# Commentary on "Planning Operations of the Earth Observing Satellite EO-1: A case study in representing spacecraft operations constraints" S. Chien, D. Tran, G. Rabideau, S. Schaffer, D. Mandl, and S. Frye

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This paper presents a report of the recent work performed at JPL to improve the way the EO-1 Earth observation satellite is managed. EO-1 is the first Earth observation satellite which is equipped with on-board planning capabilities *i.e*, with the ability to modify its activity plan following events such as new observation requests from the ground or detection of ground phenomena which require further observation. This paper deals with on-board planning as well as with planning on the ground. The latter is a kind of long-term planning performed some days before over a horizon of one week, while the former is a kind of short-term planning performed on-line. The latter focuses on long-term optimization, while the former focuses on quick local repair or improvement. Planning functionalities already existed and worked reasonably. This paper is a report of the effort made by JPL people to improve these functionalities.

It focuses on modeling questions: how to model more accurately thermal evolutions and constraints, satellite pointing trajectories and objectives, power evolutions and constraints, as well as planning constraints and preferences? This discussion about modeling is very interesting because it is seldom to see a discussion about a real-world problem and the difficulties one encounters inevitably to model it properly using a given modeling framework, here ASPEN which is based on notions of activities, resources, and temporal constraints.

For each modeling difficulty, the authors propose an *ad-hoc* solution. However, my feeling is that they never discuss the central question of the adequacy of an activity-based modeling framework such as ASPEN for modeling complex phenomena such as for example temperature, pointing, and power evolutions. My question is: would a timeline-based modeling framework (still with discrete evolutions) be more appropriate to represent these complex evolutions? I have no answer, but would like to see this question discussed. Other questions are related to:

- the origin of the significant improvement in terms of number of planned observations between the old mission management system and the new one. Is this improvement due to a more accurate model, to more efficient algorithms, or to any other reason such as for example the relaxation of too strong management rules which were enforced for safety reasons, but can be finally relaxed?
- the reasons for using a so simple priority-based greedy algorithm for planning on the ground. When planning on the ground some days before execution, one has enough time for optimization using not very sophisticated algorithms, such as for example limited tree search (with restart), local search such as tabu search or simulated annealing, or iterated stochastic greedy search.
- the contradiction between a priority-based greedy algorithm which adds observations anywhere in the current plan and the need for assessment of temporal profiles for temperature, pointing, power, or other quantities. Would a forward-search algorithm be more appropriate, because it systematically adds observations at the end of the current plan?
- the exact nature of the algorithm used on-board. Because this algorithm is described as an iterative repair algorithm, it is *a priori* more complex than the pure greedy algorithm used on the ground. Something is wrong somewhere, maybe in the reader interpretation.
- the definition of the criterion to be optimized. The authors describe algorithms, but never explicitly define the global criterion to be optimized: the number of performed observations, a sum of the weights of the performed observations with weights functions of priorities, or any other criterion?