

# Evaluation Results of Integrated Vehicle-Based Safety Systems (IVBSS)

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# Presentation Outline

- IVBSS overview
- Independent evaluation goals and objectives
- Evaluation approach
- Heavy truck results
- Light vehicle results

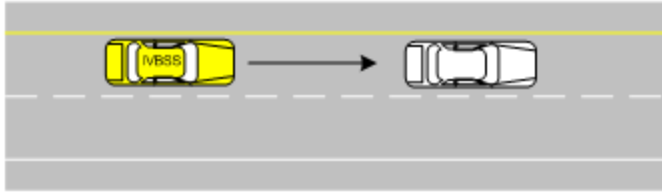


# IVBSS Program

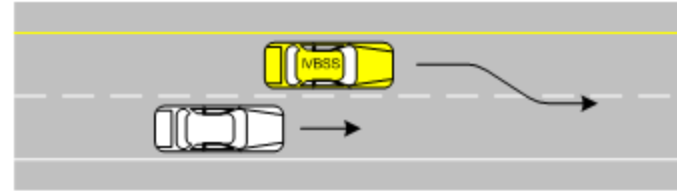
- Phase 1 (November, 2005 – May, 2008)
  - System design and development
  - Verification testing
- Phase II (June, 2008 – December, 2010)
  - Prototype vehicle builds
  - Pilot tests
  - Field operational tests/data collection
  - Data analysis and reporting

# Crash Warning Functions

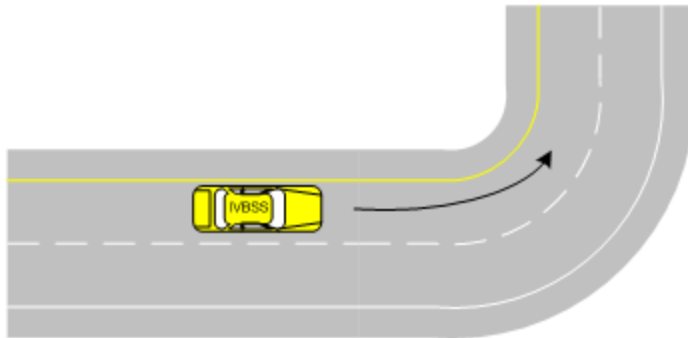
- Forward collision warning



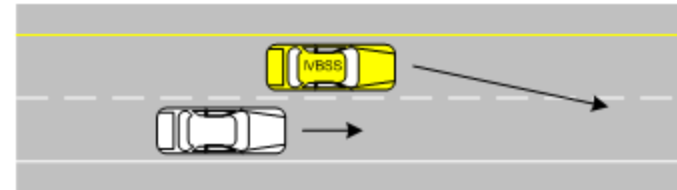
- Lane change/merge warning



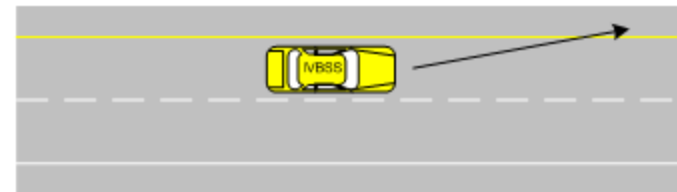
- Curve speed warning (light-vehicle only)



- Imminent drift warning



- Cautionary drift warning



# Field Operational Tests

## Heavy-Truck

- 10 prototype vehicles
- 18 professional drivers
  - 8 pick-up and delivery
  - 10 line-haul
- 10 months
  - 2 months baseline
  - 8 months treatment
- 671,000 miles accumulated

## Light-Vehicle

- 16 prototype vehicles
- 108 drivers (3 age groups)
- 40 days
  - 12 days baseline
  - 28 days treatment
- 219,000 miles accumulated



# Independent Evaluation Goals



## Safety Impact

- Safety benefits
- Unintended consequences



## Driver Acceptance

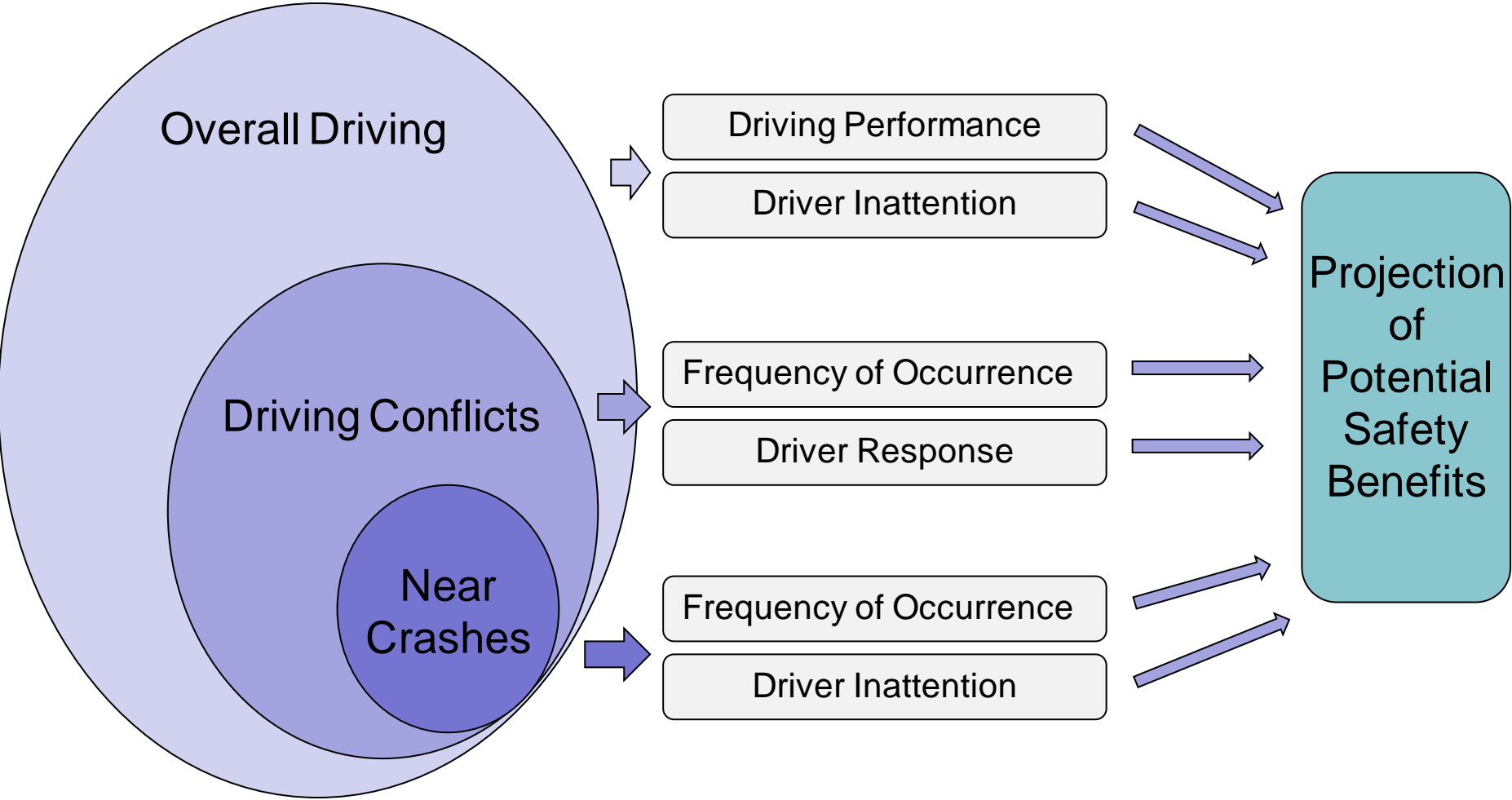
- Ease of use
- Perceived usefulness
- Ease of learning
- Driving performance
- Advocacy



## System Performance

- Sensors
- Interfaces
- Alert Logic
- Robustness

# Evaluation Approach

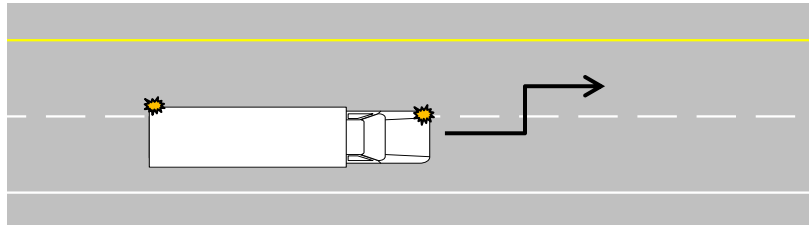


# Heavy-Truck Results

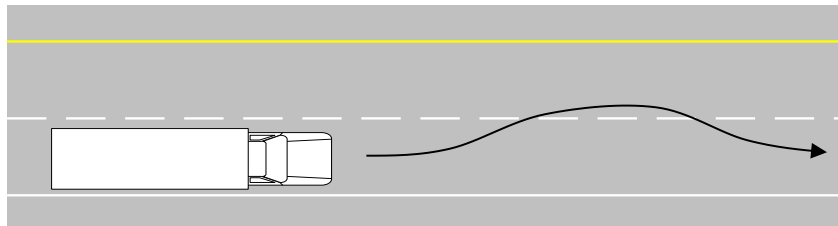


# Overall Driving

- Increased turn signal usage for line-haul drivers at speeds > 45 mph (78% to 82% of lane changes signaled)



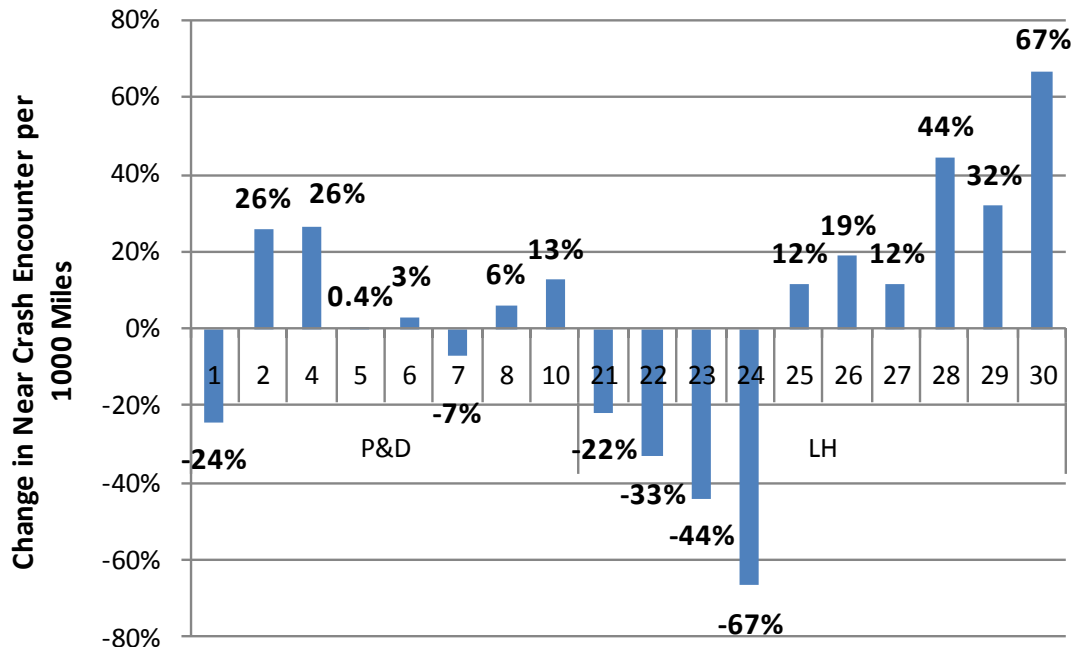
- Decrease in the rate of lane excursions for all drivers
  - 35 – 55 mph: 0.87 to 0.79 per 100 miles
  - > 55 mph: 0.35 to 0.30 per 100 miles



- 8 of 10 line-haul drivers showed an increase in the frequency of secondary tasks, but results not significant

# Near Crash Experience

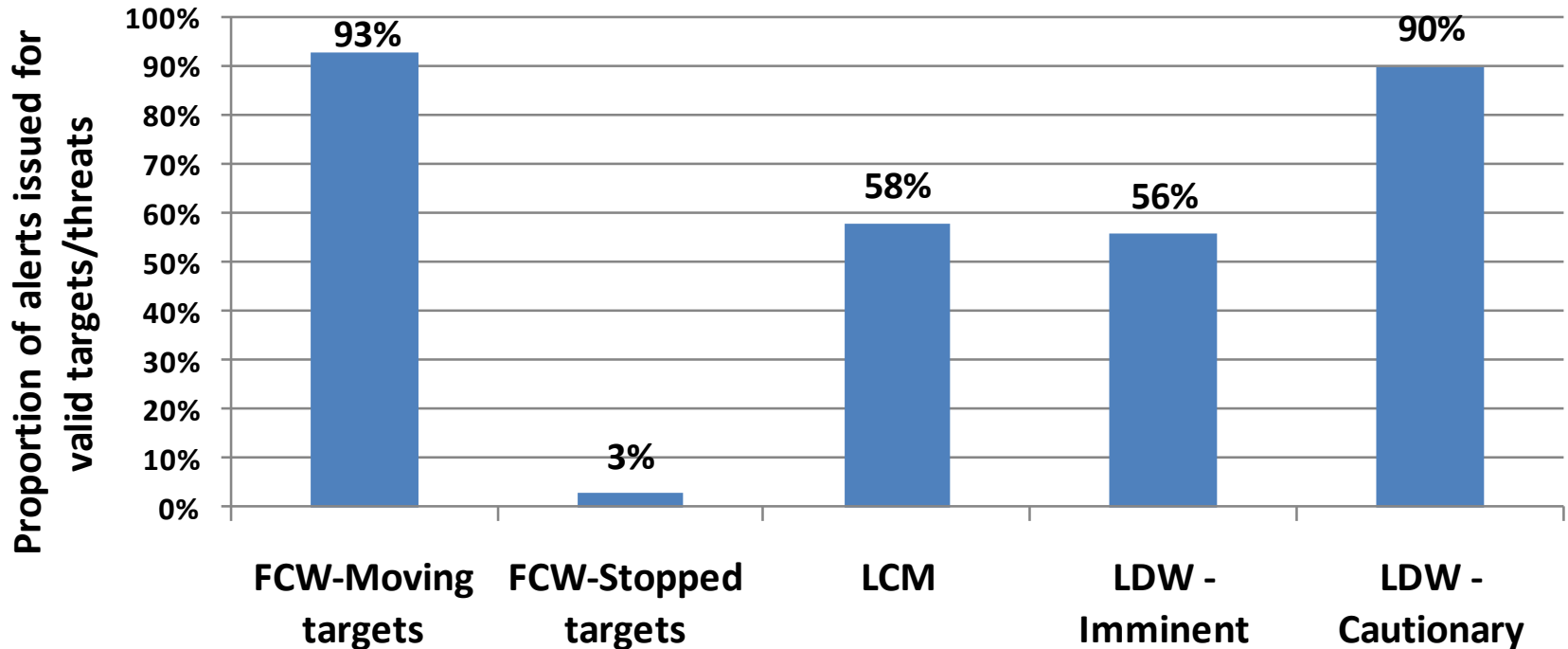
- 12 drivers experienced a reduction in near crashes
- Overall reduction in near crash rates from 8.7 to 8.1 per 1,000 miles (not statistically significant)
- Reduction in road departure near crashes to the left for all drivers



# Driver Acceptance

- 15 drivers would **prefer to drive** a truck with the integrated system.
- 13 drivers felt that driving with the integrated system would **increase their driving safety**.
- 15 drivers reported that the system made them **more aware** of their surroundings.
- No reported instances of negative adaptation.

# System Performance - Accuracy of Alerts

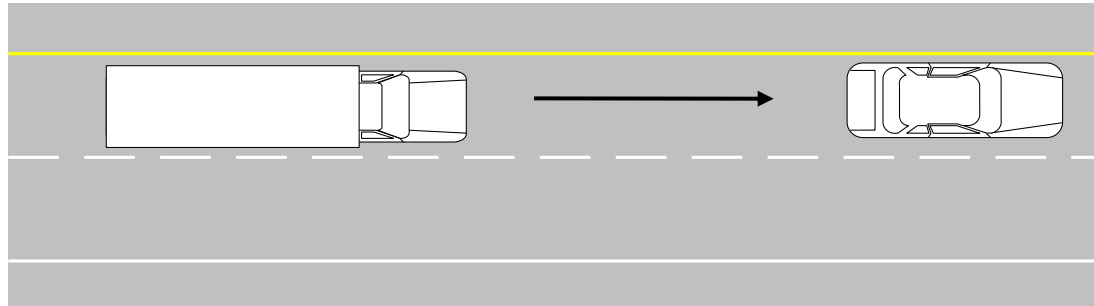


(Based on video review of 14,405 alerts)

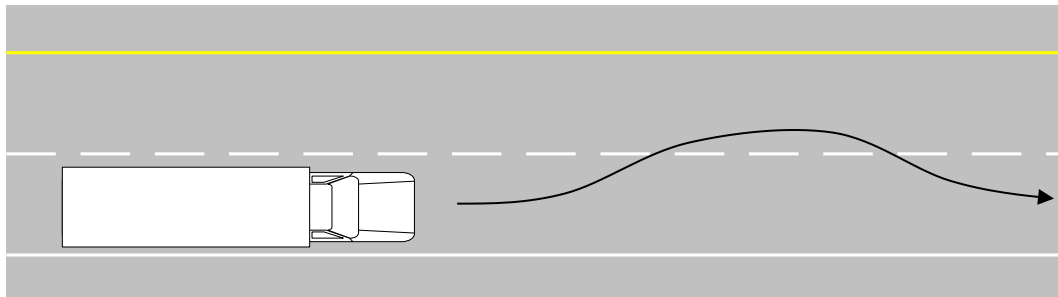
**FCW:** Forward collision warning    **LCM:** Lane change/merge warning  
**LDW:** Lane departure warning

# System Performance – Alert Rate Reductions

- 12% reduction in FCW-moving alert rate (3.3 to 2.9 per 100 miles)



- 20% reduction in LDW-C alert rate (7.0 to 5.6 per 100 miles)



# Projection of Potential Safety Benefits

Function	Pre Crash Scenario	Annual Target Crashes	Max Estimated Annual Crash Reduction	Max Estimated Effectiveness
FCW-M	Rear end/Lead vehicle decelerating Rear end/Lead vehicle moving	18,000	5,000	27%
FCW-S	Rear end/Lead vehicle stopped	19,000	Insufficient field data to estimate	
LCM	Changing lanes/same direction Turning/same direction	53,000		
LDW-I	Drifting/same lane	7,000		
LDW-C Left	Opposite direction/No maneuver Road edge departure/No maneuver	11,000	3,000	29%
LDW-C Right	Road edge departure/No maneuver	15,000	5,000	36%
Integrated System	All	123,000	13,000	11%

# Heavy-Truck Study Limitations

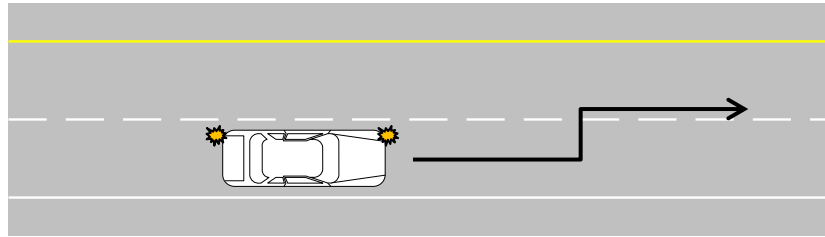
- Professional drivers participating in the study were generally very safe, even during the baseline period
- Low rates of accurate stopped object detection and side object detection prevented safety projections for 3 pre-crash scenarios
- Small sample of test subjects

# Light-Vehicle Results

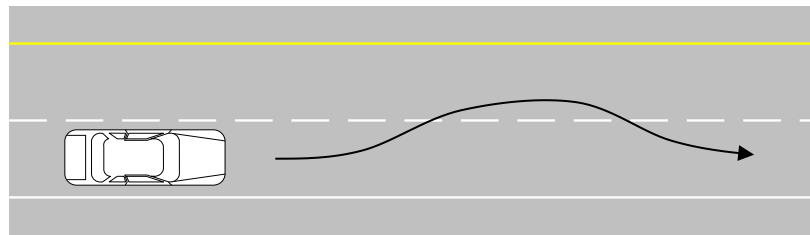


# Overall Driving

- Increased turn signal usage for all drivers (62% to 75% of lane changes signaled)



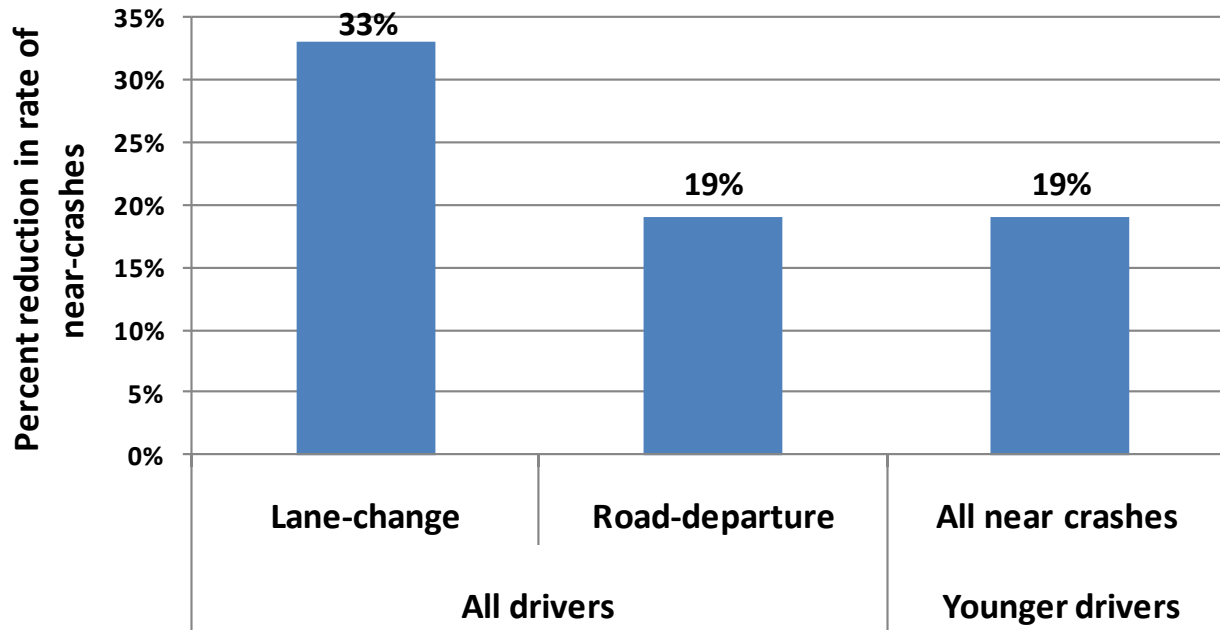
- 21% decrease in the rate of lane excursions for all drivers (1 every 2.6 mi to 1 every 3.3 mi)



- No increase in secondary task or eyes-off-forward scene engagement

# Near-Crash Experience

- Of the drivers who experienced near crashes, 58% (53 of 91 drivers) showed a reduction during the treatment period

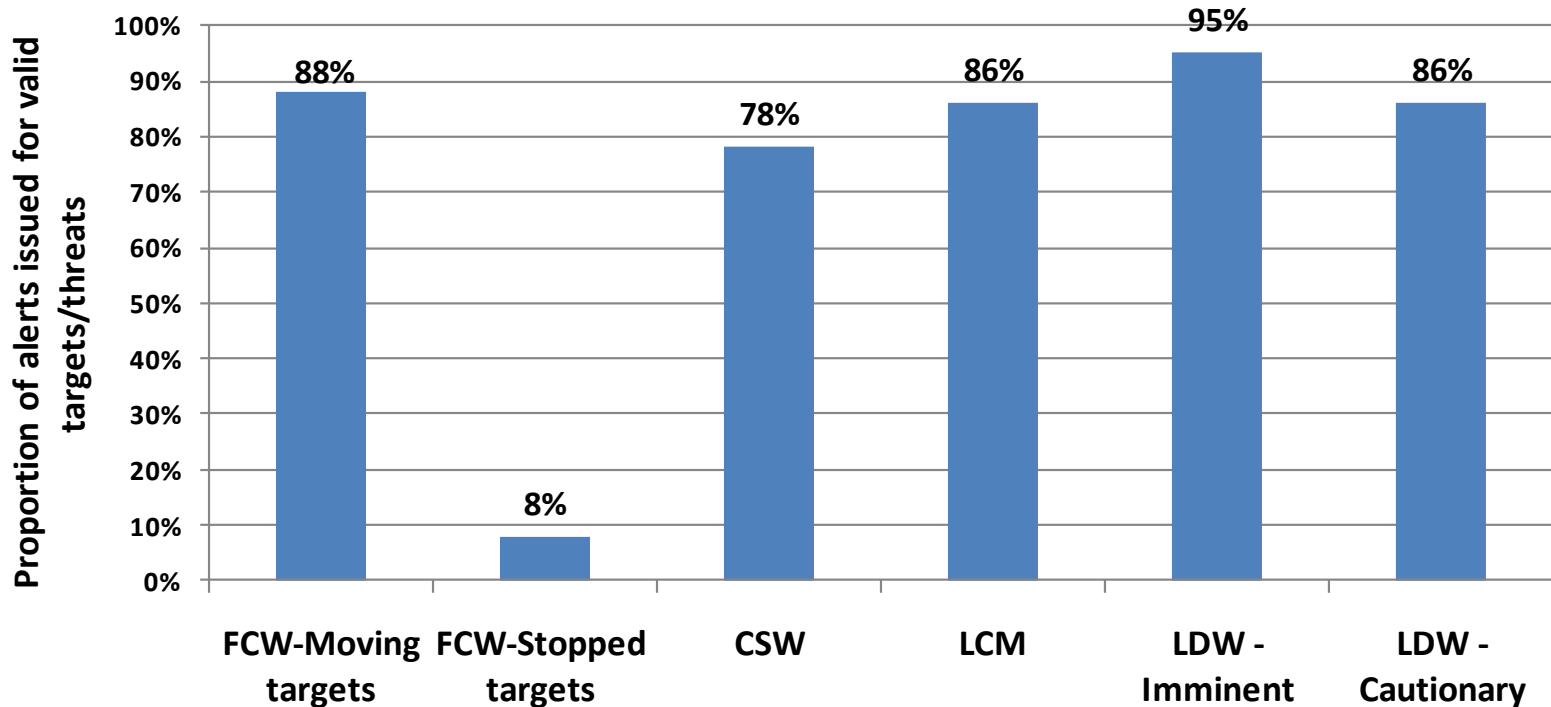


- About half of the drivers who attended focus groups said that the system helped prevent them from getting into a crash

# Driver Acceptance

- 82% of drivers felt that the system **increased their driving safety**.
- 72% of drivers **would like to have the system** in their personal vehicle.
- One third of drivers felt that the system provided **too many nuisance warnings**.
- Older drivers found the system **more useful and less annoying** than younger drivers.
- Drivers' **favorite feature** was the blind spot monitors.
- 7 drivers reported **negative behavior adaptation**.

# System Performance – Accuracy of Alerts



(Based on video review of 16,915 alerts)

**FCW:** Forward collision warning  
**LCM:** Lane change/merge warning

**CSW:** Curve speed warning  
**LDW:** Lane departure warning

# System Performance – Driver Response to Alerts

With the system enabled, drivers...

- Responded more quickly and assertively to **forward collision alerts**
- Decelerated more when entering a curve after receiving a **curve speed alert**
- Made more assertive steering corrections to resume lane position after receiving a **drift alert**

# Projection of Potential Safety Benefits

Function	Pre-Crash Scenario	Annual Target Crashes	Mean Estimated Crash Reduction	Mean Estimated System Effectiveness
FCW	Rear-end/lead vehicle stopped	1,462,000	238,000	16%
	Rear-end/lead vehicle decelerating			
	Rear-end/lead vehicle moving			
CSW	Negotiating a curve/lost control	181,000	Insufficient data to estimate	
LCM	Changing lanes/same direction	311,000	125,000	40%
	Turning/same direction	195,000	Insufficient data to estimate	
LDW-I	Drifting/same direction	51,000	20,000	40%
LDW-C Right	Right road departure/no maneuver	249,000	65,000	26%
LDW-C Left	Left road departure/no maneuver	122,000	19,000	16%
	Opposite direction/no maneuver	103,000	7,000	7%
Integrated System	All	2,674,000	474,000 313,000	18% 11%

# Questions

(Reports are available at [www.its.dot.gov/ivbss/](http://www.its.dot.gov/ivbss/))