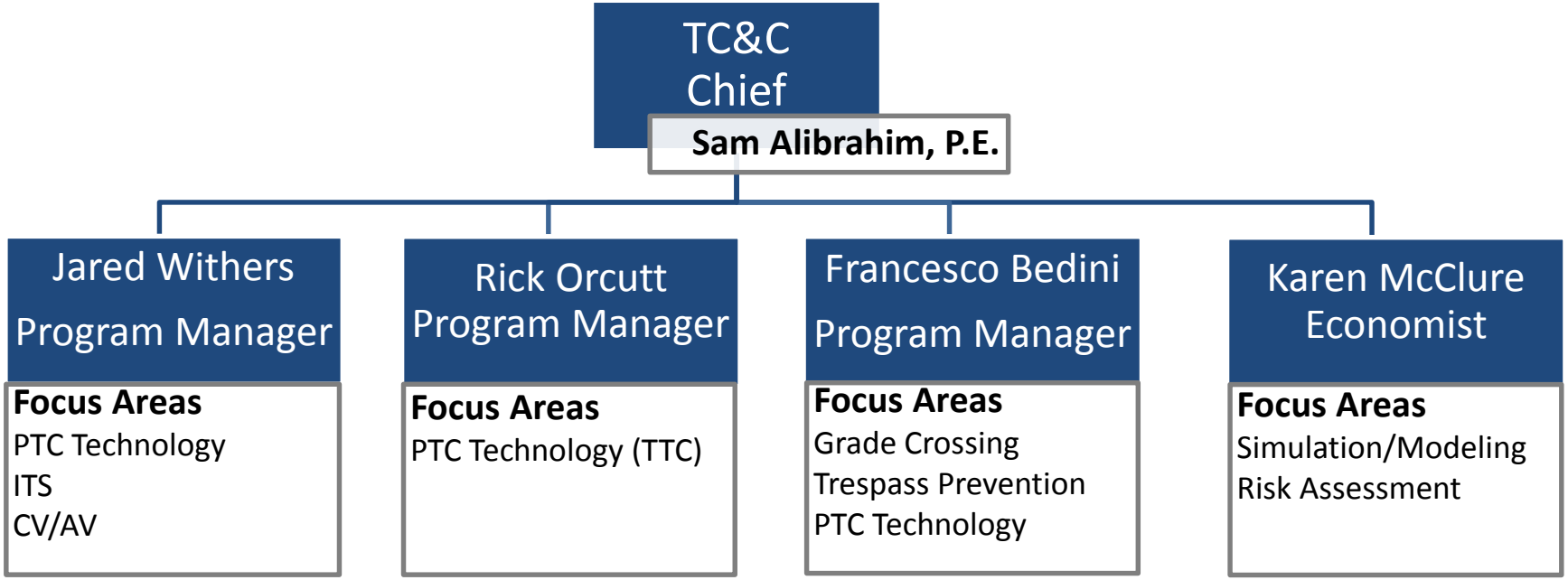
# FRA RD&T Transportation Research Board Review

# Train Control & Communication Research

Sam Alibrahim, P.E.

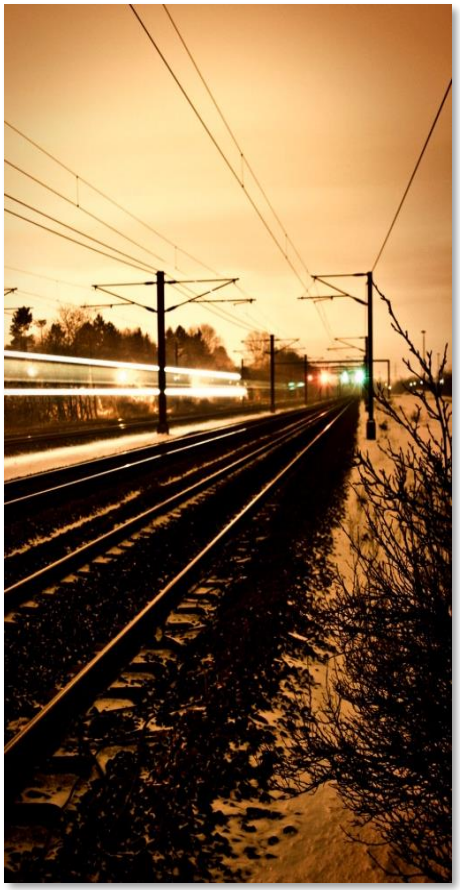
May 14, 2019

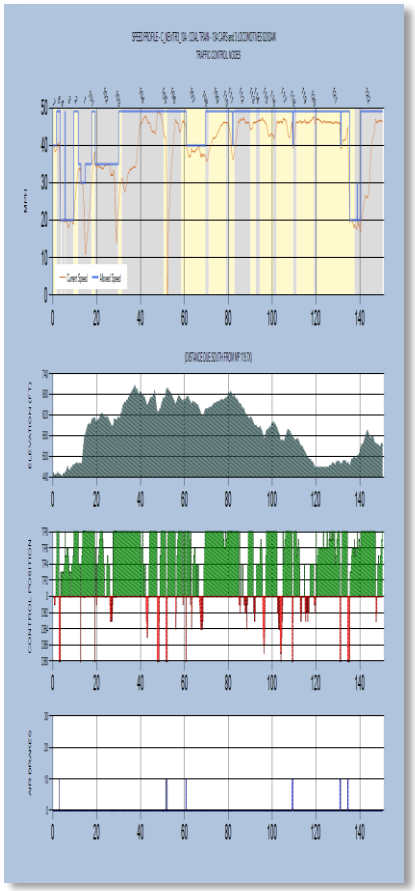
# Train Control & Communication (TC&C) Staff



# Research Areas and Sample Projects

| Train Control | Intelligent Transportation Systems (ITS) (CV/AV) | Grade Crossing Safety & Trespass Prevention | Modelling & Simulations |
|---|---|---|---|





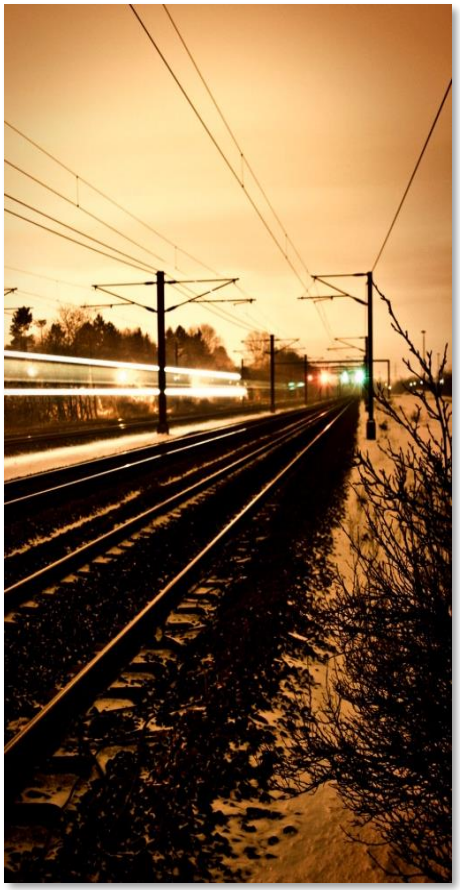
# Research Areas and Sample Projects

**Train Control**

- **PTC**
  - PTC Test Bed, I-ETMS, ACESS
  - Freight/Passenger Advanced Enforcement Algorithm (AEA)
  - Positive Train Location (PTL)
  - Employee-In-Charge Portable Terminal (EIC-PRT)
  - Monitoring Analysis of Integrated Networks (MAIN)
  - Enhanced Overlay PTC (EO-PTC)
  - Track Circuit Research
- **Next Generation PTC**
  - Quasi-Moving Block (QMB)
  - Full Moving Block (MB)
  - Onboard Broken Rail Detection
  - Centralized Interlocking Feasibility and Design
- **Automated Train Operation (ATO)**
  - Flexible Operator Location Feasibility Analysis – Phase 1
  - Automation Sensor Package - Phase 1
- **Communication**
  - Communication Test Bed Upgrade at TTCI
  - Wireless Communication Roadmap
  - Wideband Software-defined Radio Phase 1
- **Train Control Cyber Security**
  - Methods for Low Bandwidth Security
  - Improved PTC Authentication

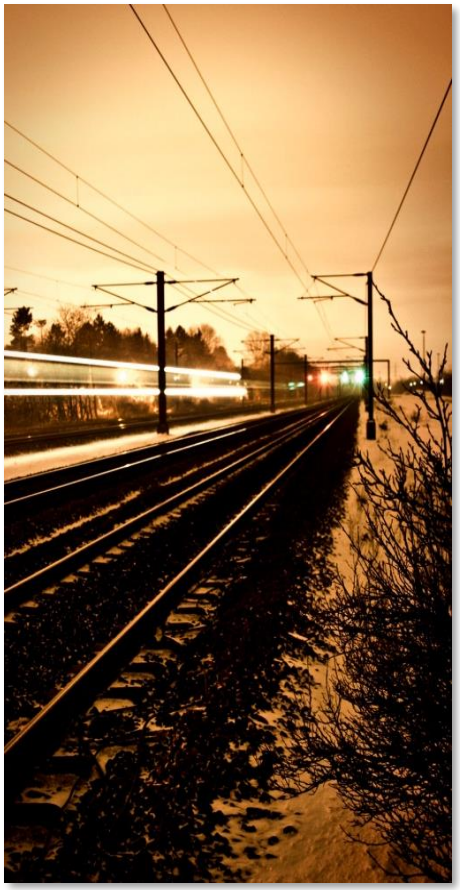
# Research Areas and Sample Projects

**Intelligent Transportation Systems (ITS)**



- **ITS Research**
  - Grade crossing taxonomy research
  - Higher Performance Digital Radio
  - DSRC Performance evaluation for railroad Applications
  - Automated vehicles requirement for grade crossing
  - Rail Crossing Vehicle Warning (RCVW)

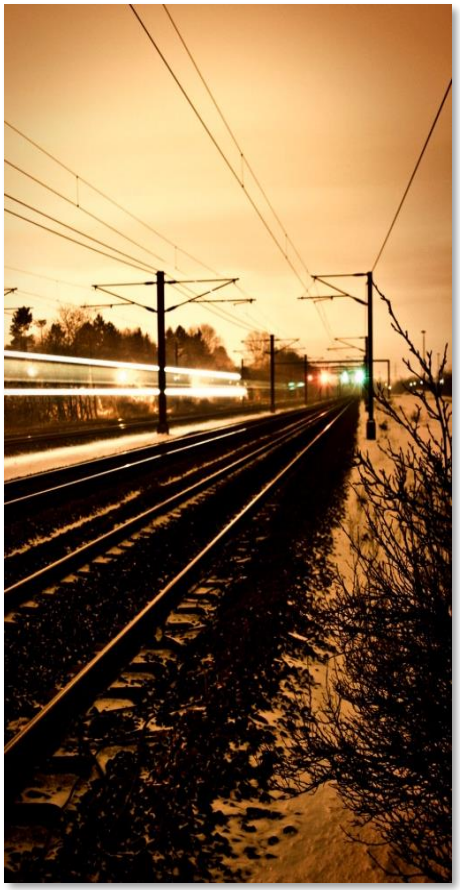
# Research Areas and Sample Projects



**Grade Crossing Safety & Trespass Prevention**

- **Crossing Technology Research**
  - Hump Crossing Scanning and database update
  - Automated Lidar grade crossing data extraction
  - Low Cost vehicle and pedestrian detection at grade crossing
- **Trespass Prevention**
  - Trespass detection using drones
  - Using Artificial Intelligence (AI) for trespass prevention
- **Human Factors Studies**
  - Driver Behavior Analysis

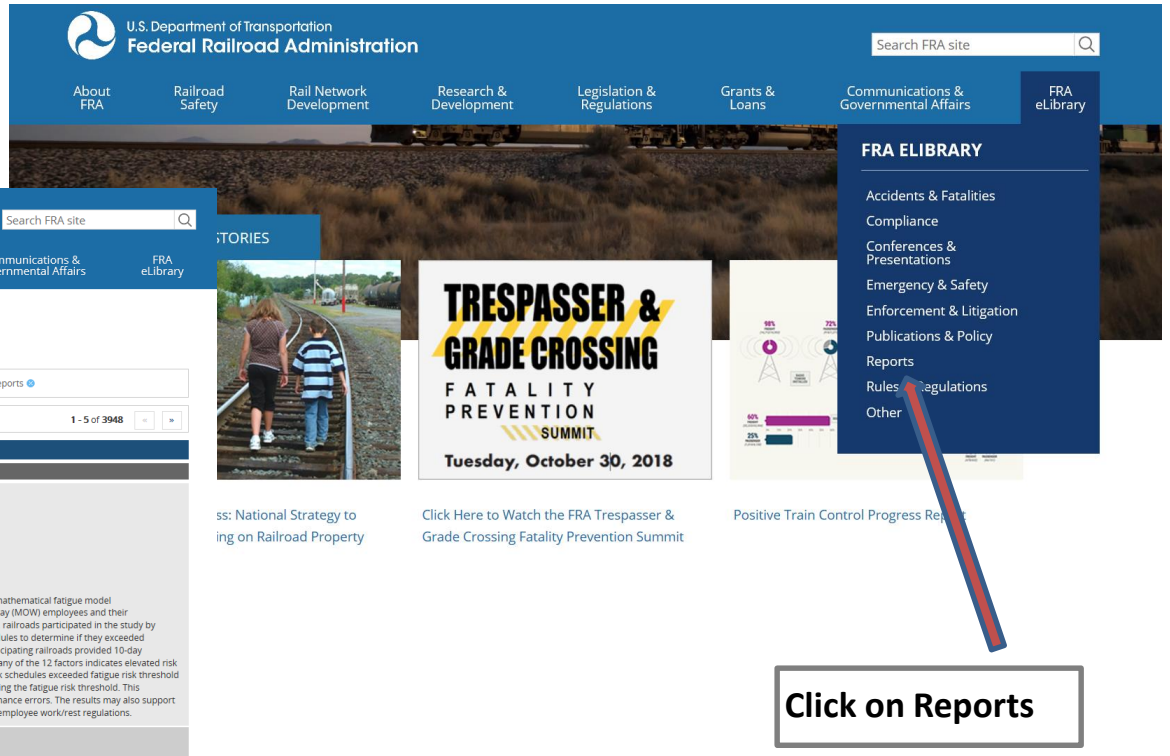
# Research Areas and Sample Projects

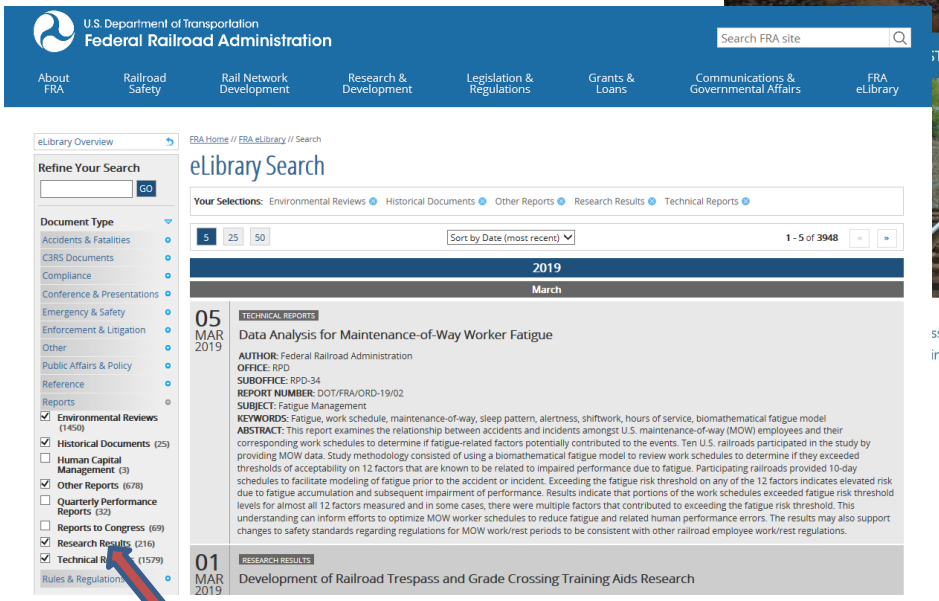


## Modelling & Simulations

- **Simulation**
  - Generalized Train Movement Model
- **Modeling**
  - GrageDec.Net garde crossing on line tool

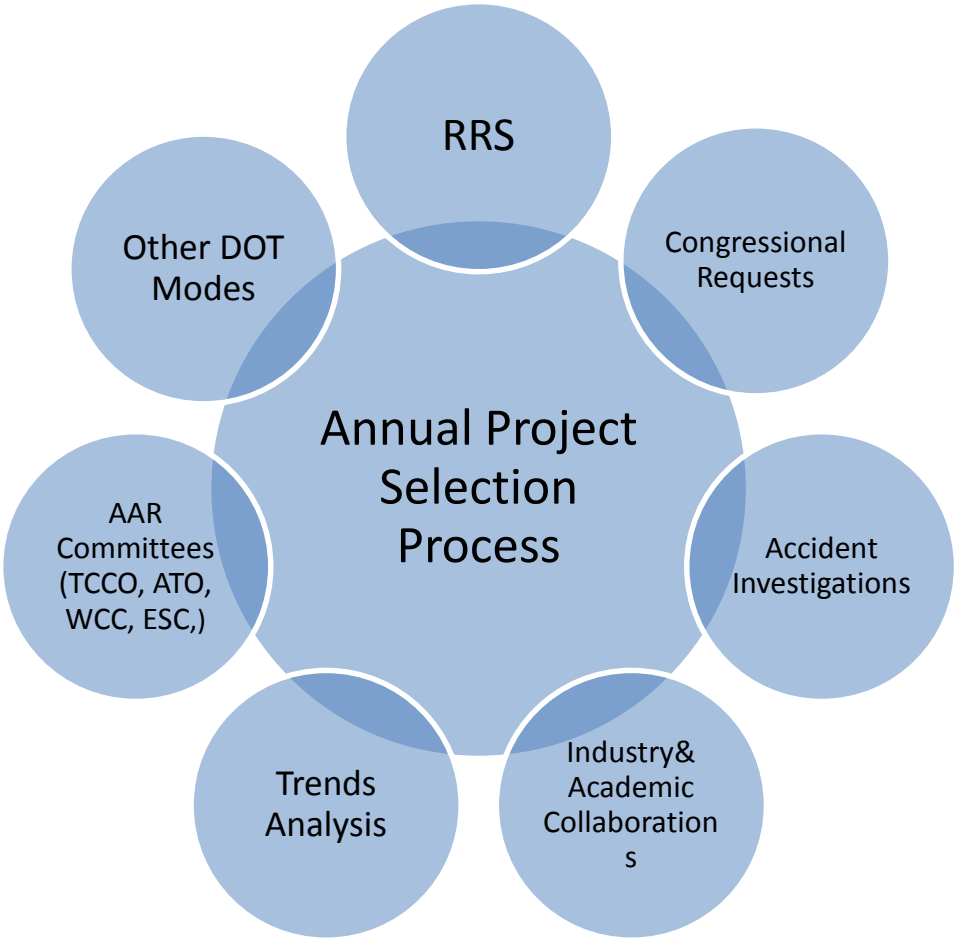
# WWW.FRA.DOT.GOV



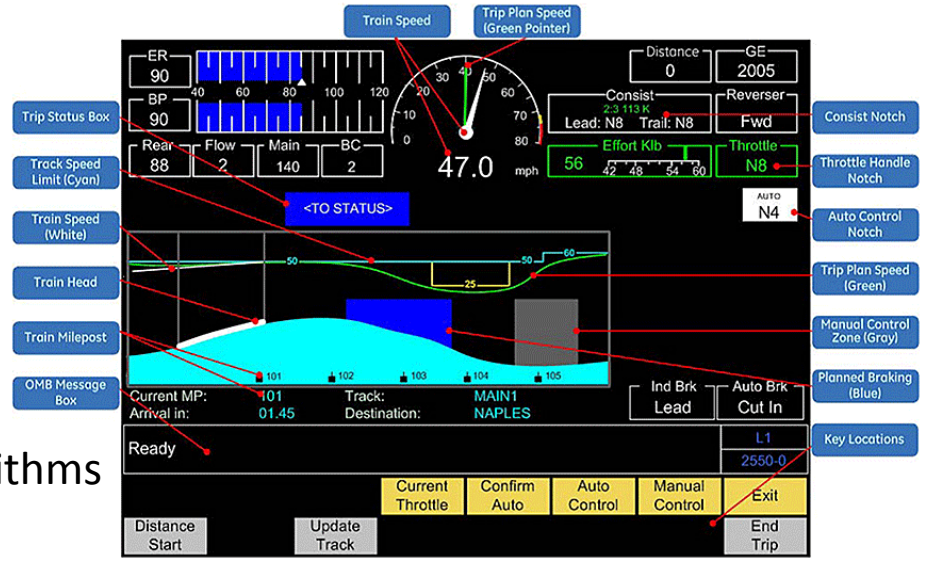
# Sample of TC&C Research Partners

# TC&C Project Selection and Prioritization



# Higher Reliability and Capacity Train Control (HRCTC)

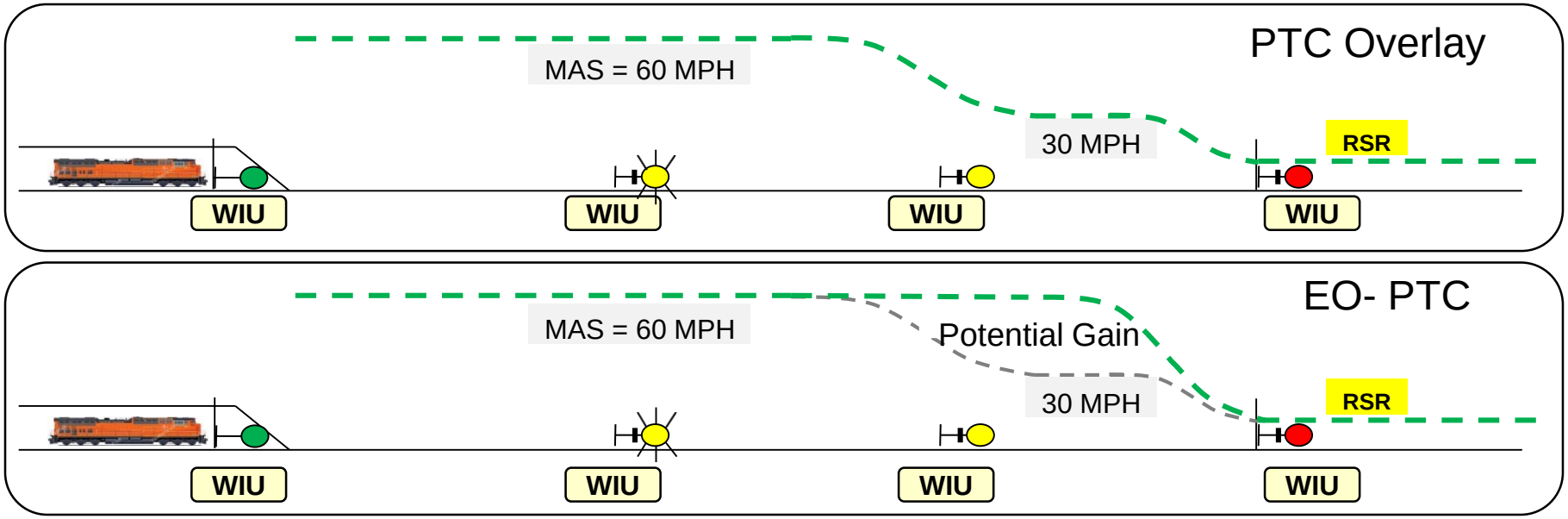
- Current overlay PTC can impact RR operations by stopping or slowing trains prematurely or unnecessarily due to:
  - Message communication failures
  - GPS issues
  - Incorrect data in the system
  - Conservative braking enforcement algorithms
  - Operator error during initialization or operation




- HRCTC Program Concept:
  - Identify significant PTC impact scenarios and bottlenecks
  - Develop potential solutions and migration plans

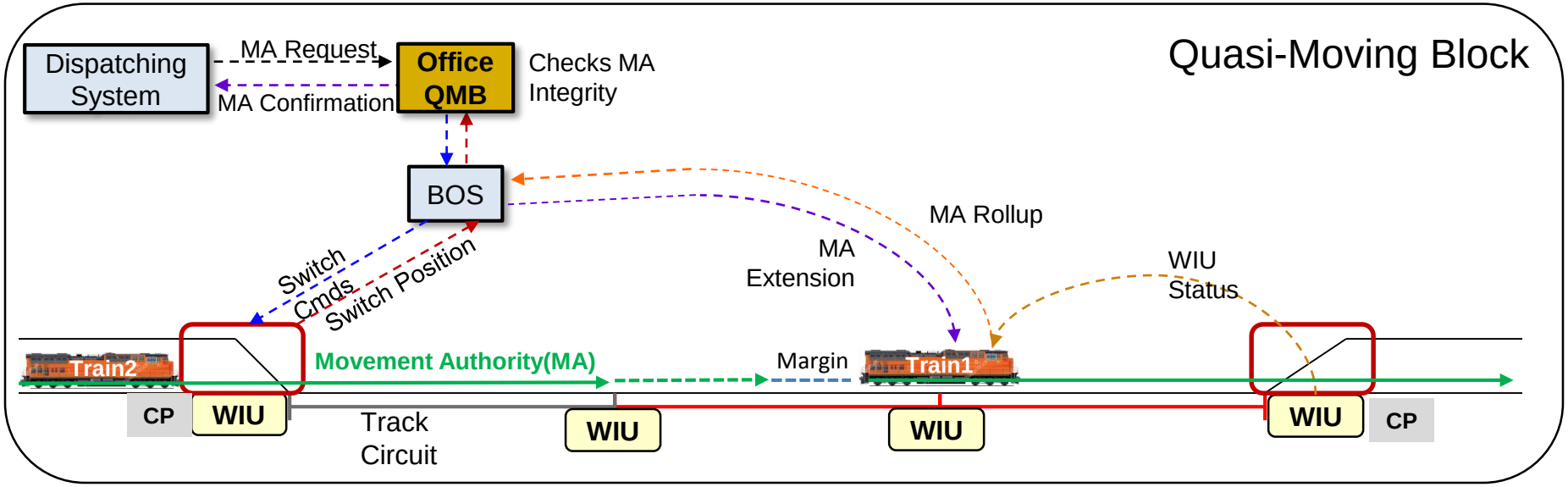
# Enhanced Overlay PTC (EO-PTC)

- Relax speed restrictions for approach and advance approach signal aspects
- Benefits:
  - Provides recovery of some capacity lost to PTC
  - Minimal changes to current overlay PTC
- Recently implemented through firmware update and operating rules change



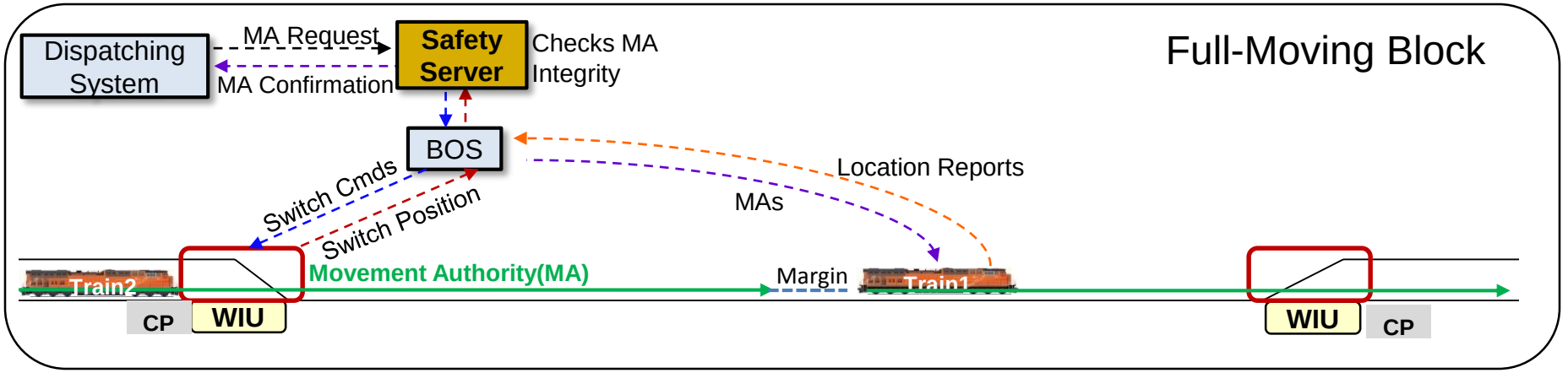
# Quasi-Moving Block (QMB)

- Onboard sets targets based on Movement Authorities (MA) and field indications
  - Office is responsible for extending train MAs, trains are responsible for rolling up their own MA and notifying Office
- Utilizes Centralized Interlocking
- Elimination of wayside signals
- MA is given to the end of the block



# Full Moving Block (FMB)

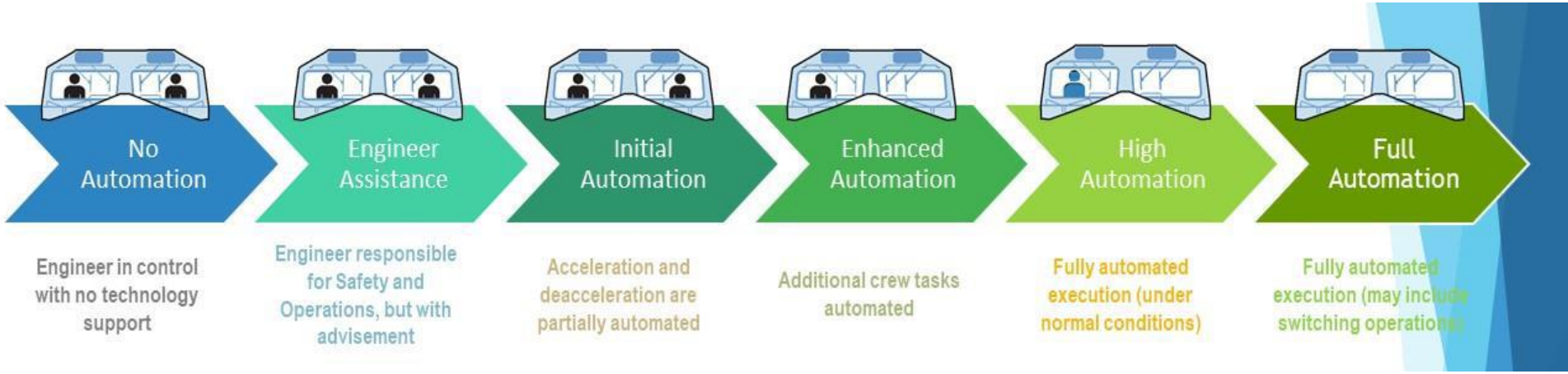
- Back Office send MAs up to leading train, with some margin
- Elimination of conventional track circuits (requires alternative broken rail protection)
- Benefits:
  - Increased capacity
  - Quicker recovery from disruptions
  - Enhanced reliability, reduced maintenance
  - Rear-end collision protection in close following moves



# Automated Train Operation (ATO)

- Integration of existing and new technologies for enhanced automation of operations
  - Not a single technology – an operational concept enabled by multiple supporting technologies
  - Requires human oversight / support at some level – various levels of automation may be considered ATO

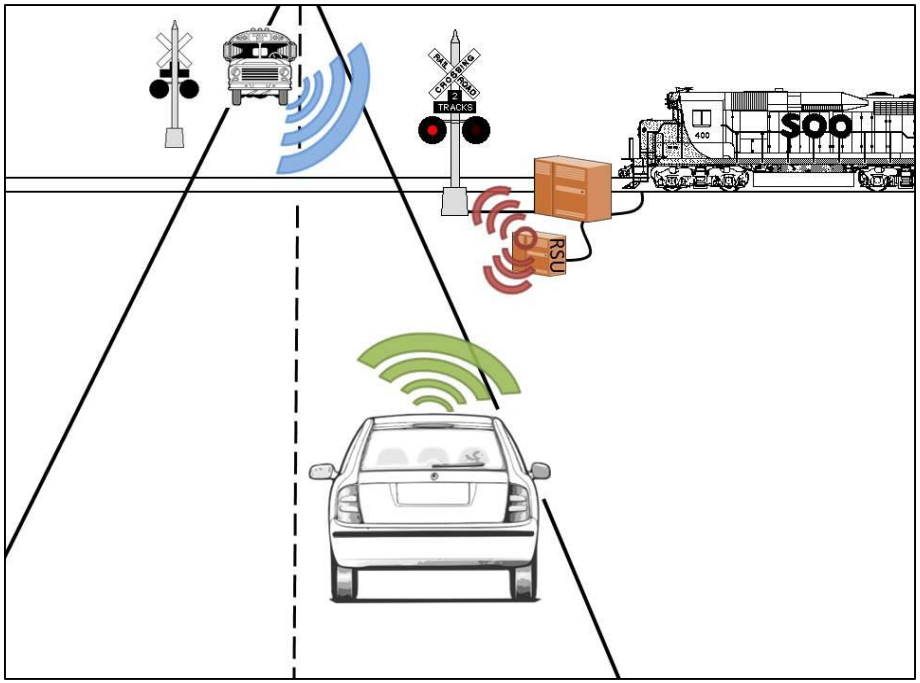
# Automated Train Operation (ATO)




- Focus is on analysis and definition of concepts and specifications for “High Automation”
- Standards will support varying levels of automation
- Deployment and evolution through levels of automation can be determined by each individual railroad

# Rail Crossing Violation Warning (RCVW)

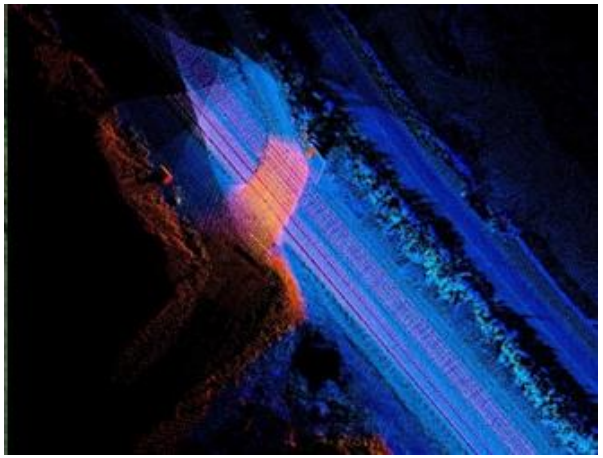
- Connected vehicle safety application for grade crossing warning
- Warn drivers of imminent violation of a rail crossing protection system
- Jointly funded by FRA and FHWA
- Continuing development in partnership with Honda



# Rail Crossing Violation Warning (RCVW)

# LiDAR Hump Crossing Survey Data

- Augment FRA's National Grade Crossing Inventory database with LiDAR point clouds of humped crossings.
- System designed to capture topography at speeds up to 60 MPH.
- Parameters reported at automatically detected grade crossings include:
  - Detection of Crossing
  - Crossing Profile
  - Roadway/Track Crossing Angle
  - Railroad/Subdivision
  - Track Class
  - Number of Tracks
  - Length of Crossing
  - Location of Crossing (GPS/MP)



# FRA LiDAR Grade Crossing Survey System

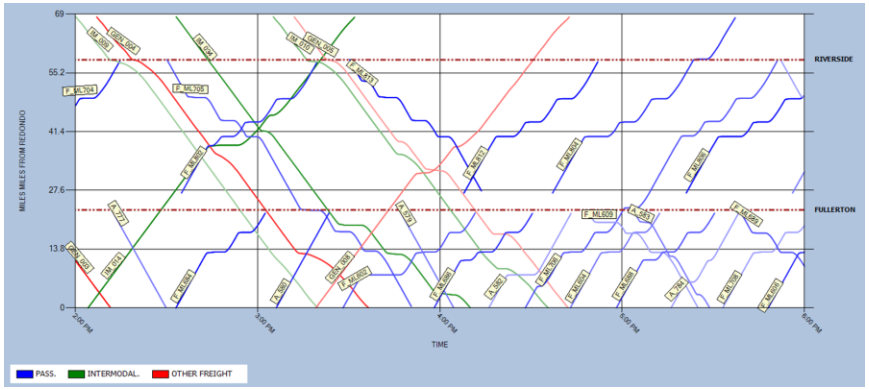
- FRA initial full LiDAR Surveying System was installed on the DOTX 218 research vehicle for demonstration and further development.

# UAV based Trespass Detection System

- Evaluate UAS capabilities (flight duration, payload, scanning technologies, etc.) for railroad applications
- Test the effectiveness of UAS technology to detect trespassers on railroad property.
- Provide law enforcement the capability and flexibility to cover wider area.


# Generalized Train Movement Simulator (GTMS)

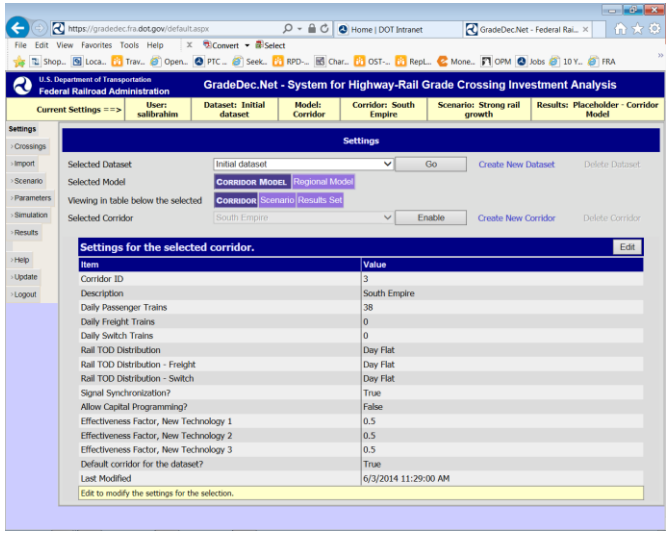
- Web based train movement model to calculate time, position, speed, and in-train forces.
- Central dispatching algorithm to prioritize train movement, makes routing decisions, prevents train deadlock, to provide safe train separation.




- Animation to identify chock points and shows the effects of capital improvements
- Simulate up to 10 years of operation in a single run and derive the probability of each PTC preventable accident.
- FRA RD&T established a user group and conducts workshops to help interested parties learn this tool, provide support and enhancement as needed.

# GradeDec.Net

- Web based grade crossing (GC) benefit cost analysis tool with easy access to the FRA crossing database and accident data.
- Used by Federal, State, Local transportation authorities, railroads, academics, and consultants to evaluate GC upgrades, closures, grade separations and impact on vehicle queues and spillbacks
- FRA RD&T periodically conducts workshops to help interested parties learn this tool and providing support and enhancement.



# Thank You!

**Got PTC?**