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Melvin DeGree
NASA, Office of Space Flight, Space Station Headquarters Office

Said Hamilton
NASA, Office of Space Flight, Space Station Headquarters Office

Post Mission Utilization Of Satellites for College and Secondary Education

Melvin DeGree and Said Hamilton
NASA, Office of Space Flight, Space Station Headquarters Office
Washington DC 20546

(ABSTRACT)

NASA is in a unique position to promote utilization of post mission satellites to provide college and secondary school educational opportunities in the mechanics and intricacies of space satellite operation. Many of NASA's communication and scientific satellites are decommissioned after completion of their mission for various reasons, such as budgetary constraints, end of life expectancy, fulfillment of scientific mission or operational constraints. Therefore, it seems sensible to assess the feasibility of developing alternative applications for these satellite resources. In particular, there may be an opportunity to garner additional, long-term educational benefits from the utilization of such satellites.

NASA is studying its options in this area by identifying its satellites which may be candidates for decommissioning. NASA then plans to assess the possible extended life capabilities of satellites identified in this conceptual process. Using the information from these studies, NASA would then assess the feasibility of establishing a process whereby colleges and secondary schools could participate in utilization of the decommissioned satellites. Success in such a program may enable NASA to: 1) create new partnerships with the college and secondary education communities; 2) provide students direct experience with space science data collection and spacecraft operations; 3) provide students an opportunity to directly operate high technology equipment and to conduct original analysis of scientific satellite data. Invaluable "hands-on" experience could thus be provided to future generations of space scientists and spacecraft engineers.

Introduction

The process and the concepts described in this paper are geared towards advancing the vision of NASA's *Human Exploration and Development of Space Strategic Plan* [1] (HEDS). In particular, it is in support of the HEDS objective to "Broaden and strengthen our Nation's achievements in science, math, and engineering," and to promote its strategy of forming partnerships with the educational community to bring the space exploration experience even into the classroom. The goal of this paper is to proffer a concept which could serve to extend utilization of NASA satellites after completion of their missions. The authors contend that extending satellite utilization will offer new opportunities to both individuals and educational institutions to engage in the space exploration experience. In addition, reutilization of NASA satellites can serve as an important element towards meeting the further HEDS objective of involving the Nation's citizens in the unfolding adventure of space exploration.

Opportunity

The primary goal of this effort described herein is to explore, categorize, and assess the means by which NASA could effect a post mission reutilization of satellites (PMRS) program by awarding operational control of a satellite to a NASA-Academia Partnership. Several opportunities

accrue to NASA in meeting this goal, such as 1) Enhancing NASA's outreach program with universities, colleges, and secondary schools, 2) Creation of a new partnerships between NASA, academia, and private industry, and 3) Purposeful extension of the usable life of valuable assets. To the Partnership would accrue several opportunities as well, including 1) Opportunity for faculty and students to get direct experience in space science data collection and analysis and space craft operations, 2) Hands on experience with high technology equipment within the educational community, and 3) Opportunity to develop a new academic curriculum centered around spacecraft data collection and operations. This paper describes the process as to how such an effort might be achieved.

PROGRAM ESTABLISHMENT

The PMRS program would be established using time honed NASA methods. NASA has a well ordered, four phase process in place to establish and implement any new program. These phases include a Feasibility Study, Conceptual Design, Development, and Implementation phases.

PHASE I - FEASIBILITY STUDY

The first phase would be a feasibility study, which would seek to establish a fundamental body of knowledge and information about the subject. The elemental part of the feasibility study has already been informally conducted. We have determined that NASA does have both active and planned satellite missions which could fall in the post mission reutilization category. A representative sample of such missions is shown in Table 1, Space Craft Missions. The extended mission and archival analysis periods both offer points of inflection at which decisions about PMRS suitability could logically be made.

Table 1 - Spacecraft Missions

Spacecraft	Launch Date	Prime Mission Period	Extended Mission Period	Archival Analysis Period
FAST	08/21/96	96 - Late 97	Late 97 - 1998	1998 - 1999
POLAR	02/24/96	96 - Late 97	Late 97 - 1999	1999 - 2000
WIND	11/01/94	94 - Mid 97	Mid 97 - 2002	2002 - 2003
GEOTAIL	07/24/92	92 - Late 94	Late 94 - 1999	1999 - 2000
SAMPEX	07/03/92	92 - Mid 95	Mid 95 - 2002	2002 - 2004
EUVE	06/07/92	92 - Late 95	Late 95 - 1999	1999 - 2000

In addition, several candidate university systems have been identified. An example of a university system would be one which included a university, college or Consortium of Universities, and Secondary School Outreach Programs. Some candidate university systems already have experience and expertise with NASA satellite missions. Further, efforts by other NASA organizations are well underway to develop a faculty/student led satellite operations capability on a university campus which had no previous satellite mission experience [2].

The initial feasibility study must be expanded in order to complete the body of information needed to establish full feasibility of the program. This study would include the full complement of current and planned satellite missions. Of course, not all missions would be suitable for PMRS program, eg., deep space missions such as the Pioneer series. The feasibility study would identify potential users, by issuing a formal Request for Information (RFI). The RFI would gauge the full extent of academia, industry, and secondary school systems interests in such a program. The study would conclude with generation of a gross life-cycle cost estimate.

PHASE II - CONCEPTUAL DESIGN

In phase II of the process, a conceptual design would need to be formulated to demonstrate a workable model of the PMRS program. Against this model would be pitted a wide array of questions and “what-if” scenarios. Questions must be answered about reliability, maintainability, life cycle, safety, risks to NASA, the University, and the public, security of the communications links, schedules, operations, and of course, costs. The ultimate goals must be defined such that a set of objectives and requirements can be generated to meet those goals.

An informal, high level conceptual program design model has been established by the authors. This model visualizes a closed loop system which is depicted in Figure 1, PMRS Program High Level Conceptual Design Model. As Figure 1 shows, the university would be the controlling entity of the program. NASA, of course, would provide the satellite and , conceivably, a relatively small training and transition budget to the university. NASA would also provide a long term, purely backup command and control capability, and an in-depth technical anomaly resolution capability.

On the other hand, the university would establish a satellite operations control center , an academic curriculum, faculty and student involvement, and hire a small technical contractor effort to maintain the satellite. It would also establish outreach programs with other universities and secondary school systems, as appropriate. Note that each entity would have a separate funding source to help defray the costs of its involvement. Thus, every party would have ownership in the program through its budget and personnel ties.

PHASE III - DEVELOPMENT PLAN

The development plan would be generated to usher in the actual deployment of the PMRS system. This concentrated effort would satisfy the technical, operational and user requirements necessary to meld together in a real system. Requirements to satisfy the conceptual design put forth in Phase II would have to be generated. These would include requirements in areas such as satellite communications, tracking, orbital calculations, resource management, and telemetry processing. Here NASA would play its largest personnel role in the process, lending its engineering and technical expertise to the university partnership effort.

This phase would see the selection of the satellite and the final participating university system. An Announcement of Partnership Opportunity would most likely be used to solicit formal partnership proposals from the interested community. A selection body or board would be seated to analyze and review the various proposals . Upon that bodyís recommendations, a Space Act Agreement would probably be used to finalize the Partnership Agreement

The Partnership Agreement would spell out the requirements and operating avenues for each party. A sample of these requirements would include these would include the contractor skills required to safely and efficiently operate the spacecraft. Program schedules would be defined. Data collection rights, if any, and ownership would be proscribed, and user community requirements and expectations would be defined. The important area of risk mitigation would result in a mutually acceptable risk coverage agreement. This agreement would spell out the responsibilities of each party in sharing any unavoidable risks in an equitable manner. A cost sharing arrangement would be agreed upon for Partnership members.

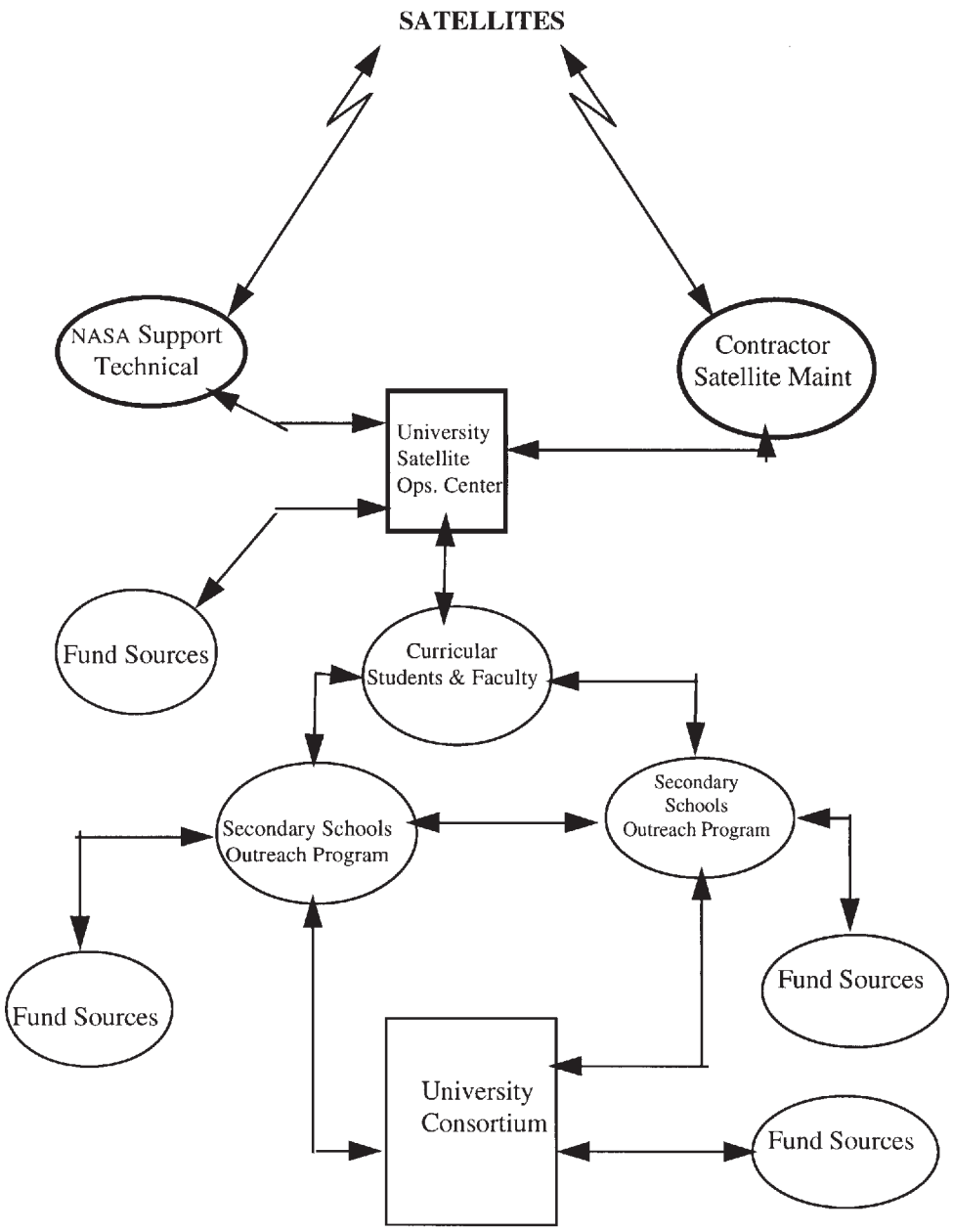

Fig. 1 -- PMRS Program High Level Conceptual Design Model

FUNDING

No program moves without funding. So the Partnership must define a defensible, sufficient, and reliable funding plan to cover the program life cycle costs. It is envisioned that NASA would be asked to provide a training and operational transition fund, over a 3-4 year interval. Major funding would come in the first year, as unexpected problems would be encountered and resolved. Year 2 would be substantially less than the first year. The third year would essentially be a consulting and oversight role. The fourth year would be basically for reviews of safety and procedures

As the NASA budget declines, the University budget would rise, such that NASA funding would be minimal, if any at all, by the fourth year. In that year the Partnership Agreement would probably call for the university partners would to provide the lions' share of the budget. The authors believe that there are a variety of non-NASA sources available to assist in the funding effort. These include industry, foundations, other Federal Agencies, and State and Local Government Agencies. The University system itself would be asked to provide some portion of that budget. Sources for the University system funds might include other universities, and even independent secondary school systems. The overall goal of the funding effort would be to place no undue financial burden on any single Partnership member. The outcome of this phase would be formal establishment of a NASA-University Partnership to reutilize a post mission NASA satellite in our nationís university system.

PHASE IV - IMPLEMENTATION

In the final phase NASAís role and experience would become secondary, while the Universityís role would become primary. Here the winning partnership proposal would be put into practice. The Partnership organization would begin the task of satellite transition from NASA to the Partnership. It would be responsible for staffing, training and operating the satellite, and would implement the programís life cycle plan for management and utilization of the orbiting vehicle.

The fruits of long labor would blossom here, with faculty, student, and institutional involvement in an educational process geared to teach, train, and motivate a new generation of space scientists, engineers, technicians and explorers. In this phase, dreams would be nurtured, ideas tested and expanded, and the vast curtain of the unknown in human knowledge would be rolled back, bit by bit, through the power of Americaís Universities, Colleges, and Secondary Schools.

Conclusion

The Post Mission reutilization of NASA satellites by University, College and Secondary School Partnerships is an achievable goal. Although there are substantial challenges in areas such as funding, maintenance, and operations, such issues can be addressed and resolved through the capabilities NASA can bring to bear on the problem. The overall benefits to NASA could well be enormous. The concept and process described in this paper define an opportunity for NASA to provide Universities, faculty, and students another avenue to gain direct experience in space science and space craft operations. Ultimately, it could lead to an increase in our younger generationís interest in space science and exploration. NASAís role in this effort and itís ability to share itís vast knowledge can create a new generation of highly talented and knowledgeable individuals, and a

new standard of educational excellence which could carry out the bold , new goals and objectives in the NASA Strategic Plan into the 21st Century.

RECOMMENDATION

The authors recommend that NASA should fully explore the ways and means to establish new partnerships with colleges and universities which meet the spirit and intent of the concepts defined in the Post Mission Reutilization of Satellites for Colleges and Secondary Education program described this paper. The authors firmly believe that such a program would lead to creation of new partnerships between NASA, private industry, and academia , and that far reaching, long term benefits would accrue to the industrial and educational space exploration community from such partnerships.

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Biographical Sketch
Melvin De Gree

Mr. De Gree is currently employed at NASA, Office of Space Flight, Space Station Program Office, Washington, D.C. He is married, and resides with his wife in Virginia. Received his BS degree in Electrical Engineering in 1965, from North Carolina A&T College, and his MS degree in Computer Science, from Howard University, in 1975. Previously worked at the U.S. Geological Survey, National Mapping Division, Office of Research and spent several years in various private industry engineering development positions. Mel is an author and a playwright, who has written 5 stage plays, 1 children's book, and has served as editor of a mathematics book. Additionally, he has spent over 10 years helping elementary school students to develop reading, writing and mathematics skills. His favorite hobbies are music and hiking.