Summary

Autonomous vehicles (AVs) rely mainly on their own perception sensors, which limits their ability to detect hazards outside their immediate surroundings. PRISM proposes a **Vehicle-to-Everything (V2X) digital twin platform** that shares data between vehicles and infrastructure to improve safety and efficiency. The main objectives of this proposal are: 1) **build and demonstrate the V2X-enabled digital twin** platform that makes this system possible, integrating vehicle and infrastructure data into a real-time shared mode; 2) implement a **distributed Multi-Access Edge on Computing (MEC)** system that reduces delays and makes processing more efficient, while also creating a collaborative mapping system where vehicles add their data to the shared digital twin; and 3) **develop AI models that analyze the shared data** to predict risks on specific road segments, and create protocols that allow AVs to use these predictions for real-time decision-making.

The main technical challenge PRISM aims to address is that **current 5G and edge computing technologies struggle** to provide the speed and reliability that AVs need for safe driving decisions. Coordinating real-time data from a high volume of vehicles and infrastructure sensors is limited by delays, inconsistent quality, and conflicting information about road conditions and/or hazards. Collaborative mapping systems also face challenges in keeping digital twins accurate when vehicles move across regions, while predictive AI models face the challenge of processing large and complex datasets while maintaining accuracy and local relevance. These include limitations in latency, data consistency, and scalable AI reliability, which create critical safety and efficiency gaps for AVs. The proposed platform combines technologies that have previously been developed separately (**high-definition mapping, V2X communication, edge computing, and AI-driven risk assessment**) into the first comprehensive ecosystem for AVs' safety. Recent advances in 5G networks, standardized edge computing architectures, and real-time AI models make this integration both technically possible and commercially relevant. The approach shifts vehicles from passive users of static data to active contributors to a continuously updated digital twin, with privacy maintained through federated learning. This allows ongoing improvements in risk prediction models without centralizing sensitive data.

The project will follow a phased plan: 1) Foundation development of the PRISM architecture (months 0-6); 2) Refinement and edge integration (months 6-12); 3) Field testing and pilot expansion (months 12-24); and 4) Deployment of a commercial-grade system (months 24–36). The commercialization strategy focuses on identifying target markets and stakeholders, developing a go-to-market approach, and demonstrating competitive advantages over existing solutions. The potential impacts go far beyond the initial safety use case. By offering real-time, infrastructure-supported situational awareness, the platform enables autonomous vehicles to anticipate and react to hazards that individual sensors might miss, changing safety management from reactive to proactive. Municipal and institutional partners gain real-time visibility into traffic patterns, road conditions, and vehicle performance, which helps optimize traffic flow, prioritize maintenance, and coordinate safety responses. Over time, this technology will enhance road safety, decrease congestion, support more efficient use of transportation infrastructure, and speed up the deployment of safe AVs on a large scale.