Commentary on: Post Servicing Mission 4 Parallel Observing with the HST

Civeit, Giuliano, Rager

by

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Introduction

This paper describes the process and accompanying software system to enable "side" observations to be added to a baseline HST schedule. They describe a partially automated, partially manual process of analyzing the schedule, enabling science observers to examine a range of opportunities, and the process of merging these "side" observations, called "parallel observations" into the schedule. They describe their prior (non) solution to the overall process, their new process and approach that is undergoing its first operational usages (as described in section 8), a number of challenges in this analysis process and their solution.

Salient Features

It's worth noting that the HST parallel observer scheduling problem has a number of features quite common in space mission scheduling problems:
1. The solution is partially manual, partially automated
2. The problem includes a blend of engineering and science constraints
3. part of the solution is to identify the low hanging fruit and harvest them
4. The solution includes some constraints represented as traditional planning and scheduling (states and resources), or at least representable as such, but also includes some that are described in other ways, or encoded in a higher level algorithm designed by human analysis of the problem structure
5. operational usage revealed further insights which spurred further changes in the solution.

Questions

1. The parallel observer process for HST bears some resemblance to the multi instrument observation selection process performed by MRO[1]. It might be useful to examine and compare the two.

2. In Figure 4 - "even though exposures from prime and parallel images can ..." is it possible to leave the data in the instruments? If so wouldn't this enable an alternative planning/scheduling possibility to overlay observations? Is the underlying constraint related to communications bus / data transfer capacity?

3. I understand that you have decided to not fully automate the parallel observer requesting process. (late section 4.), can you elaborate to explain some of the challenges that make the cost of the cost/benefit analysis so that this is the sweet spot in the solution? - what would it take to more automate the parallel observer requesting process? To enable the system to more suggest slots that are: lower in contention, meet certain science requirement, etc.? I'm thinking of value adding in ordering them, not so much completely ruling out ones since scientists would likely revolt if it was ever wrong…

4. In Section 5, Orbit structure, relating to Figure 4 - you highlight what appears to be two extreme in a spectrum of contention and observation patterns. Is it correct that there are in between cases? It seems like this pattern would be a continuum with less and more readouts. How do you handle this, with a measure and a cutoff to partition into "viable" and "non viable" orbits for parallel observation?

5. Are there the equivalent of terrestrial polar targets (e.g. they are continuously visible, or at least have many more opportunities? How are these handled, does your scheduler understand about flexibility and use the typical heuristics in scheduling the most constrained observations first (both for regular and parallel observation patterns)?

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[1] See http://trs-new.jpl.nasa.gov/dspace/handle/2014/39832?mode=full (JPL TR version of a spaceops 2006? Paper), or just google scholar "mro wenkert science scheduling", there's also an aiaa space 2007 paper

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6. Do you determine your orbit boundaries arbitrarily? Do you have to move them (orbit boundaries) because they break things, or do you just break them at the SAA or the like so it is not an issue? Or is the orbit boundary selection a simplifying assumption that does cost you something.

7. In Section 6: "all visits of the same parallel..." does this mean that you cant specify something like"I want m observations over less than n orbits"? This is a common observation template for other types of missions, does it occur, and if so how would you handle it? If not is it that it never comes up or is it that there is some side constraint on your types of science such that you know it does not come up?