BNSF and C/AV

(Connected and Automated Vehicles)

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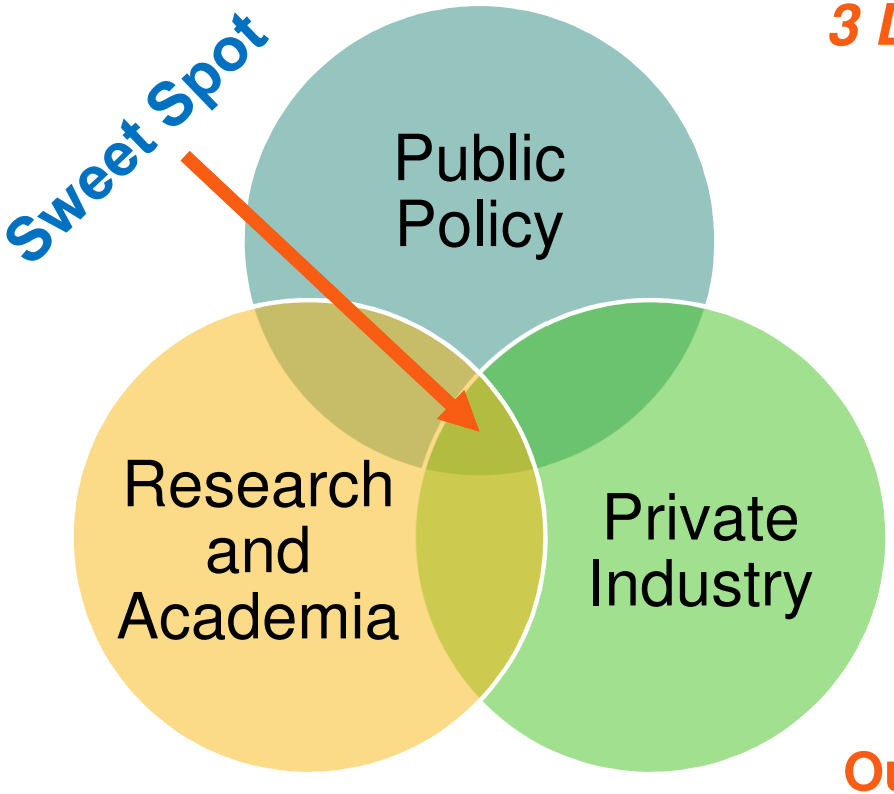
Various Interested/Impacted Teams

Public Projects	Signal/Telcom	Technology Services	Operations	Hub Ops	#Affairs *(Public, State, Federal)*
• Grade Crossing Safety • Public Policy • Public Infrastructure & Investments	• Grade Crossing Safety • PTC/NCS Infrastructure	• Systems Support • Research and Development	• Safety • Moving Block • Semi Autonomous Trains	• Hub Safety • Efficiency and Velocity	• Public Policy • Piecemeal Legislation • Productive Rule Making

BNSF Coordinated Approach

Spheres Of C/AV



3 Distinct "Spheres" of C/AV Development:

1. **Public Policy** – Local, State and Federal policy development – requires high participation level
2. ***Research and Academia*** – Silicon Valley types and Universities are developing tech and ideas in a utopian state
3. ***Private industry*** – Primary interest lies in the monetization of the technology through production, or efficiency gains

BNSF Operates at the intersection of these "Spheres"

Our Challenge and Opportunity: to reside in the "Sweet Spot"

Establishment of BNSF Principles

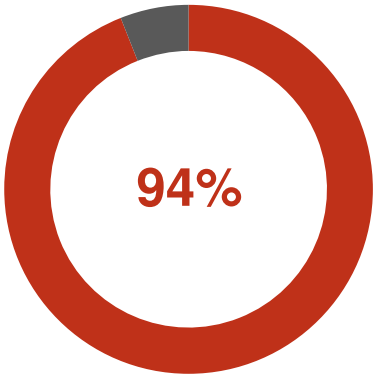
Main Policy Recommendations

- CAV guidance and navigations systems *should limit vehicle-train interaction* through emphasis in routing to *grade separated crossing* locations.
- In design of systems for CAV infrastructure, at-grade highway-rail crossings should be treated as a *dynamic intersection for CAVs to navigate*, e.g. work zones.
- Railroads *shall not be responsible for* facilitating *communication with CAVs* at highway-rail intersections.
- Railroad right-of-way is *reserved for railroad infrastructure* to ensure customer demands are met and to support future expansion needs.
- Modal equity: *Users of infrastructure should* be the primary source to *pay for the implementation and maintenance* of that infrastructure.

CAV Interaction at Highway-Rail Grade Crossings

Focused on Safety

HUMAN FACTOR INCIDENTS



94% of at-grade crossing accidents are human factor related[1]

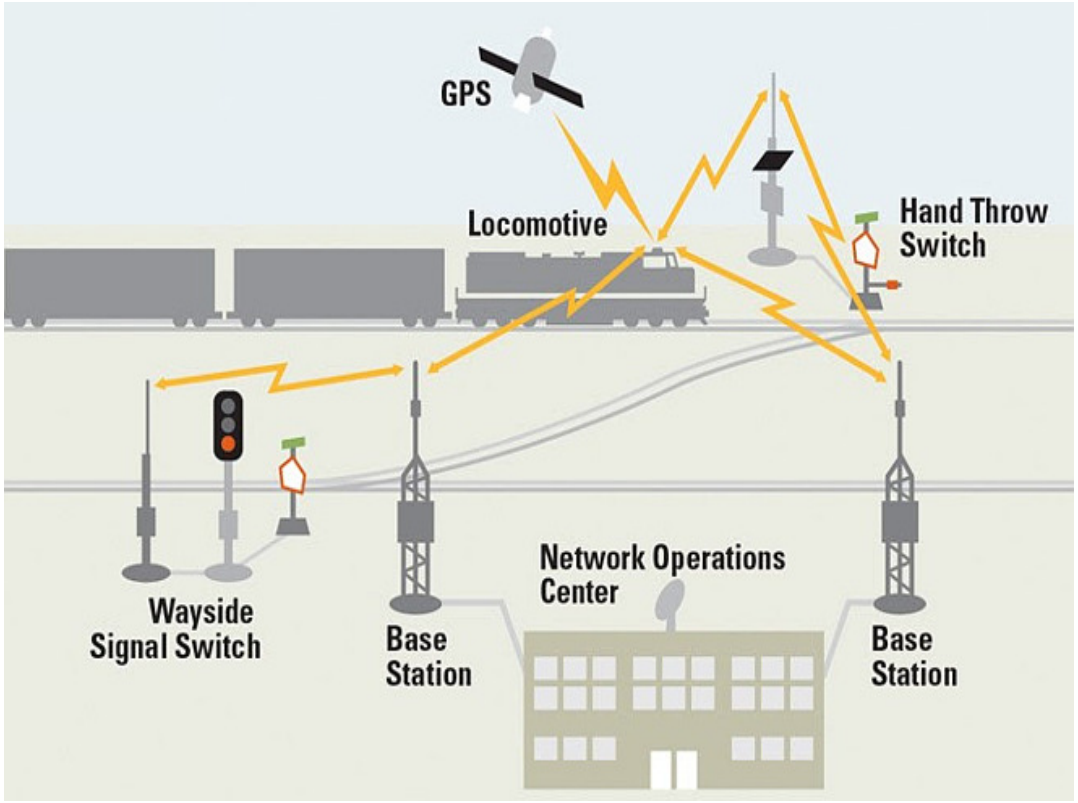
- The greatest **safety** improvement for at-grade highway-rail crossings will come from autonomous technologies reducing distracted driving incidents
- FRA and DOT offices must ensure **consistent** technical standards and regulation to support integration of connected and autonomous vehicles navigating grade crossings

Dynamic Intersections

- Highway-rail grade crossings must be treated as a dynamic intersection for CAVs to navigate, e.g. work zones, with a closed-loop safety system for detecting rail traffic
- CAV navigation systems must **prioritize** utilizing grade separated crossing locations
- Considerations for both passive and active at-grade crossings

Positive Train Control – *Not for CAVs*

- PTC is a **rail traffic control system** that uses radio communication and railroad based servers to prevent certain train to train collisions and over speeding
- PTC has no capability to communicate with highway vehicles
- For **safety and security** of railroad operations, railroads will not make such communication accessible to non-railroad entities
- Installation and modification costs for new vehicle to infrastructure exchanges must be borne by the **road authority** accommodating CAVs




Modal Equity

Railroads Reduce Highway Congestion

One BNSF intermodal train removes more than **280 long-haul trucks** from our nation's highways

Modal Equity

- Successful freight movement involves seamless interaction with all other modes
- BNSF handles **5 million** trucks per year at intermodal facilities across our network
- Many automated systems and inspection technologies for facilitating connected and autonomous trucks have already been implemented

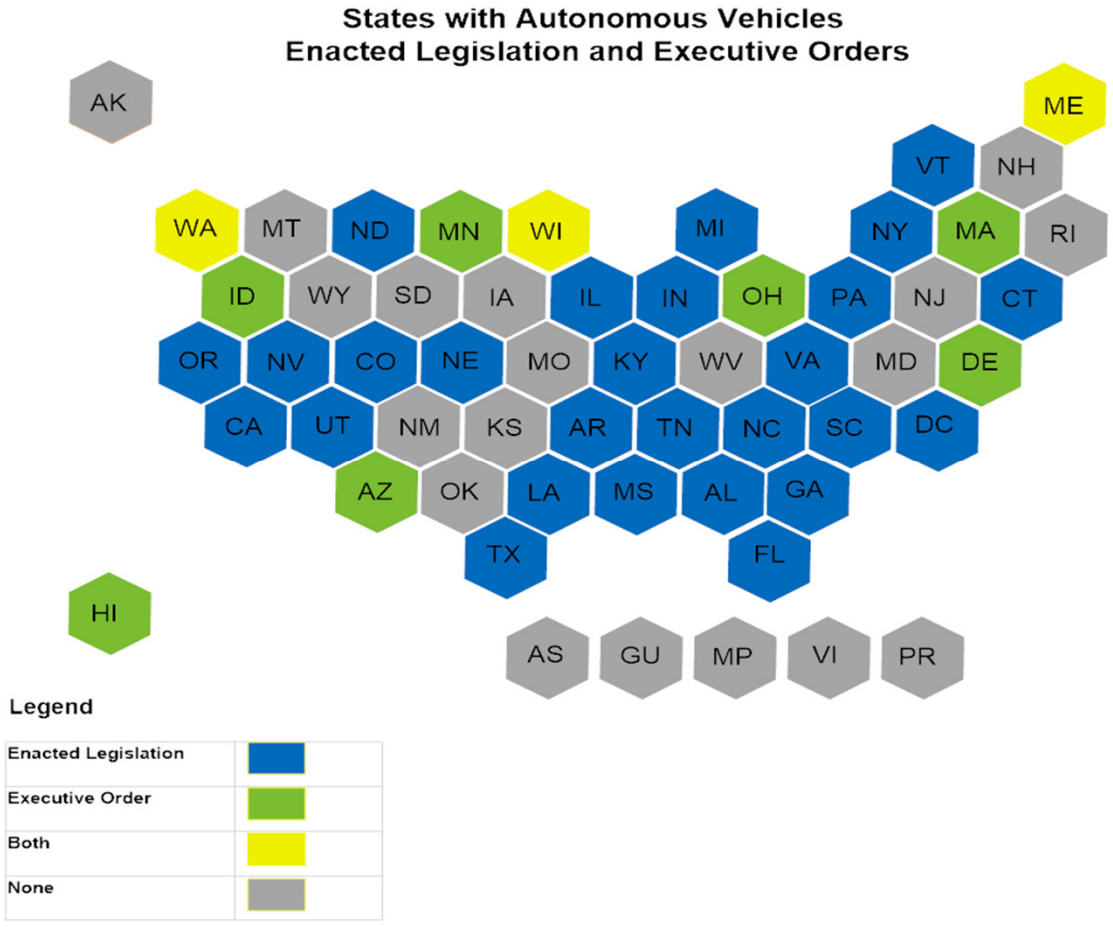
Preparing for a CAV Future

States must work with U.S. DOT and the private sector to form advisory groups for a **national** multimodal discussion

Collaborative approach with U.S. DOT, academia, and the rail industry to institute compatible CAV technology that ensures equitable automation and digitization alignment across all modes of transportation

Agencies must provide **oversight** for testing and deployment of CAV technology

Various Policies Across States



- *How do these polices address private facilities vs public ROW?*
- *Are there incentives BNSF can leverage for our own gain?*
- *What real world testing is happening and where does it interest BNSF's ROW?*
- *What is on the Horizon?*

BNSF RAILWAY

BNSF is the reliable constant
for people who need us to never stop moving