



RAIL

MOVING AMERICA FORWARD

FRA Grade Crossing Safety Research

National Grade Crossing Safety Conference 08/20/2024

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FRA Office of Research, Data and Innovation



U.S. Department of Transportation
Federal Railroad Administration

September 5, 2024

Cameras are good enough for FSD mode - Elon Musk

Connected Crossing Research for Safety and Mobility

Goal: Mitigate crossing accidents

FRA safety statistics found at <https://safetydata.fra.dot.gov/OfficeofSafety/default.aspx> reveal:

- No appreciable improvement in the frequency of HRGC incidents involving motor vehicle fatalities, or injuries over the past 20 years.
- Top causes attributed to HRGC crashes include poor driver judgement and driver distraction.

Goal: Improve mobility around rail crossings

FRA acknowledges the impact of public delays due to train-occupied crossings.

Blocked Crossing Reporter: [Blocked Crossings \(dot.gov\)](https://www.fra.dot.gov/BlockedCrossings)

Publications:

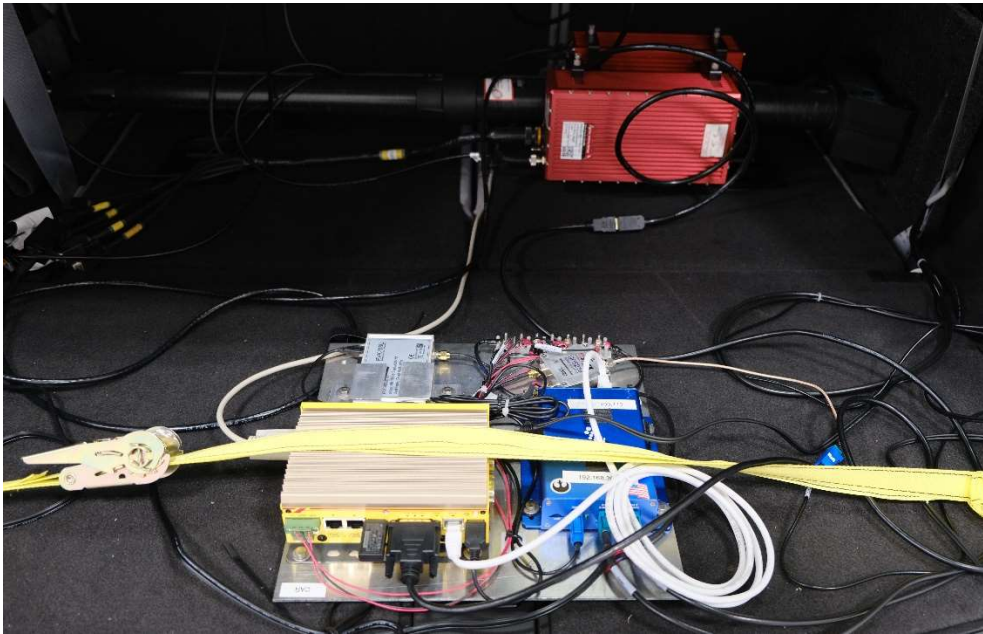
[RCVW Final Technical Report](#)

[RCVW Technical Docs & Source Code](#)

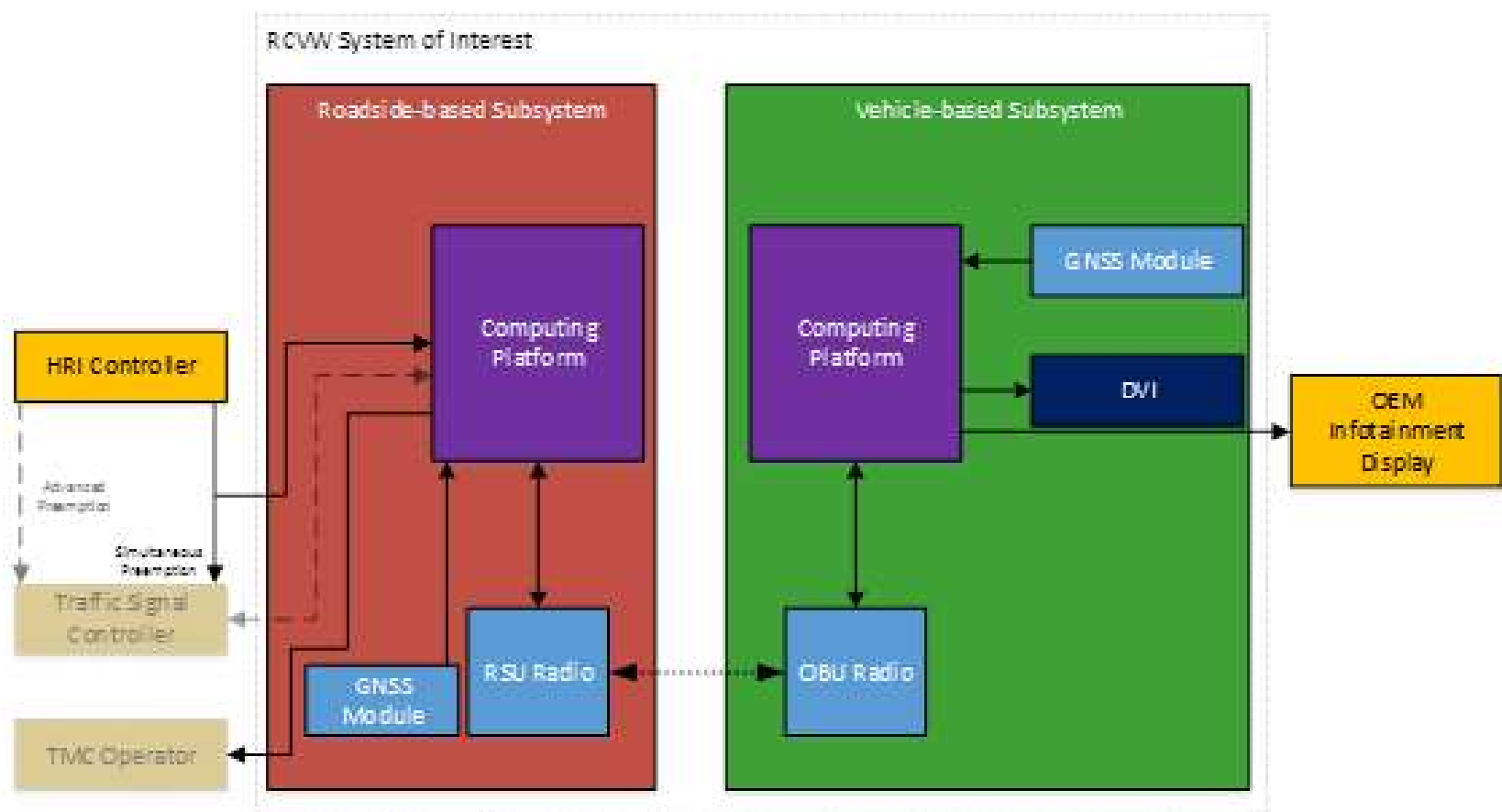
[Safe & Efficient Routing and Driving Strategies with Highway-Railway Connectivity](#)

Rail Crossing Vehicle Warning (RCVW) Objectives

- Demonstrate Connected Vehicle (CV) technology at grade crossings
- Platform to engage stakeholders
- Facilitate intermodal standards and protocols

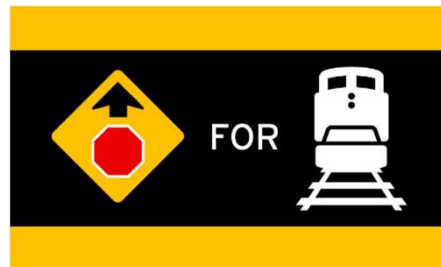
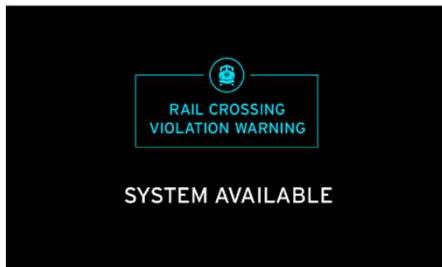


RCVW Architecture

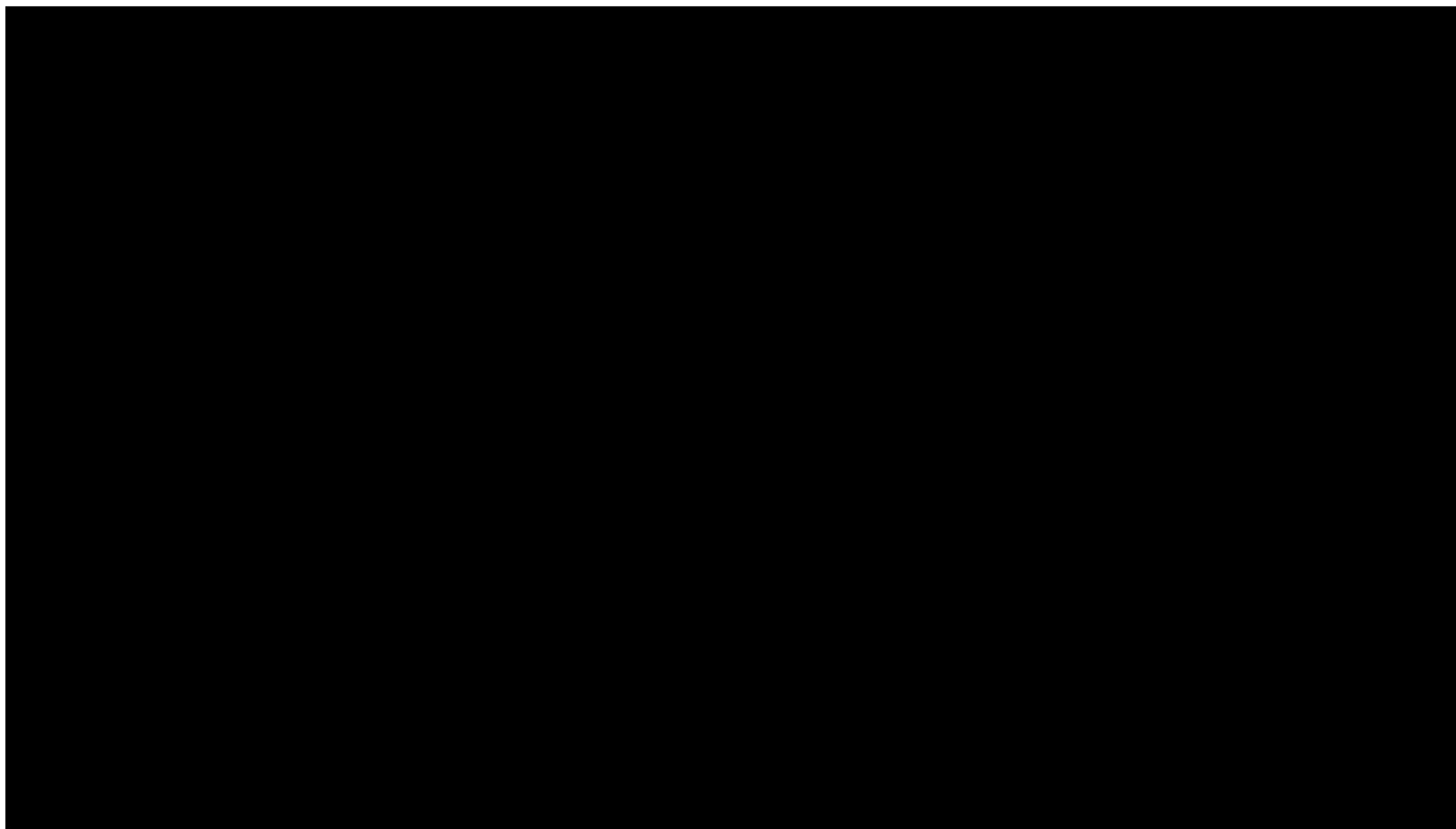


Driver Messaging

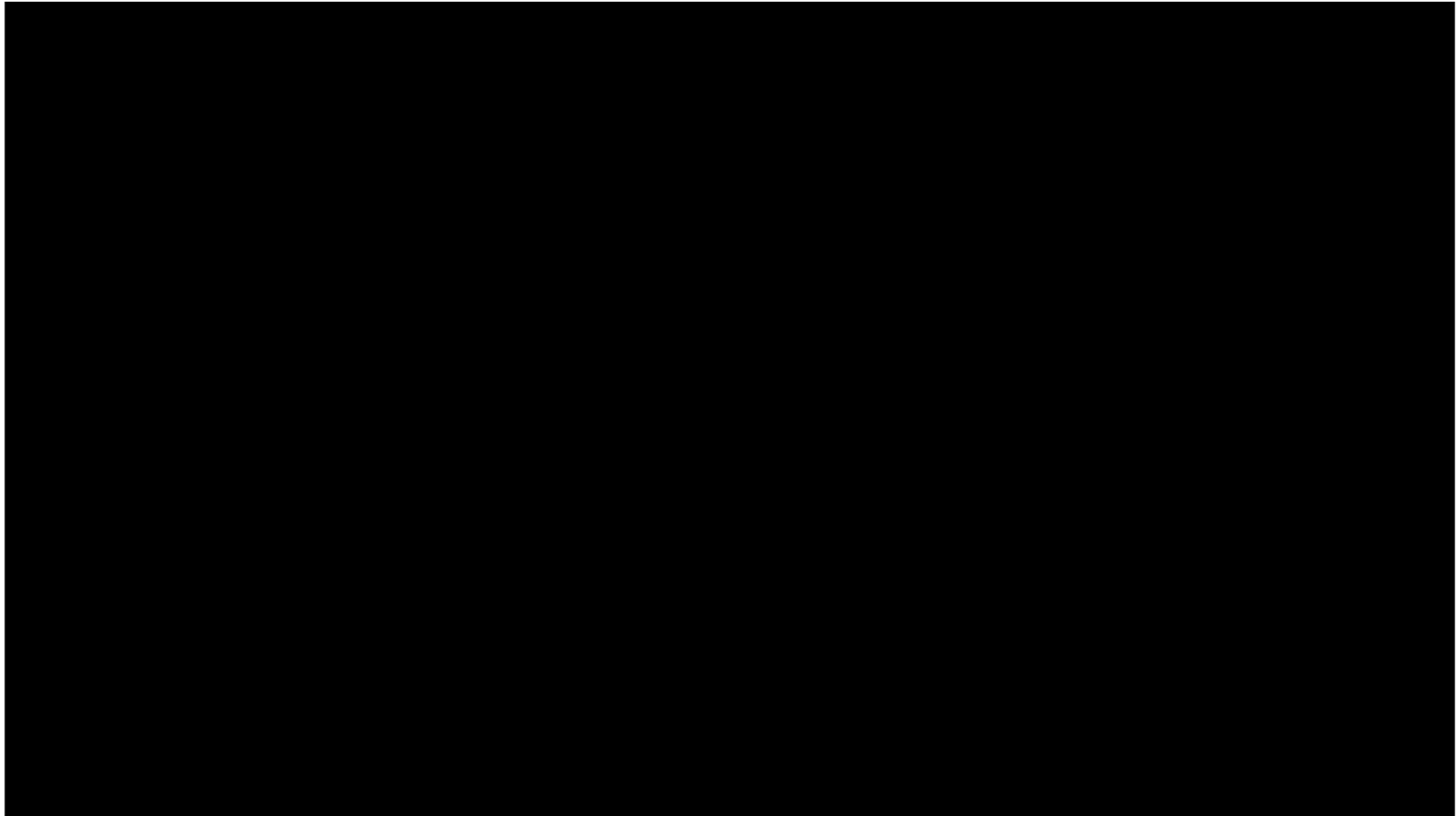
- RCVW System Availability
- Advisory Alert: Approaching Active Crossing
- Emphatic Warning: Rail Crossing Violation Warning
- Emphatic Warning: Stopped on Tracks, Clear Crossing



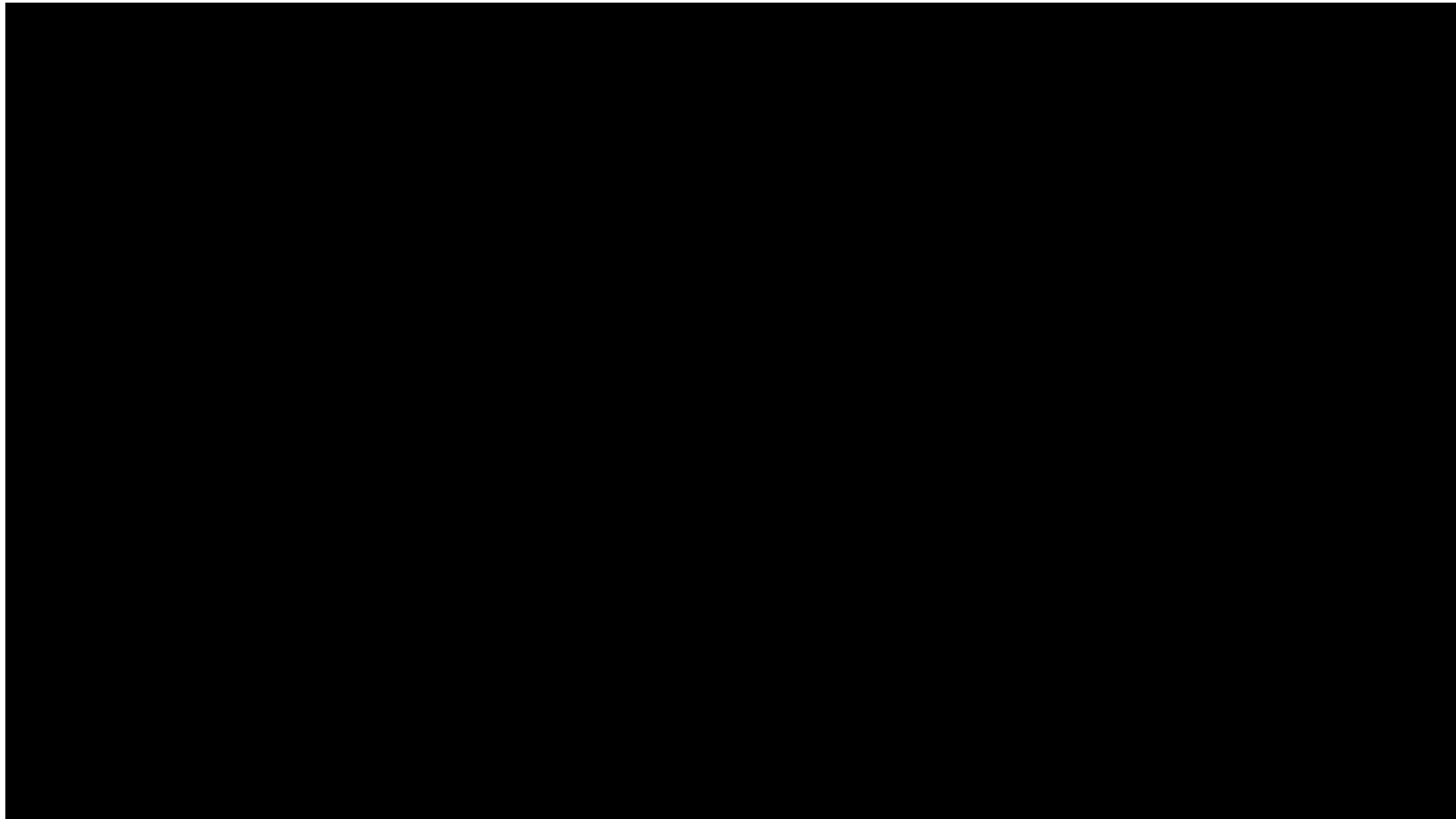
RCVW Demo



RCVW Demo



RCVW Demo



Live & Virtual Demonstrations



Michigan Rail Conference
Escanaba, MI



AASHTO Council on Rail Transportation
Kansas City, MO

Live & Virtual Demonstrations



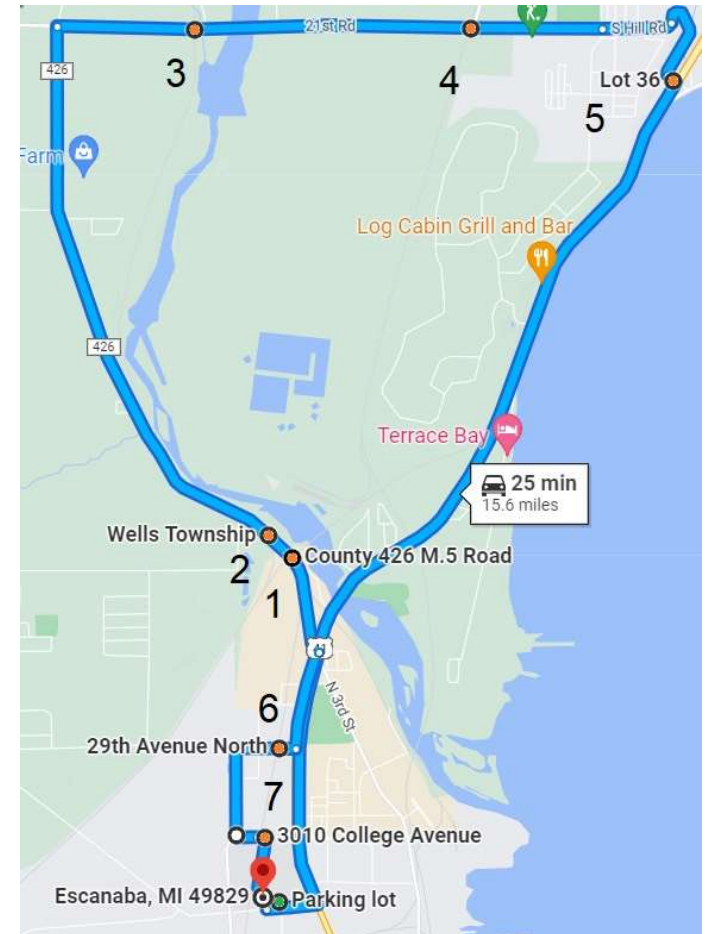
TRB Exhibit, Washington, DC



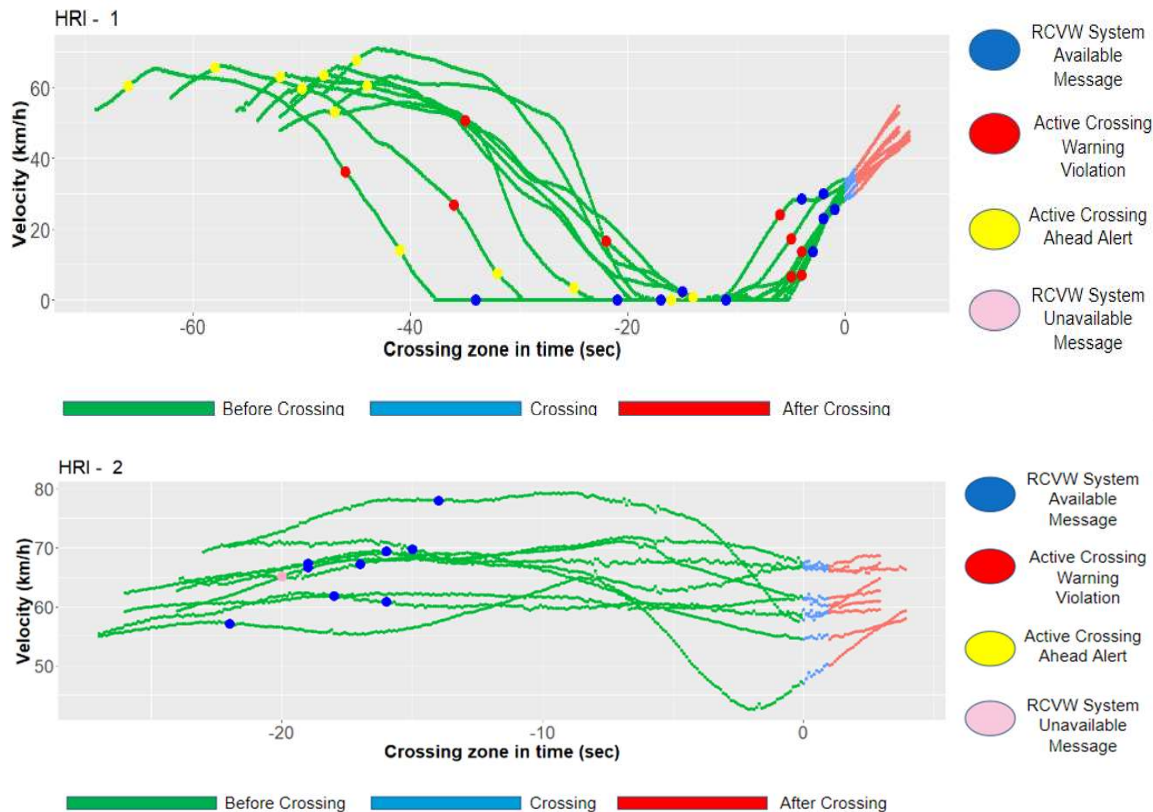
USDOT Exhibit, Washington, DC

Naturalistic Driving Study

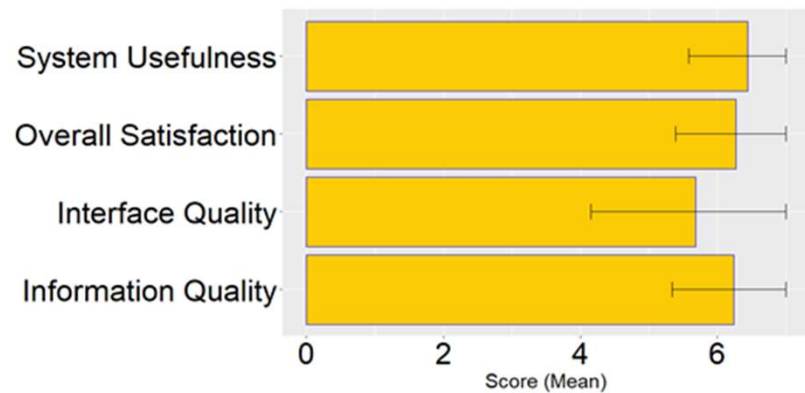
- Deployed RCVW systems at two grade crossings in Escanaba, MI and on two CVs
- Recruited **15 volunteer** drivers for driver behavior study
- 12-mile loop with 7 rail crossings 4 active (2 RCVW), 3 passive
- Collected warning data, vehicle data, and driver facial camera video for 15 rounds of driving



Naturalistic Driving Study



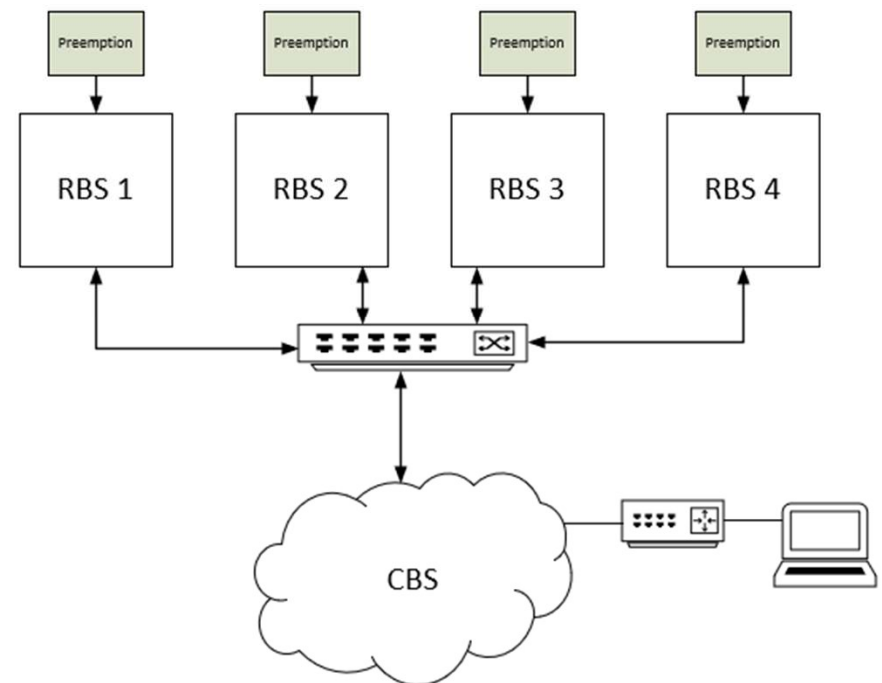
- Good system behavior
- High driver satisfaction
- Challenging sample size



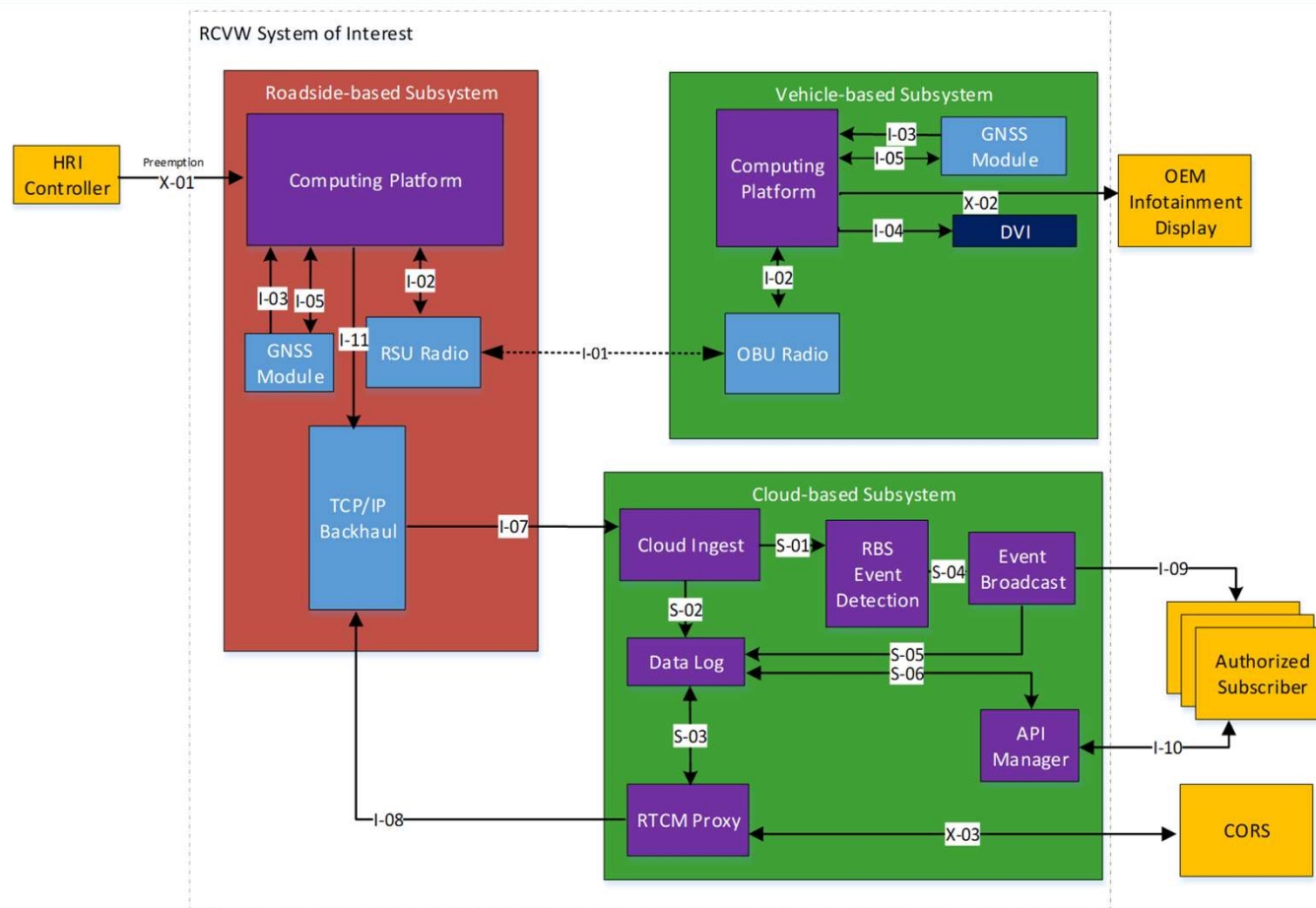
Cloud Based RCVW

RCVW RBS-connected cloud application

- Dissemination of real-time crossing status and attributes to authorized subscribed entities.
- Incorporate to SAE J3216 Cooperative Driving Automation standard and 5G low latency communication.
- Potential Uses:
 - Navigation routing
 - First responder routing
 - Traffic management centers
 - Low ground clearance trucks
 - 411 Traffic Information System
 - Blocked crossing reporting

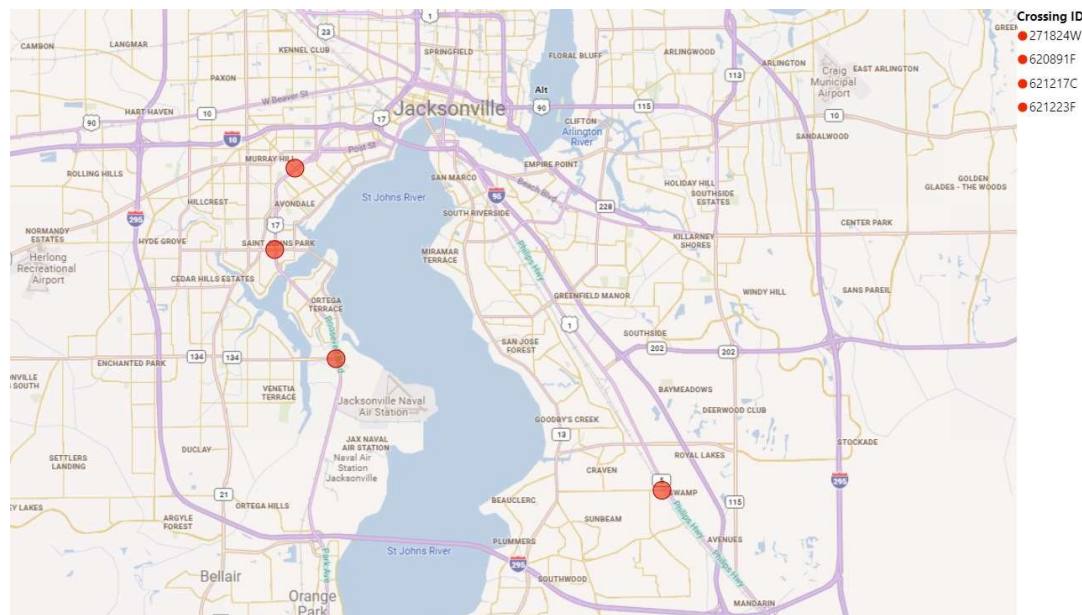


Cloud Based RCVW Architecture

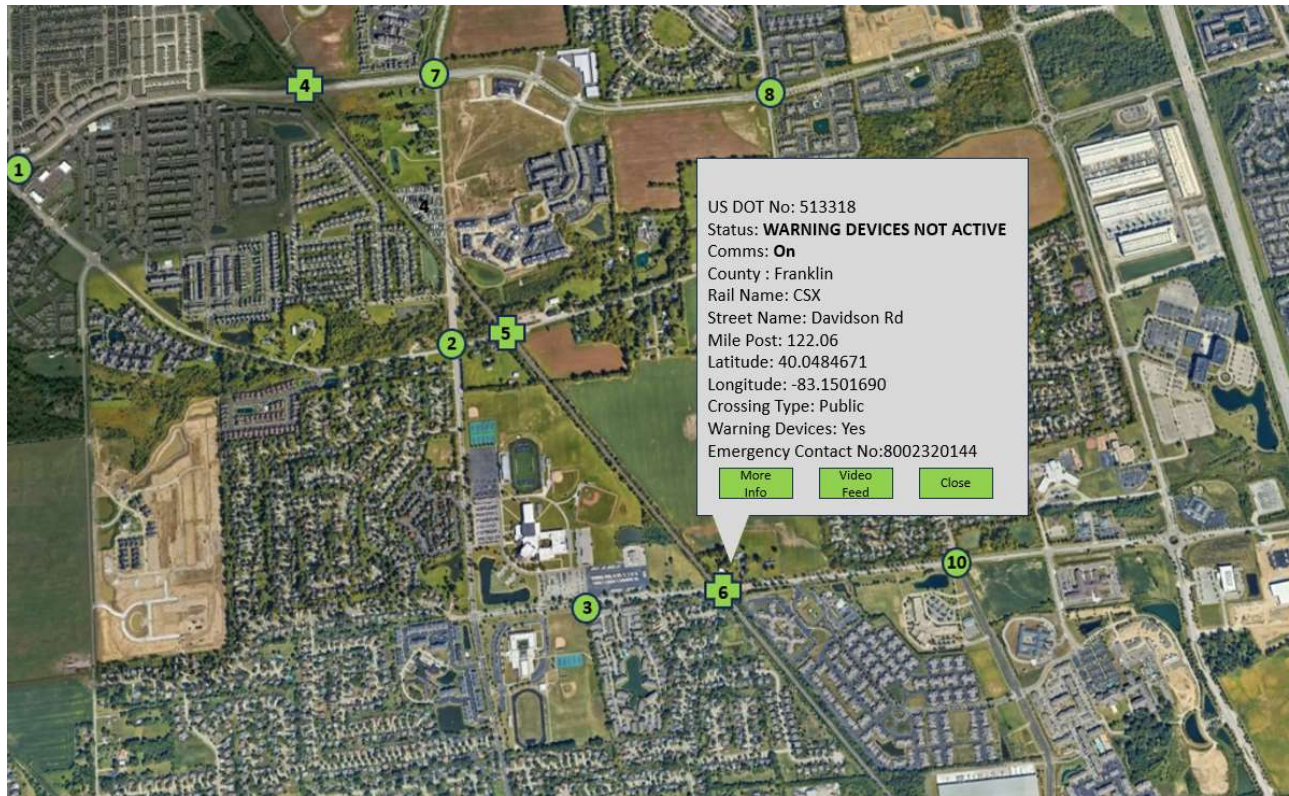


Cloud Based RCVW Field testing Jacksonville, FL

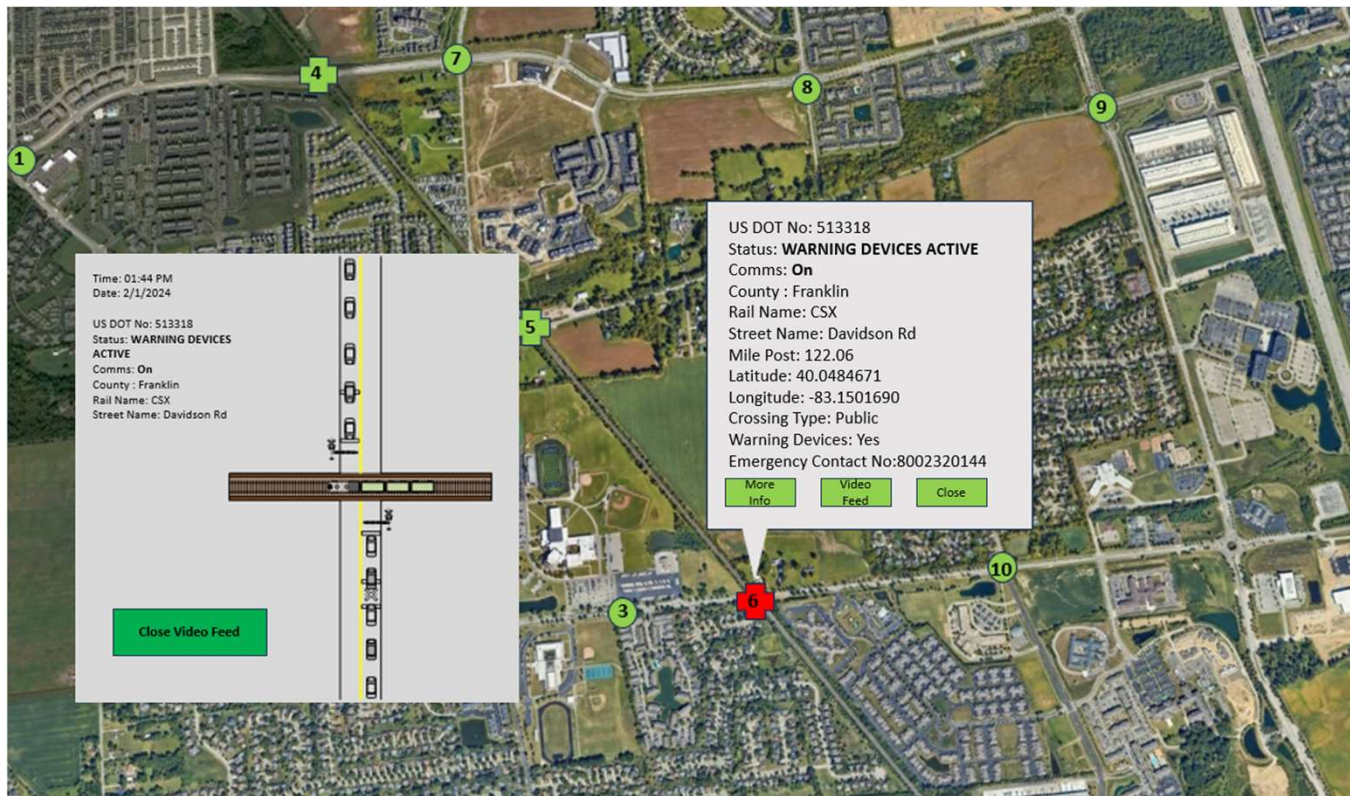
- Testing starts Aug 19th - Sept 20th, 2024.
- 4 grade crossings are instrumented and connected to simulated Jacksonville Traffic Management Center (TMC):
 - South Edgewood Ave
 - San Juan Ave
 - Sun Beam Rd
 - Timuquana Rd



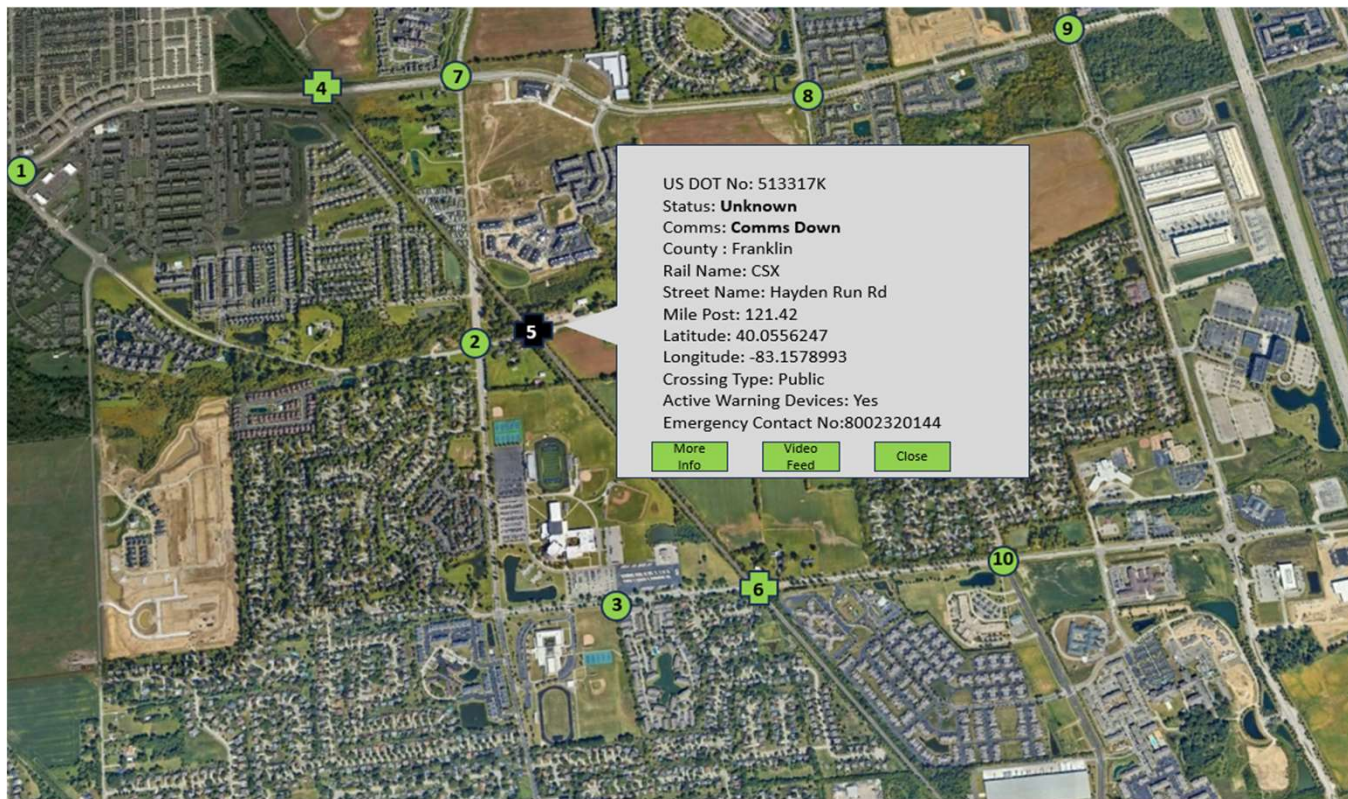
TMC warning devices not active



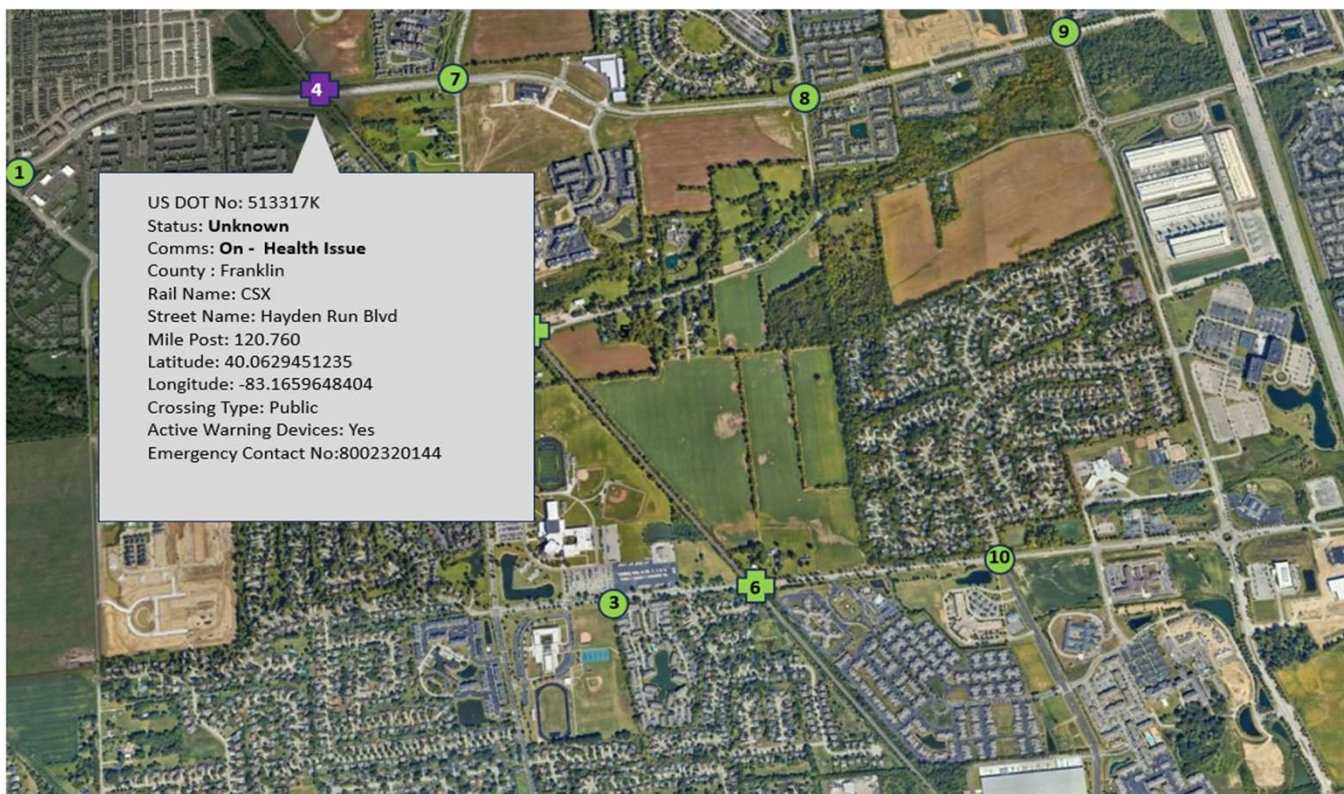
TMC warning devices active



TMC communication to RBC down



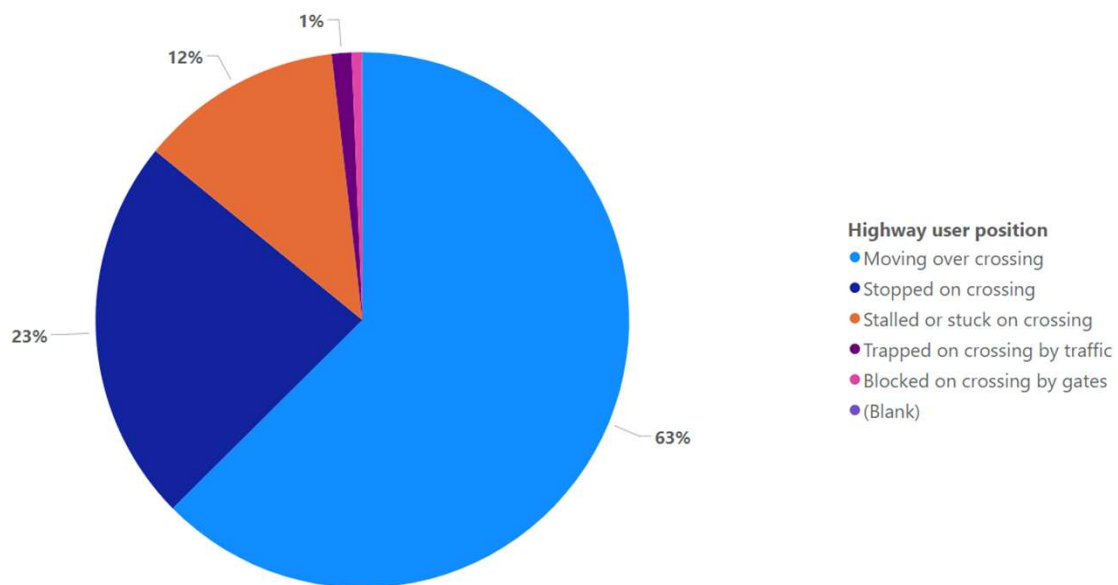
TMC RBC health issue



Grade Crossing Scanning and Digitization

How many incidents at grade crossings are due to a "hang-up"?

ACCIDENT DISTRIBUTION BY TYPE

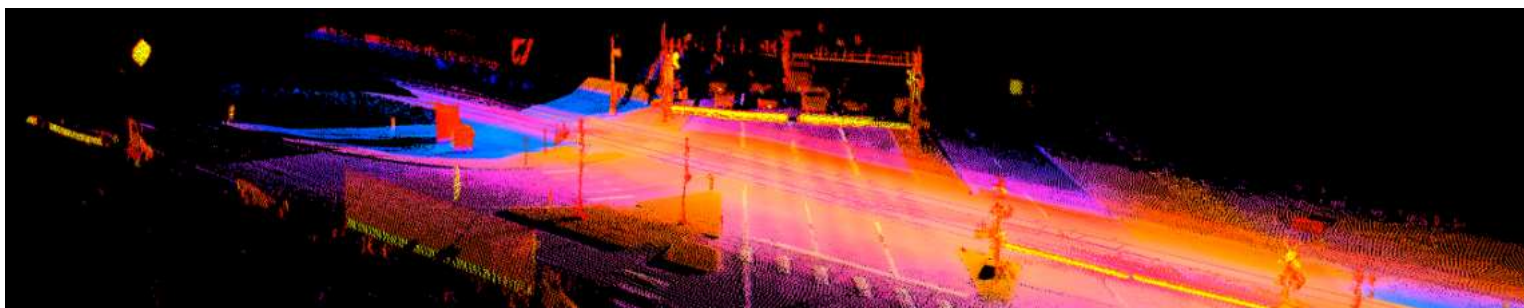


Distribution of incidents by type (2015-2023)



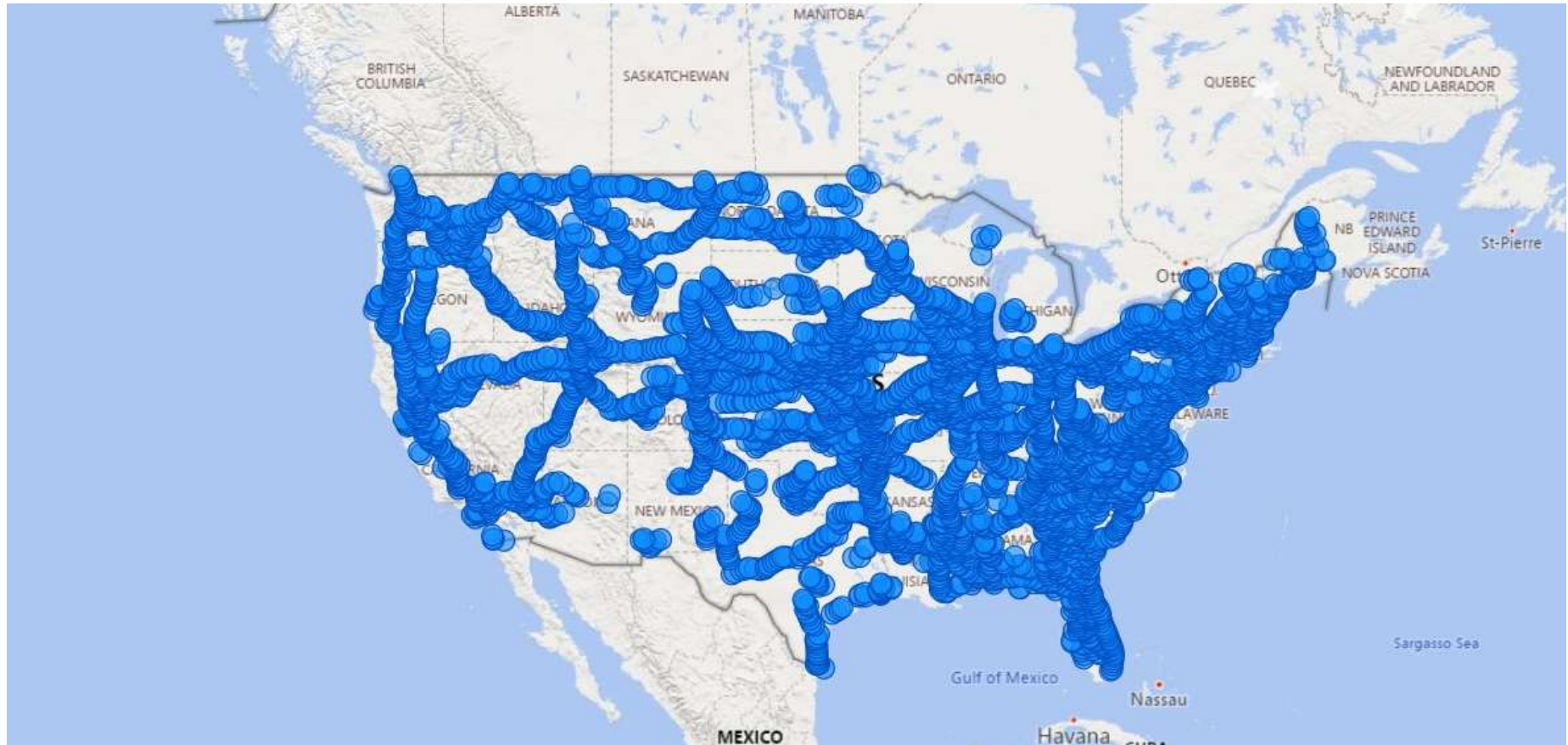
Outcome of Biloxi, MS crash, 2017 - <https://www.nbcnews.com/video/bus-train-collision-in-biloxi-kills-at-least-4-investigation-underway-892888131575>

Grade Crossing Scanning and Digitization



- Use of LiDAR technology mounted on FRA's DOTX 220 geometry car, DOTC 304 Hi-rail truck, and potentially drones to scan grade crossings.
- Produces highly accurate 3-D "point cloud," that can be analyzed to identify hazardous conditions.
- Parameters reported at grade crossings include location (GPS/MP), railroad/subdivision, crossing profile, roadway/track crossing angle, crossing length, track class, number of tracks, equipment inventory.
- More than 70,000 scan files have been collected including 51,000 unique crossing IDs.
- Project Partners: ENSCO and Michigan Technological University

Grade Crossings scanned by end of 2023



Properties Derived from Scans

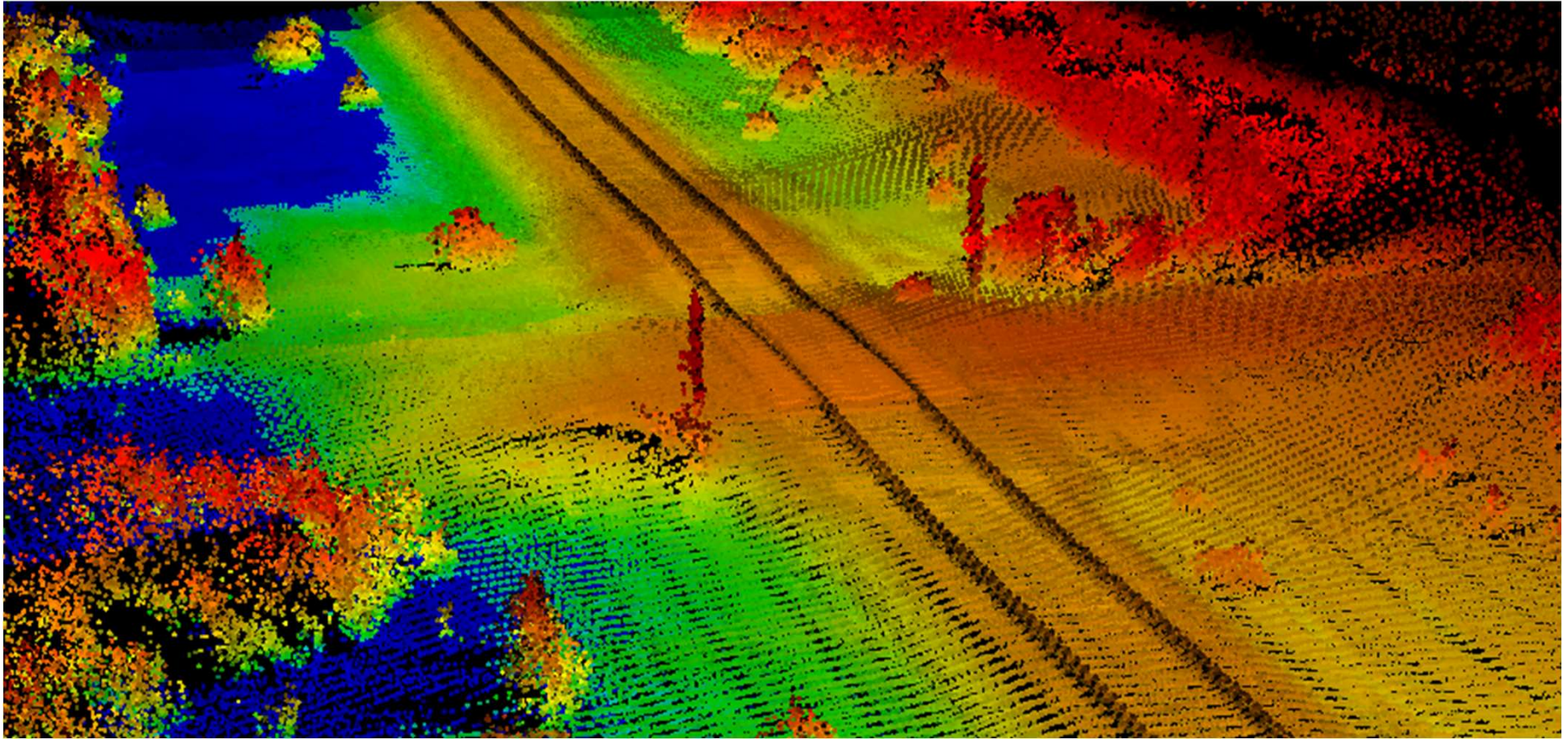
CrossingId	Gates	Net Change Elevation (m)	Net Change Elevation (in)	IntersectionAngle	IntersectionDirection	Latitude	Longitude
065682S	2	1.29	50.76	79.003319	Right	41.522343	-90.27595

Some Properties

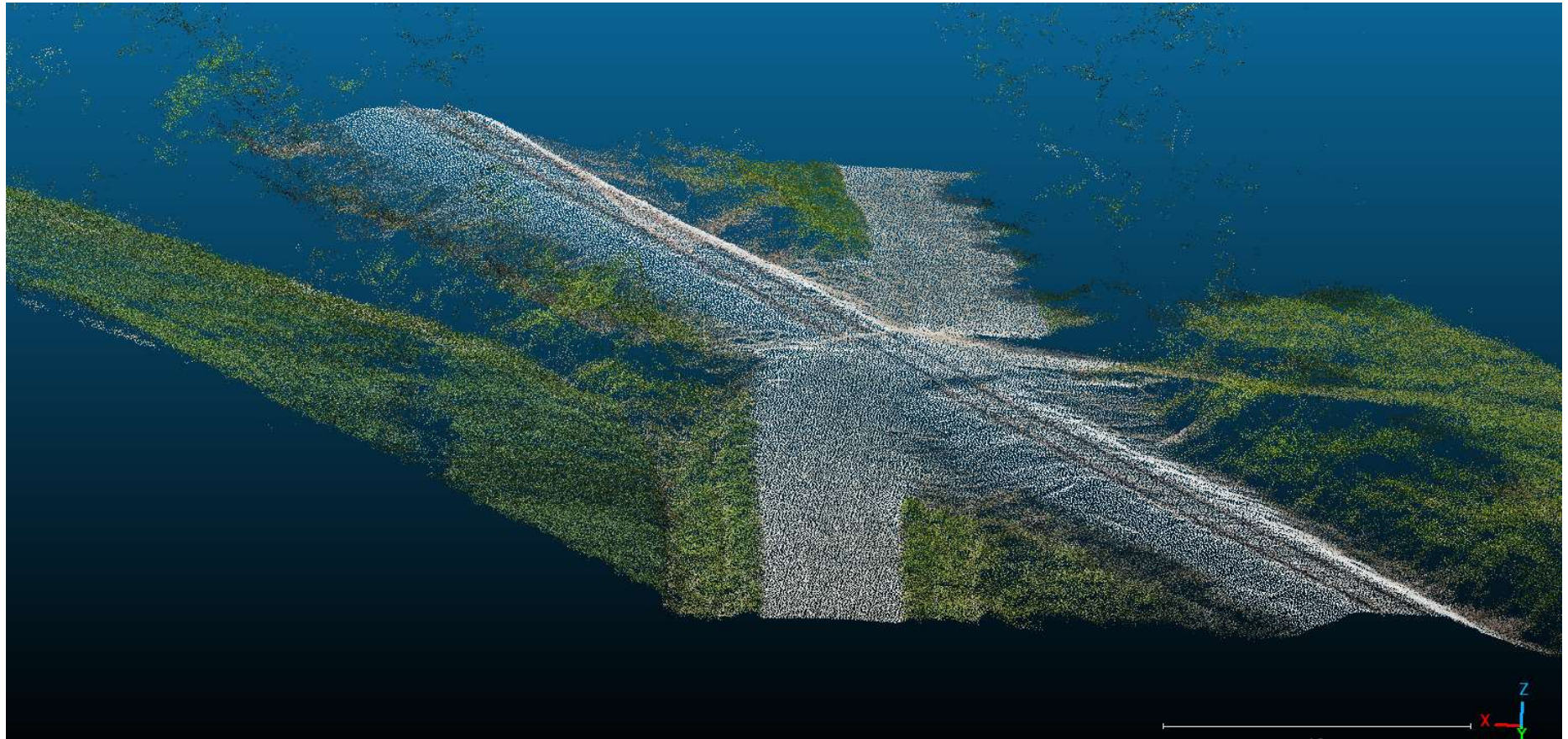
- Difference in elevation
- Crossing angle
- Sight distance



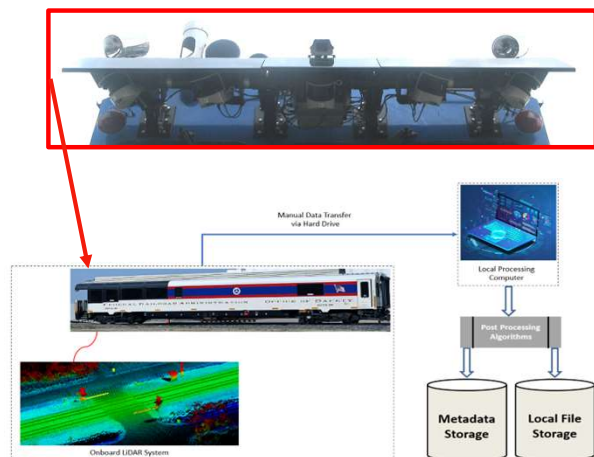
Some Examples of 3D Crossing Scans



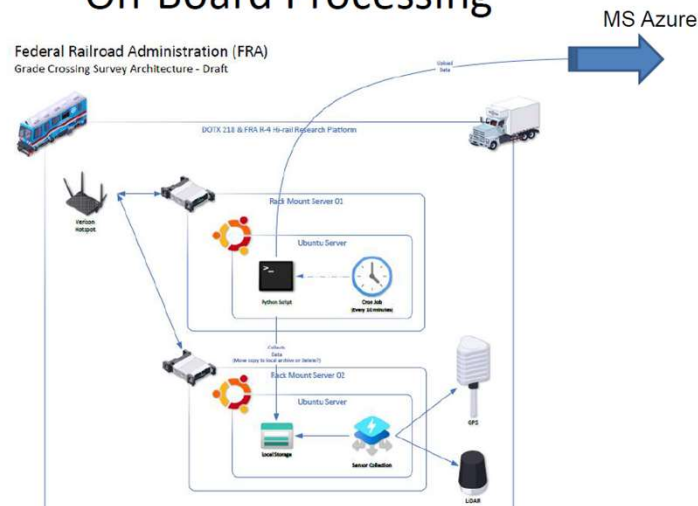
Some Examples of 3D Crossing Scans



Grade Crossing Scanning and Digitization Data Transfer Method



On-Board Processing



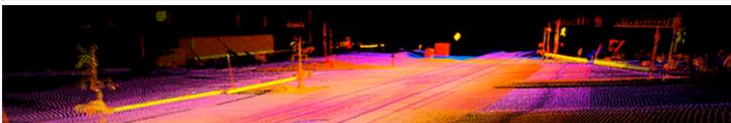
- Initially, the LiDAR scan data is transferred manually via hard drives, post processing algorithms trim and compress the data files to store in the database.
- Currently we are using more advanced onboard processing algorithms to improve scan accuracy and automate the data transfer process to the Cloud using Microsoft Azure solutions.
- Public facing website to enable stakeholders to access the scan data in a similar way as the FRA grade crossing inventory and safety data.


Grade Crossing Scanning and Digitization Data Access

RailBase

← → ↻ railbase.eecs.umich.edu/#q=planar_deviation+%3E+.8+and+planar_deviation+%3C+.9&begin=0&per=25

Welcome to RailBase
A database access tool for grade crossing data





Example Queries:

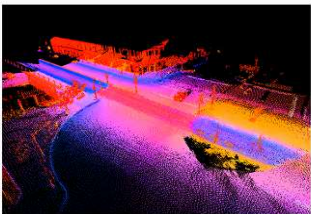
Searchable parameters:

latitude (40.246968902859294)
longitude (-103.8013553370079)
elevation (1326.4131903689372m)
roadway_width (15.75m)
planar_deviation (0.5591)
filename (DOTX18-2013031901004-142612.log)

Available Operators:

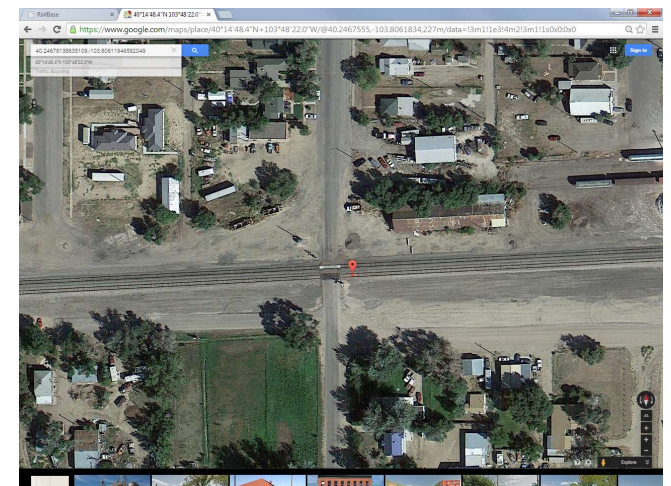
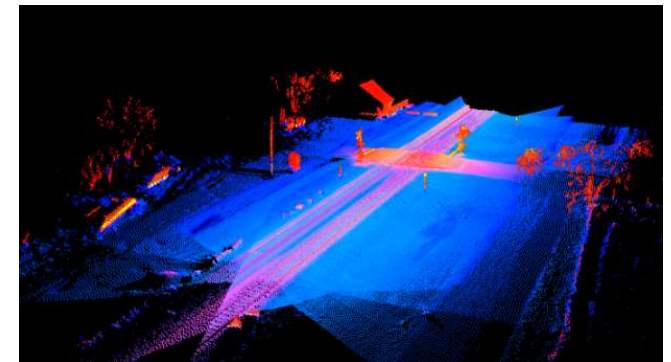
>, >= greater than, greater than or equal to
<, <= less than, less than or equal to
== equal to
!= not equal to
latlon_distance(lat1, lon1, lat2, lon2)

1-25 of 252 Crossings Found results per page [next >>](#)



filename	SNIPT-2013042309004-182253.log
latitude	40.8617
longitude	-76.7929
elevation	138.2
planar_deviation	0.801868697575
block_length	16.75

[Raw data \(LCM\)](#)
[Point Cloud \(XYZ\)](#)
[View in Google Maps](#)



Current Vertical Profile Guidelines

There are guidelines both at national and at state level

- AASHTO (national): 3 in over 30 feet
- Illinois:

"[...] the gradeline of highway approaches to grade crossings [...] must be as follows:

- From the outer rail of the outermost track coincident with a tangent to the tops of the rail for about 24 in (600 mm), then, for a distance of 25 ft (7.5 m) ascending or descending at a grade cannot deviate more than 1% from the tangent, then to the right-of-way line ([...]) at a grade not to exceed 5%;

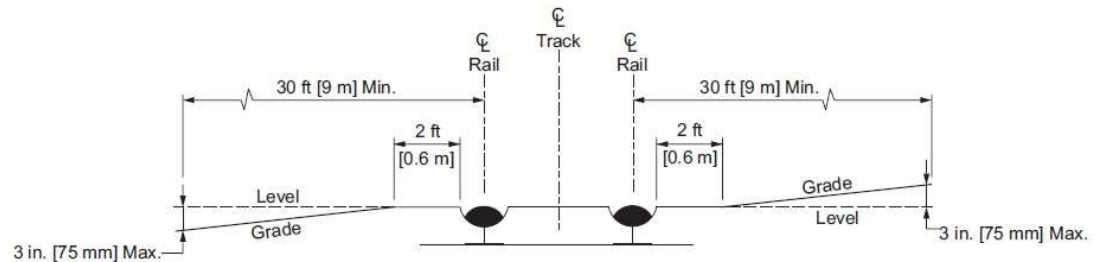


Figure 9-66. Railroad-Highway Grade Crossing

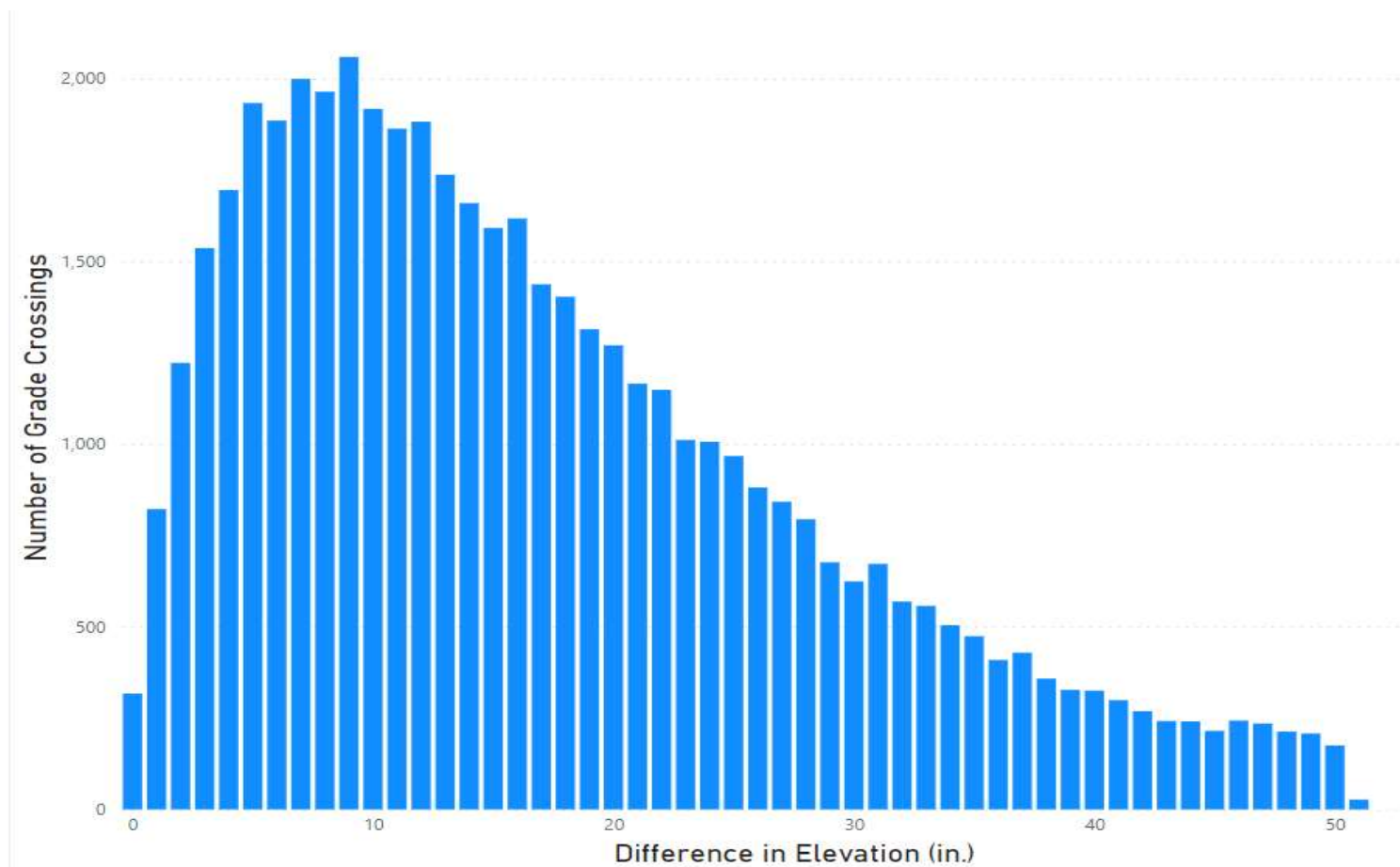
From AASHTO "Green Book", 7th Edition

First defined in AREA 1910 proceedings as a design requirement.

"highly desirable" in 1961.

Adopted by AASHTO in 1990s.

Distribution of Grade Crossings by Difference in Elevation



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