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DECISION-BASED SYSTEM ARCHITECTING FOR HUMAN NEO MISSIONS

Abstract

Decision-based system architecting represents a complex system as a set of interconnected decisions that a system architect can make about the trade space. Modeling a system using decision-based frameworks allows the architect to not only enumerate and evaluate feasible architectures, but also, to gain insight into how influential each decision is to the overall system. This paper details the process of using decision-based system architecting to model the architecture for future human NEO missions).

The modeling of a NEO mission began with the choice of the 7 metrics based on stakeholder analysis and the decomposition of NASA's six exploration themes, which outline why we should explore. The metrics are connected to 11 system-level decisions, which are divided into two major classifications: operational strategy decisions and functional allocation decisions. Each decision was populated with alternatives taken from currently or previously proposed elements and options. The final step included limiting the set of architectures to only include feasible architectures by adding constraints based on physical limitations, architectural assumptions, and system requirements.

Once the model of feasible human NEO missions was developed, it was used to enumerate the set of feasible architectures based on the principles of solving a Constraint Satisfaction Problem. This simulation enumerated 3,240 feasible architectures that could be evaluated based on the set of metrics.

In order to rank these architectures, a piecewise linear utility function was developed for each of the metrics and an aggregate benefit utility score was determined for each architecture. The ranking shows that longer duration, lower delta-v opportunities tend to provide more value and the choice of propulsive technology developed greatly impacts the potential value of these missions.

The other information that can be taken from an model is how important each decision is to the overall value of the architecture. This information can be displayed using a Decision Space View, which plots each decision as a point on a graph of how many constraints each decision is connected to versus how sensitive a given metric is to changes in the decision. Using this information, it is shown that the most influential decisions include the choice of propulsion systems for the various propulsive maneuvers.