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The DoD Space Test Program
Free Launches for Amateur Satellites

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Abstract. Finding an affordable launch opportunity is key to the success of any amateur satellite project. The Department of Defense (DoD) Space Test Program (STP) provides launches, at no cost to the experimenter, for DoD-sponsored experiments that demonstrate DoD relevance and technical merit. Amateur satellite builders seeking an STP launch must find a DoD or Federal sponsor and present their proposal for review by the DoD Space Experiments Review Board (SERB), which ranks proposed space flight experiments. The STP has launched several amateur satellites, and undoubtedly offers opportunities for future amateur satellites, perhaps even for AMSAT's Eagle.

Introduction

Amateur satellite activity is limited by, more than any other factor, the ability of amateurs to place satellites into orbit. Amateurs have repeatedly demonstrated tremendous resourcefulness in designing and constructing satellites on very limited budgets. Who else but amateurs could even conceive that a handful of guys with a $2000 budget could actually build their own satellite, much less have it successfully placed into orbit[16]? Or that a team composed largely of undergraduate woman could proudly point to *their* own on-orbit satellite[13]? However resourceful they might be, amateurs have not yet developed their own orbital launch capability. In the interim, they must scrounge free or reduced-cost rides on "professional" launches. The Department of Defense (DoD) Space Test Program (STP) is one potential source of free flights. In fact, this program has already launched several amateur satellites, including the two mentioned above. Of course, obtaining free rides into orbit isn't easy. But, "you can't win, if you don't play." This note offers some thoughts about competing for STP-sponsored flights. Preceding that, it describes the DoD Space Test Program itself and the process by it selects the experiments that it will support.

The DoD Space Test Program

The DoD Space Test Program STP "provides support to the DoD space research community by centrally financing the launch and initial operations costs for experiments with military relevance whose scope ranges from basic research to advanced development[18]". Of even greater interest to amateurs, the STP "provides spaceflight for qualified DOD sponsored experiments at *no charge to the experimenter*" [emphasis added][21]. What is this Space Test Program? And, more importantly, how can amateurs join the "DoD space research community" and have their satellites designated as "DoD sponsored experiments" and launched into orbit at no cost?

The STP was established in 1966 to provide flight opportunities to the Defense research and development community. By early 2000, the STP had launched 410 payloads on 150 missions[14]. These payloads included "free-flyers" (spacecraft deployed by the Space Shuttle or by an

expendable launch vehicle), secondary (or piggyback) payloads hosted on another spacecraft, and experiments flown on the Space Shuttle (either in the pressurized Middeck of the crew cabin or in the cargo bay). More recently, STP experiments have flown on the International Space Station (ISS). The STP is proud of what these missions have accomplished. Lt. Col. Perry Ballard states that "Every operational DOD space system originated as an STP experiment – STP is the future of DOD Space[3]".

Fortunately for amateurs, the DoD has a broad view of who qualifies for STP support: "DOD experiments normally originate in the Service (Army, Air Force, Navy, NASA) laboratories or research institutions (colleges, universities, think tanks, etc.) but are in no way limited to these institutions[21]". The title of Lt. Col. Ballard's presentation makes the STP's broad intent clear: "The DOD Space Test Program and University Satellite Projects: Launch Opportunities". Of course, the STP has limited resources and can't satisfy every request for a free launch. It is the responsibility of the Satellite Experiment Review Board to identify the experiments that best advance the objectives of the STP and warrant STP support.

The Satellite Experiment Review Board

The Satellite Experiment Review Board (SERB) is tasked with maintaining the DoD Experiment Priority List, which ranks proposed space flight experiments. The STP flies as many of the highest-ranked experiments as its budget and other resources permit.

The SERB Review Process

The first step towards a STP-sponsored space flight is to find a sponsor. Any DoD organization may sponsor an STP experiment, as may non-DoD Federal agencies. While experiments *can* originate outside of the DoD and other Federal agencies, this is clearly the exception rather than the rule. The process by which an outside organization finds a sponsor appears to be largely informal. This undoubtedly involves convincing the potential sponsor that your experiment will support the objectives of the organization and the STP. In spite of these challenges, several university satellite programs have been successful in finding sponsors.

The sponsoring agencies are expected to rank the experiments that they submit to the SERB. For some agencies, this involves an evaluation process modeled on that used by the DoD SERB. The Navy SERB maintains an informative, publicly accessible Web site that describes its activities, processes, and evaluation criteria, which are similar to those of the DoD SERB[24].

The DoD SERB review process culminates in a review meeting during which the proposed experiments are ranked. Each presenter has 15 minutes to make his or her case. The SERB provides a five-slide outline that summarizes the concept (objective and description), justification (military relevance, need for spaceflight and comparison to alternatives), and a few other details about the proposed space flight experiment. The sponsoring agency must also submit a DD Form 1721, "Space Test Program Flight Request". The heart of this 11-page form is two pages on which the experimenter must summarize this same information.

The SERB Web site[19] includes a summary of the process that is used to rank proposed experiments; a more detailed description is contained in Air Force Instruction 10-1202(I), "Space Test Program (STP) Management"[17].

The process by which experiments ranked highly by the SERB are matched up with space flight opportunities is beyond the scope of this paper. What is important to understand is that the STP will provide substantial funding and other support to the experiments that it believes demonstrate DoD relevance and technical merit.

STP Evaluation Criteria

The DoD SERB ranks proposed experiments based on three criteria: military relevance, the quality of the proposed experiment, and the priority assigned by the sponsoring agency[20]. These factors are weighted 60%, 20% and 20%, respectively, to compute a composite score for each experiment.

DoD Relevance

DoD relevance is the most heavily weighted evaluation criteria. SERB presentations are expected to demonstrate DoD relevance by explicitly referencing the U.S. Space Command's Long Range Plan and other documents. Fortunately, as is discussed below, "DoD relevance" is an extremely broad concept. In similar circumstances, the writer typically has wide latitude in making his or her case for DoD relevance.

Technical Merit

The SERB wants to sponsor experiments that are likely to be successful, that will generate results that can't easily be obtained without a space flight, and that don't replicate data that are likely to be generated by other experiments. While the written rating criteria don't mention it, the reputation and demonstrated competence of the research team are often important in the evaluation of research proposals in similar environments.

Agency Ranking

The DoD SERB will consider the ranking placed on a proposed experiment by the sponsoring agency. Outside organizations would be prudent to consider how an agency is likely to rank their experiment when they approach potential sponsors.

Competing for an STP Launch

To mangle an old aphorism, "there's no such thing as a free launch". Creating a successful STP proposal, like writing any major research proposal, is a lot of hard work, requiring hundreds of hours of labor. The proposal must convince the SERB that the project has strong DoD relevance and outstanding technical merit. Competition is fierce; the STP can provide space flights for only a small number of the experiments that it deems worthy of support. However, the process

of creating even an unsuccessful proposal will be beneficial – the experimenter will have a refined, reviewed proposal that can be submitted in other forums.

Writing Research Proposals

Writing research proposals is hard work, and creating a successful STP proposal is no exception. The researcher must craft an concise, articulate, compelling story about how his or her project will alter the course of history, or at least the small part of history that is of interest to the customer (i.e., the agency soliciting the proposals). Direct, concise presentation is mandatory. The reviewers are likely to be reading dozens of proposals, and will naturally favor those that they can understand quickly and easily. DD Form 1721, "Space Test Program Flight Request", provides two pages in which the researcher must describe the proposed experiment, its relevance to DoD requirements, and why the project is unique. Although the researcher *can* submit additional sheets, reviewers undoubtedly prefer succinct stories. Conversely, a researcher's inability to describe his experiment and its significance in an understandable, one-page abstract often evokes suspicion or skepticism. A one-page abstract can sometimes determine the future of a project. NASA is currently reviewing 750-word abstracts to determine which organizations will even be permitted to submit multi-million dollar proposals in response to the Human & Robotic Technology Broad Agency Announcement[6].

In addition to being well written, a proposal must embody a thorough understanding of the needs of the customer (the sponsoring agency) and of the current state of the relevant area of science or technology.

DoD Relevance

The following quote from the justification for the STP's Fiscal Year 1998 budget provides a sense of the breadth that "DoD relevance" encompasses:

> SPT missions are the most cost effective way to flight test new space system technologies, concepts and designs, providing an inexpensive way to:
>
> - Demonstrate the feasibility of new space systems and technologies
> - Provide early operational capabilities to evaluate usefulness or quickly react to new developments
> - Perform operational risk reduction through direct flight test of prototype components
> - Improve operational design by characterizing the space environment, event or sensor physics proposed for an operational system/system upgrade
> - Develop, test, acquire advanced payload support hardware for Launch Vehicles/Shuttle/ISS
> - Demonstrate and develop responsive R&D space capabilities[18]

Fortunately, agencies have a strong interest in ensuring that researchers understand the challenges for which the organizations need solutions. For example, NASA's Small Business Innovative Research (SBIR) solicitation is a laundry list of technologies that NASA would like contractors to develop[7]. The DoD, NASA, and other Federal agencies release dozens of research solicitations every year that similarly detail numerous space-related research challenges. Agencies document their technology needs in a variety of other formats, including long-range plans and technology roadmaps. The space-related technology needs of the DoD and other

Federal agencies are so great that they provide numerous opportunities for a researcher to demonstrate relevance. A few hypothetical experiments may help illustrate how proposals might tie experiments to unmet technology needs.

- **The integration of satellite services with mobile, wireless terrestrial networks.** Emerging DoD networks, such as Warfighter Information Network – Tactical (WIN-T) and the Future Combat Systems (FCS) network will integrate satellite services to extend connectivity. However, precisely how satellites, particularly those in low Earth orbit, should be integrated with mobile, wireless ground units is not well understood. An amateur satellite could provide a large-scale testbed for proposed satellite/terrestrial network architectures.

- **The use of the Internet protocols in space.** NASA is exploring the use of the Internet protocols to communicate with near-Earth spacecraft and to enable researchers to access on-orbit experimental data from Internet-attached computers[8]. Some of the IP-in-space experiments performed by the NASA Goddard Space Flight Center were conducted on a flight computer onboard UoSAT-12, known in amateur circles as UO-36[11,12]. Presumably, future amateur satellites could support more advanced IP-in-space experiments.

- **Integration of satellites with digital public safety communications.** A recent Air Force solicitation requested proposals to use space communications to support interoperability between public safety agencies, Federal agencies, and the DoD. An amateur satellite ought to be able to support experiments that explore the use of satellite communications to interconnect clusters of digital public safety radios with amateur radio networks.

The challenge for amateur satellite builders is to identify a documented, unmet technology need, show that solving that need is important, and convince the SERB that his experiment is likely to provide a solution.

Technical Merit

The last thing that the SERB wants to do is to waste a valuable launch opportunity on an experiment that is unlikely to provide some useful benefit. Experimenters should convince the SERB that their experiment is well conceived, and that the project team has a excellent grasp of the current, relevant science or technology.

Past STP Support for Amateur Satellites

Amateur satellites[1] *have* been launched through the Space Test Program, including:

- **PANSAT (PO-34)**[23] The Petite Amateur Navy Satellite (PANSAT) was designed and built by the Naval Postgraduate School. Its main objective was to provide students with real-world experience developing and managing a space system. PANSAT also provided store-and-forward services using spread spectrum communications.

- **ASUSat1 (AO-37)**[2] AUSat1 was designed, built, tested, and operated by students at Arizona State University. It carried an amateur transponder and other instruments.

- **OPAL (AO-38)**[15] The Orbiting Picosatellite Automated Launcher (OPAL) microsatellite was designed and built by students at the Stanford University Space Systems Development Laboratory (SSDL). This 51-pound satellite deployed six picosatellites, including the two mentioned in the introduction of this paper. It also carried a number of other instruments and experiments.

- **JAWSAT (WO-39)**[9] The Joint Air Force Academy - Weber State Satellite (JAWSAT) deployed four other satellites, including ASUSat1 and OPAL. The project included several universities, aerospace companies, the Air Force Academy, the Air Force Research Laboratory, and NASA.

- **Starshine 3 (SO-43)**[10] Starshine 3 was an optically reflective spherical satellite designed by the U.S. Naval Research Laboratory and built by volunteers. It carried 1,500 mirrors that were polished by approximately 40,000 students at 1000 schools in 30 countries.

- **PCSat (NO-44)**[25] PCSat was built by students at the U.S. Naval Academy. It continues to forward AX.25 Unnumbered Information (UI) packets.

- **Sapphire (NO-45)**[26] The Stanford AudioPhonic PHotographic InfraRed Experiment (Sapphire) satellite was designed and built by students at Stanford University, and pre-flight integration and post-launch operations were provided by students at Washington University. Its primary mission was to space-qualify micromachined infrared sensors, and also carried a digital camera and a voice synthesizer.

Of course, these terse descriptions don't provide any insight into why the SERB ranked these projects highly. But, a couple of characteristics stand out. First, all of these satellites had substantial student involvement in their design, construction, testing and operations, including undergraduates and graduate students at universities and military academies. Second, they all included one or more scientific experiments or technology demonstrations. This theme is reiterated in Lt. Col. Ballard's presentation: "Basically, STP has committed to the AFA and USNA that if they build a satellite around a SERB experiment we will launch it".

Attracting, inspiring, and developing the next generation of space engineers and scientists is a persistent theme of NASA and the DoD. NASA's mission is, in part, "to inspire the next generation of explorers ... as only NASA can". Early last year, the Air Force's top two space officials told a Senate subcommittee that the development of a "space cadre" was one of their top priorities[4]. All of the amateur satellites launched by the STP have clearly supported this theme.

An STP Launch for AMSAT Eagle?

Should AMSAT pursue an STP launch for Eagle[5]? Absolutely! The work required to create a strong proposal is substantial, the competition is intense, and the odds are long. But, the payoff is so great that, in my opinion, AMSAT would be remiss if it didn't try. The information provided here should provide a good starting point for the preparation of a strong STP proposal for Eagle. It might even put Eagle into orbit!

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