AEROSPACE

CONNECTED AND AUTONOMOUS VEHICLE TECHNOLOGIES

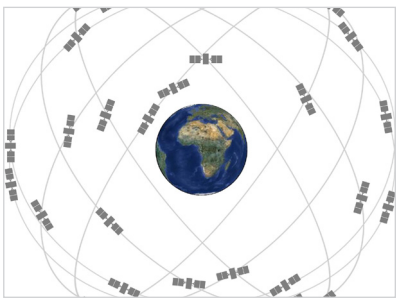
The U.S. Department of Transportation (USDOT) Connected and Autonomous Vehicle (CV/AV) Program is poised to dramatically change the transportation ecosystem. The CV/AV Program leverages the use of Internet of Things technologies to facilitate communications between automobiles, trucks, road networks, supporting infrastructure, and traffic operations. The Aerospace Corporation's Federal Civil and Homeland Security Division is addressing the needs to the public sector in the areas of transportation system safety, reliability, and efficiency. Our programmatic proposals to the USDOT, developed with internal research and development funding, have introduced pioneering software and data analytics capabilities to address the enterprise challenges created by these technological advances.

Aerospace has a long history serving as the trusted agent to government. Our history of successfully transitioning research and development into large-scale, operationally complex environments makes Aerospace uniquely qualified to address the CV/AV Programmatic and technical challenges facing government, academic, and industry stakeholders today. Aerospace employees serve on technical committees, network with government representatives, and build community awareness to enhance our technical decision making capabilities for CV/AV and related programs. Additionally, we participate in numerous industry forums including the Transportation Research Board, the Association for Unmanned Vehicle Systems International, and the Intelligent Transportation Systems trade associations. The Aerospace Corporation's technical capabilities will provide the USDOT with the requisite foundational, enabling and integrative technologies to make the CV/AV Program a successful investment in the nation's ground transportation infrastructure for the benefit of the various public and private stakeholders that rely on efficient and safe transportation and a growing world.

Our CV/AV technical strengths:

- Utilization of the Global Navigation Satellite System (GNSS) for position, navigation, and timing data
- Radio frequency (RF) communications, with emphasis on 5.9 GHz dedicated short-range communications protocol
- Sensor integration and performance (ex. Lidar)
- Digital mapping of transportation right of way and significant points of interest
- Model-based systems engineering at our onsite Concept Design Center
- Data analytics
- Artificial intelligence and deep learning
- Software assurance
- Cyber security, including RF ad hoc wireless networks, risk assessment, and technology certification
- Program acquisition and management

Aerospace research constitutes several concurrent technical and programmatic tracks of benefit to the CV/AV program.

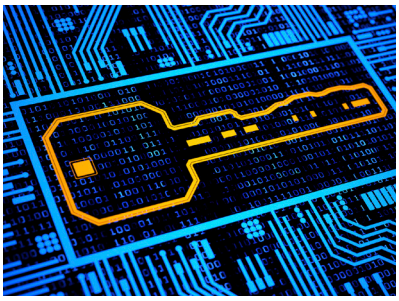


Foundational Technology Expertise

The radio frequency (RF) 5.9 GHz dedicated short-range communications (DSRC) capability and its standards are foundational to the CV/AV Program, as peer-to-peer communications systems must have a baseline of accurate and reliable positioning, navigation, and timing (PNT) information. Aerospace brings decades of expertise in the operation and application of GPS and PNT systems, providing the integration of resilient and redundant systems necessary for CV/AV Program success. Using the Aerospace IRAD program, we have integrated GPS, RF, and local PNT services with machine learning to demonstrate the resiliency of PNT technologies and to develop autonomous waypoint recognition methodologies essential to CV/AV.

Model-Based Systems Engineering

Deploying CV/AV to the transportation network is a challenge to both state and local transportation agencies. These entities do not have the technical capacity for the planning, development or implementation of the enterprise-level scope and complexity required for such an undertaking. Model-based systems engineering (MBSE) can be used to mitigate project risk while adhering to time constraints and cost. Using our Concept Design Center, Aerospace MBSE knowledge and established engineering analytics can be readily applied to transportation modeling and analysis, providing critical systems modeling and analytical capabilities for conducting scenario-focused analysis for planning, developing, deploying, and operating complex CV/AV systems.

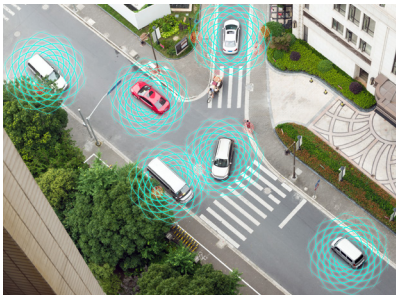


Software Assurance, Cyber Security, and Technology Certification

The CV/AV Program relies on open-source software applications tightly coupled to vehicle electronics for critical systems including ad hoc DSRC communications, plug-and-play devices (e.g., smart phones), and a cyber security certificate management system. Technical and programmatic risks are significant as the CV/AV Program pursues concurrent research and deployment tracks. Though the USDOT already has initiated a technology certification program with multiple organizations, a “system of systems” perspective is needed to navigate this technical complexity across multiple systems, stakeholders (including original equipment manufacturers, software developers, government agencies, and third party integrators/ operators), and programs.

Data Warehousing

Recent Aerospace work has focused on cloud-based data analytics to realtime data sharing for operations and third-party research access to CV/AV data sets. The USDOT is moving aggressively toward open-source cloud-based platforms to enable these activities. Aerospace’s expertise in enterprise software and agile development provides an ideal foundation for architecting and prototyping enterprise data systems. Furthermore, Aerospace’s experience with DOD and Intelligence Community customers in these two areas—coupled with our trusted advisor role—provides unique insight unavailable elsewhere.



Artificial Intelligence, Deep Learning, and Digital Mapping

Dynamic mapping is essential to the CV/AV architecture, providing digital representation and geolocation of transportation right-of-way data such as pavement markings, signage, guard rails, and significant points of interest. Uncertainty is a key variable, as exemplified by the application of deep learning algorithms to degraded sensor data, such as instances in which sensor degradation of 3% to 5% leads to the inability to recognize road signs or markings. Deep learning verification, validation, and certification processes dictate the amount of testing necessary for regulatory agencies to issue CV/AV operating certificates to OEMs. Aerospace’s ability to apply a “system of systems” perspective to the intersection of sensor performance, dynamic mapping, and deep learning can provide the CV/AV Program with a unique enterprise solution.