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SPACE SYSTEMS SYMPOSIUM (D1)
Lessons Learned in Space Systems (5)

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OPTIMIZATION OF SPACE SYSTEM DEVELOPMENT RESOURCES

Abstract

One of the key system engineering activities during any new space system development is the initial allocation, and subsequent re-allocation of key development resources: time, money, mass, power, data rate, volume, pointing accuracy, etc. Historically, development resources have been allocated initially via expert judgment, usually by the Program Manger and Lead System Engineer. As portions of the development use more resources than initially allocated, reallocation of development resources becomes necessary. Typically, unused resources are set aside for this purpose, in the form of margin, or reserves. Resource reallocation is also historically been via expert judgment, usually using either a Configuration Control Board or an Engineering Review Board. The problem arises in that over the history of modern space system development, often the space system development ends up some combination of late, over budget, or not meeting technical performance requirements. The expert judgment of reallocating key development resources has not worked well. A NASA study of eight space science missions developed in the 1980's determined that the average development cost was 121% over allocation, and that the average development mass was 24% over allocation. A 2010 US National Academies of Science study of 40 development programs found an average over budget of 27%. Current space science developments massively over budget include James Web Space Telescope and Mars Science Lander.

Twice in the history of space system development, on the CASSINI Saturn orbiter and on the TERRA Earth orbiter, an auction-based development resource reallocation system was tried, with spectacular results. Science instrument development resources, including money, mass, power and data rate were completely allocated to all eleven CASSINI instrument development projects. No margin or reserve was held back on any resource. At the end of the five year CASSINI science instrument development, all eleven instruments completed development on time, with a net cost growth of 0.9%, and a cumulative mass growth of -7%. A similar development resource reallocation auction system was used during the TERRA science instrument development, with the same results, i.e., almost no development cost or mass growth over the initial allocation.

This IAC2011 Section D1.3 (or D1.6) System Engineering Tools, Processes and Training paper describes new PhD dissertation work extending the use of an auction-based development resource reallocation system from the independent market participant case (space science instrument development) to a dependent market participant case (spacecraft development).