NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Test Procedure Verification for Blind Spot Intervention and Oncoming Traffic Safety Assist

Taylor Manahan
Transportation Research Center, Inc.

Garrick Forkenbrock
National Highway Traffic Safety Administration

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AGENDA

1. Research Objective
2. Test Methods
3. Observations and Results
4. Concluding Remarks

Research Objective

The tests described in today's presentation:

- Were assembled for research purposes
- Provide a way to objectively define, document, and disseminate how BSI and OTSA tests may be performed on the test track
- Help assess the state-of-technology
- Will be useful for evaluating vehicles with higher levels of automation in the future

Blind Spot Intervention (BSI)

- Designed to actively help the driver avoid crashing into another vehicle in an adjacent lane
- Uses steering and/or differential braking to return vehicle back into original travel lane

Subject and Principal Other Vehicles (SV and POV)

2017 BMW 540i

- Active steering for BSI response
- Operational threshold speed of 45 mph

Guided Soft Target (GST)

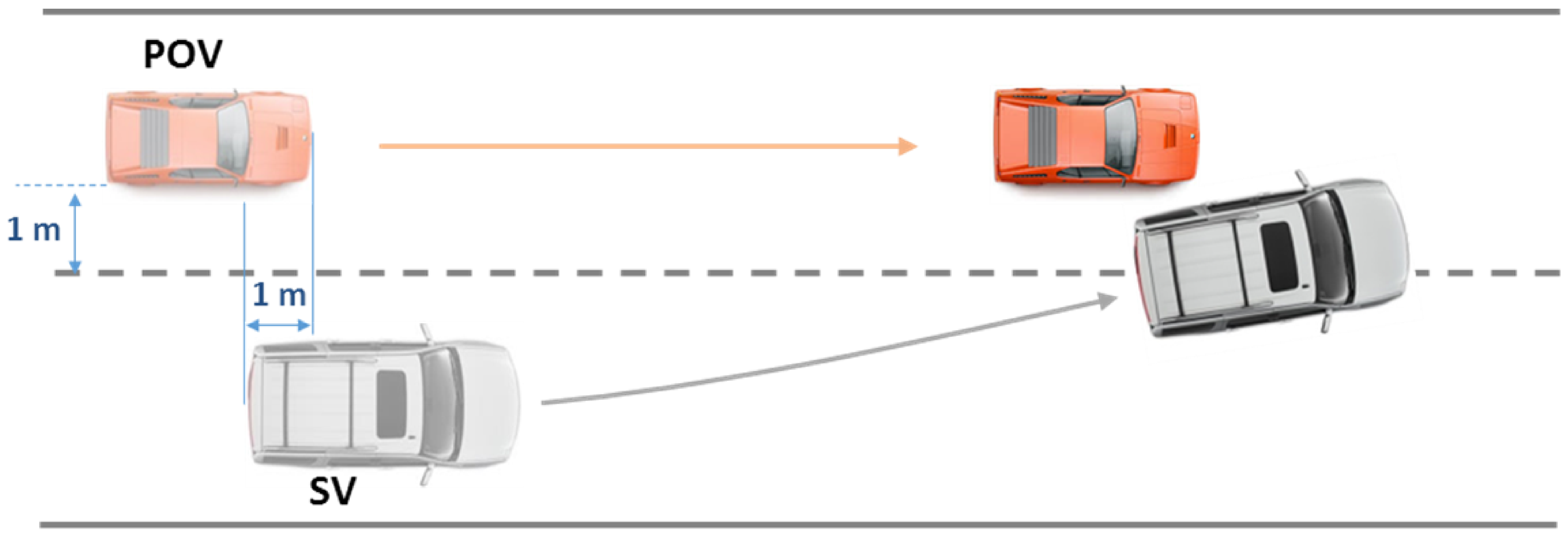
- Low Profile Robotic Vehicle
- Global Vehicle Target (GVT) Revision F

Test Conditions

- Three scenarios defined in the April 2018 draft research test procedure
    - 3 repeated trials per condition
- Robotic steering controller used for SV heading changes
- 0.7 m/s SV lateral velocity towards the left adjacent lane line
    - Emulates an intentional lane change
- TP includes provisions for performing tests with up to SAE automation level 3
    - **Only those relevant to SAE L0 discussed today**

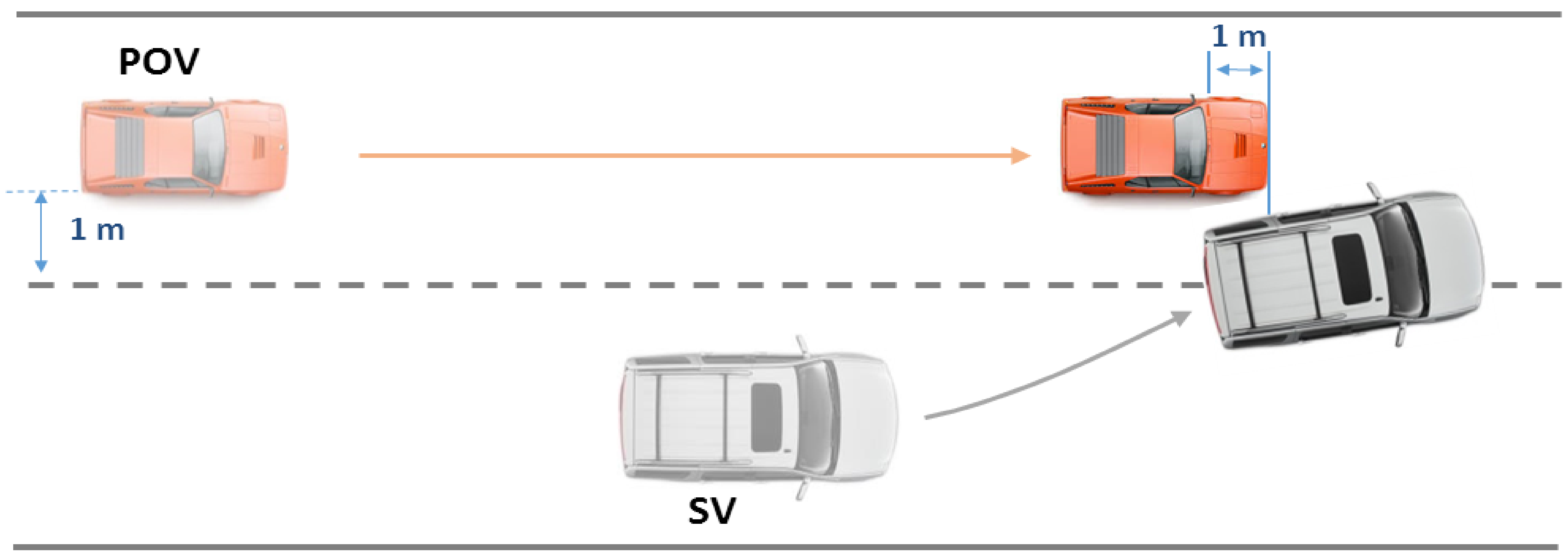
Scenario 1: Constant Headway

- $SV_{speed} = POV_{speed} = 45$ mph
- Robotically-controlled SV steering released within 250 ms after establishing heading toward left lane line



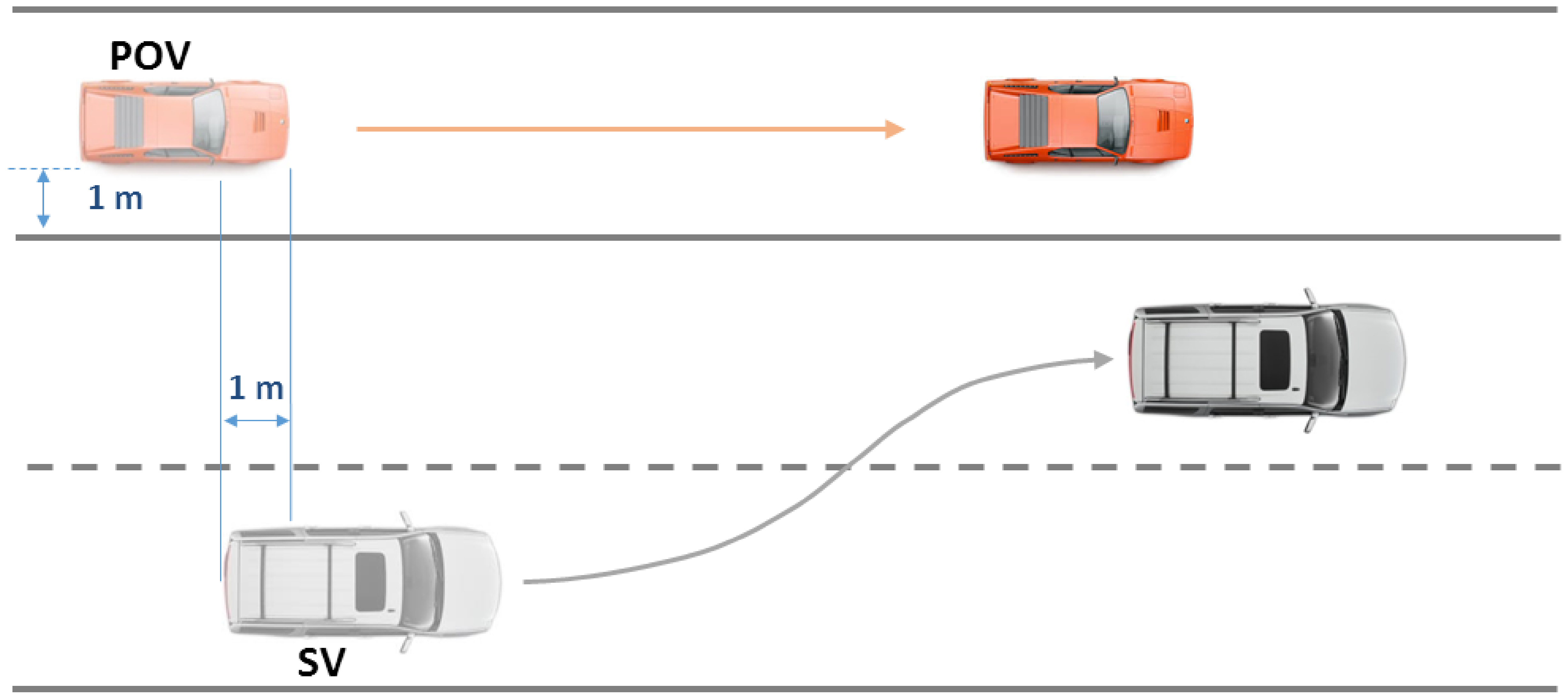
Scenario 2: Closing Headway

- SV_{speed} = 45 mph
- POV_{speed} = 50 mph
- Robotically-controlled SV steering released within 250 ms after establishing heading toward left lane line



Scenario 3: Constant Headway False Positive

- $SV_{speed} = POV_{speed}$ = 45 mph
- Robotically-controlled SV steering used to perform a full lane change, not released until end of test



Test Performability

Generally good, most issues pertain to operating a robotic platform at high speed

- Achieving steady state while operating at 50 mph requires considerable testing area
- Can rapidly deplete the platform’s batteries

Results: BSI Operation

Scenario 1

Constant Headway

Trial	BSI Activation?	Impact?	Min Lat Range (m)
1	Yes	No	0.56
2	No	Yes	0
3	Yes	No	0.28

Scenario 2

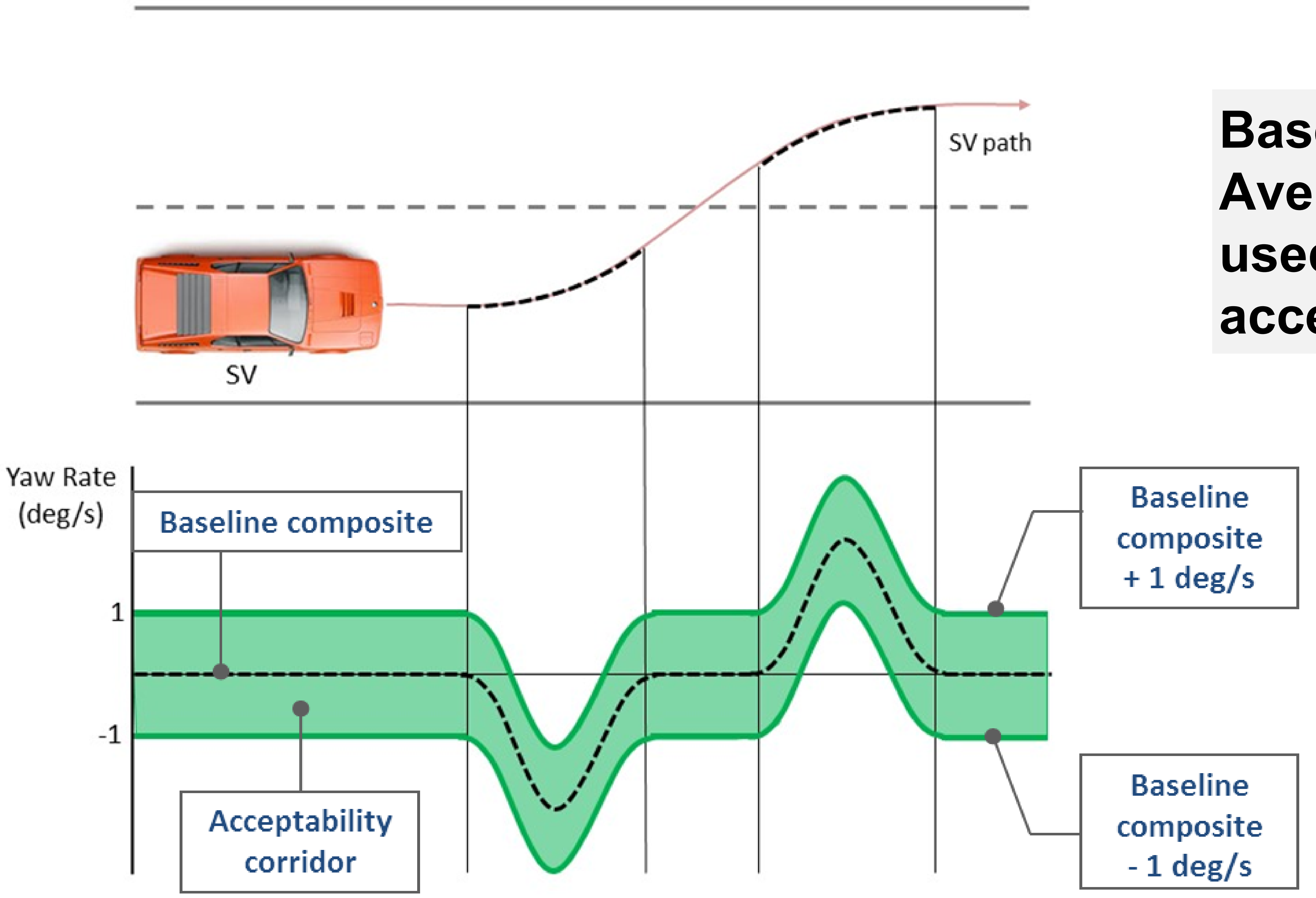
Closing Headway

Trial	BSI Activation?	Impact?	Min Lat Range (m)
1	Yes	No	0.78
2	Yes	No	0.15
3	Yes	No	0.58

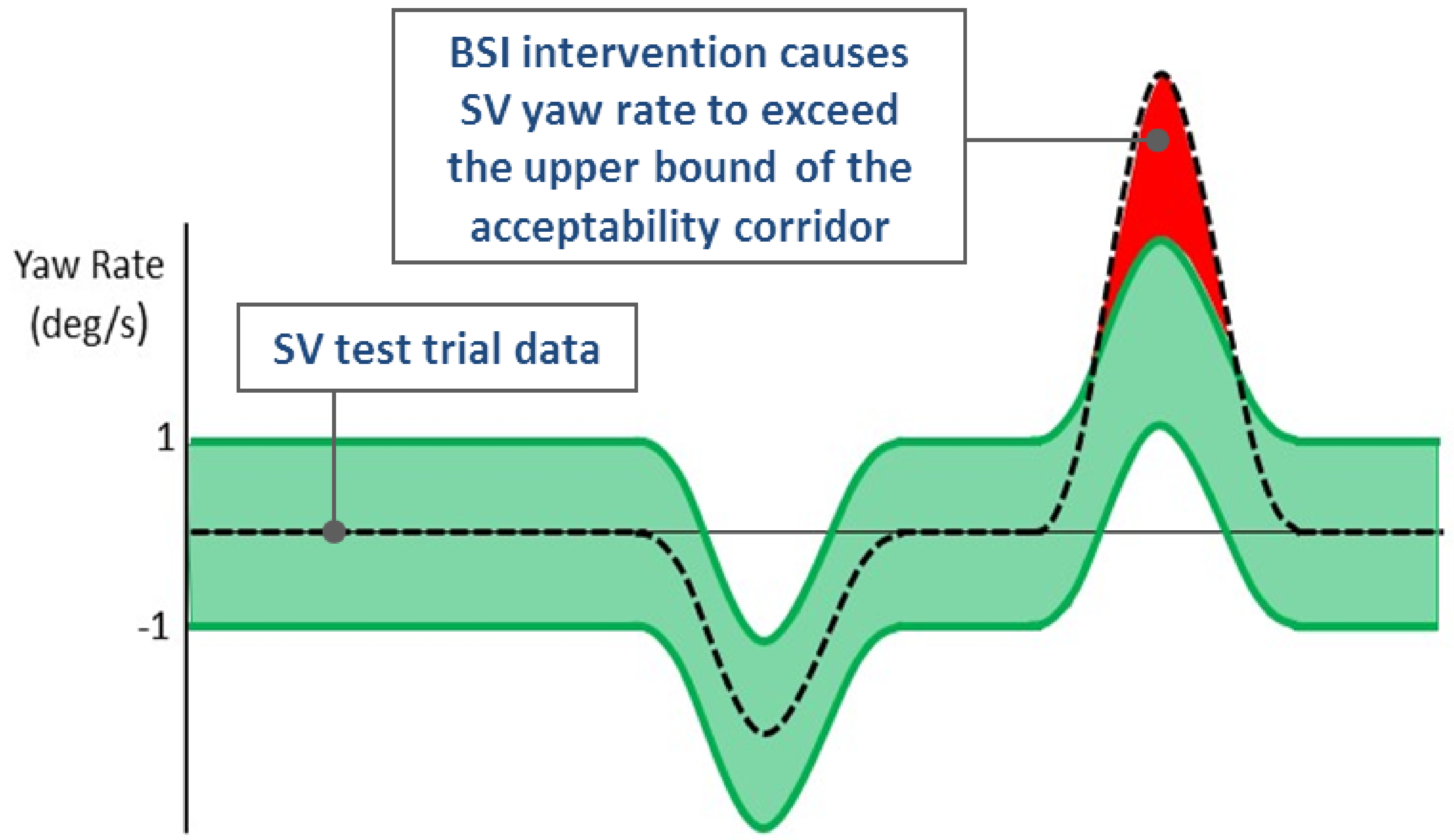
*POV speed criteria not met for all trials

Example: Closing Headway

False Positive Assessment



Baseline tests performed. Average yaw rate data used to define an acceptability corridor.



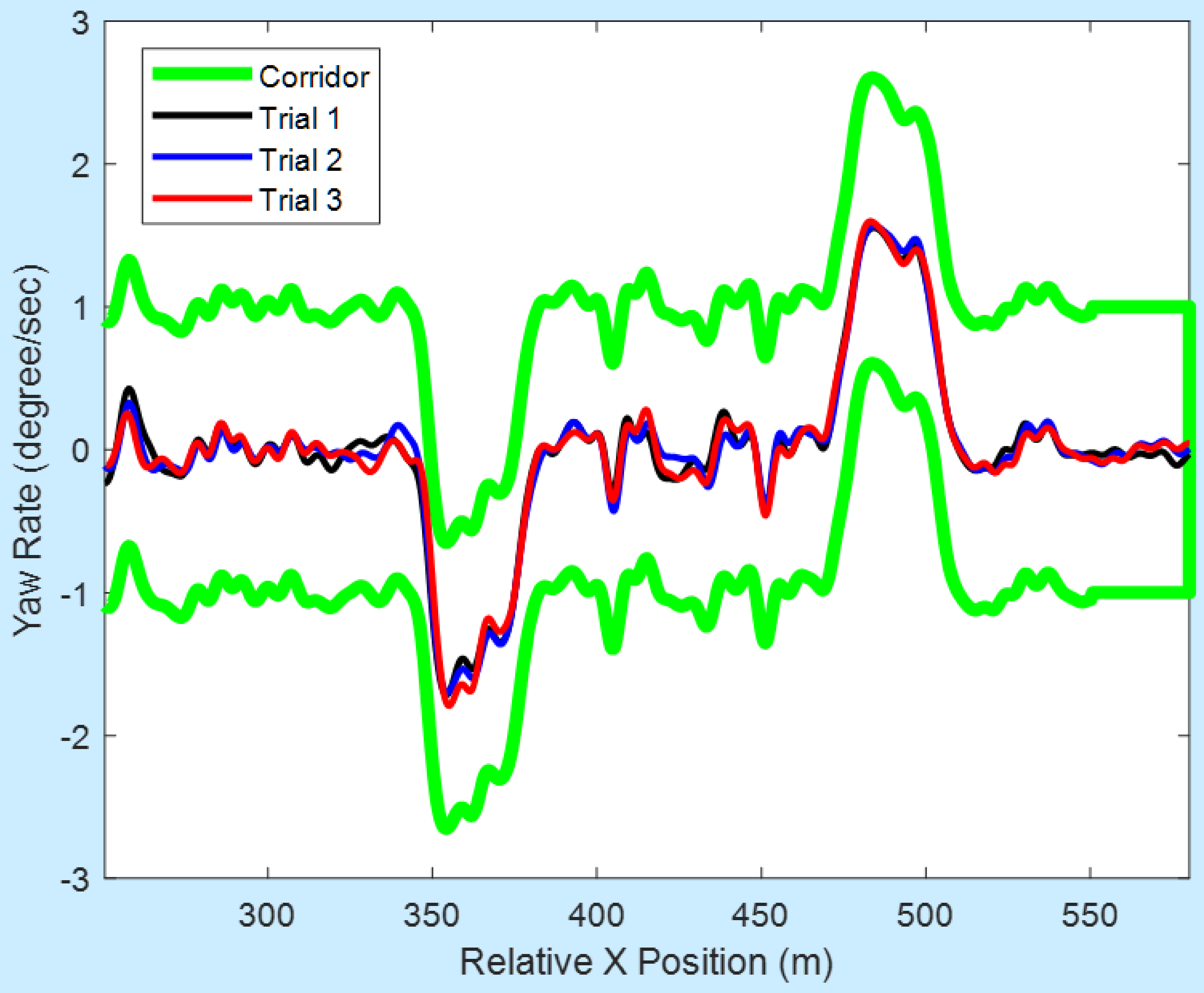
Yaw rate outside of corridor used to identify a BSI intervention

Results

BSI

Scenario 3

Constant Headway False Positive



Concluding Remarks (BSI)

- Generally speaking, the BSI tests described in the April 2018 draft research TP were found to be well-defined, but some minor refinement was needed to enhance performability
- With regards to the system operation
  - The test methods were able to elicit BSI activations during 5 out of 6 trials
  - Each activation prevented an SV-to-POV side impact
  - No false positives were observed
- Release of a research report and the refined TP is expected later this year

Oncoming Traffic Safety Assist (OTSA)

- Designed to actively help the driver avoid a head-on crash with another vehicle in an adjacent lane
- Uses steering and/or differential braking to return vehicle back into original travel lane

Subject and Principal Other Vehicles (SV and POV)

2017 Mercedes E300

- Differential braking for OTSA response
- Operational speeds between 40 - 120 mph

Guided Soft Target (GST)

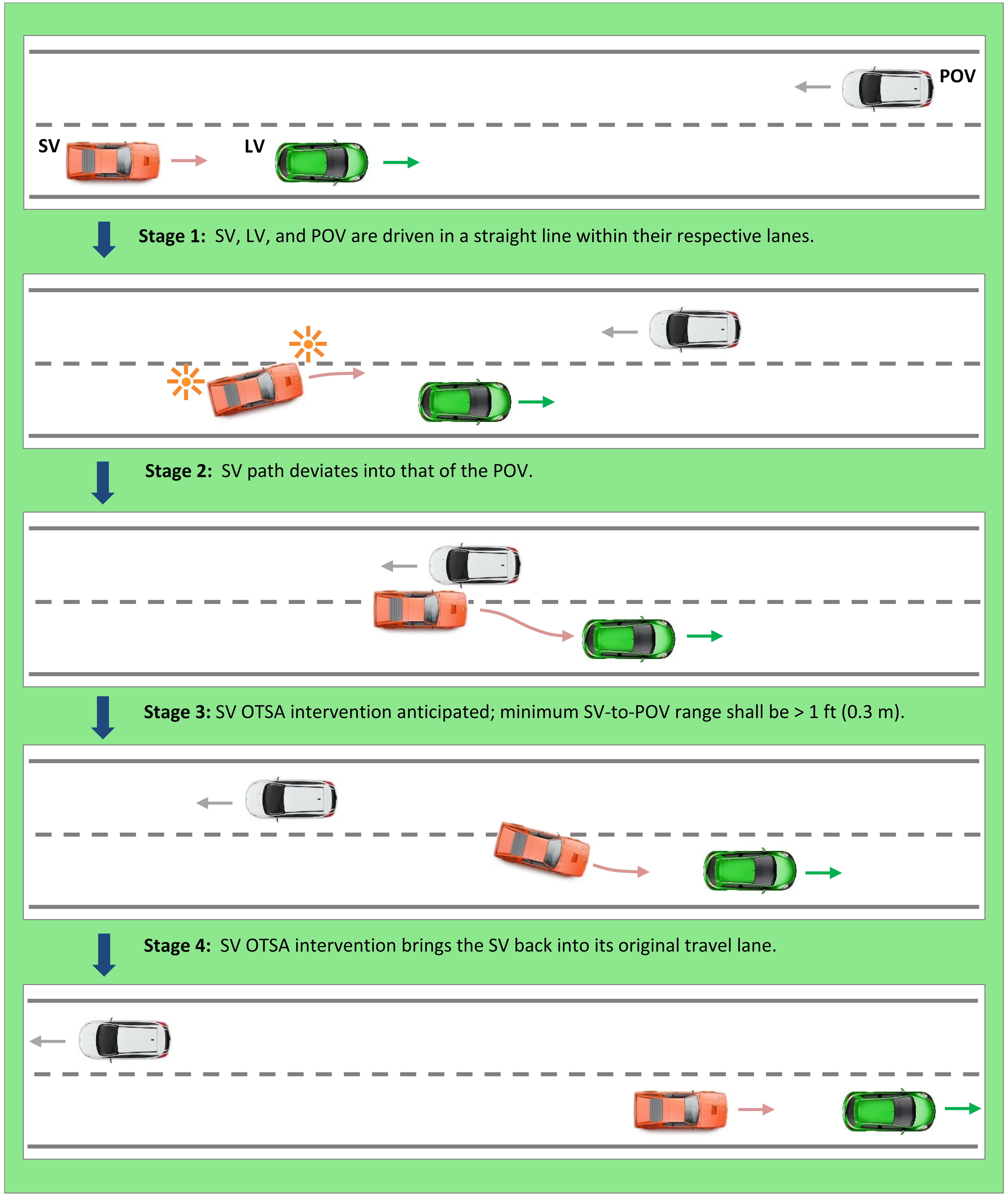
- Low Profile Robotic Vehicle
- Global Vehicle Target (GVT) Revision F

Test Conditions

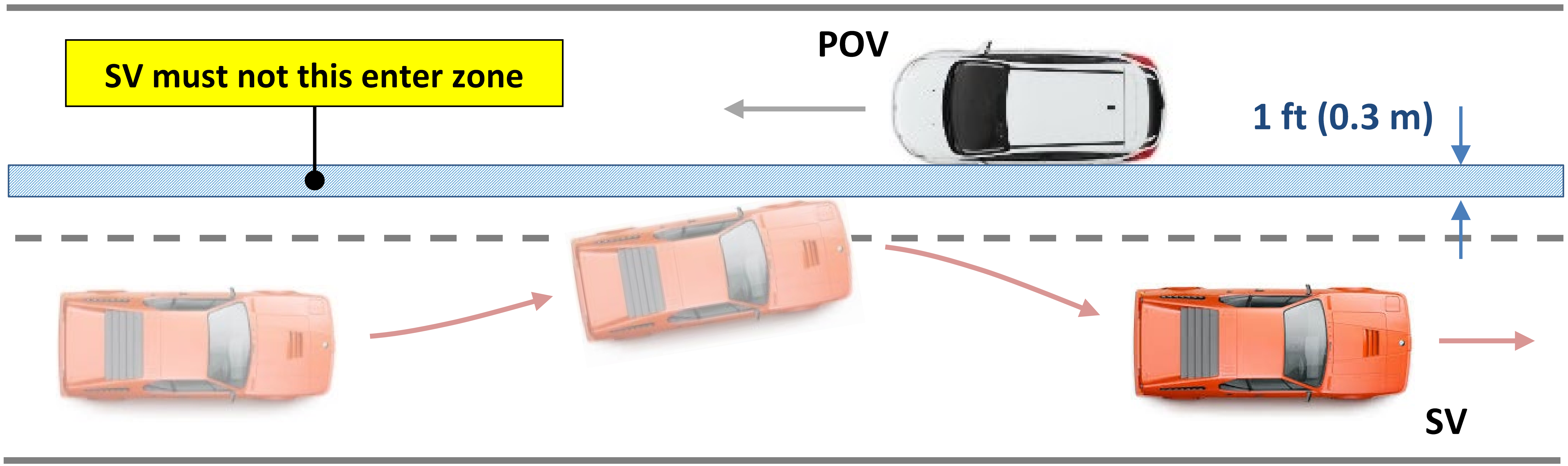
- 5 scenarios, applicable as a function of SV automation level
  - Include crash imminent and false positive tests
  - 3 repeated trials per condition
- Up to 2 SV lateral velocities towards lane line
  - Emulates unintended (0.5 m/s) and intended (0.7 m/s) lane line approaches
  - Commanded by a robotic steering controller
- 3 SV/POV speed combinations: 25/25, 45/25 and 45/45 mph
- Includes provisions for performing tests with up to automation level 3
  - **Only those relevant to L0 discussed today**

Scenario Overview (crash imminent)

- Longitudinal TTC-based inputs
  - SV turn signal (where applicable)
  - SV lane change
- Includes a robotically-commanded "bail-out" provision to insure driver safety



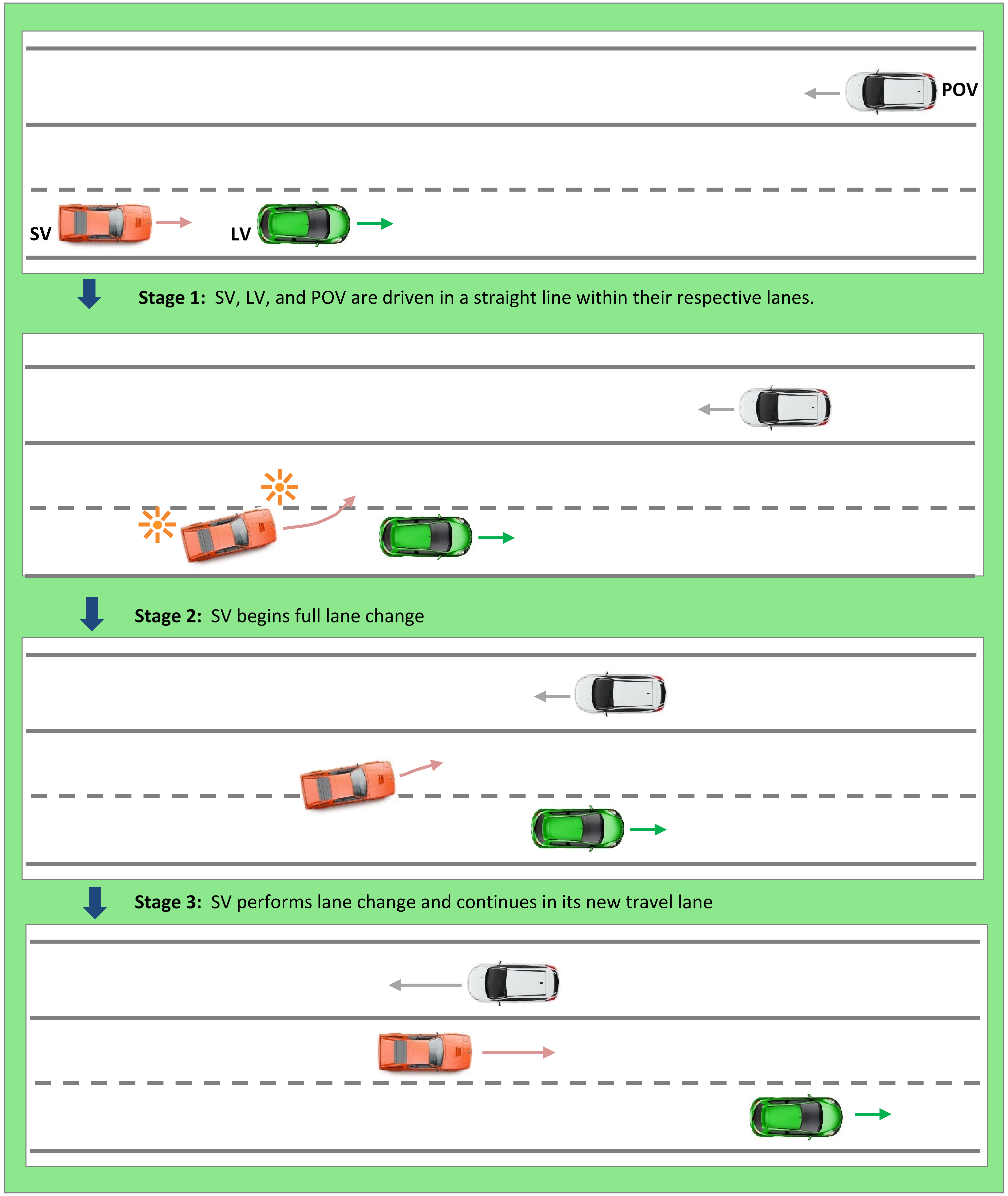
SV Bail-Out Provision



Scenario Overview (false positive)

OTSA

- Longitudinal TTC-based inputs
  - Turn signal (where applicable)
  - Lane change
- Includes a full lane change like that used for the BSI false positive tests



Test Performability

- Generally good, level of effort and GST operational considerations greater than those of the BSI tests
  - Additional actor adds complexity to the test choreography
  - Long initial separation during the 45 mph tests require a large test area and good SV-to-POV instrumentation communication (needed for closed loop control)
- Although necessary for safe test conduct, the SV bail-out provision can affect the ability to observe OTSA operation

Scenario 1

No TS, 0.5 m/s LV

Speeds	OTSA Activations	SR Aborts	Secondary Departures
25/25	0/3	3/3	-
45/25	0/3	3/3	-
45/45	*	*	*

Scenario 2

TS (no TS), 0.7 m/s LV

Speeds	OTSA Activations	SR Aborts	Secondary Departures
25/25	0/3	3/3	-
45/25	0/3 (3/5)	3/3 (5/5)	-
45/45	*	*	*

Scenario 4

TS, 0.7 m/s LV, False Positive

Speeds	OTSA Activations
25/25	0/3
45/25	0/3
45/45	*

Preliminary Results

- *Testing still in progress
- All results are preliminary and subject to change as testing continues and validity criteria evolve
- Scenario 2 45/25 tests were also performed without turn signal
  - Indicated in parentheses
  - Condition is not present in the draft research TP

Example: Scenario 2, 45_45

OTSA Concluding Remarks

- OTSA test inputs appear to be performable, however use of a robotic bail-out provision (necessary for safe test conduct) may confound observation of OTSA operation
  - Important if close SV-to-POV proximity is required to activate OTSA
  - May be vehicle-dependent issue
- Better understanding the interaction of turn signal use and OTSA availability is of interest
- Release of the OTSA test report and draft research TP is expected later this year

Additional Information

- The draft research BSI and OTSA test procedure will be available from the National Transportation Library (NTL)
  - Link: https://ntl.bts.gov/
- Contacts:
  - Taylor Manahan: taylor.manahan.ctr@dot.gov
  - Garrick Forkenbrock: garrick.forkenbrock@dot.gov

Questions?

Thank you!