

Selection of the Ground Segment for the Next Generation Space Telescope (NGST)

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Introduction

Paper scope:

The Next Generation Space Telescope (NGST) is a large aperture space telescope designated to succeed the Hubble Space Telescope (HST). NGST will continue the recent breakthroughs of HST in our understanding of the earliest origins of stars, galaxies and the elements that are the foundations of Life. It is expected that the costs of NGST should be kept within a fraction of those for HST. The ground segment has a goal of reducing the cost of NGST in comparison to HST by 50% to 75%.

To mitigate risks for NGST a flight demonstrator called Nexus is planned for 2005. Nexus is a smaller scale telescope, which plans to test the deployment and optical stability of the telescope, the "Wave Front Control" process, and the thermal performance of the sunshield. The Nexus Ground System will be developed by GSFC and STSci, and the NGST Ground System will be developed by STSci. The authors of this paper are engaged in a study to evaluate and recommend selection of a Command and Telemetry system for each of these Ground Systems.

This paper focuses on the process of selecting the real-time Command and Telemetry system for NGST. We would like to use the conference as a sounding board as we make a selection.

Ground Segment Role in Low Cost Operations:

Several ideas are associated with reduction of ground segment operations costs:

- Simplification of operations modes
- Collaboration with instrument and spacecraft developers in an Integrated Process Team
- Specification of an event driven spacecraft
- Automation
- Use of the same real-time Command and Telemetry system for development I&T, spacecraft I&T and Operations
- A cradle-to-grave method to control the program's database

Methodology

As part of our selection process we need to answer the following questions:

1. Should we use the same Ground System for Nexus and NGST?
2. How does a COTS solution compare to a GOTS solution?
3. What is the feasibility of re-using the HST Vision 2000 CCS system?
4. What is the feasibility of switching the operations paradigm to a Finite State-Based Modeling system?
5. Should we use the same Command and Telemetry system to support System I&T (vs. whatever the contractors use)?
6. Should we determine a database concept and implementation that will carry through all phases of the Mission?

To facilitate answers to these questions we will:

- Interview various Mission managers at GSFC, Johns Hopkins Applied Physics Lab (APL), and the Air Force
- Interview appropriate COTS product representatives
- Determine how reliant each system is on other COTS/GOTS systems and whether these embedded systems are installed with well defined APIs that facilitate changing or upgrading.
- Determine how much customization is required
- Determine how dependent the systems are on specific database format and systems.
- Determine the relationship between flight software and the Ground Systems (i.e., how are flight command procedures specified and are they the same for ground?)
- Develop operations concepts for all phases of the mission life cycle
- Develop top-level context and architecture diagrams
- Develop high-level requirements

Step 1: The Relationship Between Nexus and NGST

It is very tempting to make a selection now for both Nexus and NGST and "get it over with". On the other hand we are hesitant to select a Ground System for NGST in 2001 while the mission is in 2009. Therefore, it has been decided to keep the selection of the Nexus and NGST Ground Systems separate.

Step 2: COTS VS GOTS

In making a selection between COTS and GOTS three schools of thought are applied:

- Whenever possible use COTS
- Use what is familiar (GOTS)
- Use the same GOTS system that is supporting HST

Step 3: Applicability of HST Vision 2000 CCS

The key components of this system that would apply to other missions are:

- CCS provides a single set of software which is scalable and can run in very different environments
- CCS design utilizes GOTS/COTS technology and custom software
- The CCS system supports end-to-end processing including a software front-end, Command and Telemetry processing, data archival and trending.

Step 4: Finite State-Based Modeling

The traditional real-time Command systems above utilize a "STOL" user interface to support I&T through Operations. Procedure development and databases evolve as these phases evolve. An alternative development method is Finite State-Based Modeling. We are reviewing two systems that support State-Based Modeling; Altair and Mission Data System (MDS) by JPL. Initial research indicates that Finite State-Based Modeling requires more work up front with total commitment from spacecraft engineers. The benefits are realized later.

Step 5: Use the same Ground System for both I&T and Operations

Several NASA and APL missions have adopted the approach of using the same Ground System for both I&T and Operations. Examples of these are the ACE, NEAR and TIMED missions..

Step 6: Cradle-to-Grave Database

The concept of a common database, which would support all phases of the mission life cycle, is very desirable. Investigation will be performed to determine a database solution that can be used during early flight software development, spacecraft I&T and Operations as well as the capability to port the database between different COTS and GOTS Command and Telemetry systems.

Conclusion

We have not yet selected a Ground System for Nexus or NGST. What we have learned so far is:

1. There are many systems available that can re-used
2. Using the same tool for I&T and Operations is desirable
3. An interface and scheme for controlling the Program database is essential
4. Members of the FOT should be part of the I&T process and co-located with developers
5. For NGST we need an I&T system that is easily distributed and connected via secure internet connections permitting monitoring, support and participation during I&T
6. We need to select a system early enough that can be assured of use and receive consensus from the contractors that it will be used because it is available, robust and supported