

Formulation Refinement and Access to Space for the ST8 Mission

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Abstract—NASA’s The New Millennium Program (NMP) approach to space flight validation of advanced technologies is to alternate between subsystem and system flight validations¹. Candidates for each NMP project (subsystem or system) are competed through a NASA Research Announcement process, and proposal selection is determined by NASA Headquarters. Space Technology 8 (ST8) is the second NMP subsystem project. It will host four technology experiments selected from technology capability areas:

- The SAILMAST, a light-weight, deployable boom for potential solar sail structural applications
- The Next Generation Ultraflex (NGU), a lightweight, deployable solar panel
- The Environmentally Adaptive Fault Tolerant Computing (EAFTC) experiment, a Commercial-Off-The-Shelf (COTS) electronics package for validation of high speed computing in a radiation environment
- The Miniature Loop Heat Pipe (MLHP), a small spacecraft thermal control subsystem experiment

The launch is planned for 2008 on a Pegasus XL launch vehicle.

Access to space for ST8 involves working with the technology experiment development activity to baseline a mission, procuring a spacecraft bus to host the experiments, and procuring appropriate launch services through NASA. Because of the competitive element of NMP, however, the mission concept and preliminary spacecraft bus requirements were developed in parallel with the independent development of the technology experiment proposals. This initial part of the mission formulation process and the interaction between the NMP project architects and the experiment selection process is described in an earlier paper¹.

The selection of the technology payloads is a key step towards developing the procurement of the spacecraft bus

and evaluating competing launch services approaches. An earlier “Space Technology Carrier” study confirms the feasibility of obtaining a spacecraft bus from among available commercial design concepts. Additional steps used to proceed are:

- Confirmation of capabilities and cost projections.
- Development of top level requirements on the bus.
- Evaluating competing launch services options
- Developing materials to support the procurement activity

This paper tells the story of these steps in the formulation refinement of the ST8 mission leading to its establishment as a formal flight project, with some insights and comments on the benefits and risks of the approach.

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1. INTRODUCTION

The ST8 mission concept development (pre-Phase A) takes place in parallel with the competitive development of concepts for its payload of technology validation experiments and their selection. A successful JPL Concept Review validated the initial mission concept and provided valuable suggestions to aid the mission formulation (Phase A) step which preceded the establishment of an ST8 Project Office and staffing of a project team. The formulation process is well defined under JPL flight process standards. These standards define a series of design issues,

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documentation products, and reviewable activities which must be completed to satisfy the institution that all appropriate measures have been taken to allow the project to proceed to implementation.

2. FORMULATION PROCESS SUMMARY

The process for ST8 involves several key events. First is the support of selection of a set of payload experiments that satisfy the NASA Research Announcement (NRA) for ST8 and fit within programmatic guidelines for budget and schedule. Second is the development of requirements and specifications for a spacecraft bus to accommodate the selected experiments. Third is the evaluation of potential launch options, and finally is the support of the procurement process for the spacecraft bus.

Figure 1 (TBS) depicts the relationship of these events

The first of these steps was successfully completed with the selection of 4 candidate payload experiments from a field of 10 competitors in 4 different Technology Capability Areas. The result of this selection was a set of payloads which were projected to meet programmatic objectives as well as remaining within the overall capability envelope derived for the anticipated class of spacecraft bus which has been budgeted.

For the second step, the selected payloads are no longer in a competitive situation, and can participate in refining the projected capability envelope with specific interface, resource, and operational requirements that are used to procure the spacecraft bus. These provide key inputs to the Request for Proposal (RFP) package that is used for the competitive spacecraft bus procurement.

The NMP seeks to provide the most cost-effective means of providing launch services while meeting mission schedule and performance requirements. The ST8 mission evaluated the possibility of a shared launch with several earth-orbiting missions planned within its schedule framework as well as maintaining the option of a dedicated launch on a Pegasus XL vehicle.

The combination of refined mission/payload requirements and launch vehicle options supported the development of the RFP package that leads to final procurement of an industrial partner to provide a spacecraft bus and ground system services to complete the mission team.

A Project Manager, Project System Engineer, and other supporting project office staff support the spacecraft procurement process and proceed to develop and document the steps needed for a successful Preliminary Mission and Systems Review (PMSR) that JPL requires to close off the

formulation phase of the mission and proceed to Implementation Phase (Phase C/D).

3. CONFIRMATION OF CAPABILITIES AND COST

Results from the “Space Technology Carrier” (STC) study and examination of capabilities and costs from the Goddard Spaceflight Center’s Rapid Spacecraft Development Office (RSDO) catalogue aid the initial development of ST8 budget and capability estimates. The NMP office and reviewers from the Concept Review considered this information valuable but desired an update of the information to focus on the final selected mission payload and to validate the ability of industry to provide the desired capability within the budgeted costs for ST8.

A Request for Information (RFI) was suggested as a means of obtaining an updated status on candidate spacecraft concepts while providing potential industry participants early information to support eventual decisions to respond to the RFP for ST8 and solicit comments on the evolving mission concept. Table 1 summarizes the mission and payload requirements supplied with the RFI.

Table 1. Summary of ST8 RFI Specifications (TBS)

The responses from the RFI process validated the existence of a class of spacecraft bus capable of supporting the ST8 mission and remaining within the planned budget for the mission.

4. REQUIREMENTS DEVELOPMENT AND VALIDATION

The RFI also provided an update to the planned mission profile and payload interface specifications that could be used with the selected payload suppliers to refine the requirements of their design concepts and be evaluated for inclusion in the requirements and specifications to be used in the RFP. The Contract Technical Manager (CTM) for each selected payload worked closely with the payload team to refine the initial specifications derived from the study reports which led to their selection. Further evaluation of issues involving spacecraft accommodation, orbit properties, and more detailed assessment of desired experiment profiles led to the refined set of mission/payload specifications listed in Table 2.

Table 2. Summary of refined ST8 Specifications (TBS)

This activity resulted in the initial draft of mission and payload inputs to the spacecraft/ground system RFP.

5. EVALUATION OF LAUNCH OPTIONS

Several potential NASA earth-orbiting missions were evaluated as potential ride shares for ST8. Candidates were considered with a planned launch date within reasonable proximity (FY quarter or so) of the ST8 planning date, having a potential excess launch capacity (mass and volume), and with orbital characteristics that could accommodate placing ST8 within a reasonable orbit for its mission objectives. The latter did not necessarily require reaching an optimal orbit projected for a Pegasus launch case, but which would provide a radiation environment consistent with the EAFTC experiment.

The most realistic potential partner was identified as the NASA WISE mission. This would utilize a Delta II launch vehicle with WISE being the primary in an upper position on a Reduced Height Dual Payload Adapter Fitting (RHDPAF). WISE would be deployed in a circular, sun synchronous, low earth orbit, leaving excess Delta II propulsive capability to allow ST8 to be placed in its desired sun synchronous, elliptical orbit with parameters equaling or exceeding the orbit planned for a Pegasus launch.

Close coordination with the Kennedy Space Center launch services office was required, as the Delta II option contract was in the process of being updated, and consideration was needed to cost and plan for an option including the RHDPAF.

After careful consideration, the decision was made to proceed with an RFP that allowed for a Delta II launch option with either the RHDPAF or a custom designed adapter between WISE and ST8. An option to launch on a Pegasus XL to the nominal ST8 orbit was also required.

6. DEVELOPMENT OF THE PROCUREMENT PACKAGE

The basic RFP package contains a significant amount of material describing the procurement rules and process. Major technical requirements for the spacecraft bus are contained in three specific documents: the Mission and System Requirements Exhibit, the Payload Interface Description Exhibit, and the Mission and Trajectory Description document. There are numerous other referenced items, but these three are the key ST8 specific elements in the package.

The Mission/System and Mission/Trajectory documents were updated from the material that was developing from the initial mission concept. The updated content reflected the additional detail developed through interaction with the payload/experiment providers and feedback received from the RFI responses. The initial Payload Interface Description material was reviewed in draft form by the payload CTMs,

payload providers, and key flight project personnel before being placed in final form.

The total RFP package was assembled, approved, and used to initiate a successful procurement of a spacecraft bus for the ST8 mission and associated ground system services for mission operations.

The ST8 project management team, led by the project manager, is proceeding to develop the remaining products required for the PMSR and approval to proceed on to Phase B of project activity.

7. CONCLUSIONS

A tailored process, following NMP programmatic guidance and the JPL flight project process guidelines accomplished key elements of the ST8 Mission Formulation Refinement. The tailoring incorporated the selected payload/experiment providers, standard procurement procedures, and a newly forming project management team to acquire the ST8 industry partner for spacecraft and ground system services.