Independent Evaluation of U.S. DOT Field Operational Tests

Safety Benefits Estimation of Crash Warning Systems, and Discussion of Database and Data Analysis From the Perspective of an Independent Evaluator

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ACAS FOT Overview

- ACAS (Automotive Collision Avoidance System)
- System designed to address the rear-end crash problem
- 66 drivers equally distributed by gender and 3 age groups
- 4 weeks of driving with equipped vehicle
- 2 systems: ACC (Adaptive Cruise Control) and FCW (Forward Collision Warning)
- Vehicle equipped with forward radar to track up to 15 simultaneous targets
- Auditory and visual warnings via head up display

Basic Principle

Crashes *Avoided* = Crashes *Without* – Crashes *With*

Crashes *Avoided* = Crashes *Without* × $1 - \frac{\text{Crashes } \textit{With}}{\text{Crashes } \textit{Without}}$

N_a

Applicable Crashes

N_{wo}

System Effectiveness

SE

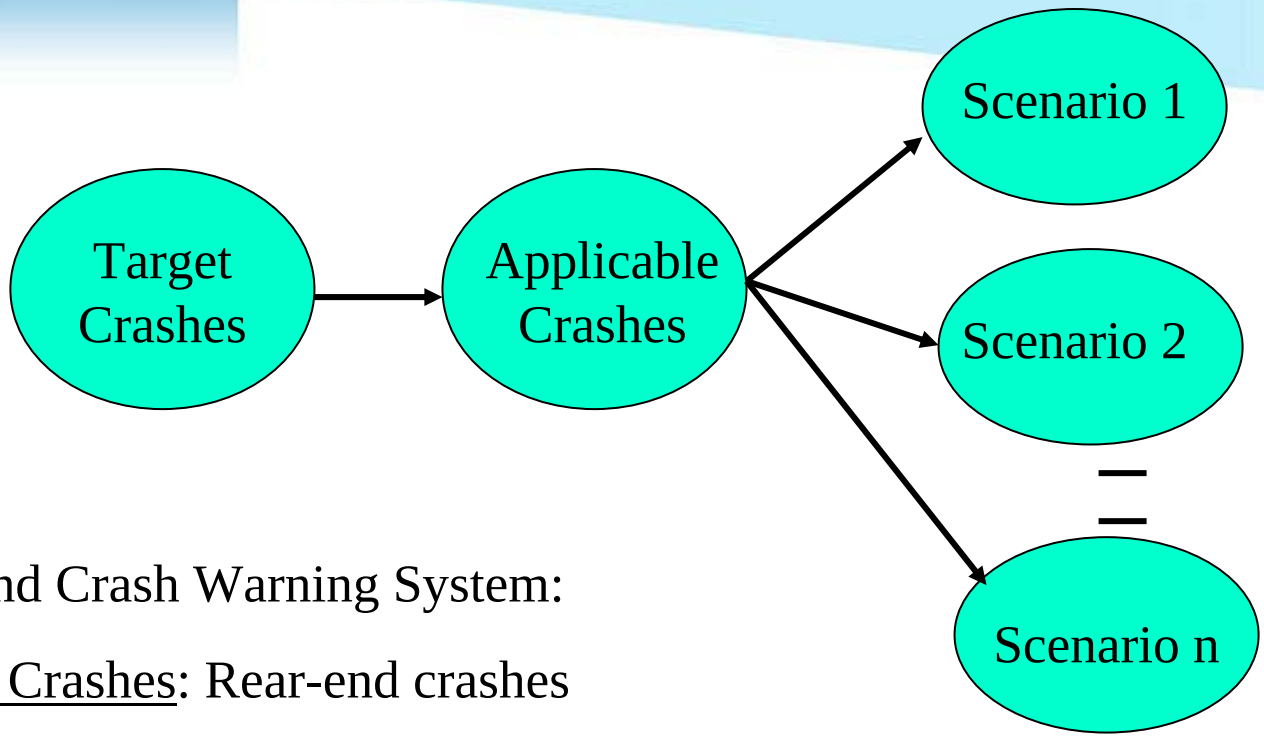
$$N_a = N_{wo} \times SE$$

Process:

1. Break down applicable crashes to the lowest level of pre-crash scenarios where system effectiveness may vary

2. Estimate system effectiveness in each pre-crash scenario

Breakdown of Applicable Crashes



Rear-End Crash Warning System:

-Target Crashes: Rear-end crashes

- Applicable Crashes: Exclude rear-end crashes caused by control loss, drunk driver, etc.

- Scenarios: Lead vehicle stopped (LVS)

Lead vehicle moving at slower speed (LVM)

Lead vehicle decelerating (LVD)

Estimation of System Effectiveness

$$\text{Crashes } \textit{Avoided} = \text{Crashes } \textit{Without} \times \left(1 - \frac{\text{Crashes } \textit{With}}{\text{Crashes } \textit{Without}}\right)$$

***System Effectiveness* SE**

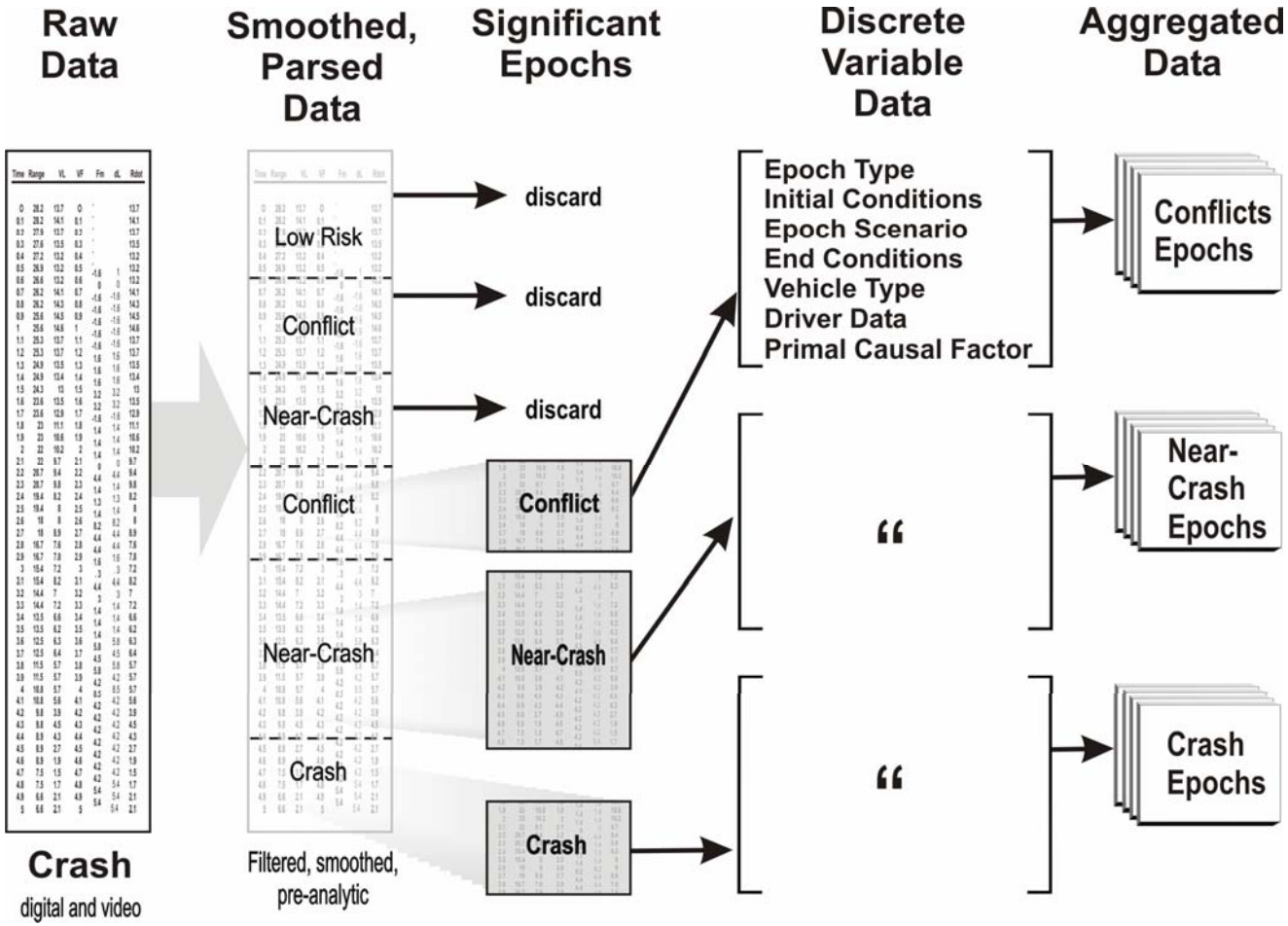
Determine Crashes *With* and Crashes *Without* from:

$$\text{Crashes} = \text{Conflicts} \times \text{Probability}(\text{Crash}|\text{Conflict})$$

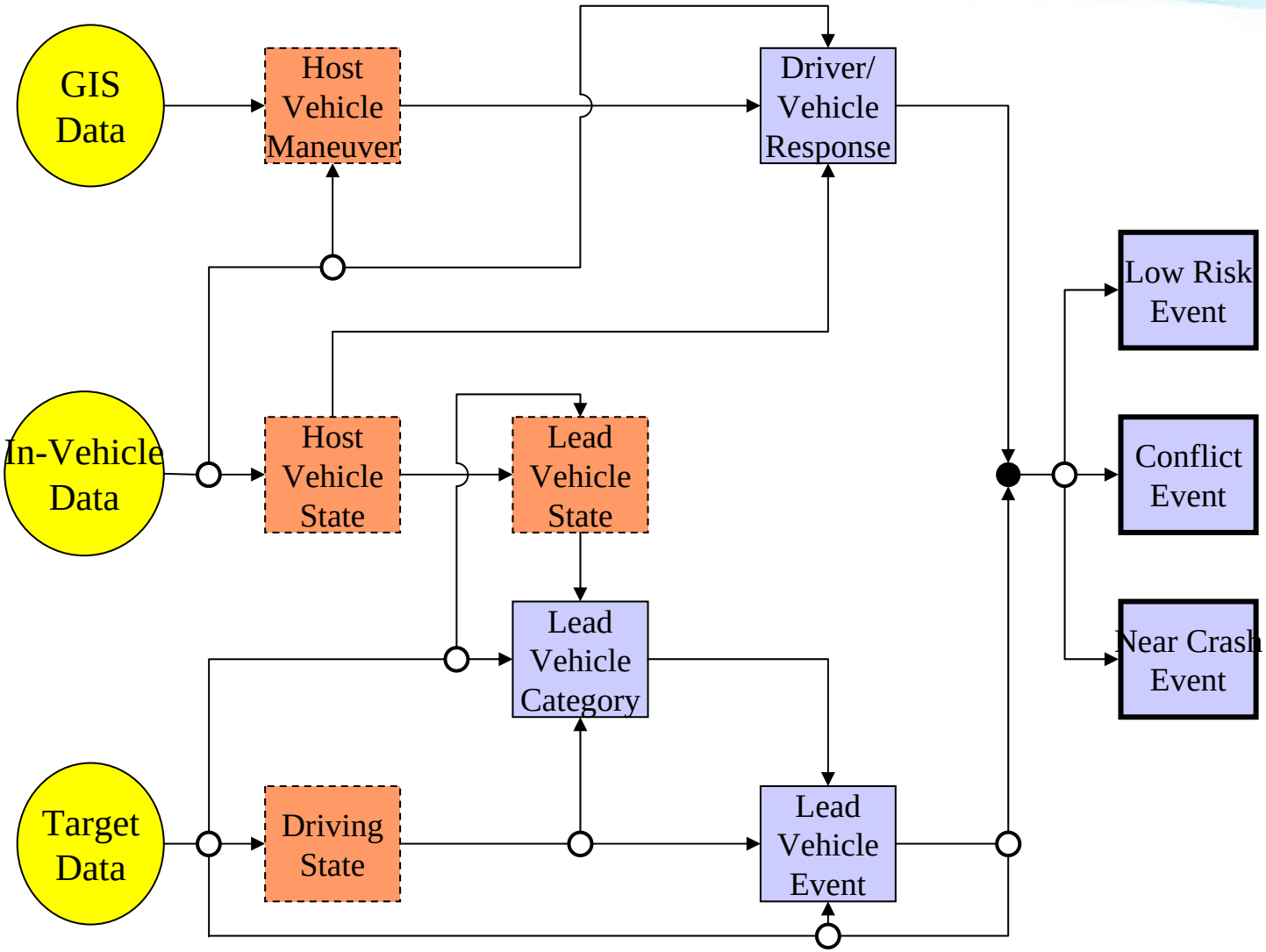
Exposure Factor ***Prevention Factor***

Exposure Factor: Conflict Identification

Identify conflicts *with* and *without* system assistance from field operational test data: (1) Mine data and (2) Set up conflict threshold

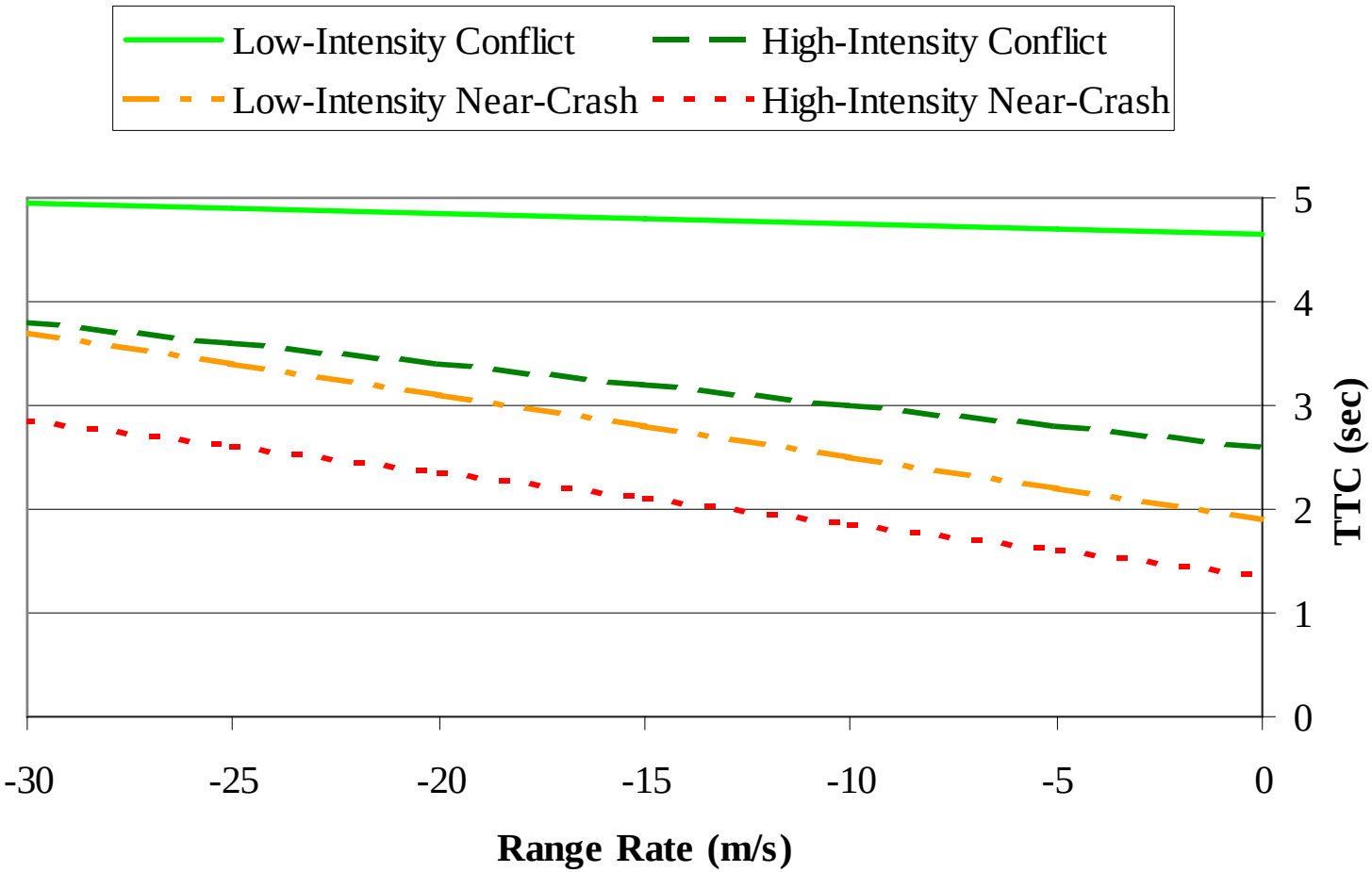


Conflict Identification – Data Mining



Conflict Identification - Threshold

Lead Vehicle Stopped – Brake Response



Probability of a Crash Estimation

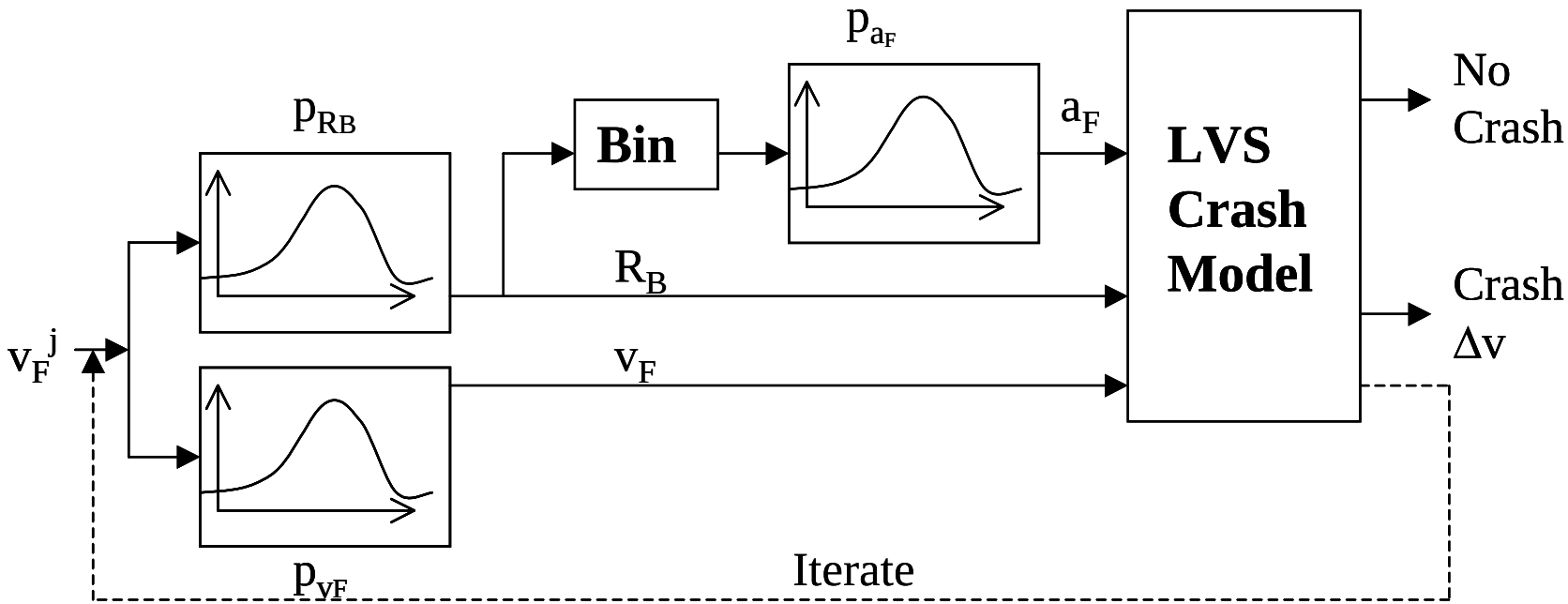
Estimate probability of a crash given an encounter with a conflict, *with* and *without* system assistance, based on:

- Initiation of Driver Response
- Intensity of Driver Response

Techniques:

- Monte Carlo Simulations
- Extreme Value Theory
- Bootstrap Technique

Probability of a Crash Estimation – Monte Carlo Simulations



v_F: Host Vehicle Speed (Initial Condition)

R_B: Distance to Target at Brake Onset (Response *Initiation*)

a_F: Host Vehicle Average Deceleration Level (Response *Intensity*)

Methodology Application - Example

S_i	GES	FOT		MC Simulations		Formula Applications			
	$N_{wo}(S_i)$	$P_w(S_i)$	$P_{wo}(S_i)$	$P_w(C\|S_i)$	$P_{wo}(C\|S_i)$	$ER(S_i)$	$PR(S_i)$	$E(S_i)$	$N_a(S_i)$
LVS	650,000	45	60	0.2	0.25	0.75	0.80	0.40	260,000
LVM	300,000	20	25	0.1	0.15	0.80	0.67	0.47	140,000
Rear-End Pre-Crash Scenarios	National Crash Data	Exposure to Conflicts		Probability of a Crash given a conflict		ER: Exposure Ratio PR: Prevention Ratio $E(S_i)$: System Effectiveness in Scenario S_i $N_a(S_i)$: No. Crashes Avoided in Scenario S_i			

$$ER(S_i) = \frac{P_w(S_i)}{P_{wo}(S_i)}$$

$$PR(S_i) = \frac{P_w(C \mid S_i)}{P_{wo}(C \mid S_i)}$$

$$E(S_i) = 1 - ER(S_i) \times PR(S_i) \rightarrow N_a(S_i) = N_{wo}(S_i) \times E(S_i)$$

ACAS Finding and Results

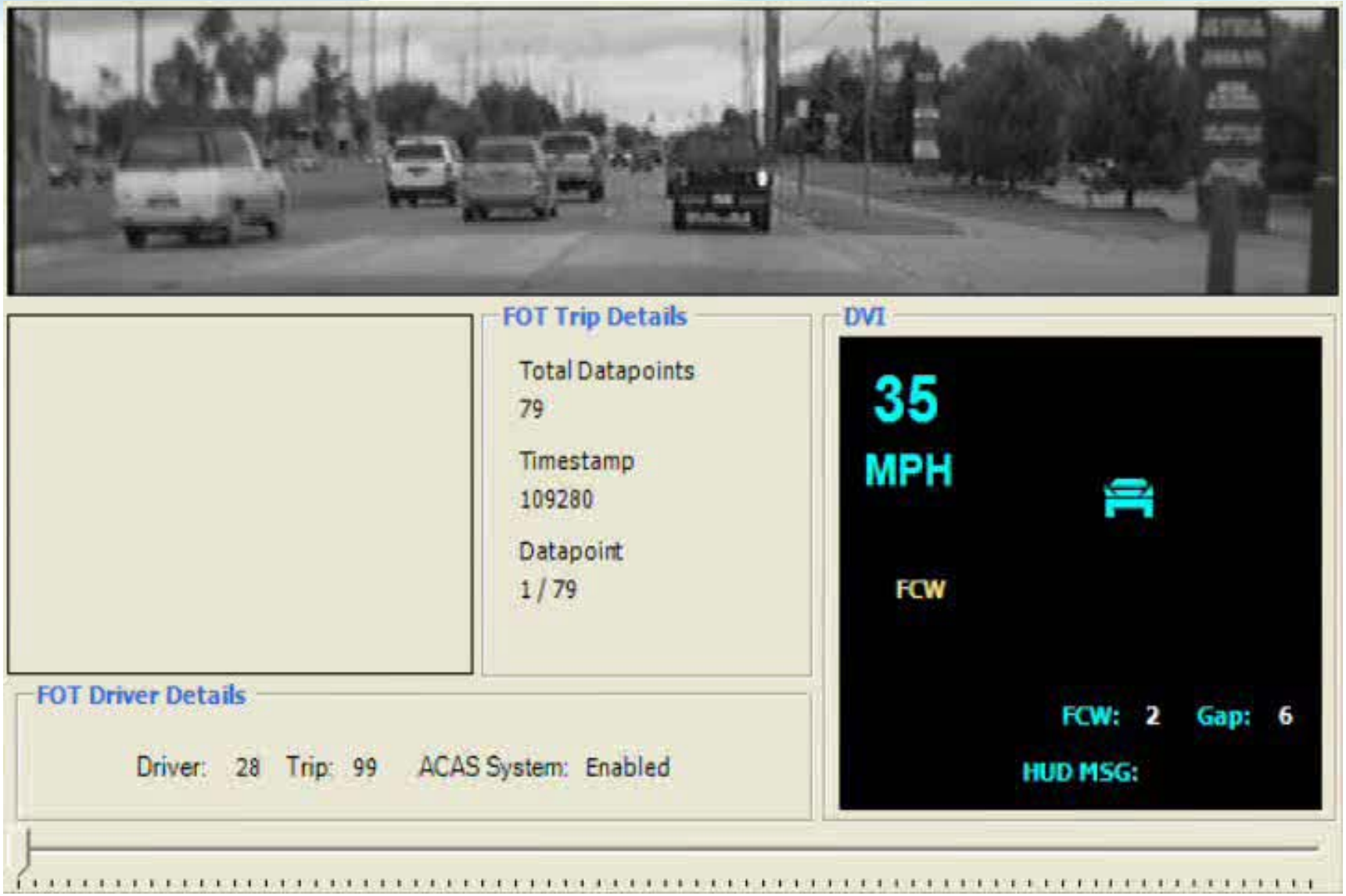
"Evaluation of an Automotive Rear-End Collision Avoidance System" is available for download at the NHTSA Office of Crash Avoidance Research Technical Publications website:

http://www-nrd.nhtsa.dot.gov/departments/nrd-12/pubs_rev.html

Database Concerns From an Independent Evaluator Perspective

- Database content
- Database format
- Tools available to mine data
- Tools available to view data and video

ACAS Tool Video



ACAS Tool Video

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