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SPACE TECHNOLOGY SYSTEMS ENGINEERING IN AN AGILE HARDWARE DEVELOPMENT FRAMEWORK

Abstract

Space systems are traditionally developed using a "waterfall" approach breaking down development into a logical progression from requirements development to the operation of the system. This top-down framework theoretically allows for the full design and analysis of systems to occur before hardware procurement or significant economic investment, which is then followed by building, testing, and operating the as-designed system. This works with a clearly identified scope and a well-defined requirements space that meets stakeholder needs. However, traditional waterfall projects still encounter changes in scope that incur significant cost and schedule delays and offer less flexibility to changing stakeholder needs. This is critical in space systems development given the capital-intensive and long-duration development timeline, often on the order of 5-10 years and billions of dollars.

Agile development, on the other hand, fixes the resources and time allocated to a project, but allows for changing scope by delivering incremental products or functions that inform the requirements for subsequent iterations. This methodology is commonly implemented in software development through frameworks such as scrum, kanban, or Extreme Programming, with a goal of delivering incremental functional products on-path to an ever-changing end-product. In space systems, hardware can have long lead times in addition to the time required to build and test products, which limits the applicability of agile development.

However, agile principles can significantly aid in the development, maturation, and implementation of new space technology – such products have an ill-defined requirements space and evolving stakeholder needs by design, but often have a fixed schedule and resources. Developing incremental products to inform the final technology form buys down risk on planned implementation by demonstrating real, rather than theoretical, value early and often in the development process. This paper will discuss how an agile methodology can be applied to the development and maturation of new space technologies, and how this affects the various aspects of the systems engineering framework for these technologies. In addition, this hybrid agile systems engineering framework will be illustrated through a hypothetical case of a fictional new space technology, in order to communicate how agile methodologies can be applied from the beginning of a technology development's systems engineering effort to buy down risk, expedite the development timeline, and remain forward-looking.