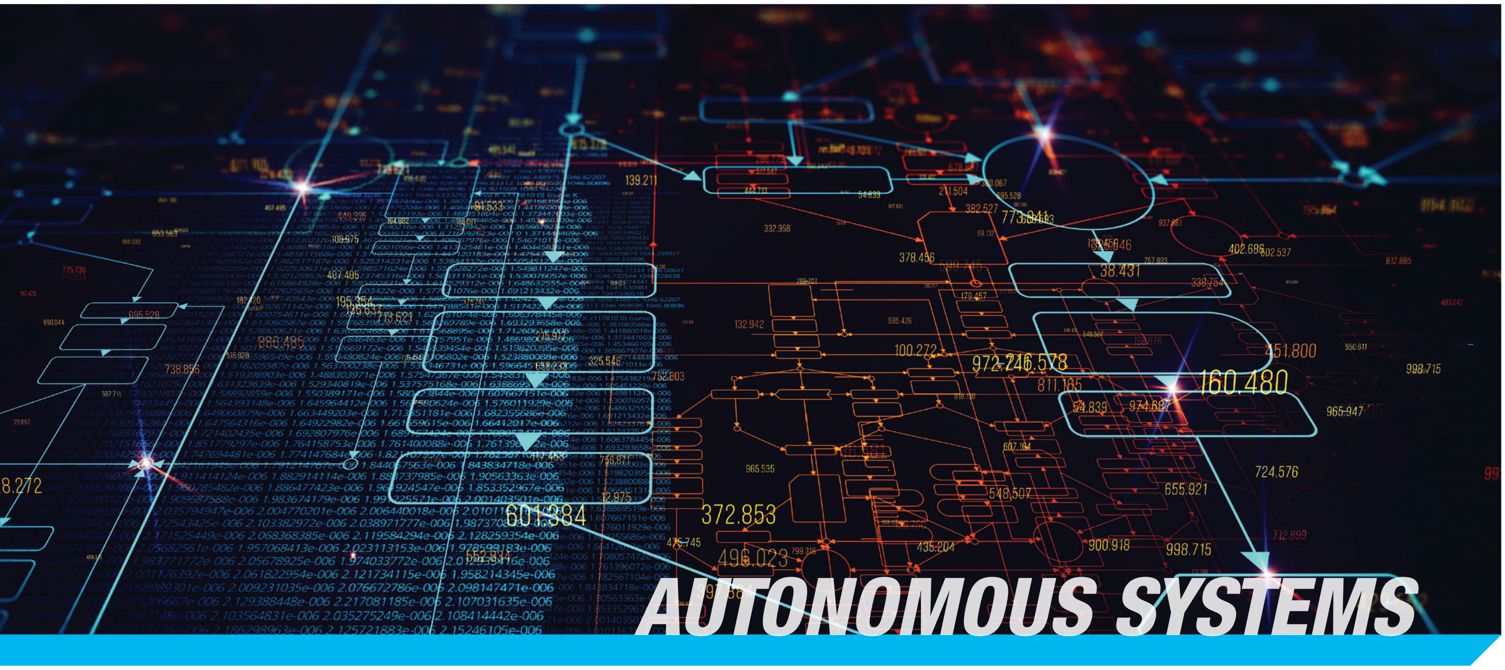
AEROSPACE



AUTONOMOUS SYSTEMS

U.S. aerospace agencies and companies employ complex systems-of-systems comprised of hardware, software, networks, and human-machine interfaces. With an increasing use of intelligent agents, artificial intelligence, and machine learning, these systems are evolving as intelligent ecosystems with the capacity to routinely upgrade themselves to meet evolving performance and safety needs in dynamic operating environments.

Assuring Effective and Safe Operations of Trusted Autonomous Systems

Effective and safe performance of autonomous systems must evolve at the “speed of need” to predict and prevent unwanted behaviors and ensure resilience and recovery. Performance of these systems directly affects lives and property, whether they exist in autonomous vehicles, aviation, or spacecraft, so these intelligent ecosystems must operate as intended, be empowered to make decisions based on mission needs, and compensate for vulnerabilities that could be exploited by nefarious actors. Assuring mission success requires system performance assessment fast enough to both identify anomalies and their impacts and take the consequent remedial actions to assure sustained and reliable operations.

By integrating continual state-of-health monitoring, learned system behavior, and the impacts of potential intelligent system changes within a system’s operational environment, we can detect anomalous behavior, predict impacts, and plan for fail-safes in advance. The framework for trusted autonomous systems can address evolving threat vectors and continuously re-optimize for the enterprise as systems evolve over time. The Aerospace Corporation’s history is based in assuring the success and reliability of complex systems. While we can and do operate at the technology level—developing tools that leverage artificial intelligence and machine learning—Aerospace applies experience in mission assurance of space systems to the verification and validation of trusted, smart autonomous systems.

Trusted autonomous systems able to operate without human intervention are key to the evolution of the space enterprise. To ensure these systems operate as planned, they must:

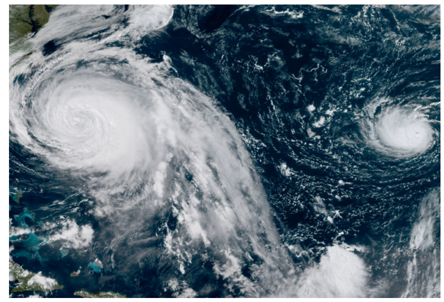
- Be trusted to operate as intended
- Serve intended mission functions
- Adapt to environmental conditions
- Be resilient to vulnerabilities
- Evolve seamlessly over time
- Predict and prevent undesired behavior
- Do no harm

As the federally funded research and development center for the space enterprise, Aerospace operates at the juncture of technology, systems and policy to provide unbiased recommendations to government about autonomous systems. Mission assurance is and always has been critical to the success of the company. With our existing low- to no-error-tolerance work practices and subject matter expertise in mission assurance, we are uniquely poised to apply our knowledge to this challenging, rapidly evolving field.

Current Autonomous Systems Projects

ENVIRONMENTAL INTELLIGENCE DATA ANALYTICS

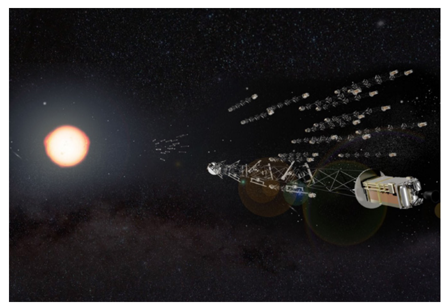
Aerospace has developed an operations impact assessment tool for environmental intelligence—improving severe weather modeling based on complex data inputs. The prototype design of the tool can predict, detect, identify and mitigate sensor outages or unanticipated degradations that may have an adverse impact on short-term weather prediction products. By instantiating reliability in the model to resolve conflicting data from various sources, an intelligent ecosystem is established that can adapt based on the data stream and ensure resiliency and reliability in the model.



Project NOAA Data Analytics is working to increase the resilience of severe weather models based on complex data inputs. Image credit: NOAA

SOLAR GRAVITY LENS

Aerospace is working with NASA's Jet Propulsion Laboratory to design an innovative mission to view the surface of exoplanets orbiting distant stars. Using the properties of gravity, clusters of small satellites would be sent to an identified focal region where they would then configure themselves into an "Einstein Ring"—an assembled lens designed to project up to 100 billion times the optical magnification. These vehicles would have to last 20-30 years just to complete the voyage itself and, upon arrival, exist for days without communications to Earth—so autonomous functioning is essential to assess and complete mission objectives.



Artist's depiction of small satellites on their journey to form the solar gravity lens.

DARPA BLACKJACK AND PIT BOSS

DARPA's experimental low earth orbit (LEO) satellite constellation program, known as Blackjack, is an architecture demonstration intending to develop and demonstrate the critical elements of a global high-speed network in a LEO constellation. In addition to providing highly connected, resilient and persistent coverage, Blackjack's mission includes the demonstration of payloads to augment existing national security space assets in LEO.
Key to the Blackjack objectives are payload- and mission-level autonomous, robust and resilient capabilities for orbital operations. Pit Boss, the autonomous subsystem for these operations, is intended to develop autonomy, integration, on-orbit cyber security and on-orbit cryptographic solutions for the Blackjack constellation. As the independent trusted advisor to government, Aerospace is providing independent evaluation for the Pit Boss source selection, helping to identify concepts most likely to succeed in solving DARPA's defined "hard problems."

Artist's concept of the Blackjack constellation on orbit. Image credit: DARPA

The Aerospace Corporation

The Aerospace Corporation is a national nonprofit corporation that operates a federally funded research and development center (FFRDC) and has approximately 4,000 employees. The Aerospace FFRDC is aligned to support the most critical programs of the Department of Defense and the nation, and to serve as its customers' innovation partner across the space enterprise. Consistent with the competencies outlined in our sponsoring agreement, Aerospace provides strategic value through independent, intellectually rigorous, relevant, and timely products and services. With three major locations in El Segundo, Calif.; Colorado Springs, Colo.; and Washington, D.C., Aerospace addresses complex problems across the space enterprise and other areas of national significance.

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