Statement of Objectives

Cooperative Driving Automation (CDA) Small-Scale Industry Prototype

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1.0 Purpose

The purpose of this requirement is to demonstrate industry-led CDA prototypes at Technology Readiness Level (TRL) 6-7 in controlled and real-world conditions in order to generate data-driven insights that will support the development of a national strategy to deploy CDA across rural, suburban, and urban roadway systems at. This effort specifically focuses on functional safety and integrity of exchanged data, and the semantic reliability of information shared between infrastructure and road users using vehicle-to-everything (V2X) communication (both direct and network communication). This includes testing trusted interactions between Infrastructure Owner-Operators (IOO) and automated vehicle (AV) developers and automated Original Equipment Manufacturer (OEM) vehicles to determine how the reliability and accuracy of external data impacts vehicle-level safety functions. The goal is to validate cooperative trust and assess, using realistic scenarios, how interoperable, communication-enhanced automation improves safety, efficiency, and throughput compared to standalone systems. For example, integrating infrastructure-based pedestrian detection may resolve challenging edge cases where onboard vehicle sensors are limited. Ultimately, by demonstrating cross-entity CDA trust, these results will inform deployment decisions and accelerate the delivery of national safety and mobility benefits.

CDA technologies (as defined in SAE J3216) use V2X communications and standards-based messaging to enhanced automated vehicles (i.e., SAE J3016 Level 1+) to coordinate their decision-making with other automated vehicles, human-driven vehicles, and the infrastructure. Prior USDOT-supported CDA research projects have shown technical proof of concepts (TRL 3-5) for several use cases with applications successfully performing the intended capability. By demonstrating industry-led CDA prototypes in controlled and real-world conditions, this project will generate data-driven insights that will support the development of a national strategy to deploy CDA across rural, suburban, and urban roadway systems.

To bridge the gap between research and commercial viability, Offerors must be able to identify and implement high-priority, deployable use cases that directly address existing technical and institutional barriers. This selection process should prioritize applications where cooperative exchange is useful for augmenting safety and mobility performance—such as occlusion, complex merging, or vulnerable road user protection where shared data enhances the situational awareness of the standalone automation. The USDOT seeks a multidisciplinary team—ideally led by an OEM, Tier 1 supplier, or ADS developer in close partnership with an IOO—to execute these use cases through robust public road testing and demonstrations. By focusing on use cases with a clear path to market, this effort will establish the necessary requirements for interoperability and functional safety that allow industry stakeholders to move beyond isolated testing. Ultimately, the objective is to demonstrate that CDA is not only technically feasible but also operationally ready to deliver quantifiable improvements in crash avoidance and mobility performance, providing a scalable model for national adoption that overcomes current deployment challenges.

2.0 Background

The USDOT envisions a future transportation ecosystem where CDA complements both human-driven and fully automated driving systems, other road users and roadway infrastructure, enabling interoperable actor coordination for improved operations. These improvements are anticipated to occur both through enhancement of existing vehicles, e.g., better handling edge cases, and within mixed traffic, e.g., smoother and safer traffic. CDA has the potential to help address transportation network inefficiencies by mitigating congestion, optimizing traffic flow in complex, multi-user environments, and enhancing safety for all road users. Recent research has identified remaining challenges and priority near-term use cases for CDA implementation, based on stakeholder feedback. Key themes that emerged from CDA stakeholder workshops revolved around interoperability, managing information relevance, and trust, including data reliability, and cybersecurity to support functional safety. A key

step in realizing feasible deployment and informing decision-making is the demonstration of trust across operational vehicles and infrastructure using standards.

To that end, the Intelligent Transportation Systems Joint Program Office (ITS JPO) research program is supporting real-world CDA prototypes, in cooperation with the motor vehicle industry, to illustrate safety and mobility benefits and spur public- and private-sector investment, adoption, and use.

Thus, USDOT expects that this project will advance the technical and non-technical elements to maximize industry momentum for near-term real-world, operational and interoperable deployment of CDA (using any SAE J3216 CDA cooperation class), through actions such as:

- Building upon existing vehicle automation and V2X infrastructure by integrating industry standards (e.g., from SAE CDA Committee) and prototype functionalities that validate the functional safety and integrity of the system. This effort demonstrates how trusted, safety-enhancing interactions between vehicles and infrastructure provide superior benefits compared to standalone systems and establishes the technical assurance necessary for large-scale deployment. The effort will prioritize industry-ready CDA technology for use cases with clear safety and/or mobility benefit potential, and maturity for feasible near-term deployment, in the following categories:

    (1) Work Zone Management;

    (2) Traffic Incident Management;

    (3) Cooperative Perception; and/or

    (4) Emergency / Transit Vehicle Awareness (E/T VA)

- Demonstrating a scalable model for CDA integration in operational contexts with industry- and agency-deployable capability and supporting implementation details, to handle diverse traffic volumes, roadway types, and current communications infrastructure maturity.
- Advancing standards-based interoperability (e.g., leveraging SAE J3316, J3251, and other draft and published standards) and informing additional standards activities (e.g., works in progress within SAE CDA committee) for CDA starting with CDA Driver Support-equipped vehicles with Level 1–2 control automation as the practical foundation for immediate pilots and deployments, including by other OEMs and IOOs; while enabling clear pathways for Cooperative Automated Driving Systems (C-ADS)-equipped Level 3–5 vehicles as technologies mature.
- Informing stakeholder decision-making, business case development and strategies on CDA deployment and adoption, including prototype evaluation showing data-driven insights where CDA yields meaningful improvements over automation or V2X alone.

The results demonstrated in this project intend to inform industry and agency deployment planning, support further research planning and determine the potential for on-road CDA pilot deployments.

3.0 Scope

NOTE: This section explains USDOT's current understanding of activities that would support advancing CDA prototypes to TRL 7. However, since deployment of CDA ultimately relies on industry to incorporate the technology into vehicle and infrastructure products and capabilities, the Offeror's proposal would need to provide the specific CDA use cases for which the Offeror has prototype components that are sufficiently mature for integration and operational prototyping, and also judged by the Offeror, to have a path toward deployment, e.g., adds sufficient benefit over automation or V2X alone.

Offerors must provide management, necessary technical and support services, bring suitable vehicle and infrastructure technologies, and road public agency implementation partners, to implement and demonstrate trusted CDA interactions (to include communicating messages that originate at the infrastructure and are used by vehicles in automated control decisions/actions), initially under closed-course/controlled conditions, and then demonstrated under on-road typical/real-world conditions.

Offerors must meet the following requirements to be considered capable:

1. This project requires partnership with original equipment manufacturers and the ability to access OEM CDA prototypes for testing and evaluation
2. OEM Vehicles must have CDA and V2X prototype capabilities
3. Offeror must have experience working with infrastructure owner-operators who are implementing V2X applications (e.g. pilots, demonstrations, and/or deployments)

The project will include following objectives:

Phase 1: Prototype demonstration in relevant/controlled environment (Base Period)

Objectives:

- Develop and validate a standardized system architecture and trust framework that ensures interoperability between vehicles and infrastructure. This objective focuses on defining the cross-cutting requirements—including hardware standards and security protocols—necessary to execute CDA use cases in complex, real-world environments.
- Conduct integration activities, including vehicle and infrastructure components, to test CDA prototypes to validate core message flows, sensor fusion, fallbacks and fail-safes for possible misbehavior or problems, cybersecurity, and safety controls in closed course/testbed conditions.
- Evaluate cooperative maneuvers (such as merging, lane changing, intersection negotiation, and platooning) in comparison with automation alone and/or connectivity alone corresponding to the use case.
- Test CDA performance under varying V2X connectivity levels (e.g., communications channel loading/congestion).
- Establish Independent Evaluation Measures and Assessment Approaches based on the use cases and including measurement of integration success with human-driven vehicles and infrastructure.
- Document operational data, potential issues and needs (e.g., standards clarification).
- Identify functional safety practices and industry/infrastructure requirements to support CDA pilot deployments.
- Develop implementation practice recommendations and instructions for the demonstrated use cases to support workforce readiness for CDA-equipped operations.
- Provide recommendations for standards, interoperability protocols, and digital infrastructure investment priorities.
- Develop an Operational Readiness Plan (ORP) to proceed to Phase 2 and conduct a formal Operational Readiness Review (ORR), that Phase 1 results provide sufficient evidence of safety, functional reliability, and fail-safe behaviors.

Phase 2: Transitional/Small-Scale Real-World Demonstration (Optional Task)

Objectives:

- Prepare and conduct demonstration under real-world conditions. Demonstration will be scheduled in conjunction with the AOR and key Federal staff.
- Develop site-specific CDA integration plans based on controlled environment testing results.
- Validate the CDA prototypes in real-world conditions on roads selected to demonstrate the operational performance and benefits; mixed traffic of connected and non-connected vehicles; collect feedback and operational metrics
- Note: Exercise of the Phase 2 Optional Task for small-scale real-world demonstrations is strictly contingent upon a successful Operational Readiness Review (ORR) at the end of Phase 1.

Offerors must be able to provide end-to-end capabilities for CDA prototype deployment, including:

1. Technology Development
2. Operational Testing
3. Safety & Risk Management
4. Independent Evaluation & Data Sharing:
5. Data, Cybersecurity & Privacy
6. Performance Objectives & Measures of Effectiveness
7. Collaboration, Governance & Stakeholder Engagement
   - Include plans to coordinate with local IOOs, transit and emergency services, OEMs, telecom providers, workforce/training partners, and standards bodies.
8. Acquisition, Installation & Operations

4.0 Required Results / Performance Objectives:

- **Demonstrate CDA Use Case Trust Framework**: Identify technical and policy opportunities/challenges of interoperable and trusted CDA deployment involving IOO and L1+ OEM vehicle automation, and develop a practicable, scalable approach to realize safe, secure and trusted interactions on public roads, including interoperability, standards and cybersecurity compliance strategies.

- **Demonstrate CDA Use Case Functionality**: Implement and validate CDA features in an operational environment with a near production-like level of capability and assess operational readiness for sustained operations.

- **Enable Scaled CDA Deployment**: Address adoption challenges in both high-density and low-connectivity areas and identify deployment obstacles still needing resolution and potential solutions. Provide feasible implementation strategies for how the demonstrated use cases may be initially deployed by OEMs and IOOs where benefits can be viable and further supporting standards. Include justification for how/why the technology has the potential to be further scaled if it reaches successful deployment.

- **Independently Evaluate CDA Benefit**: Utilizing an independent team member, assess traffic safety and efficiency improvements from CDA usage over automation and connectivity by themselves. Articulate value propositions/business cases enabling CDA deployment to scale. Include measures that support OEM and IOO deployer needs, such as:

  - Service availability, reliability and trust
  - Safety and efficiency metrics
  - Latency in cooperative communications
  - V2X message accuracy
  - User benefit/satisfaction
  - Infrastructure utilization efficiency

5.0 Place of Performance

Work will be conducted at selected CDA deployer sites and Contractor facilities in the United States.

6.0 Key Constraints & Expectations

- **Interoperability:** CDA must support interoperable actor coordination between roadway users across diverse roadway environments and vendor hardware/software stacks, using relevant communications and message standards (e.g., IEEE, SAE J2735).

- **Compliance:** Meet Federal Motor Vehicle Safety Standards (FMVSS), Federal Motor Carrier Safety Regulations (FMCSR), Americans with Disabilities Act (ADA), Buy America, and National Highway

Traffic Safety Administration (NHTSA) regulations as well as Standing General Order (SGO) on Reporting.

- **Operations:** Ensure safety and high reliability in varied weather, terrain, and traffic conditions within the applicable automation Operational Design Domain (ODD).
- **Data:** Securely collect and share operational data with USDOT and other designated reviewers.
- **Cybersecurity:** Protect CDA systems from cyber threats.

7.0 Deliverables

The USDOT has identified a set of suggested and required deliverables identified below. Additionally, Offerors must define specific project deliverables in their proposal that are tailored to the technical approach, state of existing capabilities, and proposed use case prototype implementation to achieve project objectives. Individual deliverables proposed by Offerors will be reviewed by USDOT and feedback provided.

Required Deliverables:

<u>Phase 1 (Base Period) – Controlled Environment Testing:</u>

- Project Management Plan
- Monthly status reports, bi-monthly PMR briefings, and quarterly public summaries
- Concept of Operations (ConOps) and System Requirements Specification (SRS)
- System Architecture Document (enterprise, functional, physical, communications)
- Data Management Plan (DMP) and Data Sharing Agreements
- Safety Management Plan (SMP): A comprehensive plan including the Safety Case, Hazard Log (HARA), Functional Safety (SOTIF) mitigations, and documented fail-safe vehicle behaviors.
- Test & Evaluation Plan (functional, logical, concrete scenarios; KPIs; data schemas)
- Operational Readiness Plan (ORP) and Operational Readiness Review (ORR) (Required to advance to Phase 2)

<u>Phase 2 (Optional Task) – Real-World Demonstration:</u>

- Evaluation Report: Includes use case data and analysis results, lessons learned, cost analysis, and a strategic CDA Integration Plan articulating practical deployment strategies.
- Machine-Readable Datasets: Measures-of-effectiveness datasets for USDOT reviewers per the DMP schedule.
- Small-Scale Real-World Demonstration
- Final Project Report (508-compliant for publication)

<u>Suggested Deliverables (Spanning Both Phases):</u>

- Systems Engineering Management Plan
- CDA Safety Case and Criteria for Trust Document
- Cybersecurity Plan (including SCMS/PKI integration and misbehavior detection approach)
- Comprehensive Acquisition & Installation Plans (CIP/CAP)
- Deployment Stakeholder Engagement (with OEMs, IOOs, SDOs) Summary
- Outreach/marketing materials (e.g., factsheets and videos for closed course and public road demonstrations