

A Distributed Simulation Framework Applied to Artemis Analysis, Studies, Integration, and Test

The National Aeronautics and Space Administration (NASA) established the Artemis Program, a series of missions to return humans to the Moon and explore further than before. To execute the Artemis missions, NASA is collaborating with commercial and international partners to create the necessary infrastructure and logistics plan that will establish a long term presence on the Moon ahead of exploring Mars. NASA and its partners are developing a collection of space and surface systems to support crewed missions to the lunar surface that will provide the mobility, habitation, logistics, and exploration support necessary for Artemis mission successes which includes robust scientific investigations. This paper details the design, capabilities, and uses of the Artemis Distributed Simulation (ADS) being developed by the NASA Exploration Systems Simulations (NExSyS) Team to support Artemis architecture studies. ADS utilizes international interoperability standards to connect a collection of independent vehicle and service simulations; these include but are not limited to elements such as rovers, landers, and habitation elements along with services like communications, environment, visualization, and data logging. ADS's distributed nature allows for the complex aggregation of constituent Artemis elements; this includes efficient scenario modification with the addition or removal of individual simulations representing Artemis elements or services. This capability provides support for the rapid performance of various Artemis mission trade studies exploring alternate configurations. Currently, ADS uses NASA developed simulations for development and testing; however, through the use of international simulation interoperability standards, ADS provides an integration framework to incorporate dissimilar authoritative vendor simulations as Artemis systems mature and vendor simulations become available. Vendor simulations will be able to join ADS and interact with other Artemis elements and vehicles while limiting the exposure of proprietary data. This paper describes the expansion of an existing distributed simulation infrastructure to accommodate a collaborative and dynamic framework for the Artemis Program. This work includes updated federation designs, integration into existing NASA facilities, advancements in visualizations, and advancements in human driven inputs. This paper will also outline recently completed and ongoing support and collaboration with NASA studies and testing, namely results from energetics and Human-In-The-Loop (HITL) studies. The paper concludes with a plan for future developments and facility integration to enable enhanced studies in preparation for a return of humans to the lunar surface.