Texas A&M Transportation Institute

Autonomous Vehicles and Rail Crossings

Allan Rutter, TTI

National Rail Crossing Safety Conference, April 8, 2026

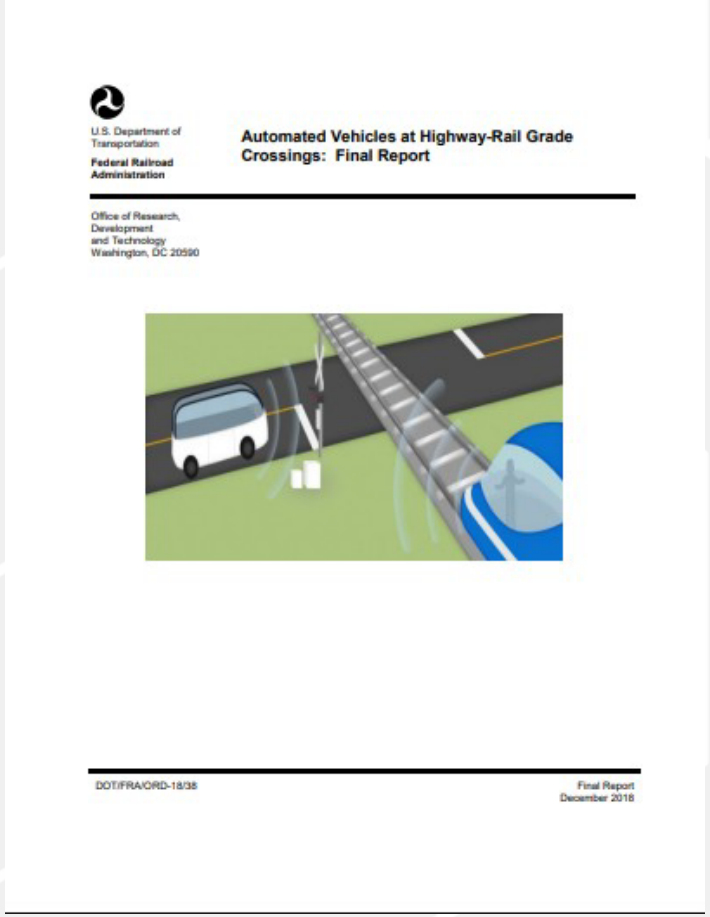
WHAT I INTEND TO COMMUNICATE TODAY

- FRA History in highway-rail grade crossings (HRGC) and AVs
- Traffic Signals and AVs – Common Issues to HRGCs
- DOT CV/AV Research
- Automated Driving Systems and HRGCs
- Future Considerations

FRA, HRGCs, and AVs

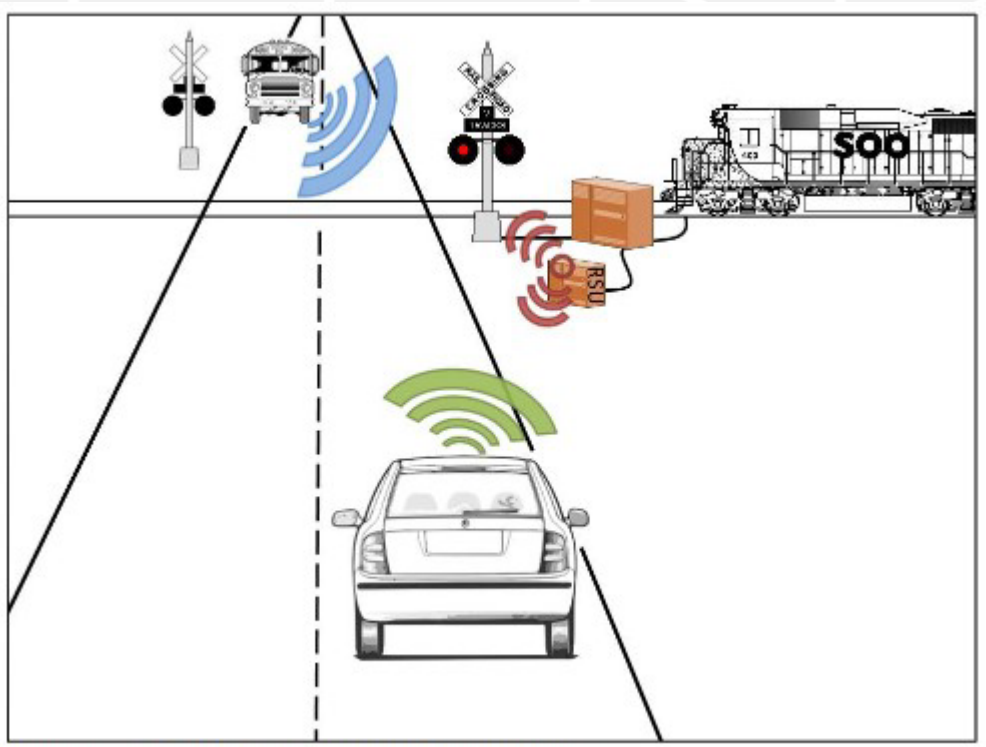
2018 Battelle Report

- “Automated Vehicles at Highway-Rail Grade Crossings: Final Report”, December 2018
- Technology Survey
- Concept of Operations



2017 Rail Crossing Violation Warning Phase I

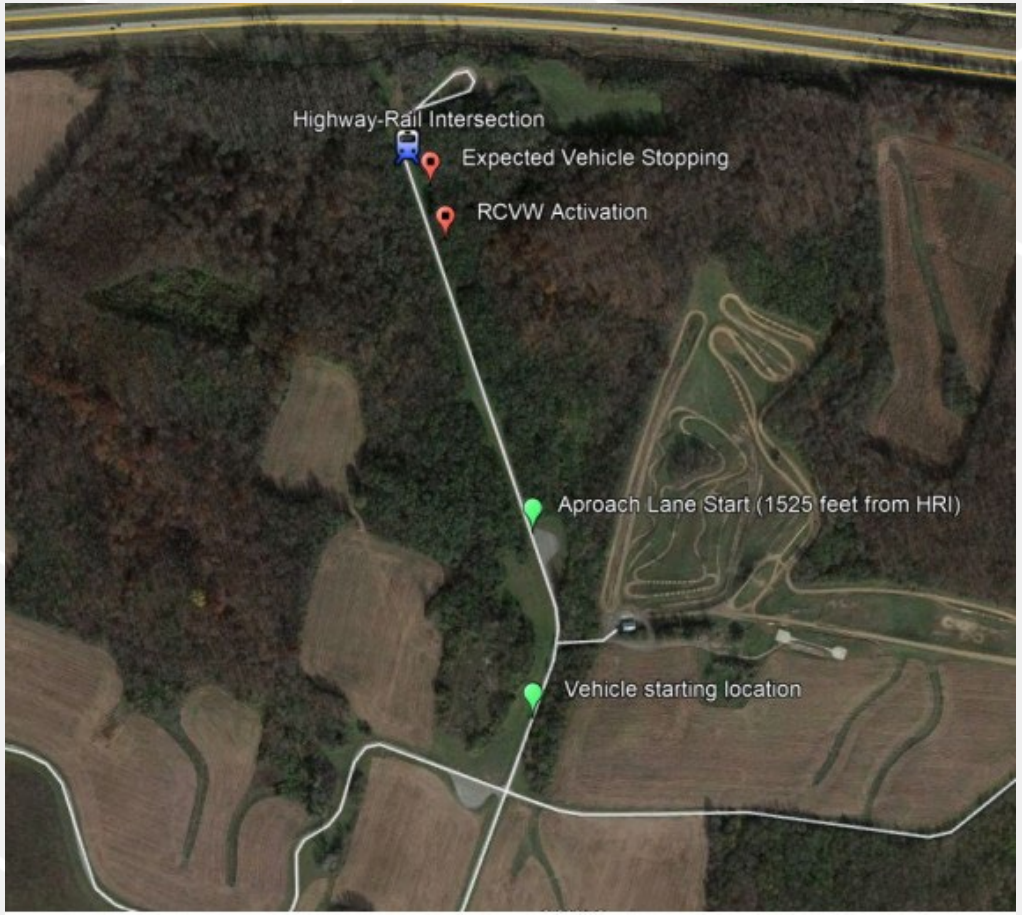
- “Prototype Rail Crossing Violation Warning Application Project Report”, September 2017 FHWA JPO report
- Inteconnecting track circuit train detection to roadside based unit, sending signal to vehicle on-board unit
- System bench tested and field tested at TTI’s RELLIS proving ground



Source: John A. Volpe National Transportation Systems Center

2022 RCVW Phase II

- Rail Crossing Violation Warning Application Phase II, February 2022
- Enhanced system field tested by Battelle on flat and grade roadways
- Employs:
  - Uses SAE J2735 Signal Phase and Timing (SPaT) message from Roadside Unit
  - MapData (MAP) positioning
  - GPS correction to Radio Technical Communiations for Maritime Services (RTCM) standards



DOT CAV Research

FHWA Pooled Fund Study CV to V2X

- Virginia DOT/UVA TPF-F(389) Connected Vehicle Pooled Fund
- 2009-2023
- States: AL, AZ, CA, CO, CT, DE, FL, GA, IL, MD, MI, MN, NH, NJ, OH, PA, TN, TX, UT, VA, WI
- Included Maricopa County, Transport Canada

- GDOT/Georgia Southern TPF 5(555) Vehicle to Everything (V2X) Pooled Fund
- Began 2025, assumed leadership 2026
- Current States: AL, CA, CT, DE, FL, GA, MD, MI, NH, NY, OH, TN, TX, UT, VA, WA, WI
- Includes Transport Canada

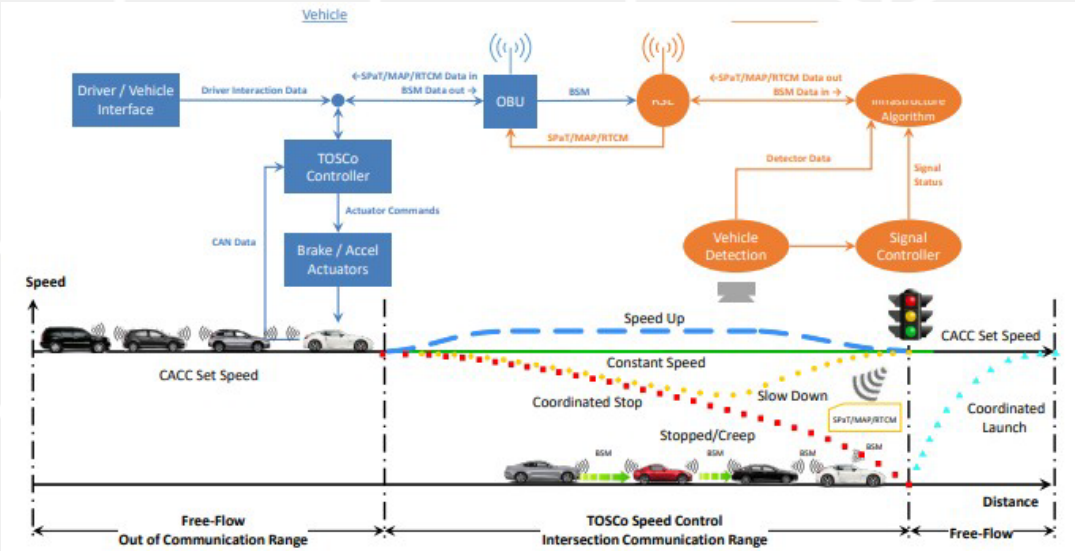
CAV Projects in Previous, Current Pooled Funds

- Connected Vehicles:
  - Connected Traffic Control Systems
  - V2I Queue Advisory Program design
  - Infrastructure messages and standards support
  - DSRC vehicle-based road and weather condition applications
  - Mapping for CV applications

- V2X program:
  - Deployment of connected work zones
  - Model CV procurement documentation
  - Public fleet OBU deployment guidance and prototypes
  - CV field equipment penetration testing framework

2022 Traffic Optimization for Signalized Corridors (TOSCo)

- Conducted by Crash Avoidance Metrics Partners LLC (CAMP) Vehicle-to-Infrastructure (V2I) Consortium, consisting of
  - Ford, General Motors, Honda, Hyundai Motor Group, Nissan and Volkswagen Group of America
  - Collaborating with TTI
- System tested at RELLIS proving ground and field tested in Houston



Source: Crash Avoidance Metrics Partners LLC (CAMP) Vehicle-to-Infrastructure (V2I) Consortium, 2022

Figure 2: TOSCo Concept

Connected Intersections

- Need to convert traffic controller SPaT messages to signals and pedestrian signs into SAE J2735 SPaT messages
- SAE J2735 SPaT messages convey current and near future timing
- This is also matched with MAP messages on lane with vehicle
- RTCM corrects GPS data for atmospheric conditions

- SPaT messages include:
  - Intersection status
  - State of each active signal group including time intervals and future interval states
  - Signal timing is expressed in time marks rather than countdowns
  - Location information to match lane signals to vehicle location

FHWA 2024 V2X Grants

- $60 million for three grants in the Saving Lives with Connectivity: Accelerating V2X Deployment program:
  - Maricopa County DOT to deploy 5.9 GHz connecting 750 roadside and 400 on-board units
  - Utah DOT to deploy systems along I-80, I-70 and I-25 in Wyoming and Colorado
  - TTI to develop V2X test cases on public roads and highways in Brazos and Harris counties

TTI's Texas TRUST V2X project

- Consortium of TTI, TxDOT, City of Houston, City of College Station, Missouri City, Fort Bend County, and an international consortium of private sector companies.
- 15 use cases to make every trip safer, smarter, and more efficient
- One case in Bryan/College Station will use highway-rail pre-emption signals to broadcast crossing engagements

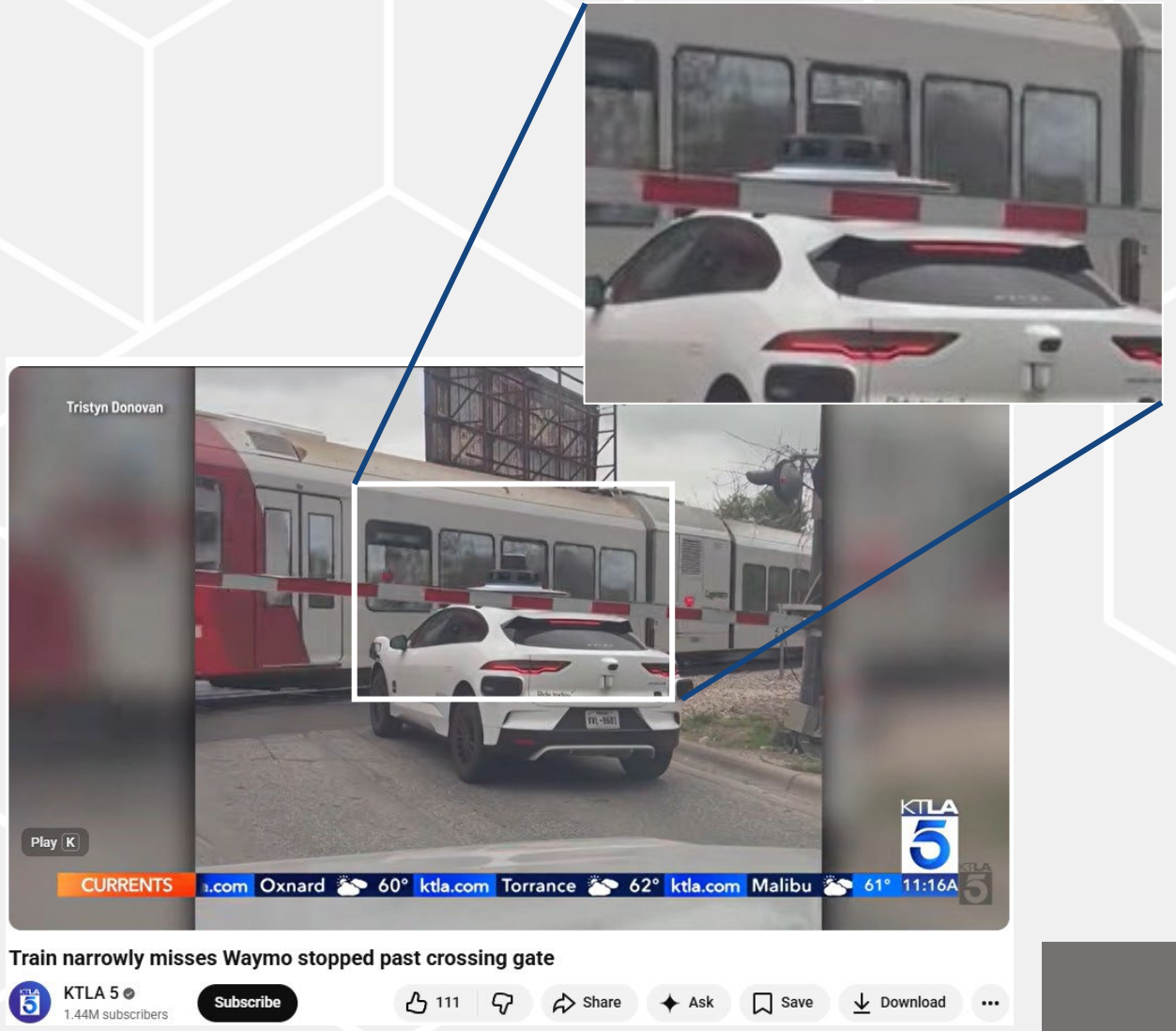
Automated Driving Systems and HRGCs

Autonomous Vehicles Deploying in Texas

- Trucks and taxis on highways and streets
- New state regulations to receive authorization for fully driverless operations takes effect this summer
- AVs use range of sensors and extensive mapping to operate vehicles, not waiting for V2X messages
- Waymo now available (through Uber app) in Atlanta

Autonomous Vehicles and HRGCs

- Incidents with Level 4 and Level 2 ADAS not recognizing HRGC gate arms
- Incident with Waymo at Austin grade crossing (Red Line commuter rail) shown here in March 2026
- September 2025 NBC News report identified 40 incidents on social media with Tesla full self-driving not stopping for gate arms



Future Issues for CAVs and HRGCs

Future Issues

- SAE J3365 V2X Rail Grade Crossing Standard
  - Information between trains, infrastructure, CAVs
  - Messages, communication interfaces, performance requirements
  - Build on J2735 data dictionary
  - Rail Crossing Task Force meeting this morning
  - Jennifer Collins, SAE contact
- Crossing Engagement messaging
  - Roadside units connected to track circuitry or to pre-empted traffic signals
  - SPaT messages send rail crossing violation warnings to connected vehicles

More Future Issues

- Crossing Monitoring Systems being deployed
  - Multiple vendors deploying train detection/monitoring systems
  - Systems often measure train speeds and lengths, predict crossing engagement and durations
  - Systems provide crossing analytics, connection to first responder dispatching
  - How to use wayside roadside units to send messages to CAVs?
- Other Crossing Detection Systems
  - City of Houston using computer traffic control system to pre-emption signals to show blocked/occupied crossings
  - TTI and UP working to use PTC data in regional dispatching to generate crossing engagement to first responder dispatching
  - How to validate such detection systems and use for public purposes, send messages to CAVs

Still More Future Issues

- Training autonomous vehicles to recognize grade crossing protection devices
  - AVs need clearer maps to recognize grade crossings along roadways
  - AVs need to recognize gate arms across roadway lanes, flashing lights
  - Law enforcement may need to enforce grade crossing traffic laws, AVs obligated to obey traffic laws

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QUESTIONS?

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