The Advanced Crash Avoidance Technologies Program

Art Carter

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Session: Crash Avoidance and Crash Causation
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"Reinventing the Automobile – A Global Challenge"
Walter E. Washington Convention Center
Washington, DC, USA

Agenda

- Background
- Target Crashes and Advanced Technologies
- Two Questions
- ACAT Program Goal
- ACAT Project Structure
- The SIM Basic Principle
- NHTSA SIM Structure
- Project Partners
- Perspective

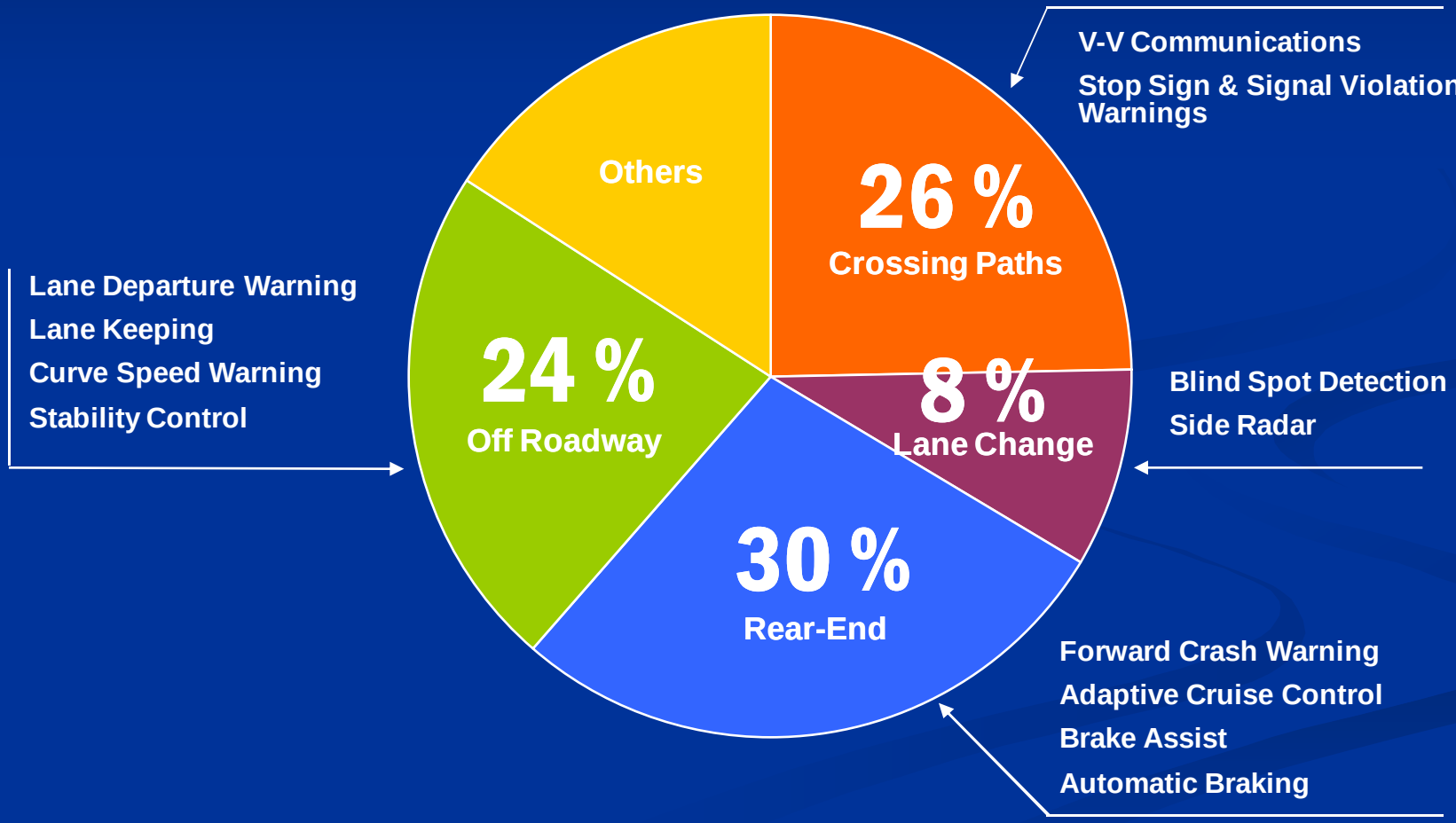
Background

- The automotive industry has made great strides in the development of advanced technologies[1] intended to prevent crashes and their consequences.
- To date assessing the effectiveness of advanced technology safety systems in reducing crashes has been time consuming and expensive.

1: Traction Control, All Wheel Drive, Electronic Stability Control, Foreword Crash Warning, Lane Departure Warning, etc…

Target Crashes & Advanced Technologies

2005 GES



Two Questions

- Is there a "methodology" that will effectively measure the link between "technological performance" and "safety impact?" for preproduction systems.
- Based on the methodology developed, how effective will new technologies be in preventing crashes and reducing their severity while protecting vehicle occupants?

ACAT Program Goal

- Using analytical methods, estimate the safety benefits of advanced crash avoidance technologies
  - Use crash data
  - Naturalistic data
  - Objective tests conducted by NHTSA

ACAT SOW

Task 1 - Safety Impact Methodology

- Preliminary SIM Analysis
- Preliminary SIM tool

Task 2 - Safety Area and Countermeasures

- Crashes and Technology
- Scenarios and Performance
- Safety area and Countermeasure specifications

Task 3 - Objective Test Development

- Identify set of tests scenarios
  - System and HF

Task 4 - Conduct Objective Tests

- Input to refine, calibrate, and validate model
  - Test track, simulator, roads, lab
- Results

Task 5 - Estimate Safety Benefits

- Delivery of final SIM

The SIM[1] basic principle

$$B = N_{WO} - N_W \qquad B = N_{WO} \times SE \qquad B_i = \sum N_{WO_i} \times E_i$$

Where,

B = benefits (number of crashes, number of fatalities, "harm," or other such measures).

N_{wo} = value of this measure, (i.e. number of crashes) that occurs ***without*** the system. (baseline)

N_w = value of the measure ***with*** the system fully deployed.

N_{wo} is usually known from crash data files, N_w is not known for pre-production systems. It is necessary to estimate the effectiveness of a countermeasure and combine it with Nwo.

SE = effectiveness of the system

An extension of this idea is that the overall benefits consist of the sum of benefits across a number of specific crash scenarios:

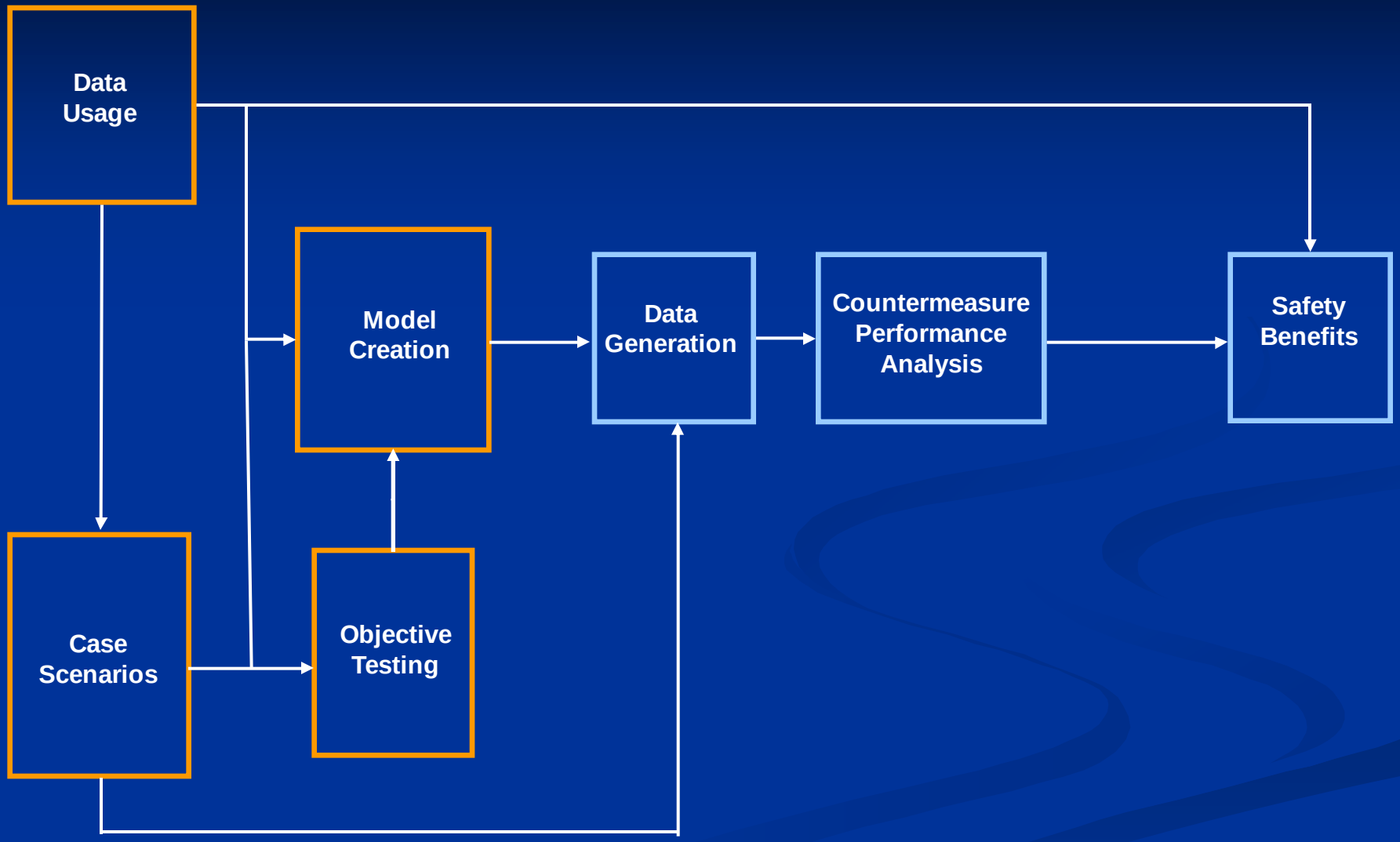
"i" = individual scenarios.

E_i = effectiveness of the system in reducing the number of crashes in a specific crash-related scenario

N_{woi} = baseline number of crashes in individual scenario "i"

1: SIM = Safety Impact Methodology

NHTSA SIM Structure



ACAT Projects

Technologies

ACAT I

- Advanced Collision Mitigation Braking System. Automatically predicts impending collisions, warns the driver and applies braking in order to reduce the effects of an impact.
- Driver Alert, Lane Departure Warning, and Emergency Lane Assist.
- A Next-Generation Backing-Collision countermeasure that provides levels of automated control to avoid backing collisions.
- Pre-Collision Safety System. Automatically predicts impending collisions, warns the driver, applies braking in order to reduce the effects of an impact, and tightens the seat belts to increase passenger restraint performance.

ACAT II

- Head-on Crash Avoidance
- Lane Departure Prevention and Side Object Warning

Perspective

- Advanced Crash Avoidance Technology
  - Area potential to reduce number, and severity, of crashes
  - Need to promote with industry and consumers
    - Need safety benefit information
  - ACAT alternative to provide safety benefit estimates
    - Provide information needed to consider technology as candidates for NCAP
    - ACAT possibilities

Back up Slides

Field Operational Tests (FOTs)

- Primary evaluation method for driver support systems with the goal of estimating real-world safety benefits.
- Definition
  - A study undertaken to evaluate a function, or functions, under normal operating conditions in environments typically encountered by the host vehicle(s) using "quasi-experimental" methods.
- Cost
  - Expensive: Previous and ongoing FOTs (ACC, IVBSS, LDW, etc…) have cost upwards of $40 Million
- Complex

- - Need an alternative - -

ACAT Objectives

1. Formulate and "exercise" a "Safety Impact Methodology" (SIM) tool to evaluate the ability of advanced technology applications in full vehicle systems to solve specific motor vehicle safety problems. (Evaluate methods to estimate the benefits of advanced crash avoidance technology.)
2. Demonstrate how the results of Objective Tests can be used by the SIM to establish the safety impact of a real system (i.e. estimate safety benefits)
3. ACAT II: Evaluate methods to determine the level of user acceptance of the technology.

SIM Data Alternatives

- A key step in a SIM is the creation of the numbers shown in the previous equations.
- Three methods are being developed
  - Monte Carlo simulations
    - GM/VTTI & Volvo/UMTRI
  - Crash reconstructions
    - DRI/Honda
  - Driving Simulator
    - Toyota

Monte Carlo Simulations

- Develop a computer model of the human-vehicle-environment
- Determine appropriate values, or distribution of values, for model parameters such as driver reaction time, etc.
- For each relevant scenario, establish the distribution of initial conditions such as lead vehicle deceleration, initial range, etc. as well as dynamic conditions
- Exercise a dynamic model using distributions above
- Estimate ratio of number of crashes with, and without, the countermeasure system

Crash Reconstruction approach

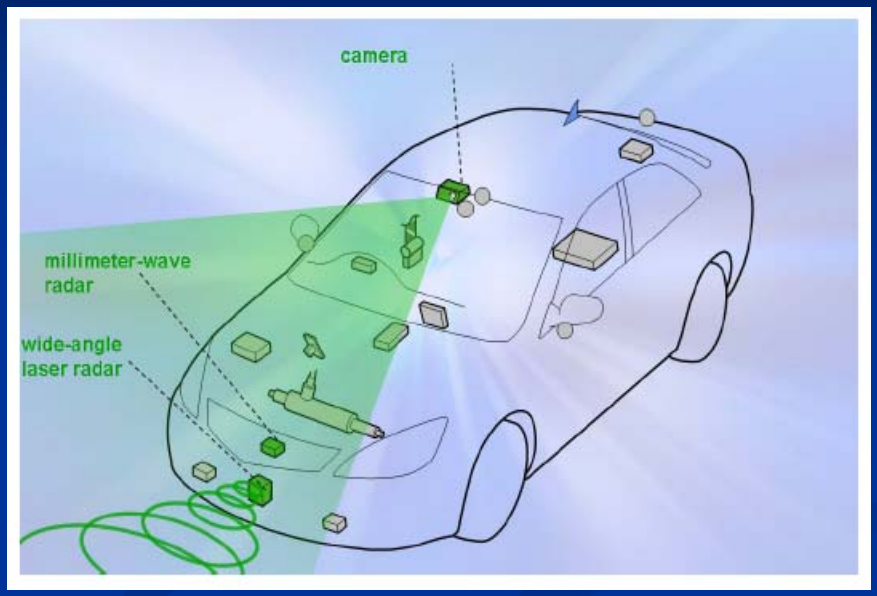
- Identify relevant cases using crash descriptions from files such as GES and CDS
- Reconstruct each case to provide further detail of initial conditions for each scenario
- Develop a computer model of the human-vehicle-environment
- Determine appropriate values for model parameters such as driver reaction time, etc. for tests
- Validate and calibrate model against objective tests and reconstructed data
- Apply model to a subset of relevant cases, for both original conditions without the countermeasure system and again for each case with the countermeasure active
- Estimate ratio of number of crashes with, and without, the countermeasure system

Driving Simulator approach

- Identify relevant cases using detailed crash descriptions from files such as CDS
- Summarize the conditions that describe each of several mutually exclusive subsets of the relevant cases
- Develop a computer model of the countermeasure system for incorporation in the driving simulator
- Develop curve profiles of specific parameter values from crash data files for situations without the countermeasures
- Exercise the simulator for mutually exclusive subsets of conditions with the countermeasure active for an appropriate sample of subjects
- Estimate the ratio of number of crashes with, and without, the countermeasure system for the conditions of each subset

ACAT Projects

Dynamic Research, Inc.



ACAT I

- Federal Share $1 Million
- Technology: Advanced Collision Mitigation Braking System. Automatically predicts impending collisions, warns the driver and applies braking in order to reduce the effects of an impact.

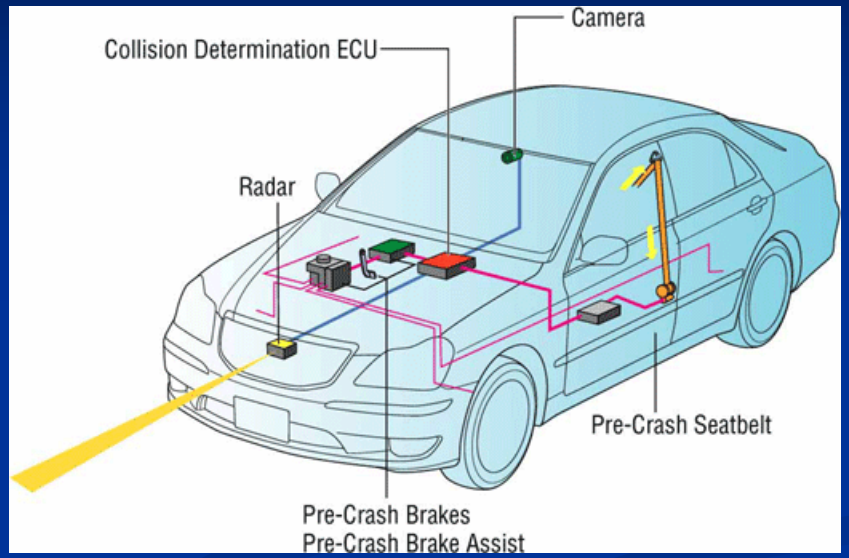
ACAT Projects

ACAT I

- Federal Share $1 Million
- Technology: A Next-Generation Backing-Collision countermeasure that provides levels of automated control to avoid backing collisions.

ACAT Projects

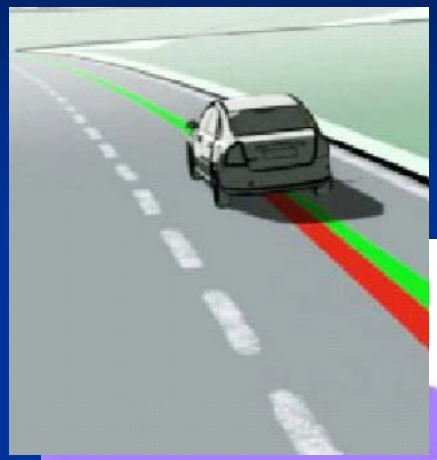
TOYOTA
TOYOTA TECHNICAL CENTER, USA, INC.

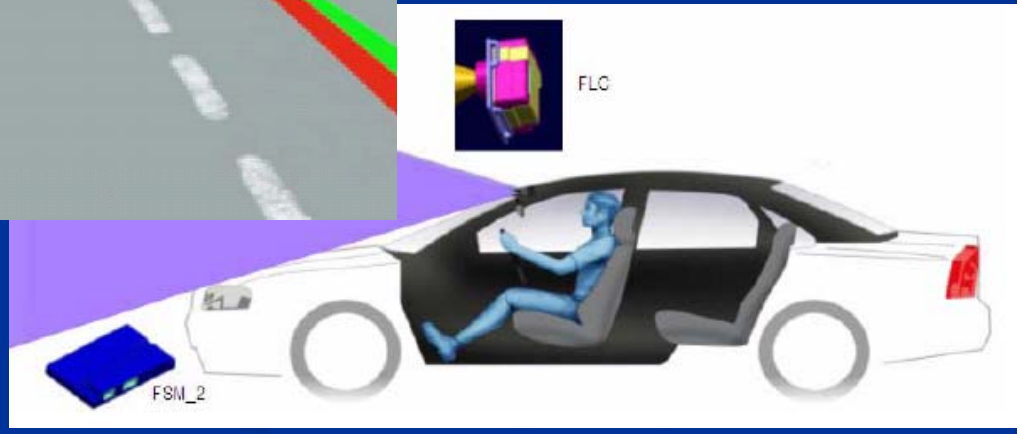


ACAT I

- Federal Share $250,000
- Technology: Pre-Collision Safety System. Automatically predicts impending collisions, warns the driver, applies braking in order to reduce the effects of an impact, and tightens the seat belts to increase passenger restraint performance.

ACAT Projects





- **ACAT I**
- Federal Share $1 Million
- Technology: Driver Alert, Lane Departure Warning, and Emergency Lane Assist.

ACAT Projects

ACAT II

- Federal Share $x Million
- Technology: Head-on Crash Avoidance

ACAT Projects

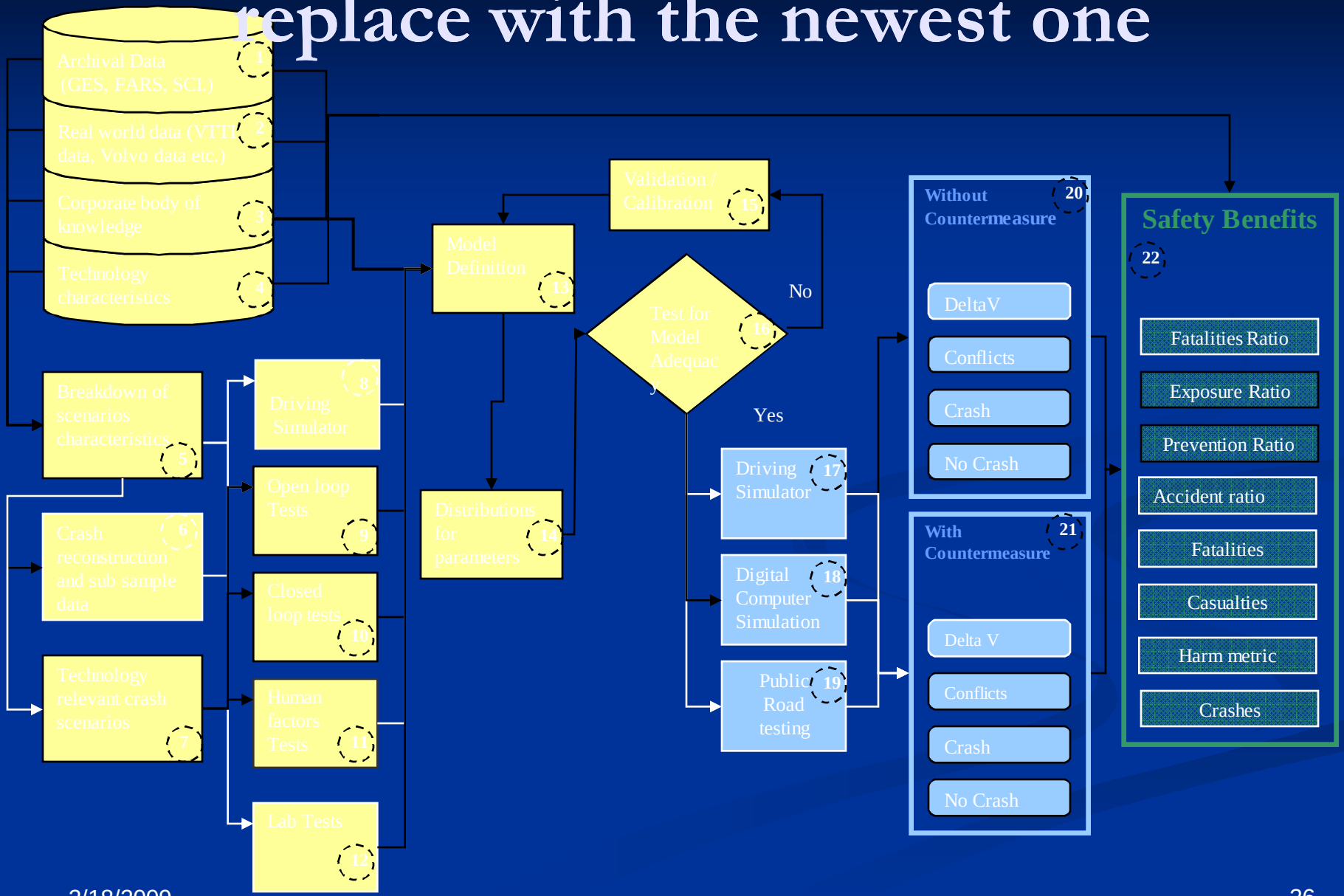
ACAT II

- Federal Share $x Million
- Technology: Lane Departure Prevention and Side Object Warning

NHTSA "Baseline" SIM

- Constructed based on the three approaches taken to create a Safety Impact Methodology by the current ACAT cooperative agreement partners.
- Created to help the NHTSA ACAT team to better understand the various processes and steps undertaken by the cooperative agreement partners.
- Used as the starting point for ACAT II

NHTSA "Baseline" SIM replace with the newest one



NHTSA Team

- Project Leads
  - NHTSA
    - Art Carter and John Harding
  - Technical Support
    - URC
      - August Burgett, Gowri Srinivasan, Raja Ranganathan
    - Volpe
      - Jonathan Koopmann

Crash Sequence
is this slide needed?

- In estimating the safety benefits, an analysis of events leading up to the crash is required. This requires addressing each part of the crash sequence