NHTSA

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Advanced Driver Assistance Systems Research Overview

Advanced Driver Assistance System Research

ADAS Research Strategic Objective

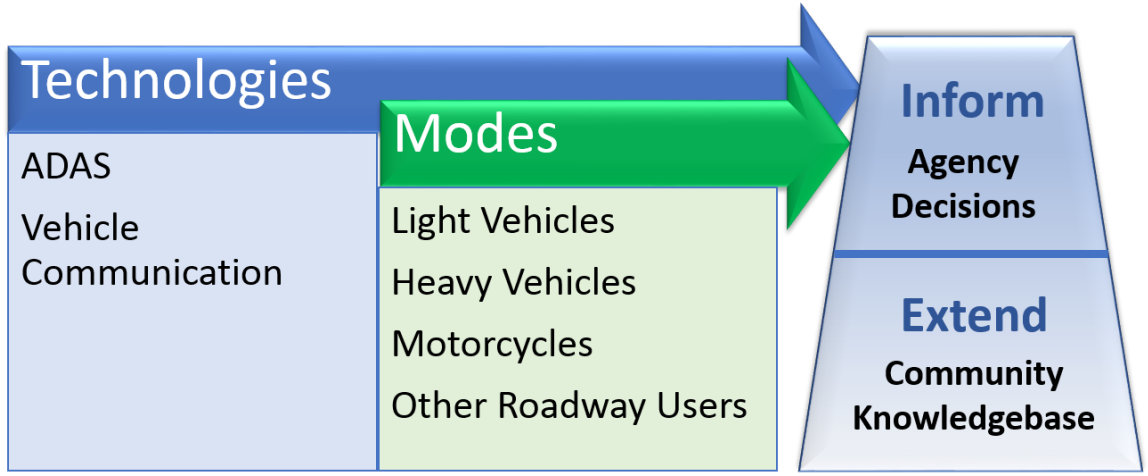
Advance the safe development and deployment of ADAS technologies capable of saving lives and reducing harm

ADAS Research Goals

- Understand enabling technologies & trends
- Establish methods & procedures to measure performance
- Quantify anticipated effectiveness & and safety benefits
- Assess & optimize implementation of vehicle communication technology

Advanced Driver Assistance System Research

ADAS Research Scope



ADAS Research Plan

- Development and refinement of objective test procedures
- Evaluation of system performance and reliability
- Evaluation of safety effectiveness and unintended consequences
- Crash avoidance component and enabling technology research

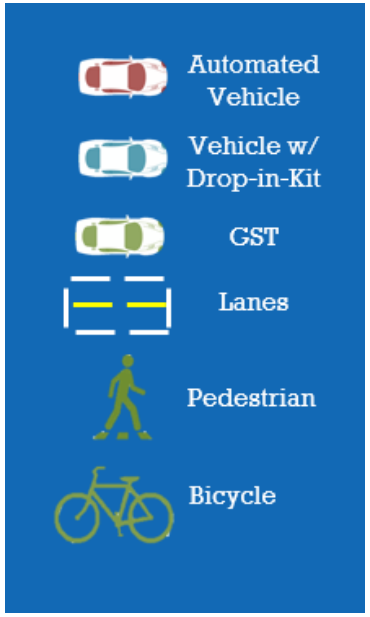
1. NHTSA Draft Test Procedures for ADAS Research
2. ADAS Safety Performance Synthesis & Simulation
3. Radar Congestion Testing
4. Safety Implications of Potential ADAS Sensor Degradation Over Vehicle Lifetime

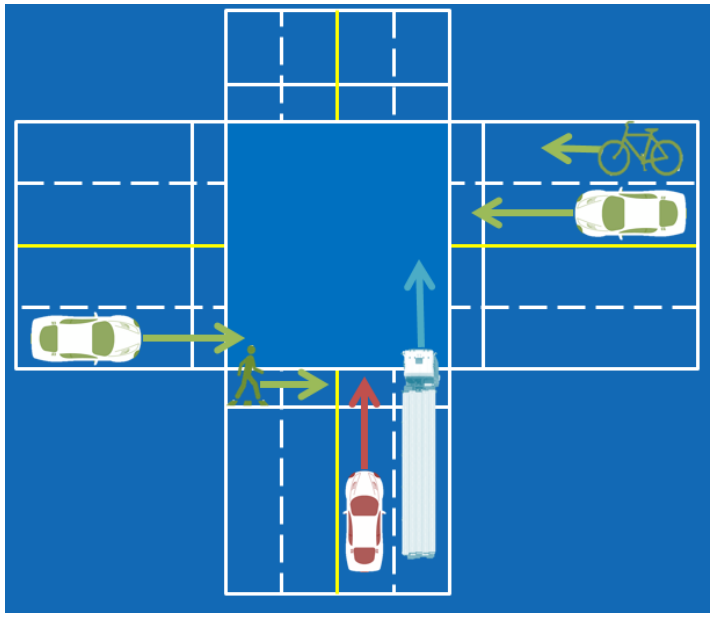
NHTSA's Draft Test Procedures for ADAS Research

Garrick Forkenbrock

ADAS Evaluation Process (for research)

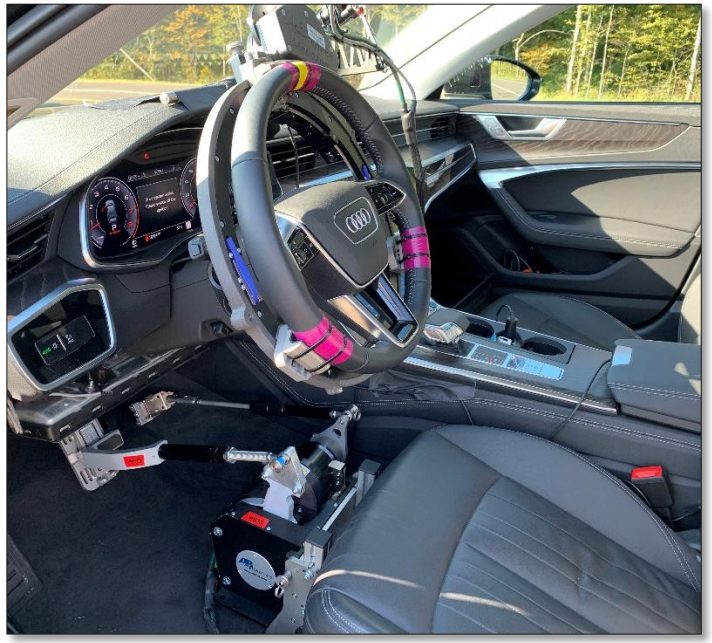
- Develop and validate objective procedures for the latest crash avoidance technologies
- Use appropriate equipment and innovative test methods
- Document and disseminate research findings





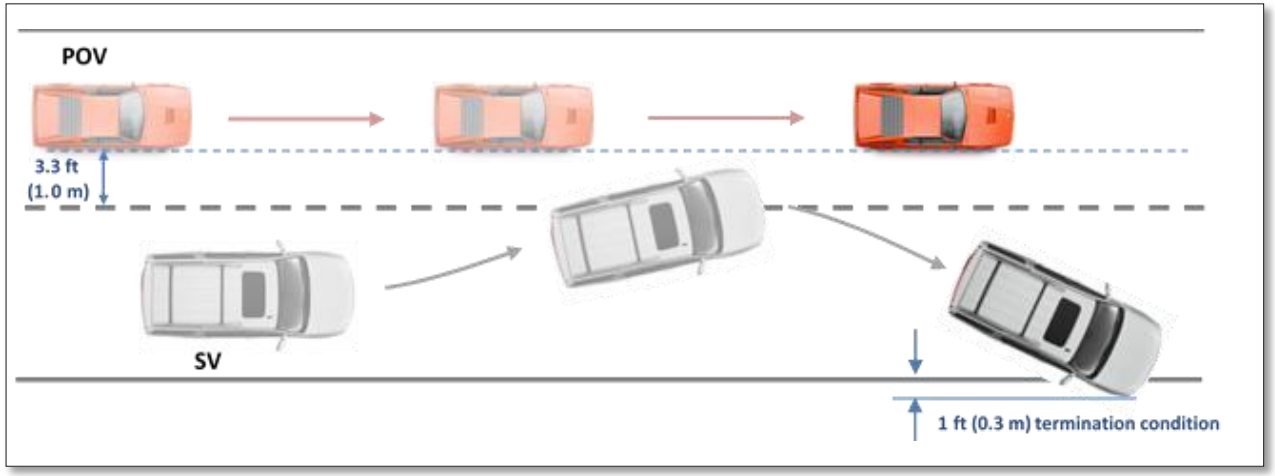
Test Equipment

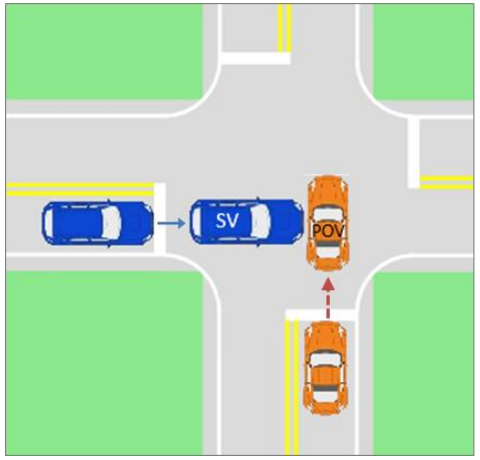
- Robotic control used to accurately choreograph most test scenarios
- Equipment is scalable…closed-loop of up to 5 actors is presently supported
- Experience gained with ADAS applications will be important for future evaluations
  - ADS
  - Simulations validation

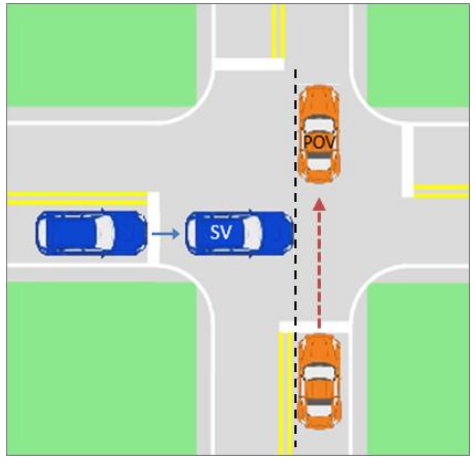


New Draft Research ADAS Test Procedures (Light Vehicle)

- Active Parking Assist
- Blind Spot Detection
- Blind Spot Intervention*
- Intersection Safety Assist*
- Opposing Traffic Safety Assist*
- Pedestrian Automatic Emergency Braking
- Rear Automatic Braking
- Traffic Jam Assist



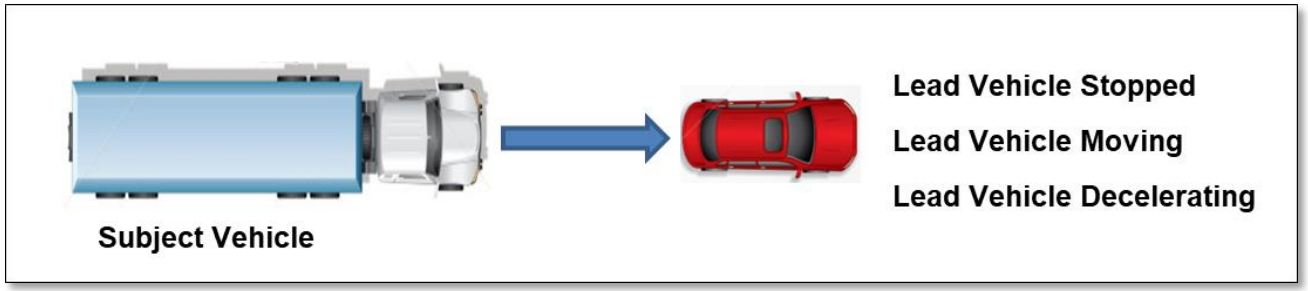


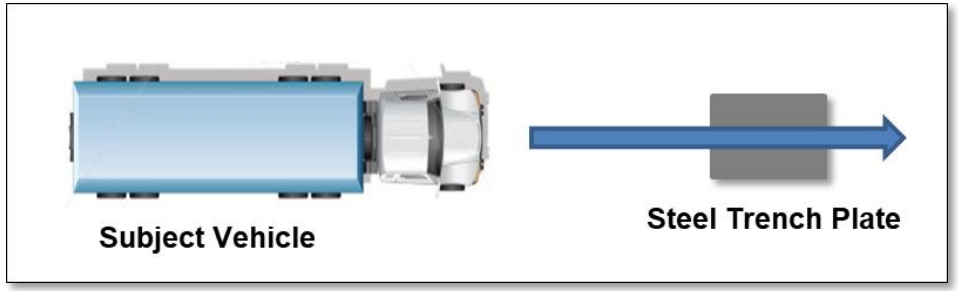


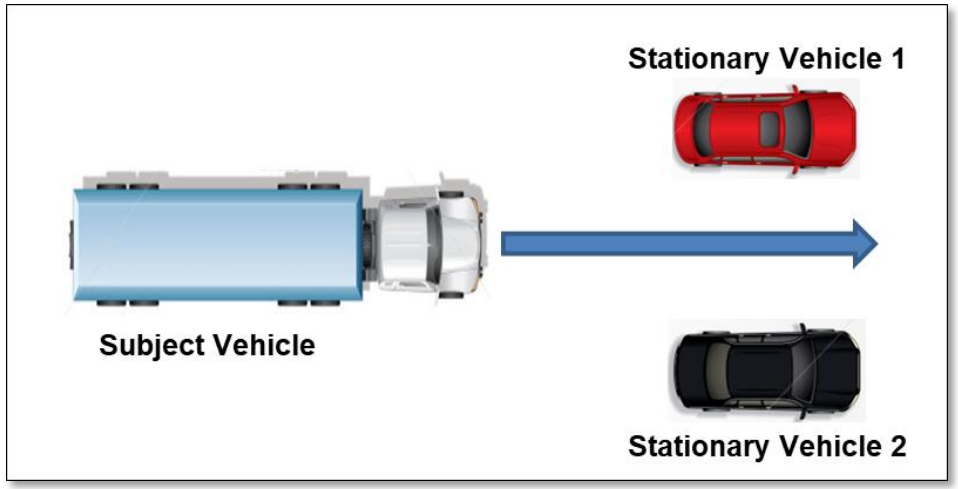
*Include provisions for automation levels 1-3, where applicable

New Draft Research ADAS Test Procedures (Heavy Vehicle)

- Forward Collision Warning
- Automatic Emergency Braking
- DOT HS 812 675
- Presently available from the NTL





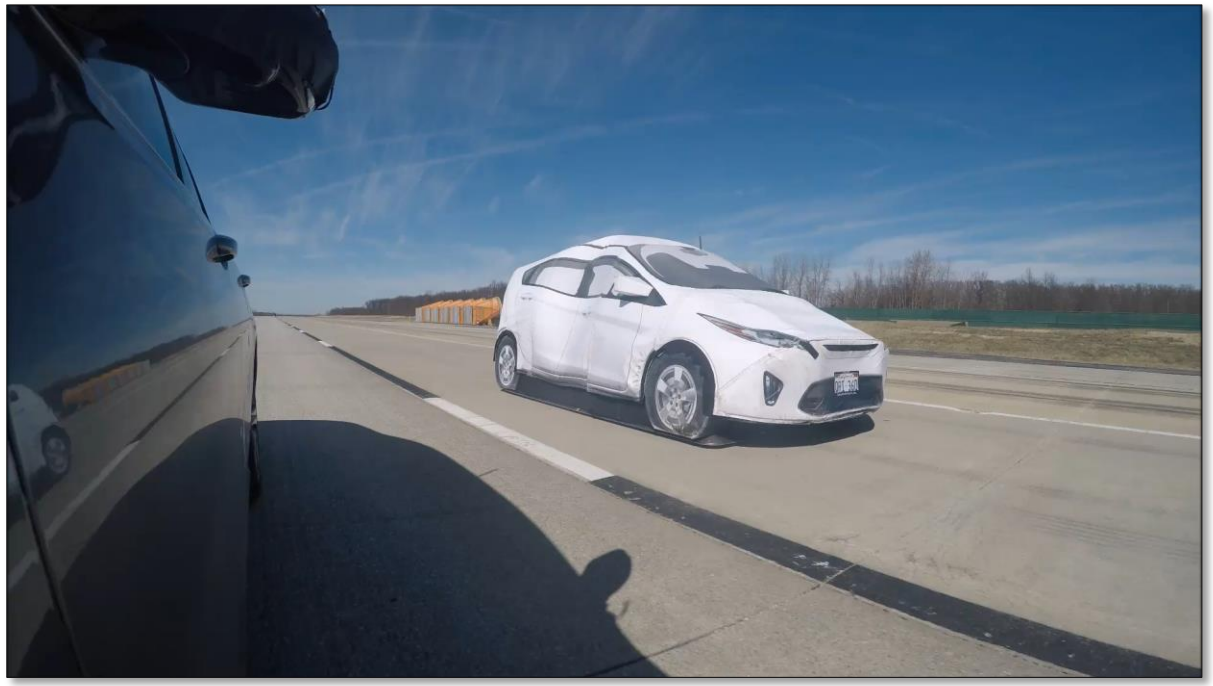


Example: Blind Spot Intervention

Scenario: SV Lane Change with Constant POV Headway, 25_25 mph

Successful Crash Avoidance

POV Impact



Example: Intersection Safety Assist

Scenario: Straight Crossing Path, 25 mph

Example: Intersection Safety Assist

Scenario: POV Left Turn Across Path, 6 mph

Example: Pedestrian Automatic Emergency Braking

Scenario: Obstructed Child Crossing, 25_3.1 mph

Example: Traffic Jam Assist

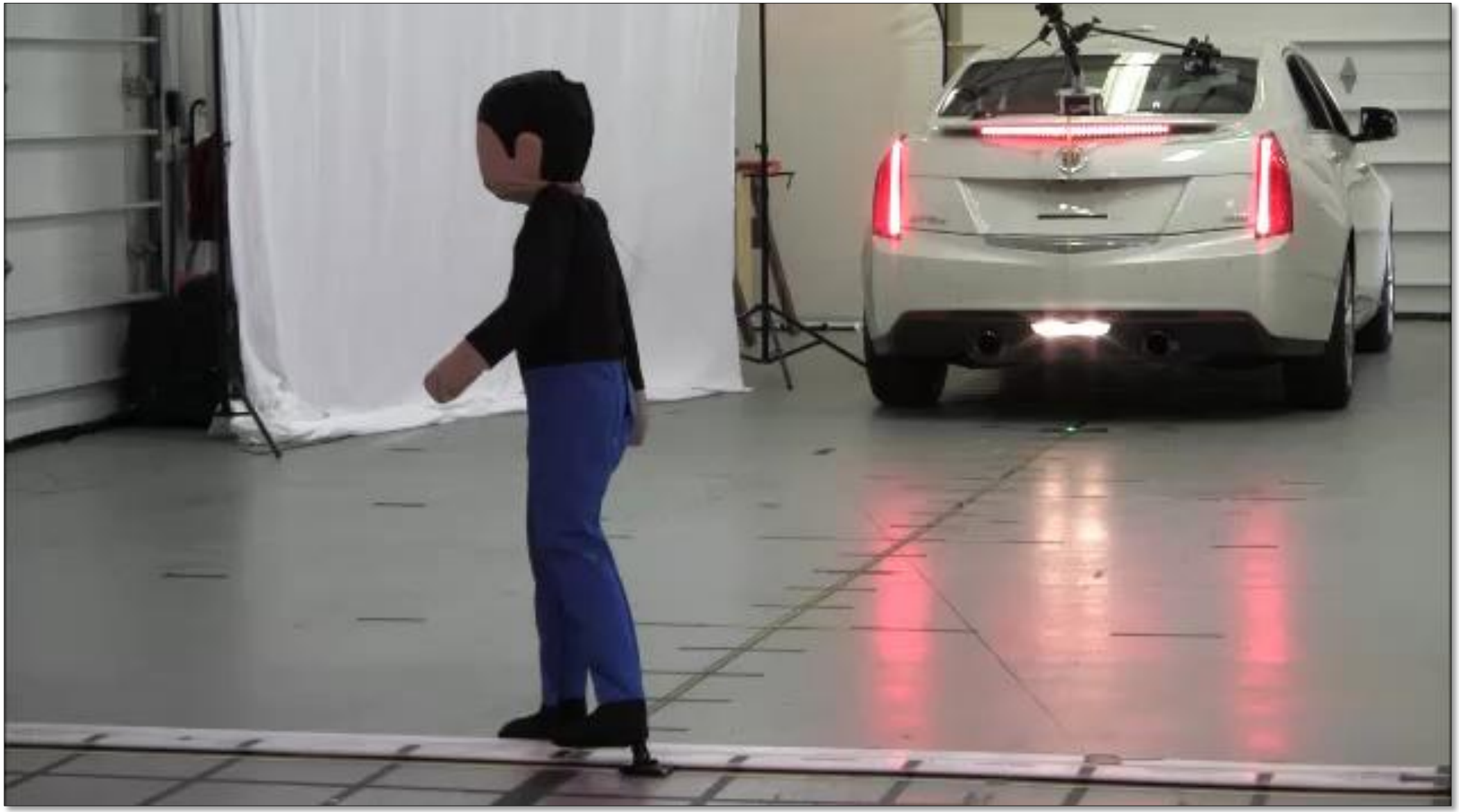
Scenario: Cut-in from an Adjacent Lane, 25 mph

Example: Opposing Traffic Safety Assist

Scenario: Drift Into Adjacent Lane, 25_25 mph

Example: Rear Automatic Braking

Scenario: Zero Offset (see DOT HS 812 766)



Example: Heavy Vehicle AEB

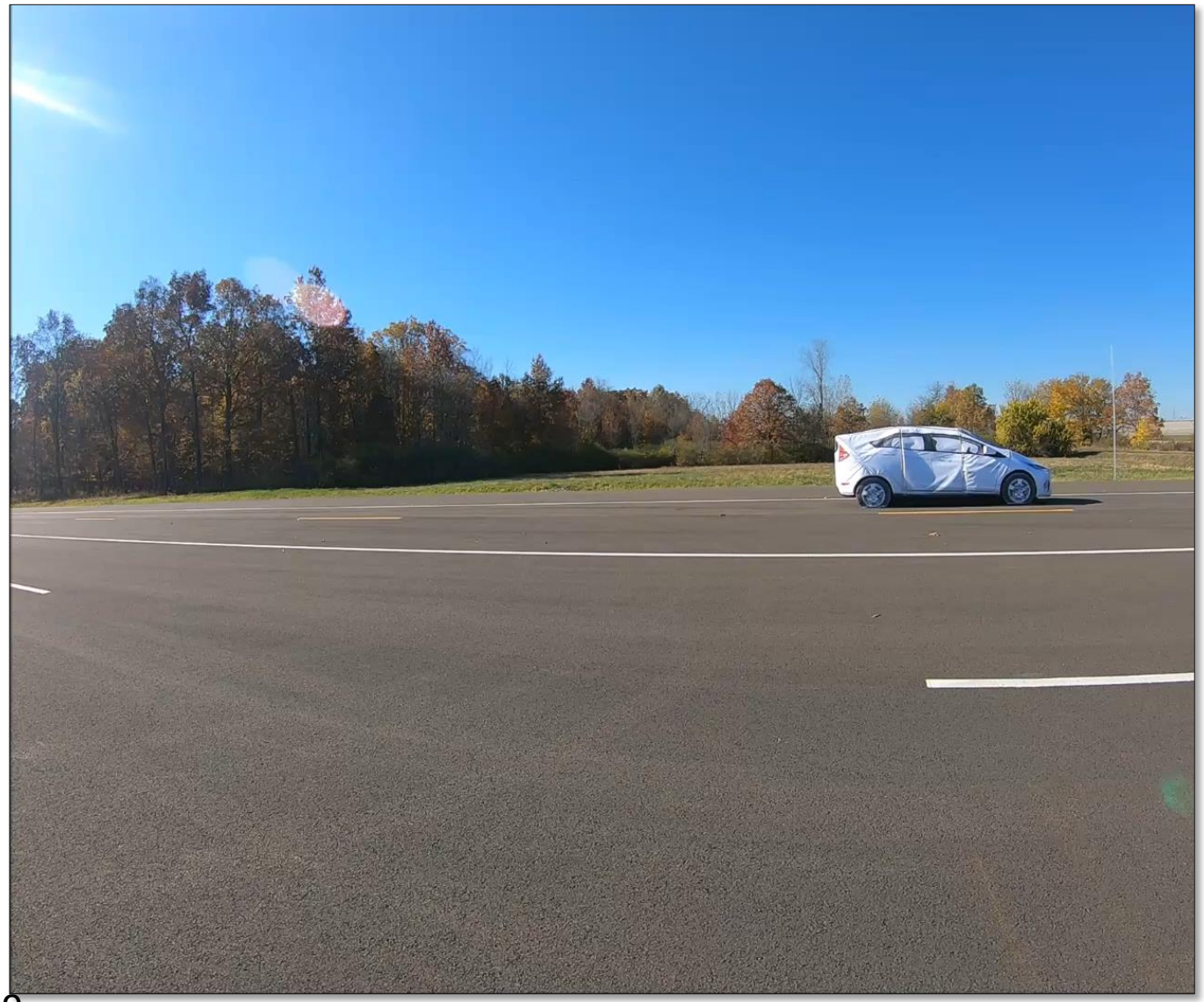
Scenario: Lead Vehicle Stopped, 25 mph

Example: Traffic Jam Assist

Scenario: Sudden Reveal, 5 Actors

Example: Traffic Jam Assist

Scenario: Sudden Reveal, 5 Actors



Concluding Remarks

- NHTSA's new ADAS draft test procedures and test tools allow us to research most systems presently available
- These systems now map to a large number of pre-crash scenarios, however…
  - Actual real-world operation (and therefore effectiveness) of systems now in production may require very specific conditions be satisfied
  - Understanding the existence of these differences is important
- Providing common test methodology may help improve the real-world applicability of these technologies

Test Procedure Questions?

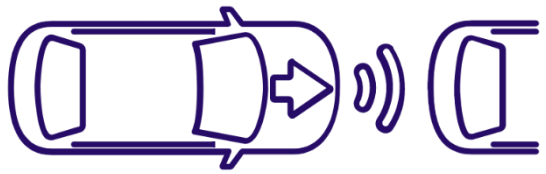
ADAS Safety Performance Synthesis & Simulation

Rob Heilman

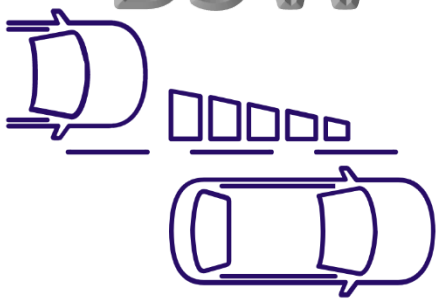
ADAS Safety Performance Synthesis & Simulation

- Motivation
  - ADAS applications proliferating throughout the automotive market
  - Known effects of ADAS deployment results in positive safety benefits
- Research Question
  - How effective are production ADAS applications in producing safety benefits?
  - How is ADAS effectiveness best characterized and quantified?

AEB



BSW



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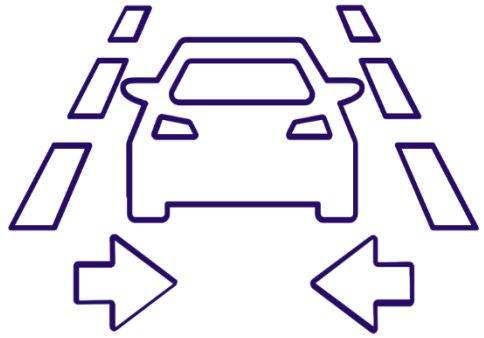
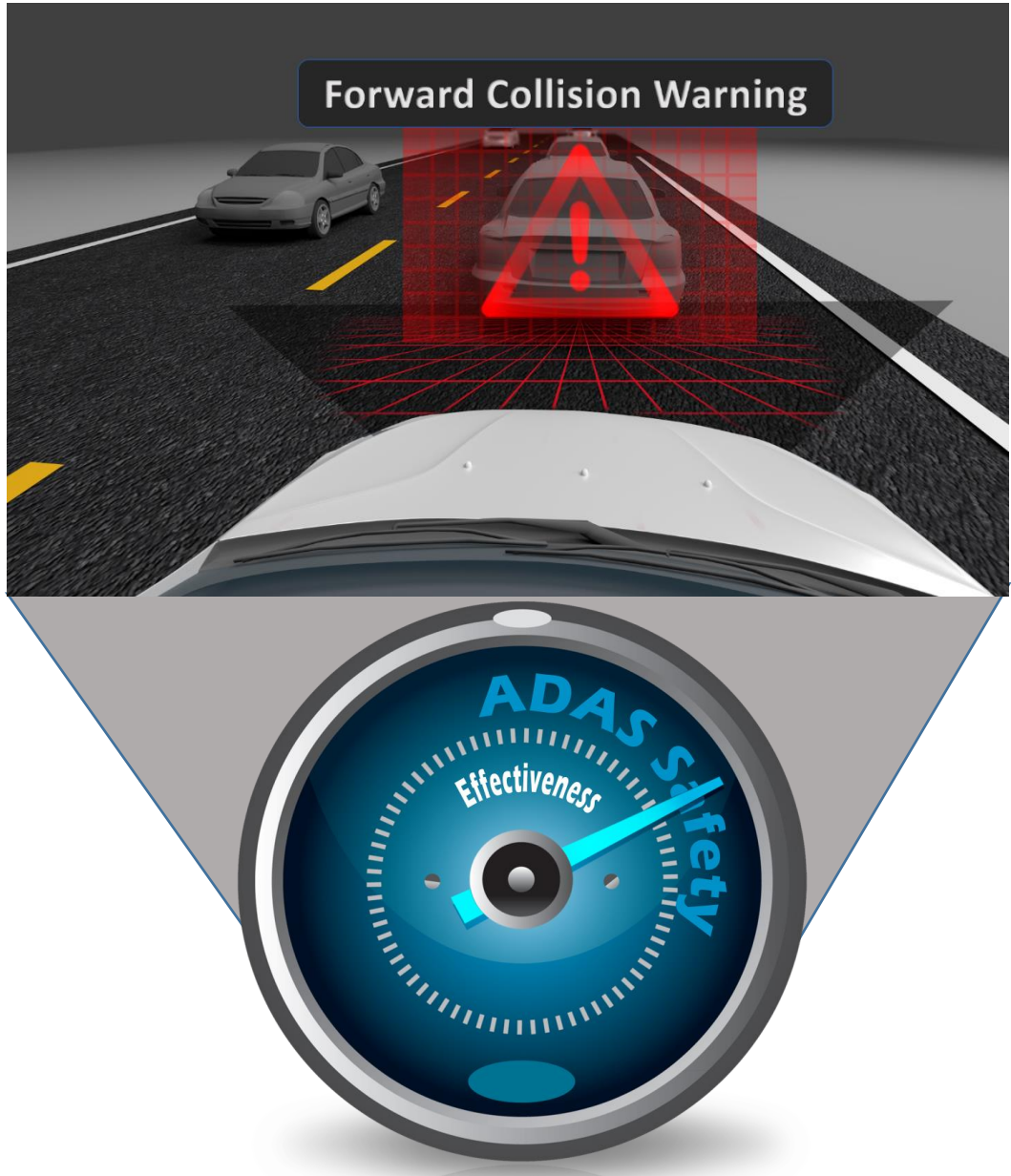


ADAS Safety Performance Synthesis & Simulation

- Document synthesis of ADAS research and data acquisition to date
- Update & validate NHTSA ADAS effectiveness simulation tool with ADAS test data
- Use simulation and test data to assess effectiveness of key ADAS applications
- Apply effectiveness measures in performing ADAS safety benefits analyses

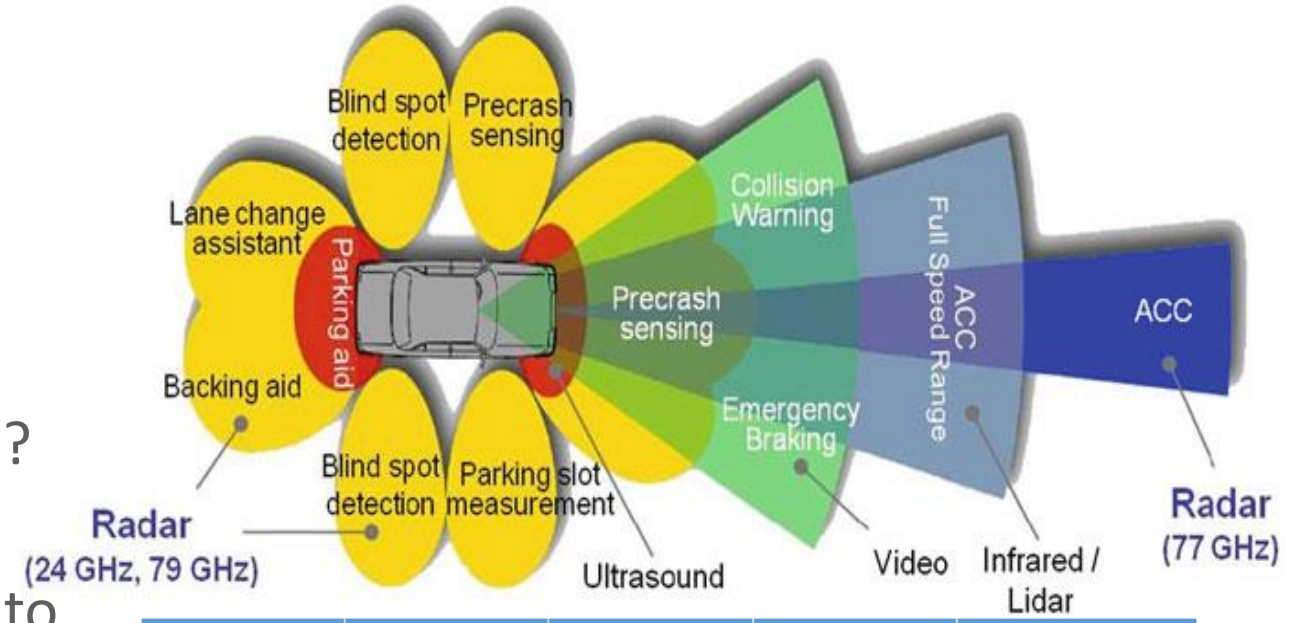


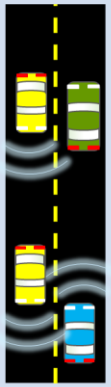
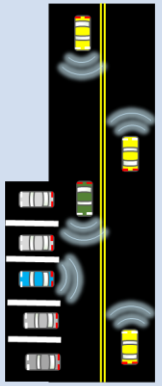
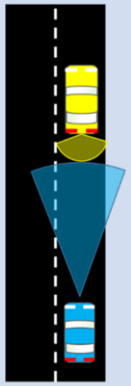
Radar Congestion Testing

Dr. Stephen Stasko

Radar Congestion Testing

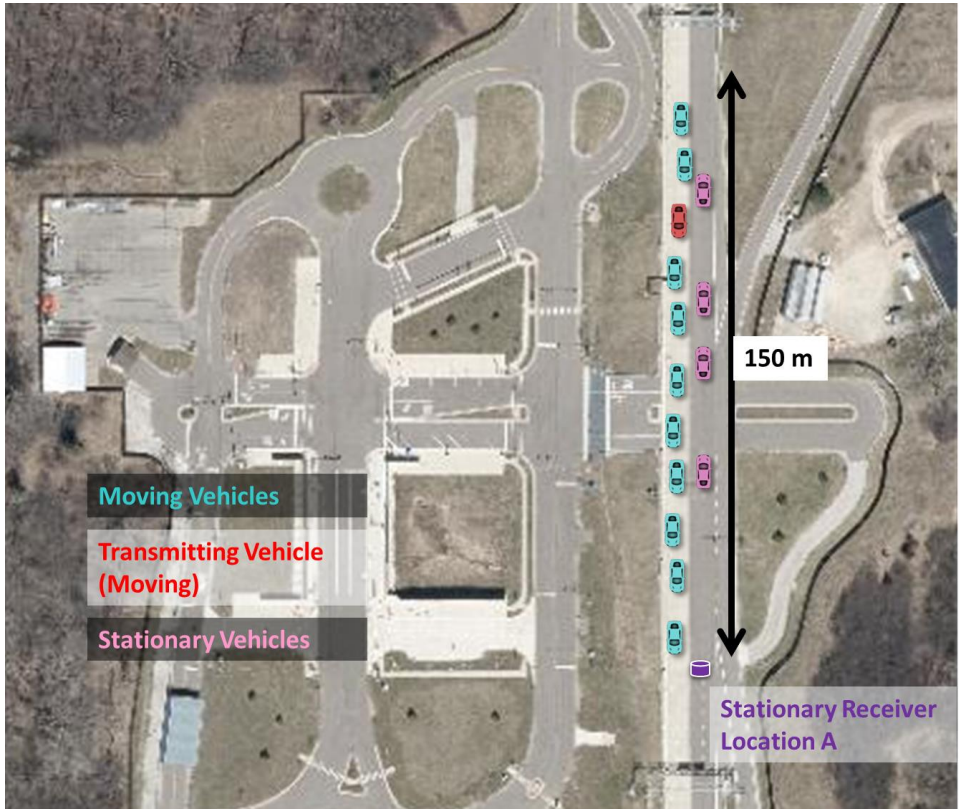
- Motivation
  - Proliferation of radars on modern vehicles
- Research Question
  - Is radar & perception performance impacted by dense radar environments?
- Initial Work
  - Identify & model challenging scenarios to measure:
    - Raw interference power of other radars
    - Effect on performance
  - Simulation suggests that, absent mitigation, radars will be challenged to work in select environments



SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Opposing Traffic	Multiple Lane Congestion	Side-by-Side Forward Illumination	Backing Out of Parking Space	Rear and forward facing in traffic
Case1: Ego LRR, Inter. LRR Case2: Ego MRR, Inter. MRR	Case1: Ego LRR, Inter. LRR Case2: Ego MRR, Inter. MRR	Case1: Ego LRR, Inter. LRR Case2: Ego MRR, Inter. MRR	Case1: Ego SRR, Inter. LRR Case2: Ego SRR, Inter. MRR	Case1: Ego LRR, Inter. SRR Case2: Ego SRR, Inter. LRR
				

Radar Congestion Testing

- Track Testing initiated to empirically measure interference in automotive radar band 76-81 GHz
  - Characterize the received power in realistic environments and improve the model
    - Path loss, Doppler spread, multipath
  - Refine & validate the simulation with improved channel model
- Develop test procedures to measure the impact of radar interference
  - Sensor and Vehicle level performance testing
  - Evaluate the effectiveness of production radars to mitigate interference

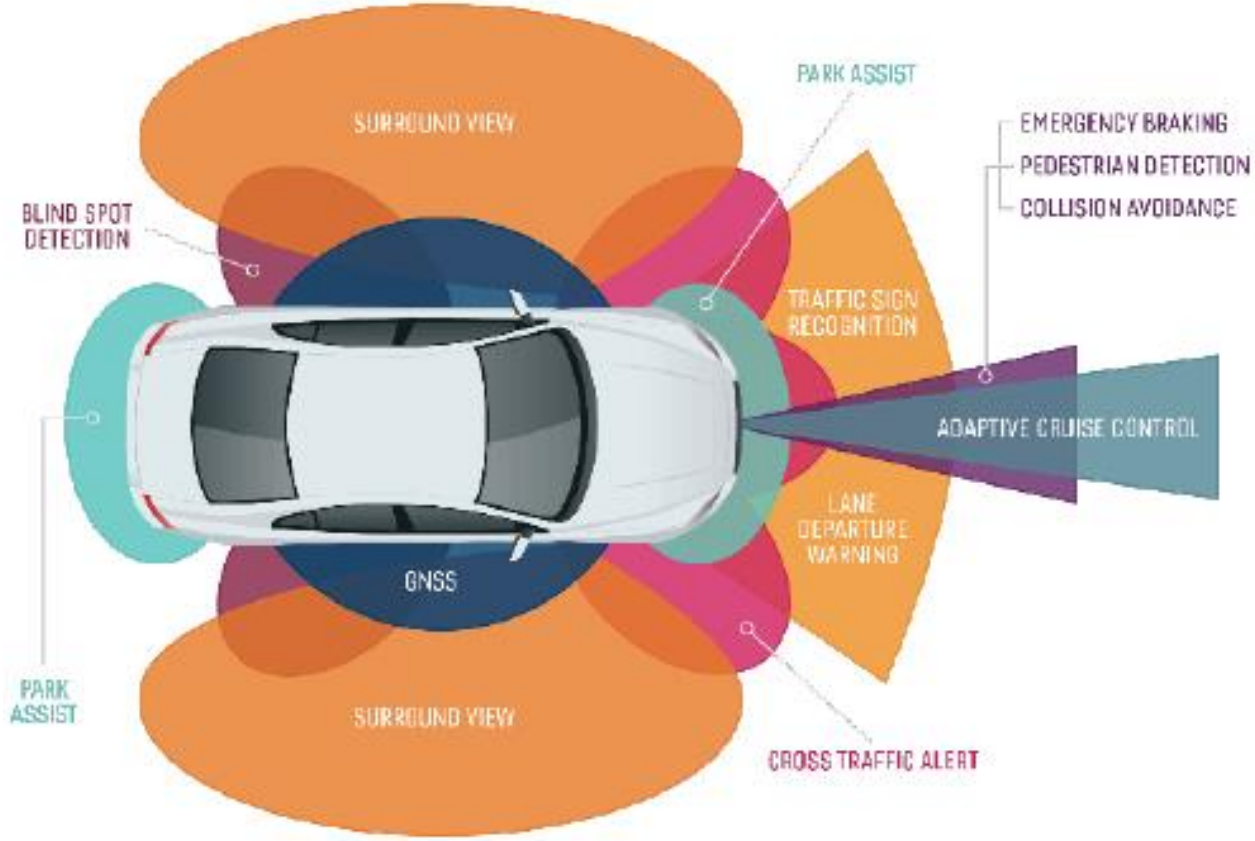


Safety Implications of Potential Advanced Driver Assistance System (ADAS) Sensor Degradation Over Vehicle Lifetime

Dr. Stephen Stasko

Sensor Degradation Study

- Motivation
  - Proliferation of Sensors
  - Criticality of sensor performance to safety
  - Increasing average vehicle age
- Research Questions:
  - What are the sources of degradation?
  - How can degradation be quantified?
  - How can the effect on sensor output be quantified?
  - **What effect may sensor degradation have on ADAS performance over the vehicle lifetime?**



Sensor Degradation Study Approach

- Knowledge Acquisition
  - Literature search
  - Industry interviews
- Testing & Data Acquisition
  - Degradation
    - Simulate and validate
  - Sensor Output
    - Test degraded sensor against baseline
    - Quantify any reduction in sensor output
  - System
    - Select sample degradations
    - Test ADAS system with degraded sensor against baseline ADAS without degradations
    - Document system performance impacts