Connected and Automated Vehicle Safety Data- Overview

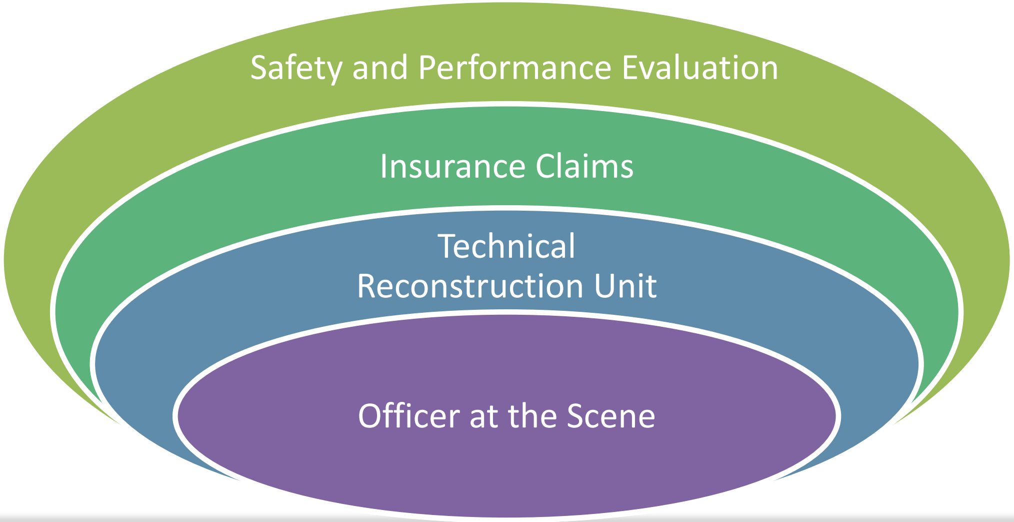
Andrea Bill
Bill@wisc.edu

Civil and
Environmental Engineering
UNIVERSITY OF WISCONSIN–MADISON

WISCONSIN TOPS

TRCC CAV Data Project Background

- The rapid proliferation of connected and automated vehicle (CAV) technologies offers many benefits, but this is very disruptive to transportation, regulation, liability, and enforcement
- Law enforcement agencies need access information access in the event of a crash or incident on roadways
- EDR access has been valuable, but information is falling quickly behind
- New, disparate, proprietary, and big data are being created already, but access to it for safety and enforcement purposes is currently limited
- How can data from these CAV and ADAS systems be acquired and integrated with current EDR access?



Project Steps

- Terminology Review
- Literature Search
- Initial Data Requirements
- Conversations with Wisconsin State Patrol
- Conversations with WisDOT (includes DMV) stakeholders
- Final Data Requirements

Terminology Review

Categories
Driving Task Assistance
Braking
Parking
Situational Warnings
Other

SAE Recently Endorsed an ADAS Common Naming Effort led by AAA, Consumer Reports, J.D. Power, and the National Safety Council

- Collision Mitigation (CM) – 40
- Surround View Camera (SVC) – 20
- Adaptive Cruise Control (ACC) – 20
- Blind Spot Warning (BSW) – 19
- Automatic High Beams (AHB) – 18
- Rear Cross Traffic Warning (RCTW) – 15
- Driver Monitoring (DM) – 13
- Semi-Automated Parking Assist (SAPA) – 12
- Dynamic Driving Assistance (DDA) – 10
- Forward Collision Warning (FCW) – 8
- Fully Automated Parking Assist (FAPA) – 3
- Remote Parking (RP) – 2
- Trailer Assistant (TA) – 2
- Many others

MMUCC Standards

DYNAMIC DATA ELEMENTS

DV1. Motor Vehicle Automated Driving System(s)

S1 Automation System or Systems in Vehicle

01 Yes
02 No

99 Unknown

S2 Automation System Levels in Vehicle*

00 No Automation
01 Driver Assistance
02 Partial Automation
03 Conditional Automation
04 High Automation
05 Full Automation

06 Automation Level Unknown

99 Unknown

S3 Automation System Levels Engaged at Time of Crash*

00 No Automation
01 Driver Assistance
02 Partial Automation
03 Conditional Automation
04 High Automation
05 Full Automation

06 Automation Level Unknown

99 Unknown

*MMUCC 6 changes these by adding the word “highest” at the beginning of the statement

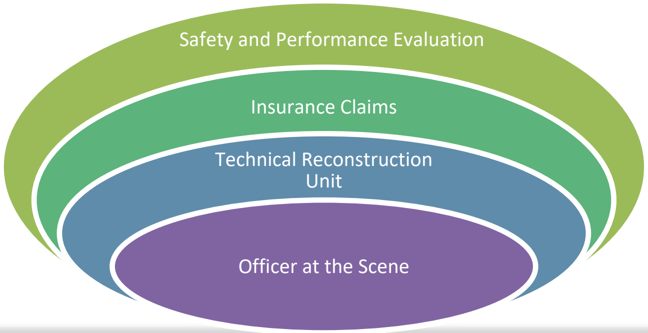
Existing Standards and Stakeholders

- TRB
  - Multiple NCHRP Reports [17-24 and NCHRP 20-24(98)]
- AAMVA
  - Automated Vehicles subcommittee
  - Manufacturers should design HAVs to record vehicle behavior sensor data and the driver–vehicle interface. Law enforcement should be provided with access to this information as well as a minimum of 30-seconds pre-crash and post-crash data for completing a proper investigation.
- SAE
  - J3197: Automated Driving System Data Logger
  - Event based (e.g., rollover, pedestrian impact, rear impact, etc.) with ADAS actions (e.g., brake application, gear, longitudinal/lateral motion, etc.)
- Others: AASHTO, IEEE, ISO, CAT Coalition

Recommended Data Requirements

Data Hierarchy

- **Final Decision Making Data**: Vehicle Decision Making; Human Decision Making
- **Operational Data**: Human-Machine Interface; Operational Design Domain (ODD); Subsystem Function
- **Component Data**: ADAS Data
- **Raw Data**: Sensor Data

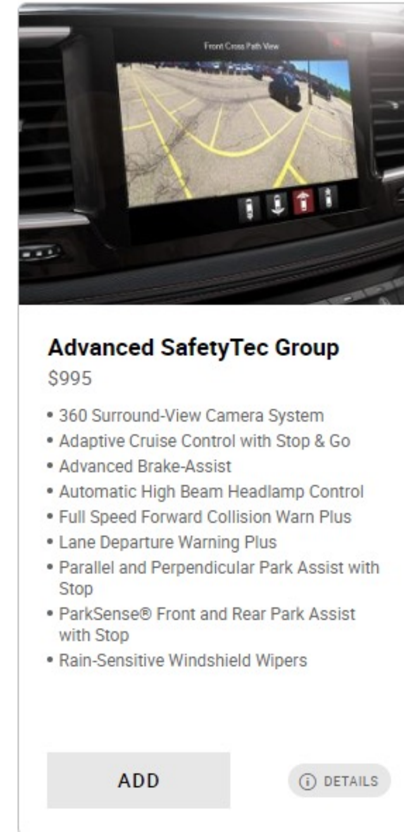


Data Requirement Recommendations

Recommendation: Work with NHTSA to require a vehicle system specifications ID on all new vehicles

- The vehicle identification number (VIN) has been required by NHTSA since 1981 and has existed since 1954.
- Newer vehicles have so many options, particularly among North American manufacturers who allow option changes within trim levels.

Example: Chrysler's Advanced SafetyTec Group is an option on <u>all</u> trims

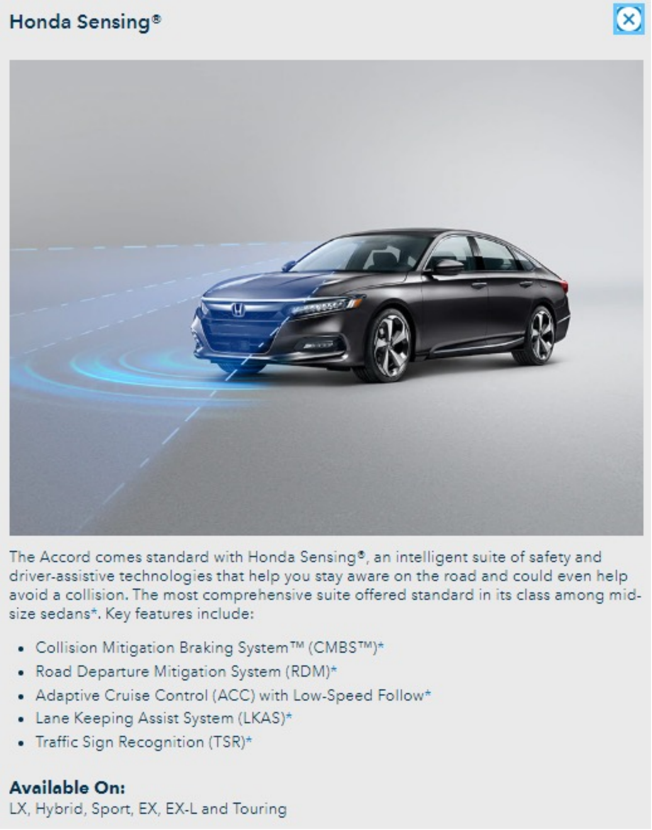


Data Requirement Recommendations

Recommendation: Suggest MMUCC Automated Driving System standards be updated to include each ADAS and CAV Subsystems

- ADAS and CAV subsystem data will become more and more relevant to crash analysis in the next decade and beyond.
- Each ADAS and subsystem should have its own set of checkboxes, instead of just one set for general AV functionality.

Example: Each of the five Honda Sensing ADAS systems should have separate MMUCC data elements for engagement during crash



Data Requirement Recommendations

Recommendation: Update EDR specifications to include much broader CAV data availability

- EDRs are the primary mechanism for downloading historical vehicle system data surrounding a crash investigation.
- Currently, EDR future recommended data does not include anything on ADAS, CAV systems, or AVs in general.

Example: The future EDR technology list includes only two elements related to CAVs. With more systems and more complex ADAS, a much broader set of data elements is required

Data Element / Description	Current EDR Technology	Near Term EDR Technology	Future EDR Technology
Cell Phone (On / Off)			X
Siren Status (On / Off)			X
Clutch Pedal Position			X
Crash Type (Frontal, Side, Rear)			X
Distance to car in front / headway			X
Distance Traveled			X
Driver Requested Torque			X
Driver Video Camera			X
Driver's Eye View Video Camera			X
Engine - time started			X
Lateral Lane Position			X
Microphone			X
Number of Occupants			X
Accident Notification – Date and Time			X
Pitch Rate			X
Principal Direction of Force			X
Roll Rate			X
Vehicle Direction / Heading			X

Additional recommendations that should be considered and expanded upon in a larger brainstorming effort

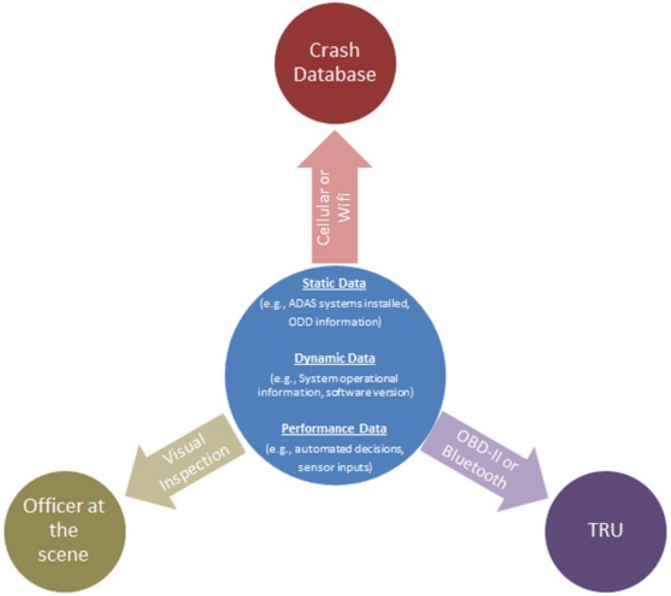
- System software version number
- System status for each sensor and ADAS
- System indication (e.g., ped/bike detected) for each ADAS
- Vehicle operating within its ODD – ODD should be discretized to make this more actionable
- Time-series handoff of vehicle to human or vice versa
- ADAS subsystem interaction data (e.g., lane keeping system and forward collision warning system)
- Human machine interface data (e.g., eye tracking sensor, steering wheel pressure)
- Vehicle decision-making data
- Vehicle maintenance data (e.g., when the check engine light is engaged and what codes were engaged)
- Vehicle performance data (e.g., tire age, tread depth, and pressure; brake pad thickness, etc.)

Data Requirement Recommendations

Recommendation: Improve methods to access the vehicles data stream

- The main **question here is how does data get from EDR, vehicle system specifications ID**, and other information systems on the vehicle get into the crash database?
- The more this process can be automated, the easier and more likely it will be to be able to expand data collection capabilities and record data for more crashes.

Example: Both static and dynamic elements can be collected at the time of a crash. If this data could easily be downloaded and stored electronically in the crash database, this would improve the amount of data available for safety programs and reduce the burden on officers at the scene.



Data Requirement Recommendations

Recommendation: Develop a repository of ADAS and CAV subsystem operational descriptions by manufacturer

- Although the USDOT is working on standard definitions, vehicle manufacturers will envision CAV subsystems differently, and these differences can be key in analyzing a crash.
- Therefore, it is recommended that an online repository of ADAS and CAV subsystem descriptions be kept for each manufacturer and vehicle.

Example:

Vehicle Manufacturer: Toyota

ADAS Manufacturer: Toyota

Manufacturer Name: Pre-Collision System with Pedestrian Detection

System Type: Collision Mitigation / Forward Collision Warning

Image with relevant sensor locations and warning system lights, locations, and types

Basic Description: Using an in-vehicle camera and a radar sensor or a laser sensor that are designed to help detect a vehicle or a pedestrian in front of you, the Pre-Collision System with Pedestrian Detection (PCS w/PD) is designed to help you mitigate or avoid a potential collision. If the system determines that a frontal collision is likely, it prompts you to take action using audio and visual alerts. If you notice the potential collision and apply the brakes, PCS w/PD may apply additional force using Brake Assist (BA). If you do not brake in time, it may automatically apply the brakes to reduce your speed, helping to minimize the likelihood of a frontal collision or reduce its severity.

Operation Description: ***(Disclaimer: For example only, not an actual description of the system)***
This system works with two sensors, an in-vehicle forward facing camera and a radar sensor mounted on the front bumper of the vehicle. The camera is used for object detection and classification using Toyota's proprietary machine learning algorithm. The radar sensor provides an accurate distance to the object to the nearest 2 cm. The system is designed to determine possible collisions beginning at 25 m from an object when an audible beep and indicator light on the dash is illuminated. If no braking action is taken by the driver when the vehicle is 10 m from the object, brake assist will be applied using with increasing force. If no braking occurs within 5 m of the object other than the brake assist, the vehicle will brake to a stop.

Data Requirement Recommendations

Recommendation: Address need for data retrieval in connected vehicle interactions with the vehicle

- Connected vehicle systems will allow communication between vehicles (V2V), infrastructure (V2X), and many other systems, known as vehicle-to-anything (V2X).
- As these systems are currently being tested and will be increasing in usage over the next 10 years, these will be increasingly relevant data needs.

Examples:

V2V interaction: an adaptive cruise control system in a following vehicle that uses an on-board unit (OBU) to communicate with a lead vehicle's OBU to understand the lead vehicles throttle and braking patterns. If the lead vehicle's brakes fail, or more likely the brake signal fails, the following vehicle could end up in a rear-end collision, for example.

V2I interaction: In this scenario, a signalized intersection has a roadside unit (RSU) attached to its controller. Vehicles equipped with an OBU can both send the RSU information and receive information from the RSU. The vehicle can use SPaT data from the intersection to determine when the signal will change to green. It is possible the RSU could send incorrect information to the vehicle that would lead the driver or CAV to make a decision to run a red signal in the event that the in-car messages are all that is read. This could be a bigger problem in CV applications failing such as pedestrian warnings or signal priorities.

Data Requirement Recommendations

Recommendation: Enhance lines of communication between stakeholders

- Lines of communications between auto manufacturers and public stakeholders has generally been limited.
- There are many stakeholders who need to be able to, at a minimum, understand the systems that are going onto vehicles, and better, create standards for these systems.
- Stakeholders include NHTSA, ATSIP, MMUCC, AAMVA, State Patrols, etc.

Example:

Develop an ADAS Safety Data Collection Working Group that meets quarterly to discuss new ADAS systems and stakeholder data needs. This will serve as a general idea exchange group that can spawn off ad hoc groups to focus on specific tasks as needed. For example, to develop the standard CAV data repository and determine thorough definitions for ADAS systems that are a good mix between fully understanding system inputs and outputs without delving into manufacturer intellectual property.