Paper ID: 13337
oral
student

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

Author: Dr. Dale Arney
National Institute of Aerospace/Georgia Institute of Technology, United States

Dr. Alan Wilhite
National Institute of Aerospace/Georgia Institute of Technology, United States

SPACE SYSTEM ARCHITECTURE DECISIONS TO IMPROVE DEVELOPMENT RISK

Abstract

During the conceptual design of space system architectures, many criteria drive concept selection, including cost, mass, safety, and risk. During detailed design and development, systems that are mass constrained often require significant resources to ensure they are developed within the mass budget. Reducing development risk by selecting architectures that are insensitive to uncertainty in performance requirements, mass growth, propellant boil-off rate, and other assumptions can mitigate cost growth and schedule delays. The purpose of this research is to explore system architecture options, determining their impact on development risk. Several concepts of operations for lunar and Near Earth Object (NEO) system architectures are modeled within a system sizing and synthesis tool. Uncertainty in performance, mass, boil-off rate, and other assumptions is represented by sampling from distributions on each variable. The probabilistic sizing results of the lunar and NEO architectures are then presented, which indicate the likelihood that the uncertainty will increase risk. This process will inform the system architect on decision drivers that minimize development risk. The results of this analysis suggest that utilizing suborbital burning propulsive stages in conjunction with on-orbit refueling mitigates growth risk. Offloading propellant in architectures that have mass growth and then refueling it in orbit deemphasizes the importance of meeting the mass budget. This lack of sensitivity prevents the cost increases and schedule delays that plague complex system development during detailed design and development. Other benefits of suborbital burning with refueling include improved launch vehicle performance (payload to orbit), reduced mission risk due to launch reliability (if multiple providers are utilized), and improved value for the architecture ($/kg of payload delivered).