

# Estimating Potential Safety Benefits for Advanced Vehicle Technologies

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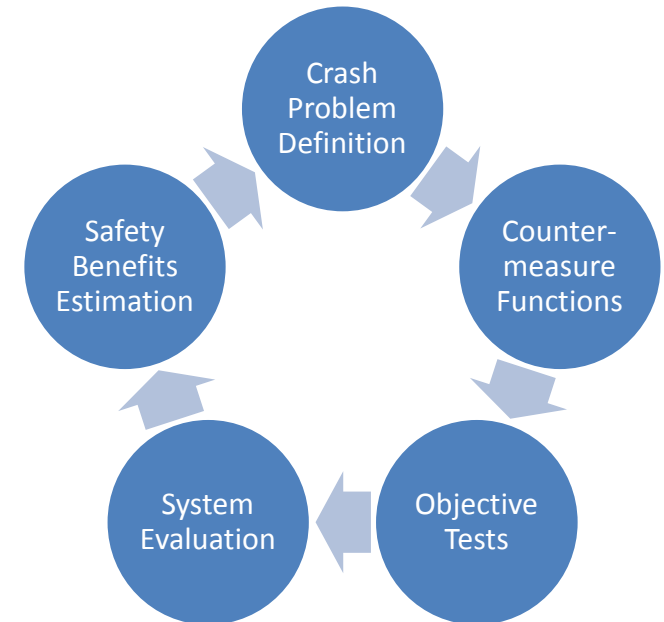


# Presentation Outline

- ❑ Background
- ❑ How do we project potential safety benefits?
- ❑ What is the crash problem?
- ❑ Examine key steps within the process
- ❑ Projecting safety benefits

# Advanced Vehicle Technology Research

- **Division within the Volpe Center**
- **Research Crash Avoidance:** Identify effective intervention opportunities for vehicle or cooperative based warning and automated systems and estimate potential safety benefits.
  - National crash data query and typology
  - Test procedures and instrumentation
  - Data mining and analysis of naturalistic driving data
  - Safety benefits estimation and simulation tools
- **Also: Safety of Automotive Electronics**
- **Also: Vehicle Cybersecurity**



# Technologies Researched

Level	Vehicle Feature
Driver	Drowsy Driver Detection
	Pre-Crash Sensing - Advanced Restraints
Vehicle-Based	Intelligent Cruise Control & Forward Collision Warning
	Lane Change Warning & Lane Drift Warning
	Lateral Drift Warning & Curve Speed Warning
	Pedestrian Warning
Cooperative Technology	Intersection Movement Assist
	Left Turn Assist
	Blind Spot Warning
	Electronic Emergency Brake Lighting
	Do Not Pass Warning
	Vehicle-to-Infrastructure
	Vehicle-to-Pedestrian
Automatic Controls	Crash Imminent Braking
	Lane Keeping Technology
	Cooperative Cruise Control

# Projecting Potential Safety Benefits

*Crashes Avoided =*

$$\# \text{ Target Crashes} \times SE_{\text{Crash}}$$

- Identify and define a safety system

$SE_{\text{Crash}} =$

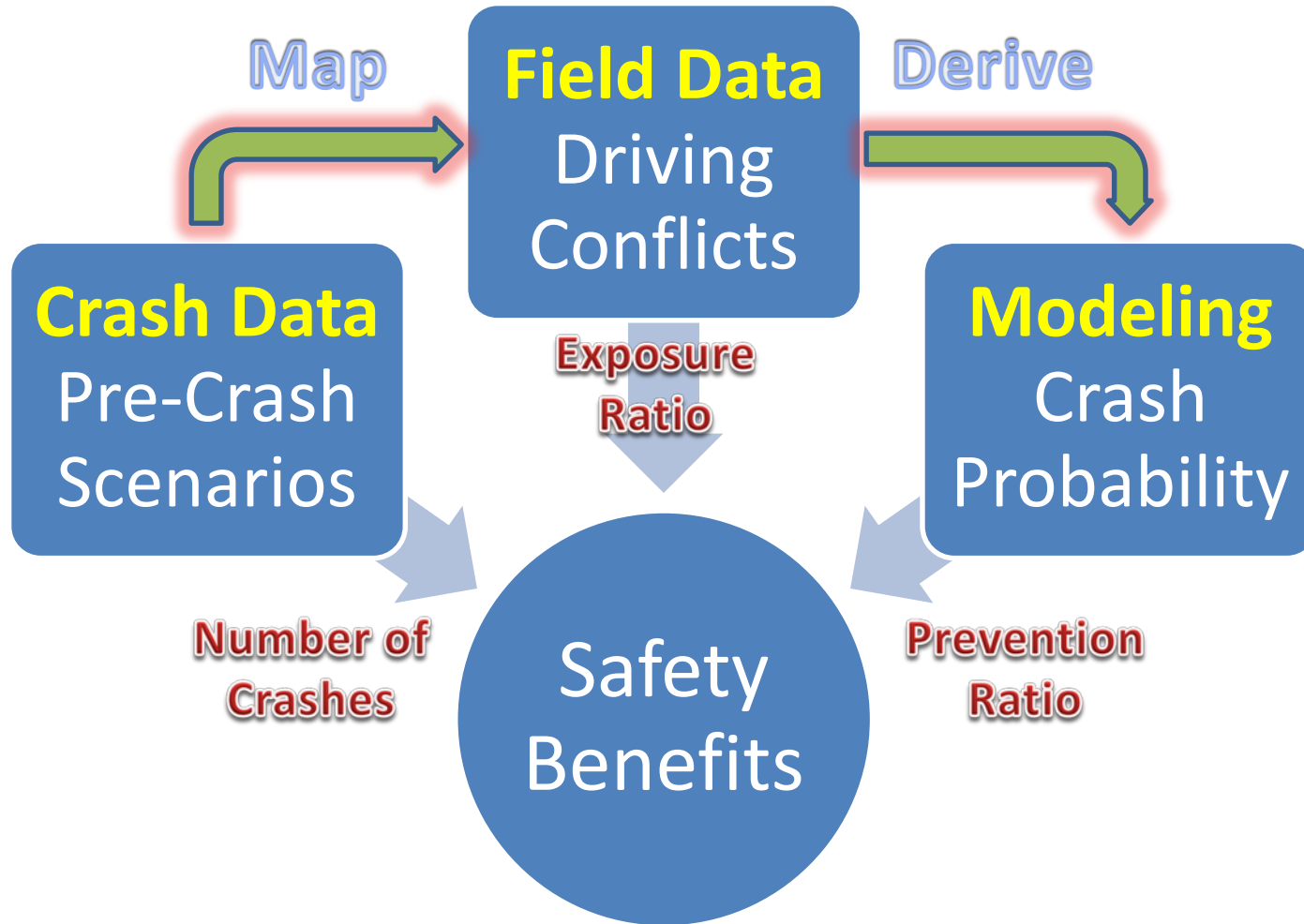
$$1 - \text{Exposure Ratio} \times \text{Crash Prevention Ratio}$$

**Exposure Ratio**  $\equiv$  Probability of encountering a driving conflict

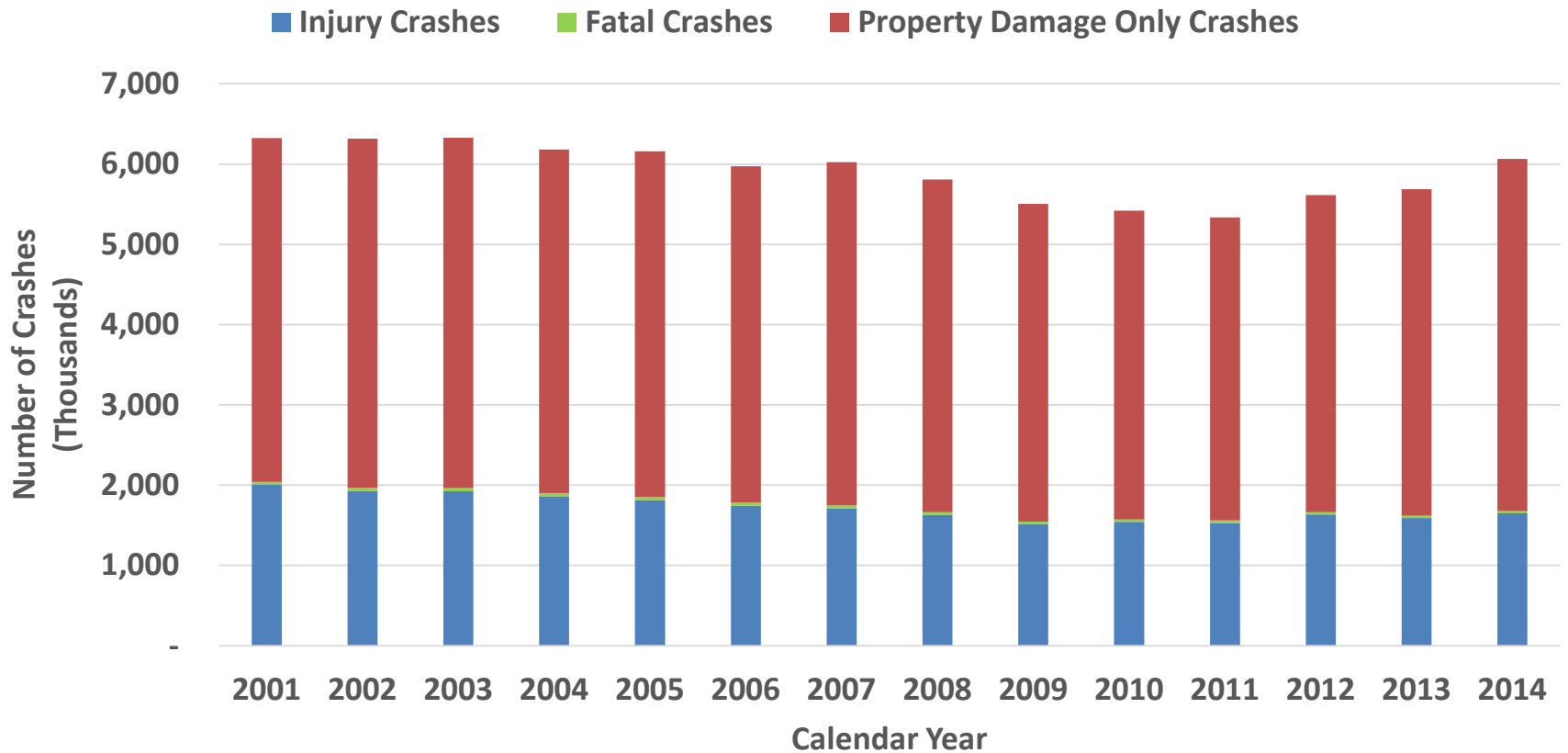
**Crash Prevention Ratio**  $\equiv$  Probability of a crash given an encounter with a driving conflict

- Ratios are estimated from driver/vehicle/system performance data with and without automated vehicle functions
- Approach is used in vehicle-based, vehicle-to-vehicle, and pedestrian safety system research
- Potential to estimate injury mitigation

# Safety Benefits Estimation Data Flow



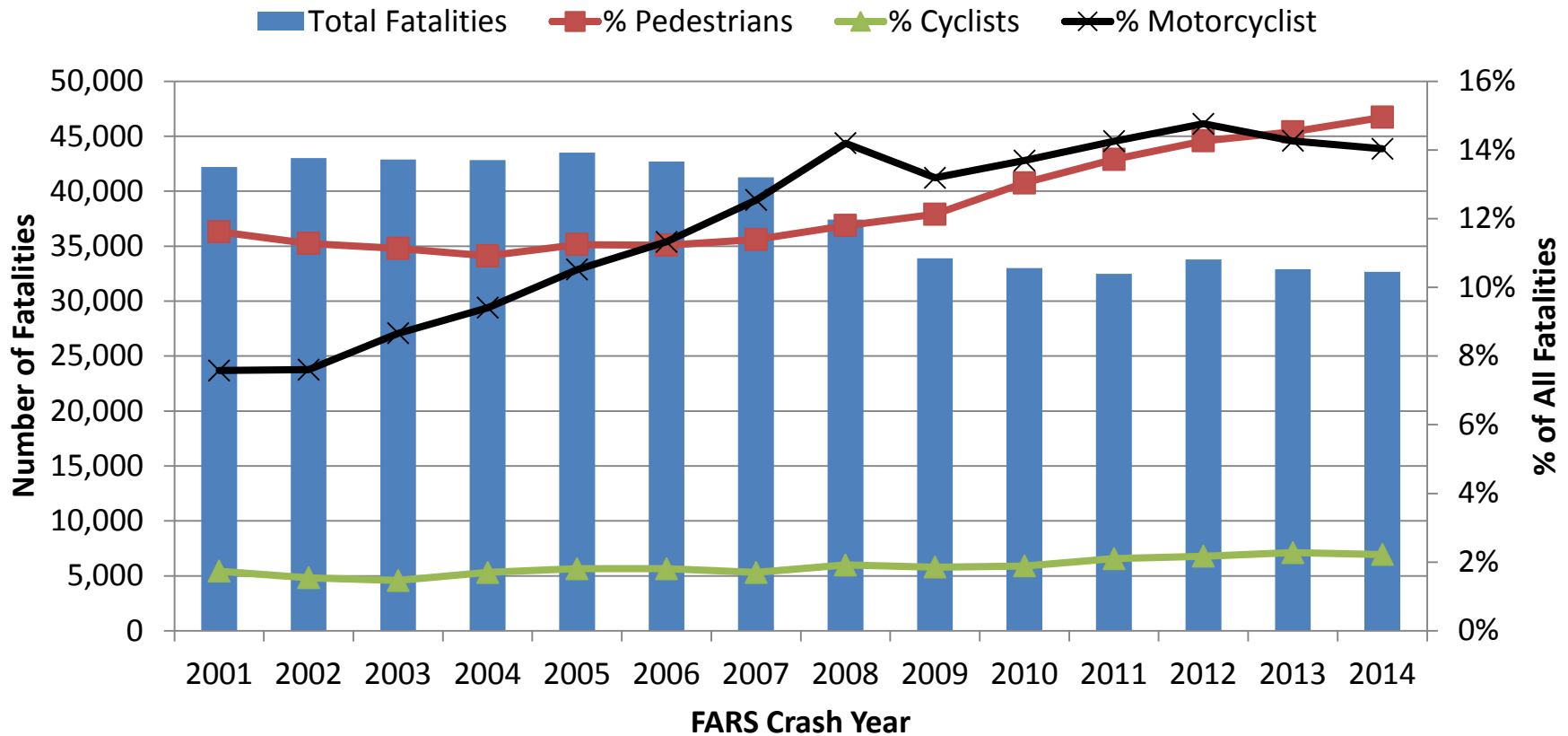
# National Crash Trends



In 2014: 3,026B Miles      275M Registered      214M Licensed

Since 2001: VMT ↑8%      Vehicles ↑24%      Drivers ↑12%

# Crash Fatalities Trends



Total fatalities have decreased by 9,521 (↓ 23%)

Since 2001: Pedestrians ↑ 3%

Cyclists ↑ 1%

Motorcyclists ↑ 7%



# Defining 37 Pre-Crash Scenarios

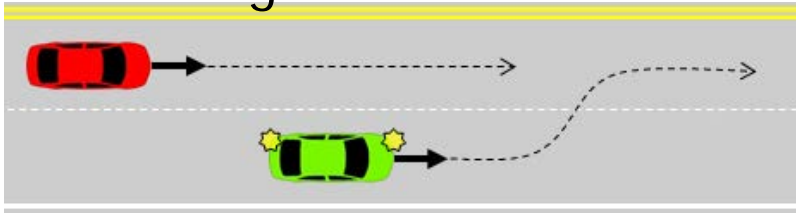
Crash Type	Pre-Crash Scenario	Crash Type	Pre-Crash Scenario
<b>Animal</b>	Animal/maneuver	<b>No Driver</b>	No driver present
	Animal/no maneuver	<b>Non-Collision</b>	Non-collision - No Impact
<b>Backing</b>	Backing into vehicle	<b>Object</b>	Object/maneuver
<b>Control Loss</b>	Control loss/vehicle action		Object/no maneuver
	Control loss/no vehicle action	<b>Opposite Direction</b>	Opposite direction/maneuver
<b>Crossing Paths</b>	Turn right @ signal		Opposite direction/no maneuver
	Straight crossing paths @ non signal		Other - Opposite Direction
	Turn @ non signal	<b>Other</b>	Other
	Other - Turn Across Path		<b>Parking</b>
	Other - Turn Into Path	<b>Pedestrian</b>	Pedestrian/maneuver
	Other - Straight Paths		Pedestrian/no maneuver
	Running red light	<b>Rear-End</b>	Rear-end/striking maneuver
Running stop sign	Rear-end/lead vehicle accelerating		
<b>Cyclist</b>	Cyclist/maneuver		Rear-end/lead vehicle moving @ constant speed
	Cyclist/no maneuver		Rear-end/lead vehicle decelerating
<b>Evasive</b>	Evasive maneuver/maneuver		Rear-end/lead vehicle stopped
	Evasive maneuver/no maneuver	Other - Rear-End	
<b>Hit and Run</b>	Hit and run	<b>Road Departure</b>	Road edge departure/maneuver
<b>Lane Change</b>	Turning/same direction		Road edge departure/no maneuver
	Changing lanes/same direction		Road edge departure/backing
	Drifting/same direction	<b>Rollover</b>	Rollover
<b>Left Turn Across Path/ Opposite Direction (LTAP/OD)</b>	LTAP/OD @ signal		<b>Sideswipe</b>
	LTAP/OD @ non signal	<b>Vehicle Failure</b>	

# Example Pre-Crash Scenarios

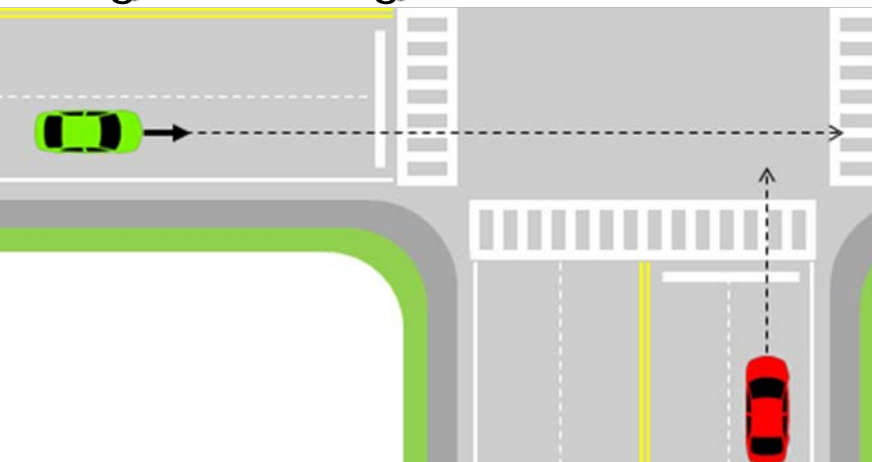
Rear-End – Lead Vehicle Stopped



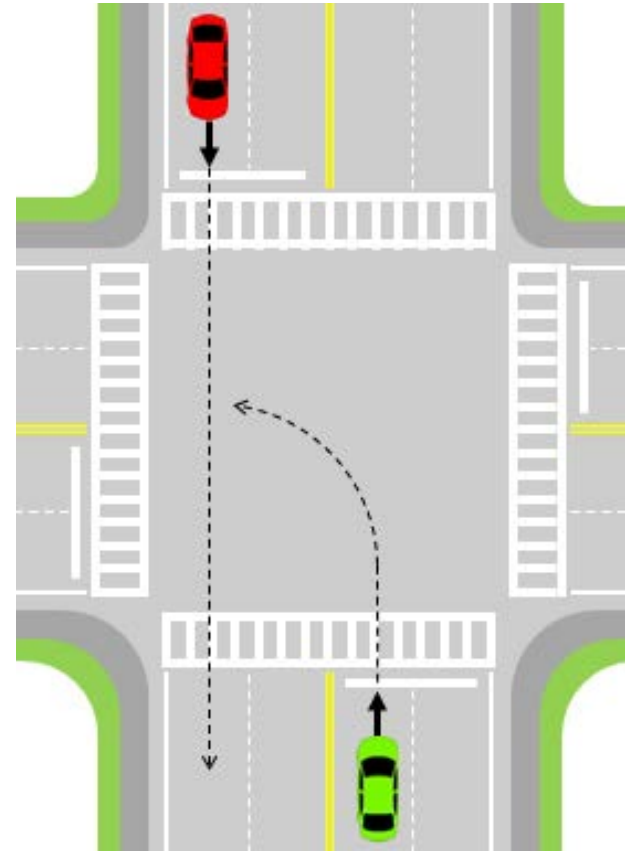
Lane Change



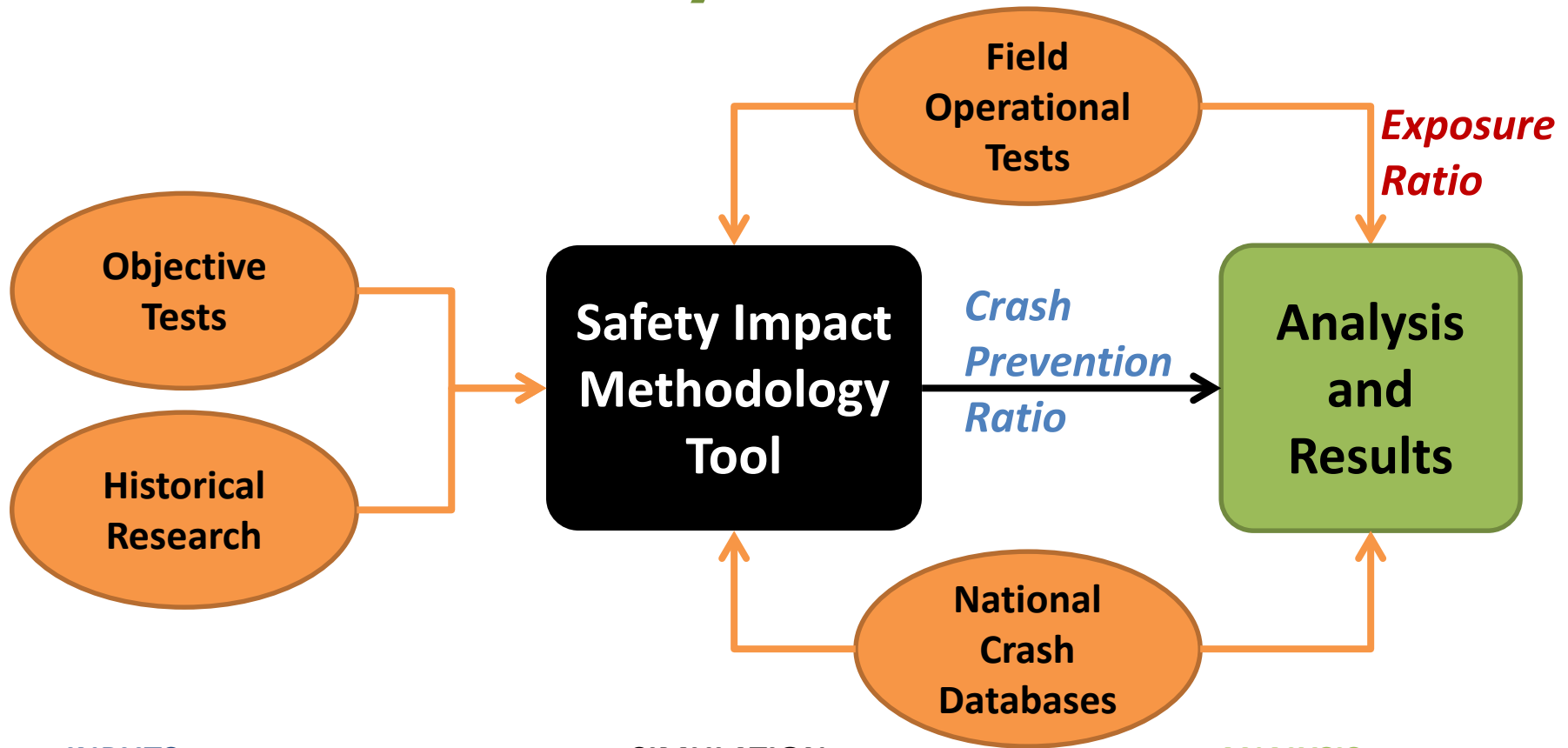
Straight Crossing Paths



Left Turn Across Path /  
Opposite Direction



# Crash Probability Estimation



## INPUTS

- Pre-Crash Data
- System Data
- Driver Data

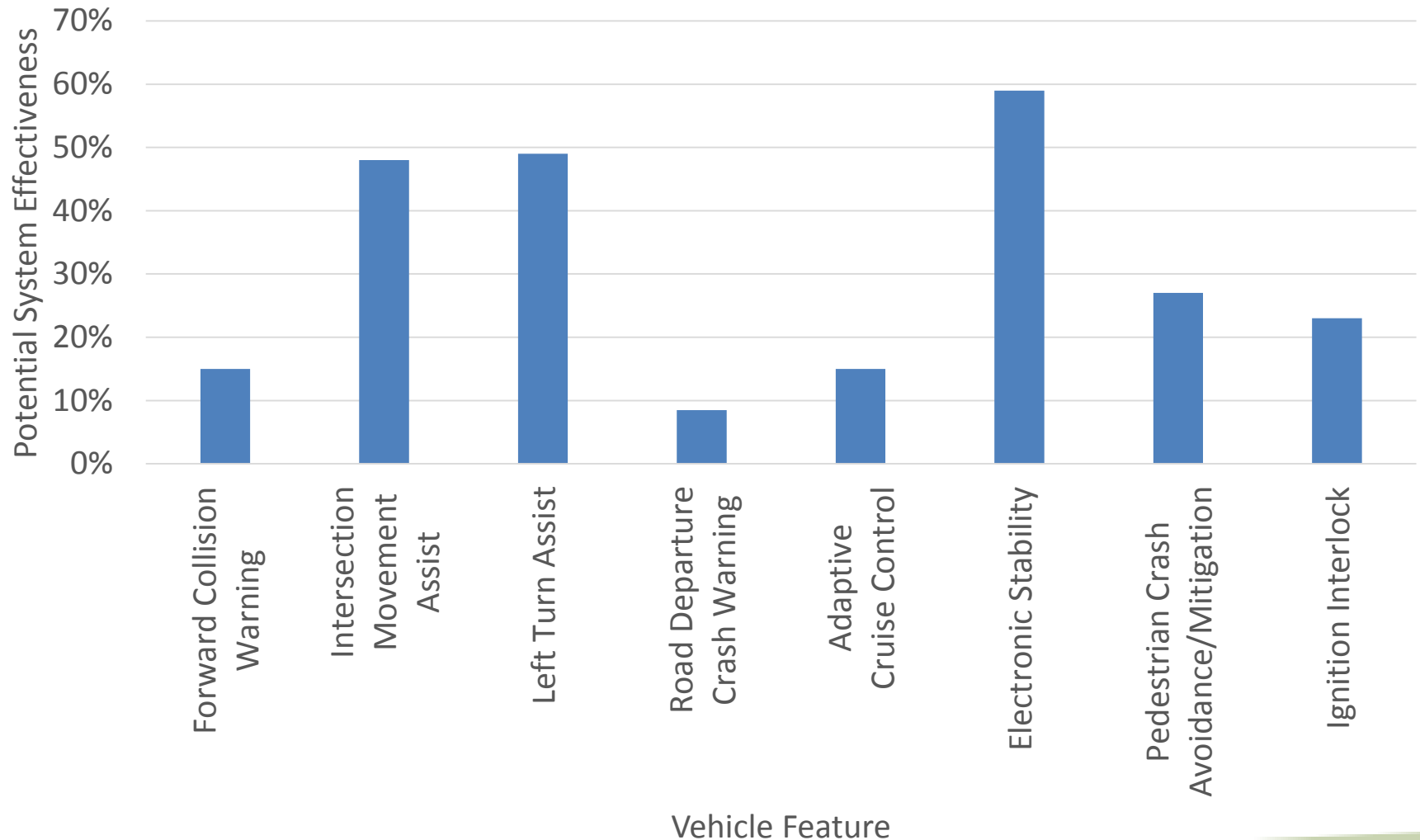
## SIMULATION

- Treatment
- Crash Counts
- Impact Speeds
- $\Delta V$  Values

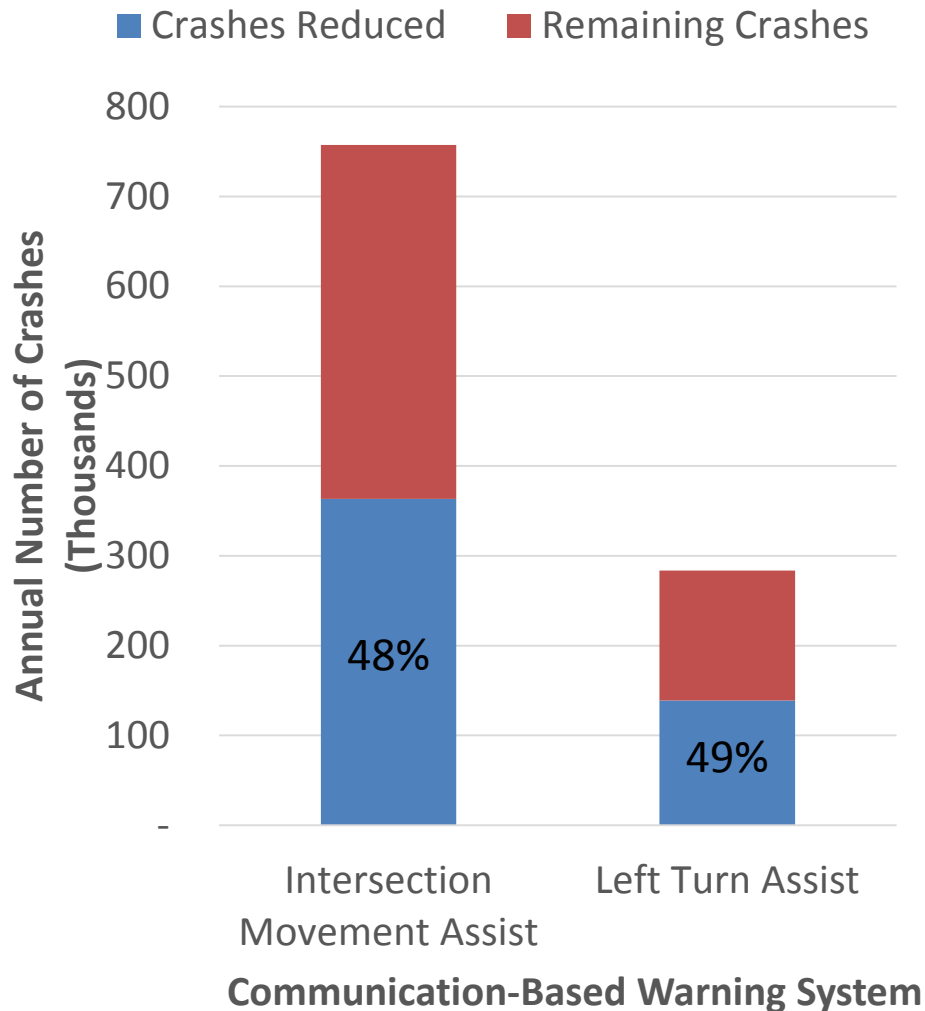
## ANALYSIS

- Crash Avoidance
- System Effectiveness
- Safety Benefits

# Potential Crash Avoidance Effectiveness



# Example of Potential Safety Benefits



## Other Factors

- Deployment, penetration rates
- Driver interaction
  - Acceptance, usage, misuse, negligence, and abuse
- False activation
- Unintended consequences
- Operational boundaries
  - Speed, environment
- Crash statistics over time
- Improvement of technology

# Questions and Contact



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