NHTSA

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Exploring the Practical Limits of Multi-Actor Test Track Evaluations

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Agenda

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1. **Test Target Evolution**
2. **Current Test Scenario Expansion**
3. **Testing Challenges**
4. **Concluding Remarks**

Earlier-Generation Test Equipment

Vehicle Targets

- Balloon cars
- Strikeable Surrogate Vehicle
- Smart Car Guided Soft Target

Robotic Controllers

- ATI Heitz steering machine and brake actuator

Pedestrian Targets

- 4a articulated
- TASI
- NHTSA-developed

Motivation for Test Target Advancement

- Initially, rear-end crash scenarios were the focus
  - Large crash population
  - Test targets limited to longitudinal tests
- Later, a need to support new ADAS[1]/ADS[2] technologies emerged
  - Test targets with improved realism and applicability
  - Required by the testing community for research and performance assessments

[1]Advanced Driver Assistance System

[2]Automated Driving System

Sample Driving Examples Relevant to ADAS/ADS Operation

- References
  - Pre-Crash Scenario Typology for Crash Avoidance Research
  - Description of Light-Vehicle Pre-Crash Scenarios for Safety Applications Based on V2V Communications
  - Development of California Regulations to Govern the Testing and Operation of Automated Driving Systems
- Used to guide equipment selection
  - Type of actors
  - Number of actors

No.	Driving Examples
1	Respond to speed limit change and speed advisory
2	Perform high/low-speed merge
3	Move out of travel lane and park
4	Respond to encroaching oncoming vehicle
5	Detect passing and no passing zones and perform passing
6	Perform car following (including stop and go)
7	Respond to stopping vehicle
8	Respond to lane changes
9	Respond to static obstacle in path
10	Navigate intersections and perform turns
11	Navigate roundabouts
12	Navigate a parking lot and locate spaces
13	Respond to work zones and person directed traffic
14	Respond to access restrictions
15	Make appropriate right-of-way decisions
16	Respond to emergency vehicles & bus
17	Yield and provide safe distance for peds and bikes
18	Animal crash avoidance
19	Back out of urban area (viewing obstructions on both sides)
20	Respond to encroaching vehicle same direction

Current-Generation Test Tools

- Global Vehicle Target
- Robotic platforms
- Robotic steering, brake, and throttle controllers
- Vulnerable road users
- Synchronization of up to 5 actors

Scenario Expansion

- The new test tools were used to develop and validate the draft research test procedures announced in the November 2019 ADAS request for comment
  - 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
- Multi-actor scenarios are now being evaluated for research purposes

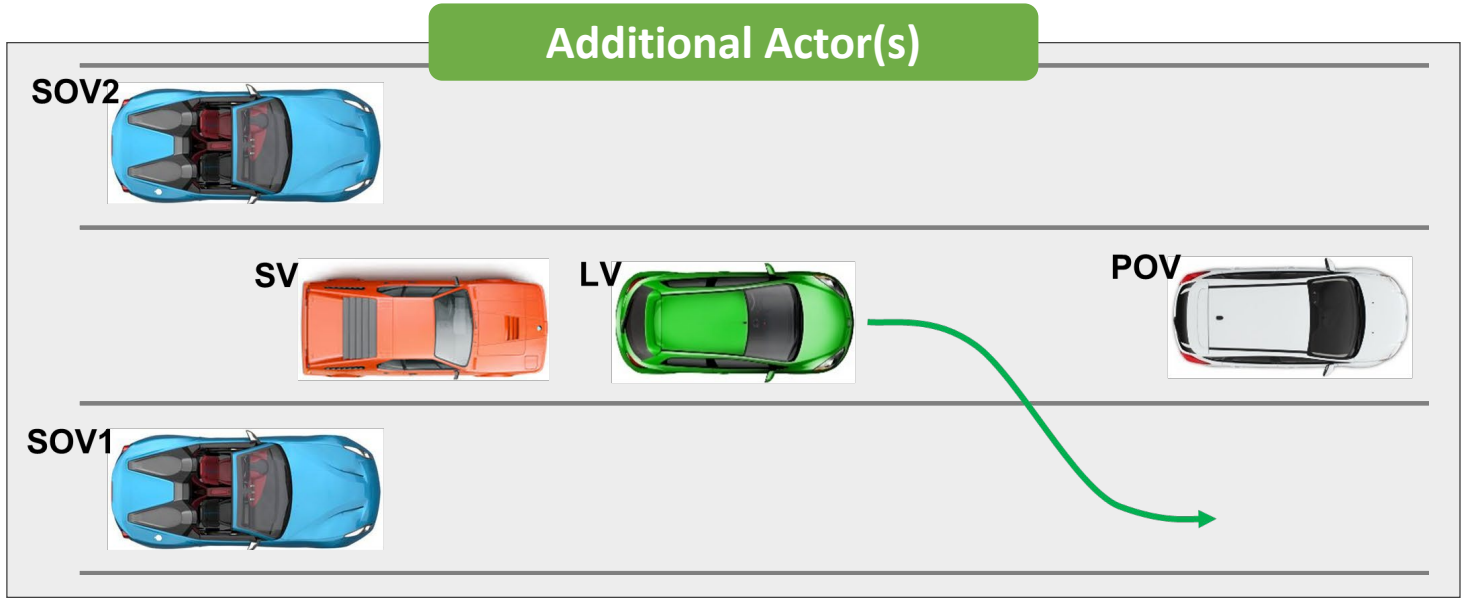
Traffic Jam Assist Multi-Actor Test Development

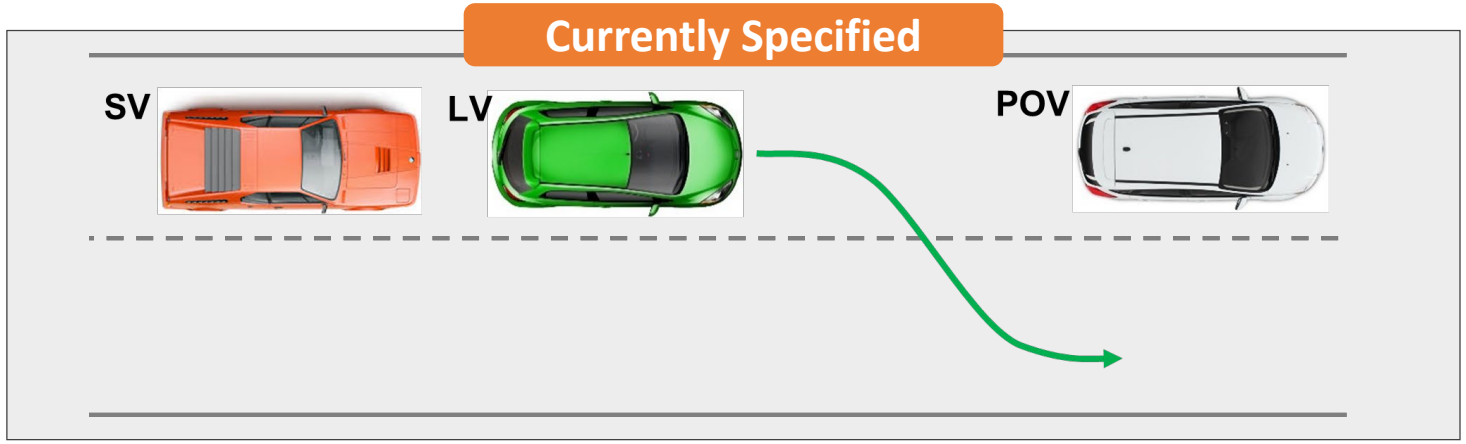
Suddenly Revealed Stopped Vehicle

Higher

Test Complexity

Lower





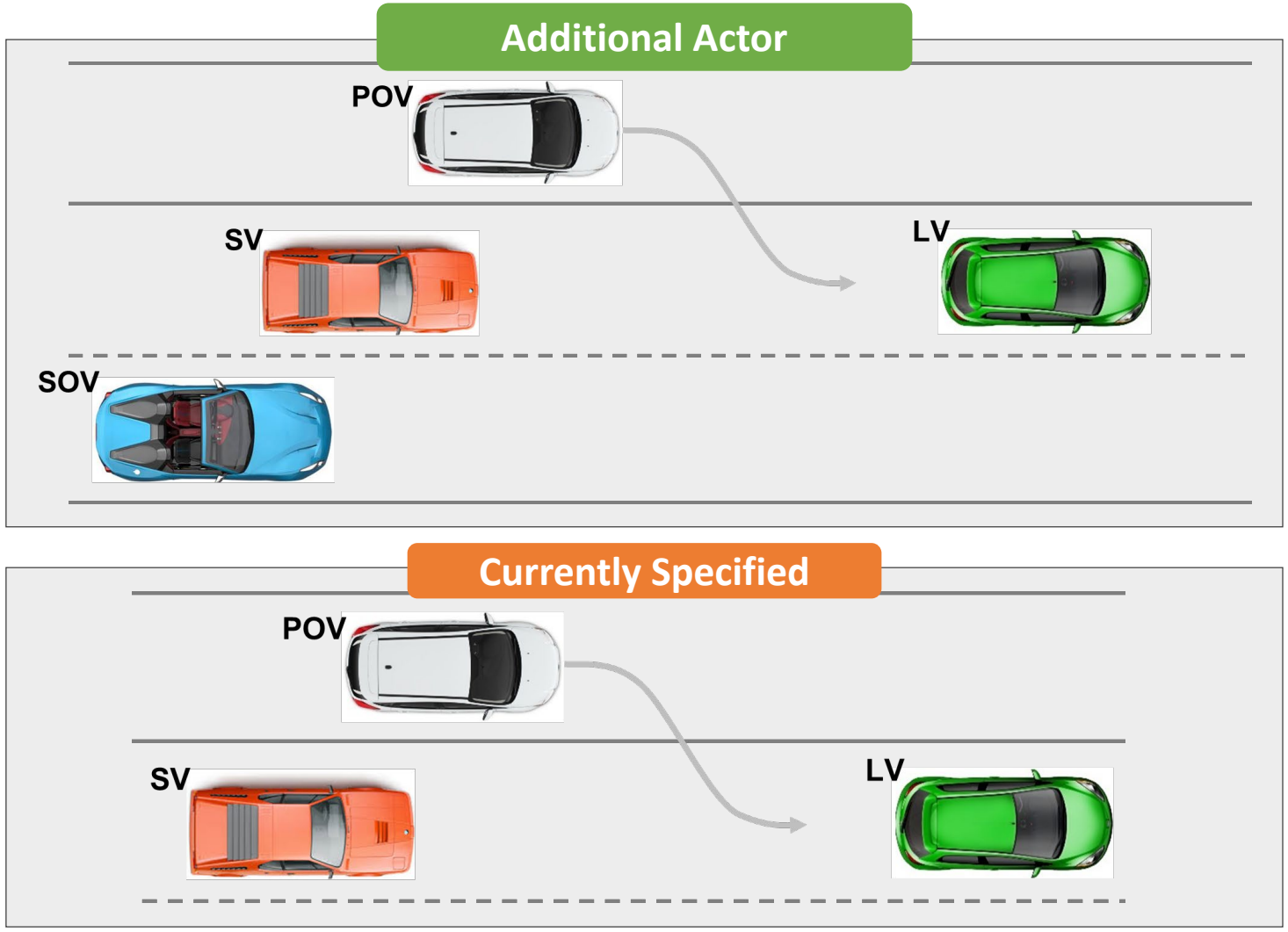
Traffic Jam Assist Multi-Actor Test Development

Lead Vehicle Lane Change with Braking

Higher

Test Complexity

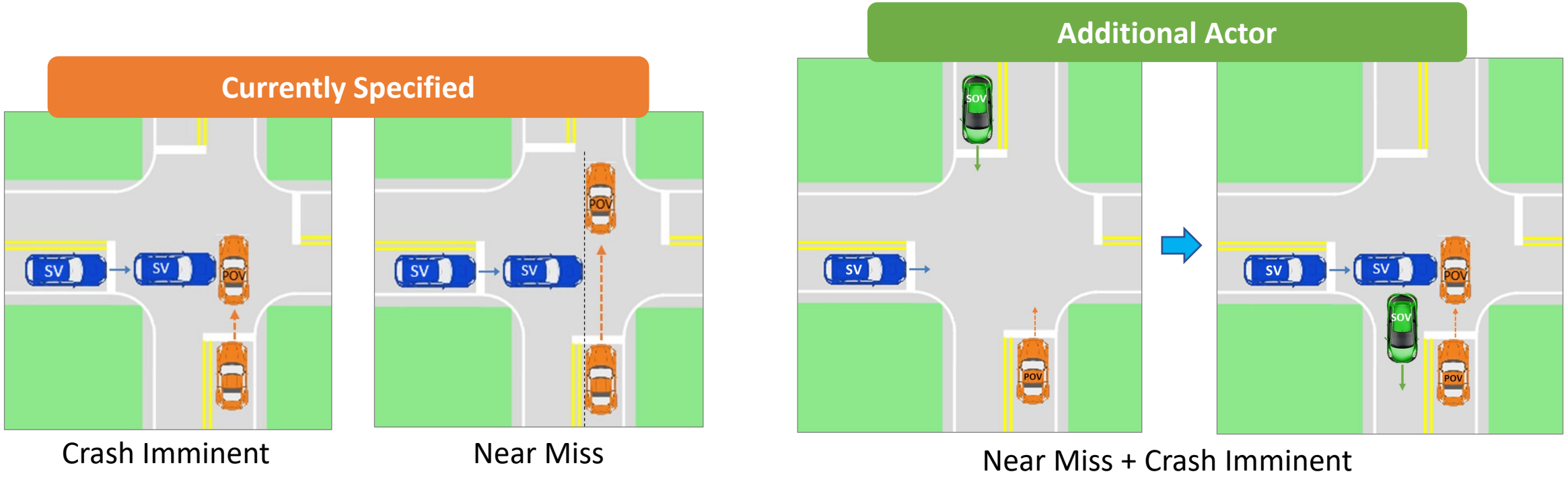
Lower



Traffic Jam Assist 5-Actor Example

Intersection Safety Assist Multi-Actor Test Development

Straight Across Path



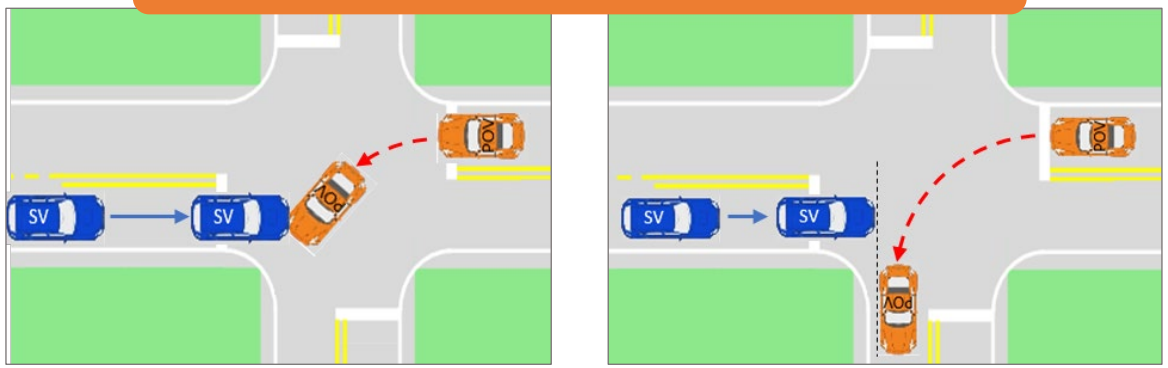
Lower → Higher

Test Complexity

Intersection Safety Assist Multi-Actor Test Development

POV Left Turn Across SV Path

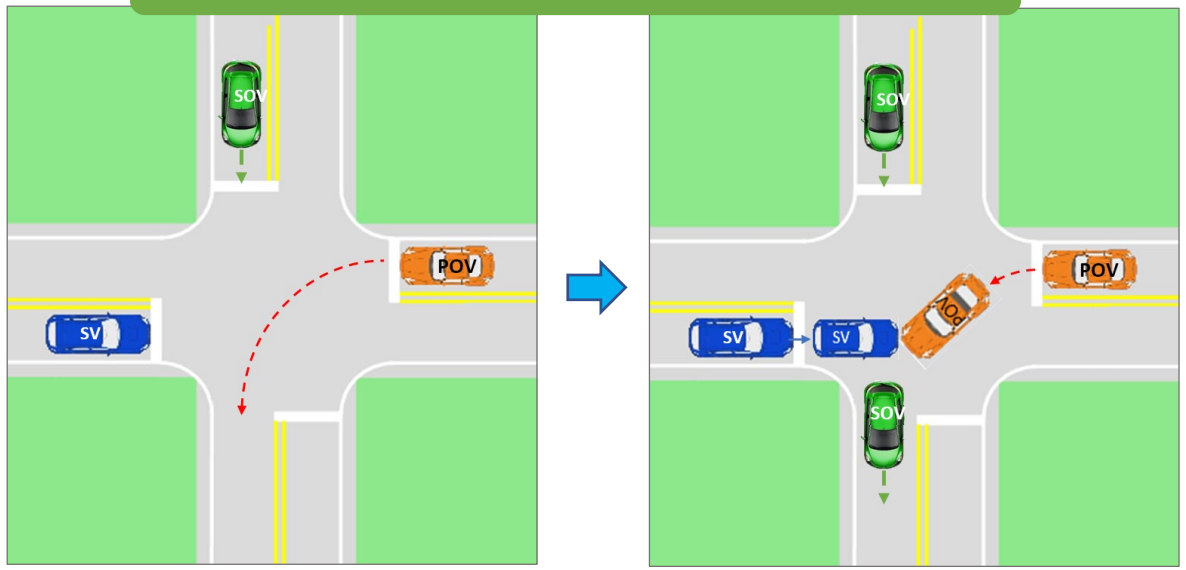
Currently Specified



Crash Imminent

Near Miss

Additional Actor



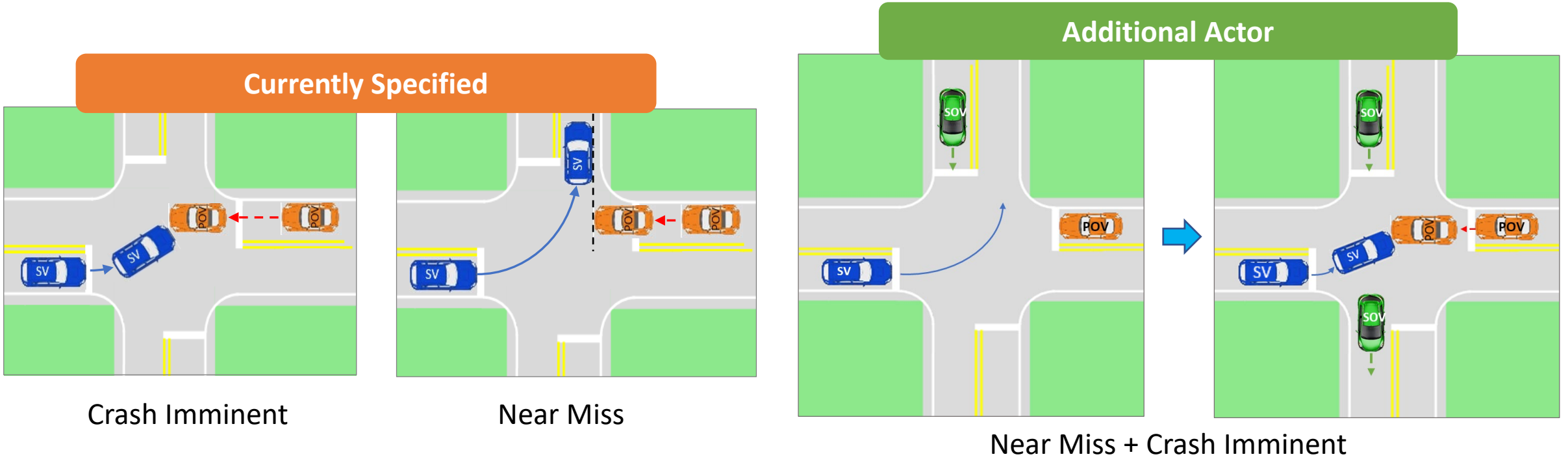
Near Miss + Crash Imminent

Lower → Higher

Test Complexity

Intersection Safety Assist Multi-Actor Test Development

SV Left Turn Across POV Path



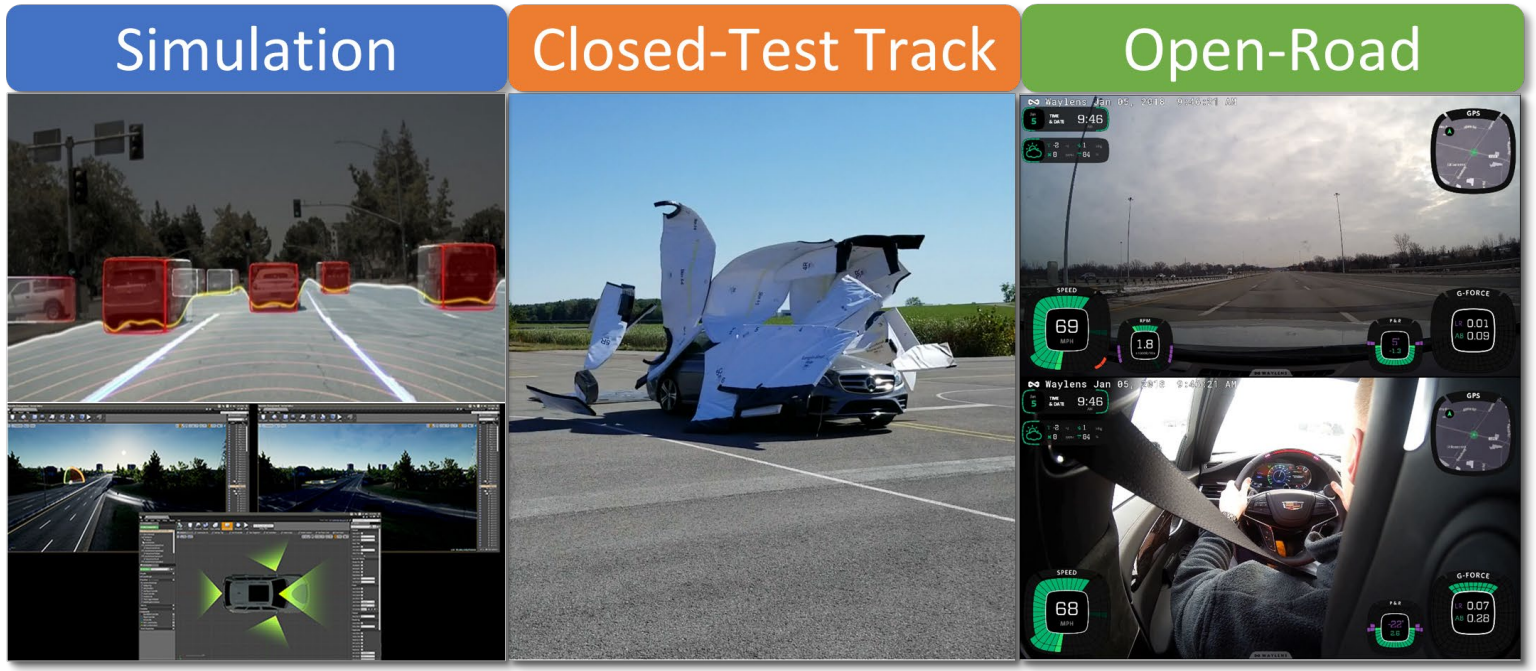
Lower → Higher

Test Complexity

Supporting ADS Relevant Research

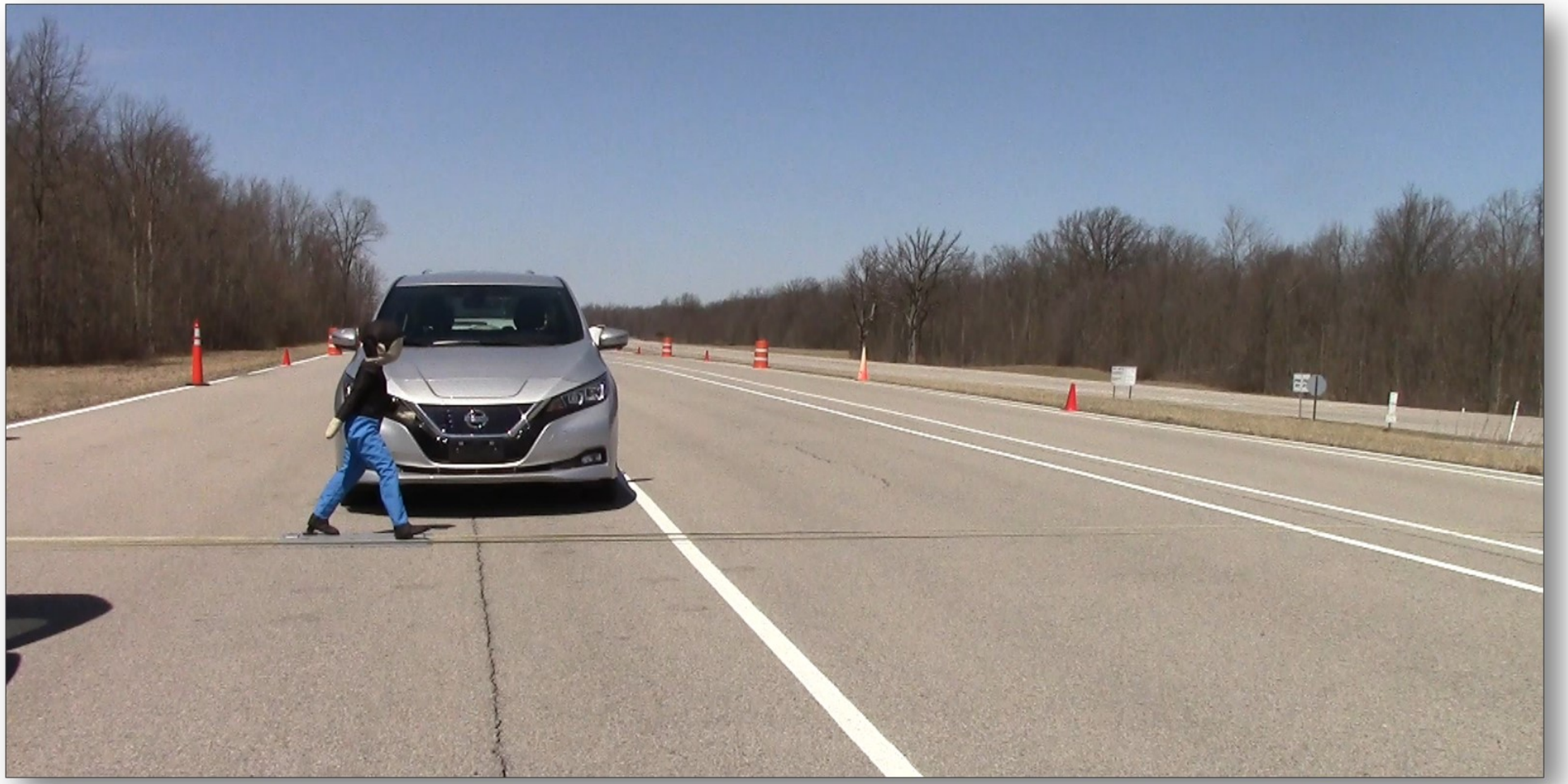
Use of these tools is not only important for understanding, and objectively quantifying, the performance the latest ADAS features, but also

- ADS test track research
- Simulation validation



Low Speed Shuttle Testing (Level 4 Automation)

PAEB Obstructed Child Scenario



Acknowledgment of Higher Test Burden

- Although advanced test tools have dramatically expanded testing capabilities, their use can impose a high test burden
  - Constant communication among the various actors must be realized
  - More actors = increased time spent preparing and maintaining equipment
  - When impacts occur with one (or more) of the test targets, the time needed to reset and reinitialize can significantly reduce the number of tests performed per day
- These concerns are common among industry and other testing organizations
- The level-of-effort needed to accurately perform complex scenarios must be weighed against what the test results will be used for

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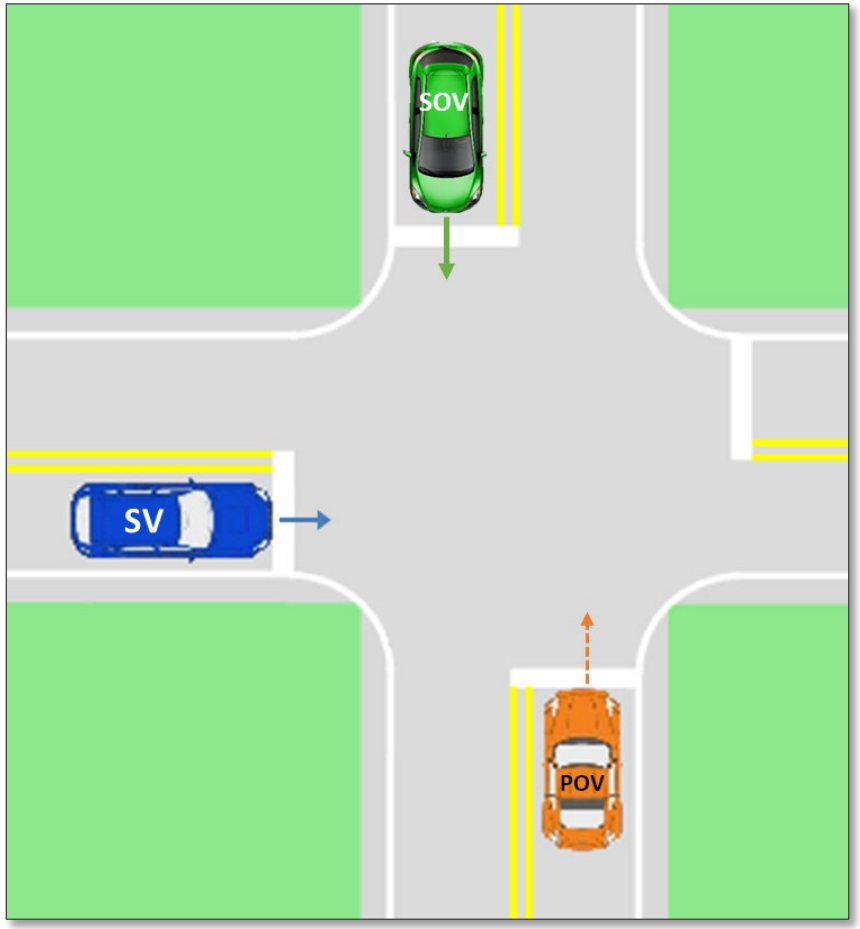
Scalability Example (Simple)



Scalability Example (Complex)

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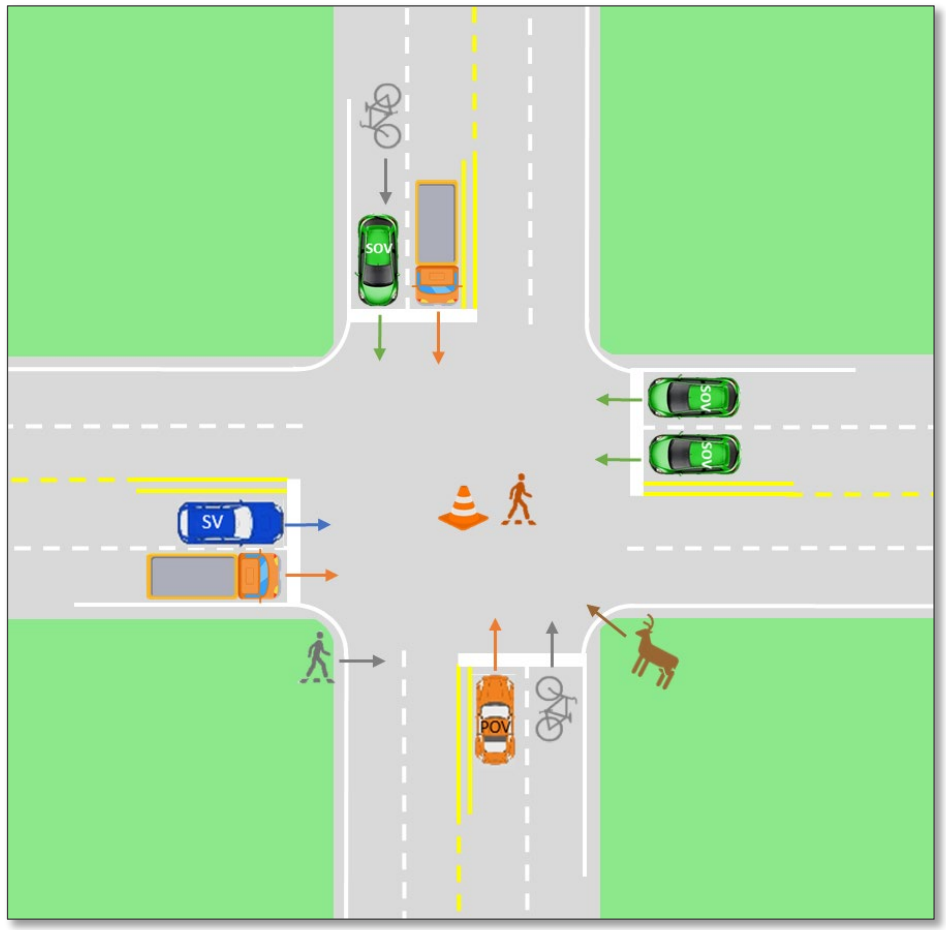

Unexpected Events Will Happen…

What's the Solution?

- NHTSA is still trying to understand the factors needed to determine the best balance of test track versus other methods, such as simulation
- Collaboration within the research community is essential
- Identifying a common testing approach is desired

Concluding Remarks

- The intent of this discussion is not to dismiss the importance of performing track-based evaluations
  - Contemporary test tools have introduced an unquestionably important capability
  - When properly executed, such evaluations will always play an important role in quantifying a vehicle's performance
- Rather, we acknowledge the test burden associated with the use of complex and highly synchronized track-based efforts, and why NHTSA must determine the role of simulation in its research efforts
- Industry feedback regarding these matters is of great interest

Contacts for Additional Information

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Questions?

Thank you!