# PRISM: AI-Powered Dynamic Real-Time Mapping System for Safer AV

Objective

This proposal develops a Vehicle-to-Everything (V2X) digital twin platform that creates real-time digital maps of transportation infrastructure, enabling autonomous vehicles to share data and make safer decisions through AI-powered risk assessment and distributed edge computing.

- Digital Twin Development
- Distributed Edge Computing
- Collaborative Mapping
- AI Risk Assessment
- Real-time Decision Support
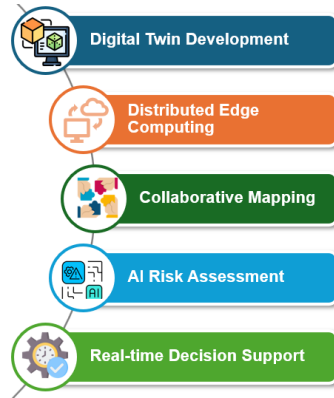
State-of-Practice

Building a V2X digital twin platform faces significant technical hurdles, but recent research shows promising solutions. The biggest challenge is achieving ultra-fast response times while handling enormous amounts of data from millions of connected vehicles and smart infrastructure.

Major Technical Challenges

- **Speed Requirements** (Need responses faster than 10 milliseconds for safety-critical decisions)
- **Keeping Everything Synchronized**
- **Managing Conflicting Information**
- **Data Quality Issues**
- **AI Model Challenges**
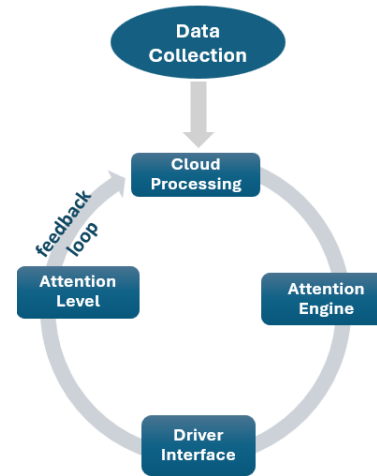- **System Reliability**

Novel Technical Approach

Our V2X digital twin platform brings together several mature technologies for the first time, creating a comprehensive solution that transforms how autonomous vehicles interact with their environment. Instead of treating mapping, communication, and computing as separate systems, we unite them into one intelligent ecosystem that arrives at the perfect time when 5G, edge computing, and AI have matured enough to make this integration possible.

Feedback loop: Data Collection → Cloud Processing → Attention Engine → Driver Interface → Attention Level → (back to Data Collection)
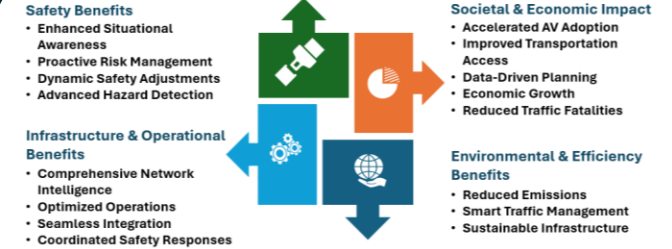
Market Opportunity

- Industry Transition
- Massive Market
- Regulatory Alignment
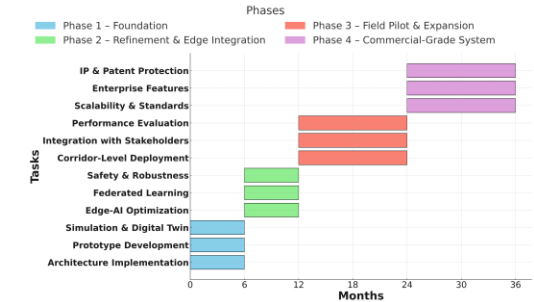- Comprehensive Solution
- New Category Creation

Technical Innovation

Active Vehicle Participation
Transforms vehicles from passive map users into active contributors that continuously update shared digital twins with real-time road conditions

Collective Intelligence
Leverages data from entire vehicle fleets while protecting privacy through federated learning, creating situational awareness far beyond individual vehicle sensors

Dynamic Risk Scoring
Combines predictive environmental modeling with crowd-sourced driving data to anticipate hazards and automatically adjust vehicle capabilities

Real-time Adaptation
Enables instant response to changing conditions like construction zones, weather, or emergency situations across entire geographic regions

Comprehensive Integration
First platform to unify collaborative mapping, AI risk assessment, and autonomous driving management in one system

Impact

Safety Benefits
- Enhanced Situational Awareness
- Proactive Risk Management
- Dynamic Safety Adjustments
- Advanced Hazard Detection

Societal & Economic Impact
- Accelerated AV Adoption
- Improved Transportation Access
- Data-Driven Planning
- Economic Growth
- Reduced Traffic Fatalities

Infrastructure & Operational Benefits
- Comprehensive Network Intelligence
- Optimized Operations
- Seamless Integration
- Coordinated Safety Responses

Environmental & Efficiency Benefits
- Reduced Emissions
- Smart Traffic Management
- Sustainable Infrastructure

Technical Development Roadmap

Phases:
- Phase 1 – Foundation
- Phase 2 – Refinement & Edge Integration
- Phase 3 – Field Pilot & Expansion
- Phase 4 – Commercial-Grade System

Tasks (Months 0–36):
- IP & Patent Protection
- Enterprise Features
- Scalability & Standards
- Performance Evaluation
- Integration with Stakeholders
- Corridor-Level Deployment
- Safety & Robustness
- Federated Learning
- Edge-AI Optimization
- Simulation & Digital Twin
- Prototype Development
- Architecture Implementation

Risk Mitigation & Transition

RISK CATEGORY	KEY RISKS	MITIGATION STRATEGY
Technical	• Latency bottlenecks • Model drift across federated clients	✓ Lightweight compression ✓ Periodic global synchronization ✓ Fallback controllers
Commercial	• Slow municipal procurement • Delayed adoption cycles	✓ Start with corridor-scale pilots ✓ Showcase key KPIs (VRU safety, congestion relief) ✓ Build partnerships with ITS vendors
Transition	• Vendor lock-in risks • Legacy system integration challenges	✓ Open API standards ✓ Modular plug-and-play design ✓ Alignment with DOT/ARPA-I frameworks

Commercialization Strategy

Category	Details
Target Markets	Municipal agencies, DOTs, smart cities; OEMs, fleet operators
Go-to-Market	Partner city pilots → ITS partnerships → subscription model
Timeline	Year 3: 2-3 cities → Year 4: 10+ cities → Year 5: U.S. scale
Competitive Edge	<$4K per intersection, VRU integration, DOT compliance