceX-10 commercial resupply mission that carried STP-H5 to the ISS. Rodent Research 4 examined how two different drug treatments affected bone and soft tissue regeneration in mice, compared to a control group. The experiment uses microgravity to stand in for battlefield stress, allowing the Army to evaluate new treatment regimens for wounded soldiers. It also advances limb regeneration studies and astronaut rehabilitation programs.²²

Roll-out Solar Array. The Roll-out Solar Array, or ROSA, is a unique experiment slated to launch to the ISS in the summer of 2017. Sponsored by AFRL, ROSA promises to enable the launch of lighter, flexible solar panels that “roll out” to their full size after launch, enabling larger panels to be launched on smaller missions. ROSA will be the first experiment conducted entirely on the end of the ISS’s robotic arm, which will measure the vibrations and stresses encountered during solar array deployment.

Deployable CubeSats. STP makes heavy use of the flexibility afforded by the ISS Commercial Resupply missions and the NanoRacks CubeSat deployer²³ to launch SERB missions that are CubeSats, or can be built into a CubeSat form factor. Several SERB CubeSats have recently been launched from the ISS through STP’s efforts. These include the AFRL Globalstar Experiment and Risk Reduction Satellite (GEARRS),²⁴ which launched in 2015 and demonstrated the use of the Globalstar satellite communications network as a viable communications approach for small satellites. The Army’s Space Missile

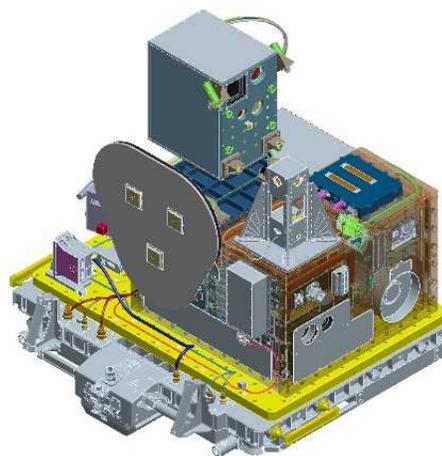


Figure 8: STP-H5

Defense Command Kestrel Eye satellite is slated to launch in the summer of 2017, and will provide low-cost satellite imagery for the Army.²⁵ The increasing use of CubeSats across the industry is reflected in recent SERB lists; as STP missions increasingly use the CubeSat form factor, the STP office in Houston provides a very cost-effective way to provide these missions access to space.

THE FUTURE

Upcoming Missions

STP-3. The STP-3 rideshare launch will be STP's next large multi-payload mission.²⁶ The STP program is allocated a medium-lift launch vehicle every four years from Air Force Space Command. In keeping with its recent approach, STP has chosen to execute multi-manifest missions in order to maximize the number of space vehicles that can take advantage of this lift capability. STP-3 is STP's 18th medium-class launch vehicle mission, and is the third STP multiple-payload EELV medium-class mission. Slated for launch in 2019, the mission will carry the STPSat-6 spacecraft and the Long Duration Propulsive ESPA (LDPE) spacecraft to geosynchronous orbit (GEO).

STPSat-6. STPSat-6 is a refurbished surplus spacecraft bus from a previous DoD mission. It hosts the Space Atmospheric Burst Recording System 3 payload (SABRS-3), an operational payload from the National Nuclear Security Administration, a major funding partner on STPSat-6. NASA is also a major funding

partner on STPSat-6; its Laser Communication Relay Demonstration (LCRD)²⁷ payload will demonstrate technologies for the next generation of the Telemetry and Data Relay System (TDRS) constellation. STPSat-6 will also carry seven SERB payloads to GEO.

STP-H6. Following on the success of the ISS external pallet missions, STP-H6 is slated for launch in late 2018. As currently configured, STP-H6 will carry eight SERB experiments to the ISS, including experiments related to star tracker and communications technology and space environmental monitoring.

RALI. STP is also currently funded to develop a Rapid Agile Launch Initiative (RALI) capability. This congressionally-funded effort calls on STP to select a "venture class" launch vehicle from among the emerging small launch market, and to launch several small SERB payloads and spacecraft in calendar year 2018.

Ongoing Efforts

STP, in its effort to provide access to space to as many experimental missions as possible, continues work on launch enablers. It continually brokers rideshares and notifies the community of available rideshare opportunities. It runs a bi-annual US Government Rideshare Working Group meeting where government agencies can exchange information on rideshare opportunities and other topics of interest to the rideshare community. It has delved into the arena of small satellite and rideshare policy, publishing papers on such topics as rideshare mission assurance¹⁸ and

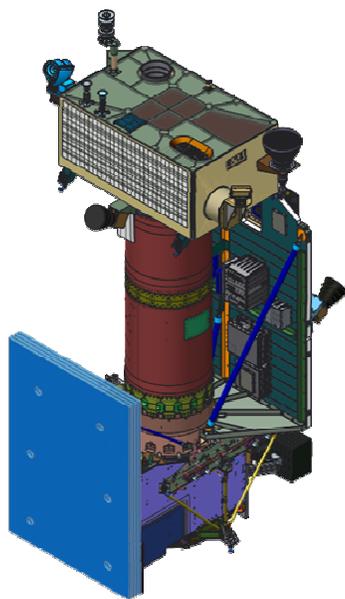


Figure 9: The STPSat-6 Satellite

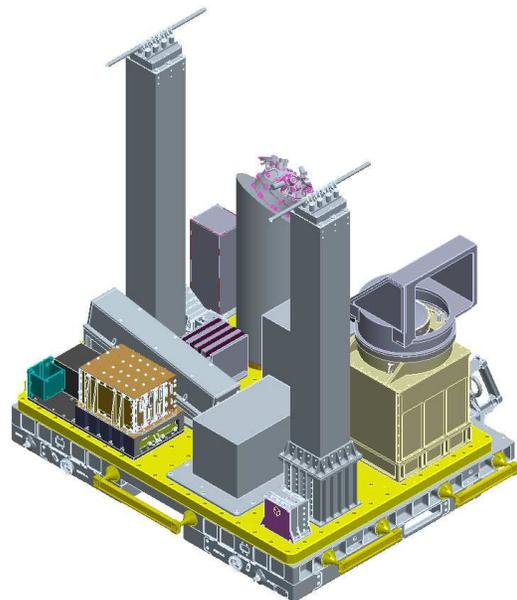


Figure 10: STP-H6

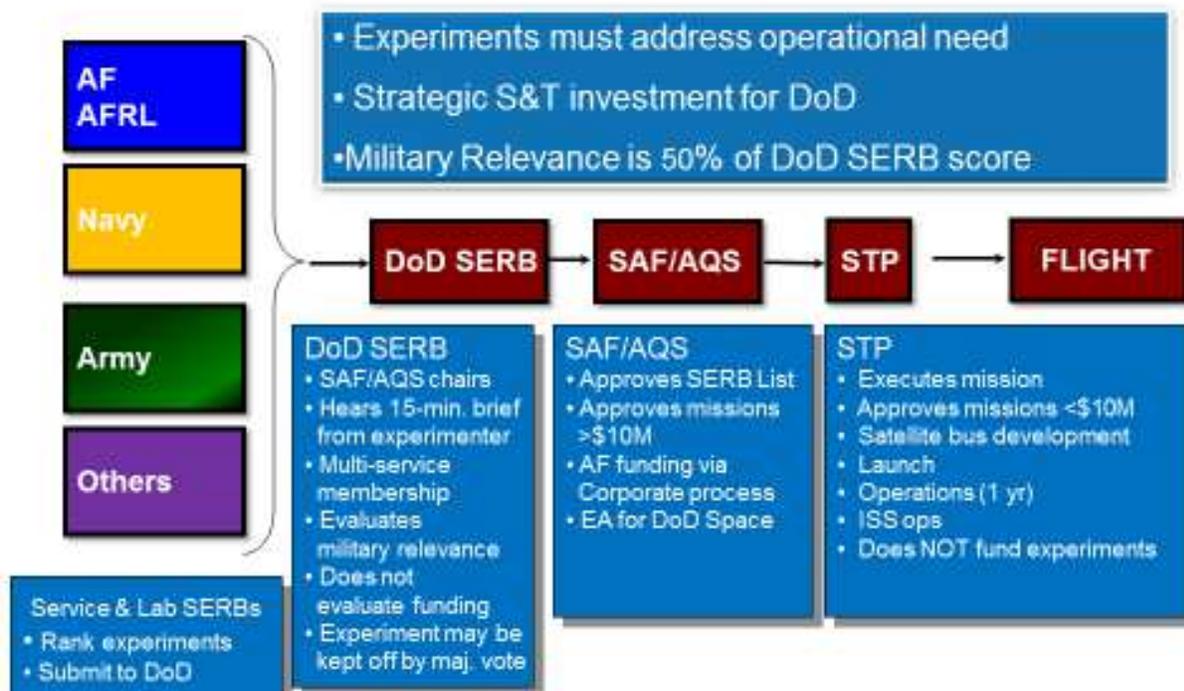


Figure 11: The Space Experiments Review Board (SERB) process

SmallSat policy.²⁸ Its experience in rideshare mission integration is now proving critical as the larger Air Force ponders the Space Enterprise Vision (SEV).²⁹ To that end, STP is working to update the Rideshare User's Guide to reflect the changing industry. It is also working on initiatives related to deployment order and rideshare loads analyses. As part of its work on rideshare enablers, SMC and STP are currently in the process of manifesting additional propulsive ESPA spacecraft busses, similar to EAGLE, in order to fly more prototype technologies in support of the SEV.

This work continues to be in addition to STP's ongoing mission of supporting, bundling, and flying the DoD's experimental payloads through the Space Experiments Review Board. Air Force Instruction 10-1202 governs STP's management and execution, including the SERB process, which will be described in the next section.

THE PROCESS

Principal investigators (PIs) who wish to work with STP to launch a space experiment can approach STP in several ways. The most common is through the SERB, but PIs can also bring reimbursable missions to STP, or partner with STP on rideshare missions.

Sponsorship

The SERB process is for experiments with military relevance who wish to use STP funds and resources to gain access to space. A PI who has an experiment or experimental spacecraft with military relevance would begin by finding a DoD sponsor for the experiment. The sponsor does not need to fund development of the experiment; it simply signs off on a form (Form DD1721) indicating that the experiment is of interest to the sponsoring DoD service or agency. Many such experiments come from universities or government laboratories, and need not be built by the sponsoring agency.

The SERB Process

All such experiments are then reviewed, approved, and ranked by a service- or agency-level board, which is convened once a year, usually in the summer. The Air Force will convene an Air Force SERB for all Air Force-sponsored experiments; the Navy will convene a Navy SERB for all Navy-sponsored experiments, and so forth. Each service or agency then submits a prioritized list of its own candidate payloads as input to the DoD SERB.

The Secretary of the Air Force, Office of the Assistant Secretary for Acquisitions, Space Programs

(SMC/AQS) convenes the annual DoD SERB to review, discuss, and prioritize candidate payloads from the provided agency lists. The DoD board is a 16-member board with representation from across the DoD. It includes representatives from the Army, the Navy, and the Air Force, as well as the Office of the Secretary of Defense, the Missile Defense Agency, NASA, DARPA, and U.S. Strategic Command.

The DoD SERB reviews all experiments through a series of 15-minute briefings, one for each proposed experiment. The DoD board then ranks the experiments based on military relevance (50% of the final score), experiment quality (40% of the final score), and service- or agency-level ranking (10% of the final score). The resulting prioritized list is provided to STP, who can then spend its resources to find the ranked experiments access to space.

Figure 11 shows the full SERB process. Experiments must brief the SERB annually until they are manifested if they wish to continue to be considered for STP flight. Rankings may change from year to year, and most missions will brief the SERB several times before they are ready for manifest. STP tries to fly as many experiments as possible from the SERB list, but it is limited by its funding profile, by the spaceflight opportunities it can procure, and the maturity of the SERB experiments themselves. Experiments with flexible mission requirements are easier to fly than missions with more stringent or difficult requirements.

Categorization and Bundling

Following the DoD SERB, the prioritized list is signed by SAF/AQS and forwarded to STP for execution. The first step in the execution process is to categorize the payloads based on launch approach: ISS or expendable launch vehicle (ELV). Payloads identified as compatible with an ISS launch are often assigned to the STP-Houston office where they begin the process of manifesting with NASA. The ISS is a very economical means for STP to access space; such payloads are launched to the ISS on existing Commercial Resupply missions, and most payloads requesting an ISS flight are manifested in a timely manner.

Payloads identified as requiring an ELV are assigned to the STP-Kirtland office where they are bundled by their desired orbit and projected readiness date. These bundles are then evaluated against STP's budget and their ranking within the SERB list. Workable missions are identified and the spacecraft acquisition or rideshare process is initiated.

STP mission planners are always on the lookout for piggyback and secondary ride opportunities for STP

payloads. Those opportunities are worked on a case-by-case basis and can be a very economical means to spaceflight.

Manifest and Spaceflight

While STP has flown on everything from high altitude balloons to microgravity aircraft to sounding rockets, most STP missions fall into one of three categories: free-flying orbital missions, ISS missions, or piggyback / secondary missions. For payloads with unique orbit requirements, STP can fund, develop, integrate, and launch its own free-flying spacecraft, capable of carrying one or more payloads with the same basic requirements. In most cases, one of the payloads chosen for the spacecraft has a high priority and is considered the primary payload. Available power and mass margins are then considered to determine additional payloads to be hosted on the spacecraft.

Some organizations request spaceflight for fully integrated spacecraft at the DoD SERB, seeking only launch services and operations support from STP. In these cases, there is no need for an STP-developed bus. For situations such as these, STP identifies and may procure a launch vehicle for the spacecraft and might also fund spacecraft operations (up to one year).

Some payloads desiring flight can be flown as piggyback or secondary missions. Piggyback missions – also called hosted payload missions – are payloads that fly on a host spacecraft. Secondary missions are small spacecraft that share a launch vehicle with a primary spacecraft. Both are economical methods of space access, but in both cases, the primary payload typically drives the schedule and orbit.

A final category of STP missions is ISS missions. The STP-Houston office has many options when it comes to flying payloads with the ISS. They can place a payload in the interior, on the exterior, and can even eject small satellites from a variety of deployers currently on the ISS.

SUMMARY AND CONCLUSION

The STP program provides a much needed service for the DoD by providing a single point of contact for access to space for DoD experiments. STP has provided this service for an impressive 50 years, and expects to continue to provide this service into the future.

The Air Force is also celebrating an anniversary in 2017: 70 years as a separate service. The motto for the Air Force's 70th Anniversary is "Breaking Barriers since 1947." STP, a DoD program administered by the Air Force, is proud to be the organization "Breaking

Space Barriers” for the last 50 years. Only time will tell what future systems will ultimately be fielded using technologies demonstrated through STP, but STP will continue to break space barriers to ensure cutting-edge DoD research has a path to space.

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