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A DESIGN ARCHITECTURE FOR AN AUTONOMOUS PRE-LAUNCH PROCEDURE CONTROL SYSTEM

Abstract

With the advent of inexpensive small satellite development, the launch vehicle industry is being pushed into a more frequent, and sustainable launch model. To satisfy this growing market, a design architecture for a fully automated and sustainable pre-launch procedure control system, powered by distributed cloud services, is proposed. The motivation behind automating the pre-launch procedures, as part of the Ground Station Control software developed by C6 Launch Systems, is to minimize human intervention, which reduces both human-introduced errors and operating costs, allowing minimal initial investment capital for smaller launch providers, and sustainable overhead costs. The first design architecture principle considered is an overarching autonomous decision engine. This stateful decision engine is responsible for keeping track of multiple parallel pre-launch procedures and determines the overall "go", and "no-go" states for the launch itself. The decision engine is comprised of fault trees, designed using principles similar to software object orientation, allowing distribution of the design into multiple subsections, for each subsystem. The second principle investigated are the decision nodes themselves, which will initially make decisions based on hard-coded, pre-optimized tolerance thresholds. However, the goal for autonomous decision making is to implement autonomous ensemble-based machine learning models for applicable decision making nodes. The use of ensemble methods is preferred due to their advantages of combining weak learners to form a strong combined model since a single model isn't reliable for decisions with high severity. This also allows quick implementation of such models, since datasets from only a few launches have the potential for creating highly reliable models. The final design principle considered is leveraging distributed cloud services as the powerhouse, rather than developing proprietary ground station services. As Amazon Web Services (AWS) recently introduced its Ground Station service, it's clear that cloud computing services will penetrate the space industry, and small launch providers have the opportunity to fully integrate from the start as the industry moves towards a more open space. By combining these base design principles, pre-launch procedures can reach a level of autonomy allowing a sustainable business model, quicker turnaround, and competitive pricing for the consumer.