2013 DOE Vehicle Technologies Program Review

Look-ahead Driver Feedback and Powertrain Management

Principal Investigator: Rajeev Verma

Eaton Corporation

Project ID: VSS087

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Overview

Timeline

- Start: 10/2011
- Finish: 9/2014
- 50% complete

Budget

- Total project funding
  - DOE: $914k
  - Cost Share: $238k
- Phase 1:10/2011-1/2013 - $367k (DoE)
- Phase 2:1/2013-1/2014 - $308k (DoE)
- Phase 3: 1/2014-9/2014 - $241 (DoE)

Barriers

- Driver acceptance
- Safety concerns
- Cost effectiveness

Subcontractors

- UMTRI
  - Driver interface, pilot test
- ORNL:
  - Tech consulting & evaluation
- Con-Way Freight
  - End user

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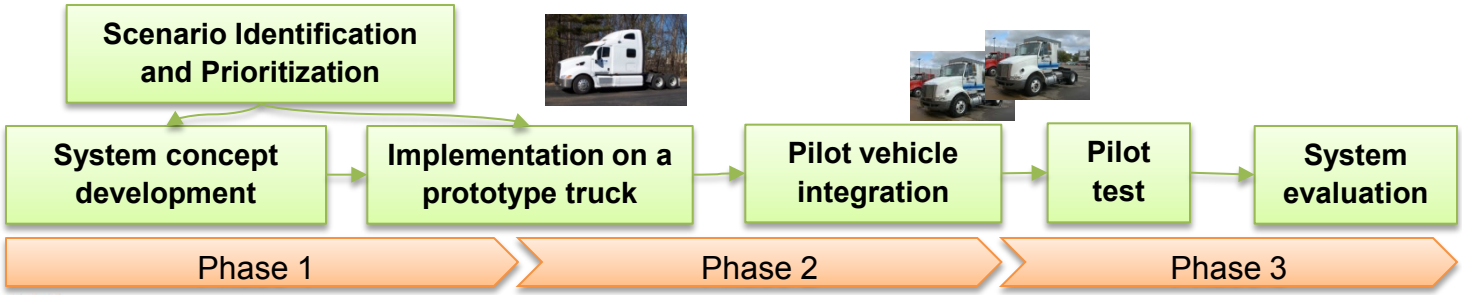
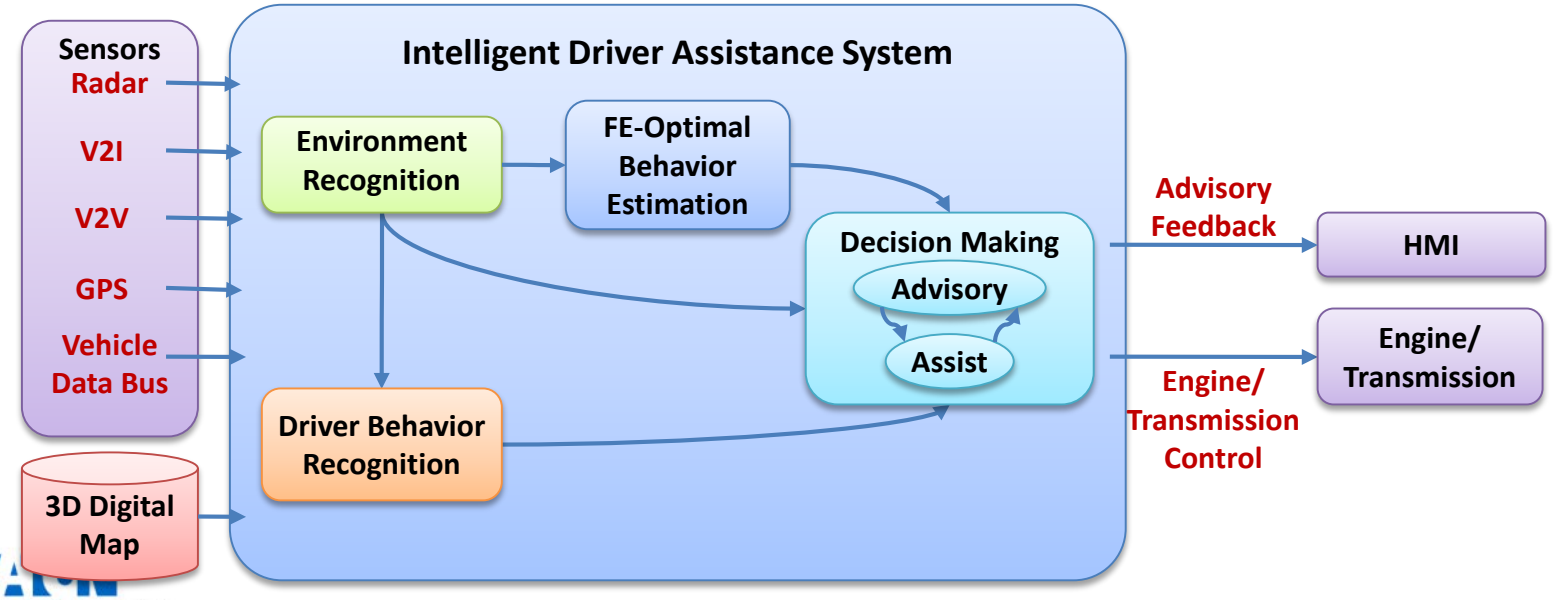
Relevance

- Overall Project Objective
  - Develop and demonstrate on real vehicles a driver assistance technology to reduce commercial fleet average fuel consumption by at least 2%
- Phase 1 Goals
  - Develop functional requirement specifications
  - Identify driver scenarios that impacts fuel consumption the most
  - Develop feedback strategy for target scenarios
  - Develop candidate driver interface and scenarios for driving simulator workload study
- Phase 2 Goals
  - Perform driving simulator study
  - Finalize HMI display and DAS
  - Pilot vehicle integration
- Phase 3 Goals
  - Pilot test
  - System evaluation



Approach

- Built upon existing and next-gen sensor and information technology
  - Will assess the impact of various options and their commercialization potential
- Scenario-specific feedback strategy
  - Leverage over 600k miles of naturalistic driving data from a recent DoT study
  - Separate environment caused inefficiency from driver caused inefficiency
- A combination of powertrain control and advisory feedback
  - Maximize fuel saving potential with minimum distraction



Key Milestones in Phase I

Month/Year	Milestone or Go/No-go Decision
1/2012	Milestone: Decide on target driving scenarios for fuel consumption impact analysis
3/2012	Milestone: Completion of look-ahead controller hardware design
6/2012	Milestone: Identify and prioritize the driving scenarios that have the most impact on fuel consumption
9/2012	Milestone: Completion of functional requirement specifications development
12/2012	Milestone: Completion of the development of driver interface candidates and the simulation study plan
12/2012	Go/No-go: Demonstrate through simulation the feasibility of the technology and the target fuel economy improvement

Key Milestones in Phase II

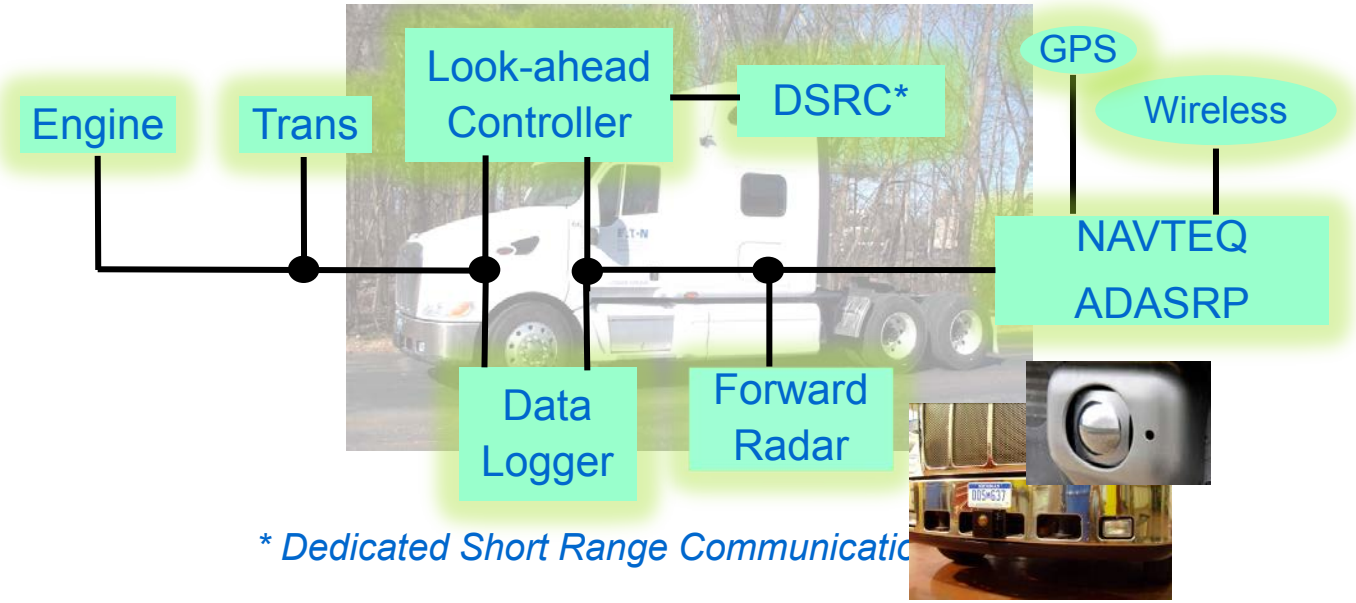
Month/Year	Milestone or Go/No-go Decision
6/2013	Milestone: Perform driving simulator study and down select Human-to-machine Interface (HMI)
6/2013	Milestone: In-vehicle HMI Algorithm and Hardware Development
6/2013	Milestone: Data Acquisition System Integration
11/2013	Milestone: System Integration and Validation on the Prototype Vehicle
12/2013	Milestone: Pilot Test Planning
12/2013	Go/No-go: Pilot Test Vehicle Preparation
12/2013	Go/No-go: System functional on the test vehicle

Technical Accomplishments and Progress

- Task 2.1: Voice-of-customer collection and functional requirements development
  - VOC collection completed with 2 major trucking fleets
  - Functional specification document completed
- Task 2.2: High fuel-consumption impact scenario identification
  - Driving scenarios for system engagement finalized

Technical Accomplishments and Progress

- Task 3.1: Look-ahead System Development
  - Target platform is a Single Board Computer
  - DSRC devices (for V2V and V2I communication) – integrated with the system and tested on Mi V2I test-bed



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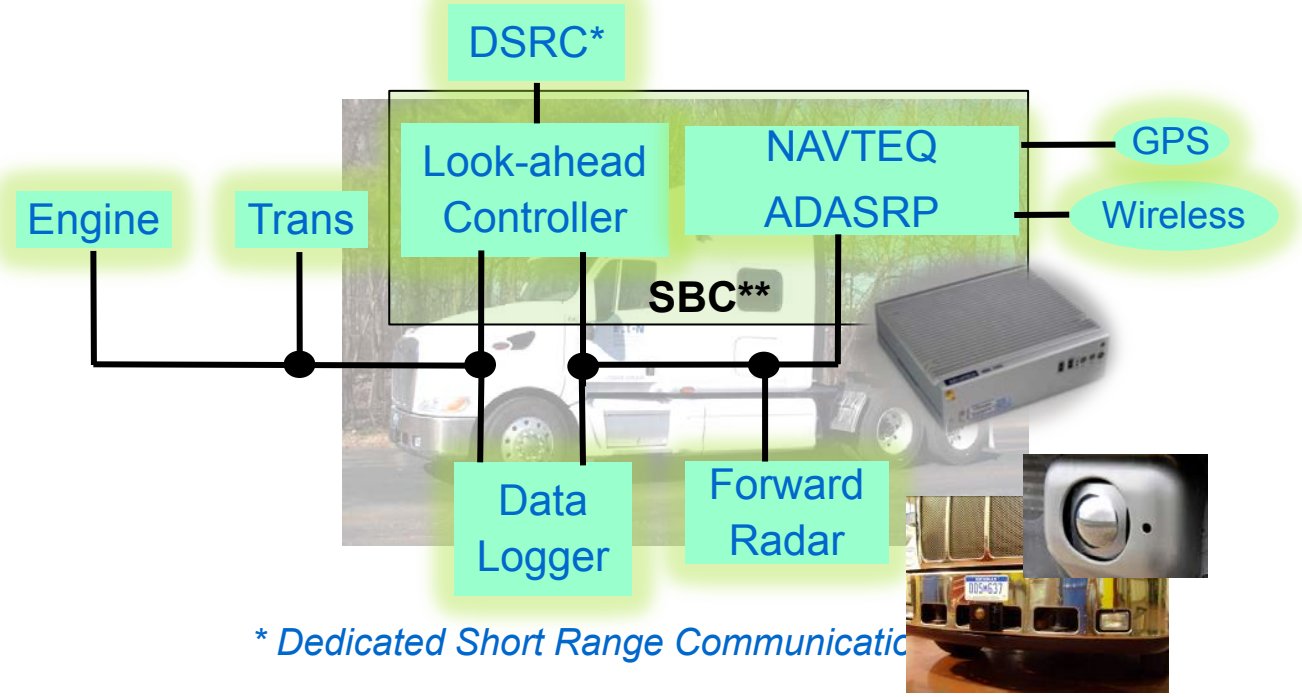

** Dedicated Short Range Communicatio*

*** Single board computer*

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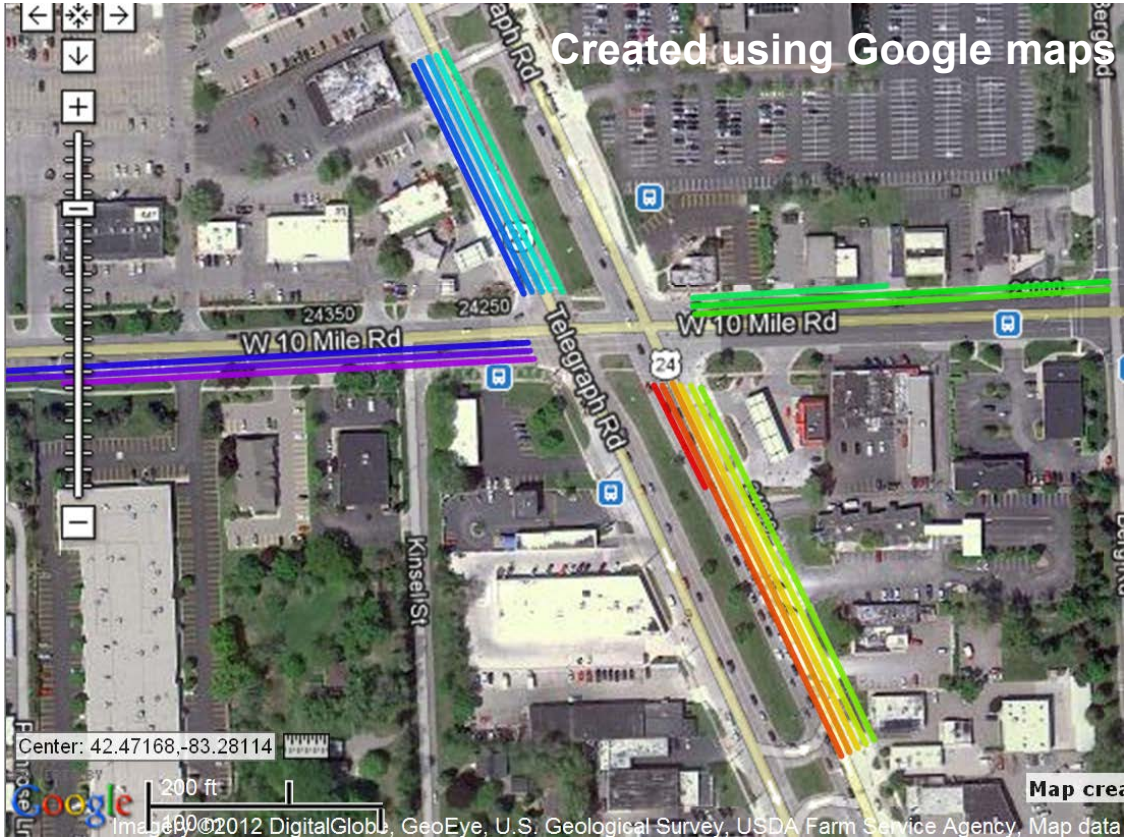

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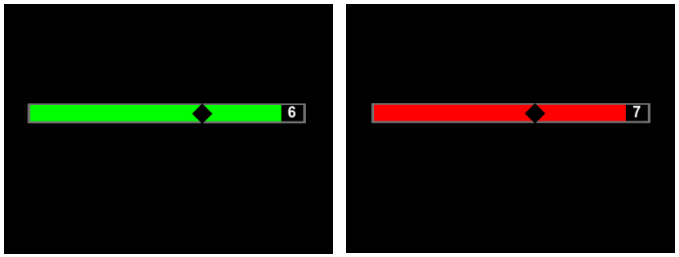
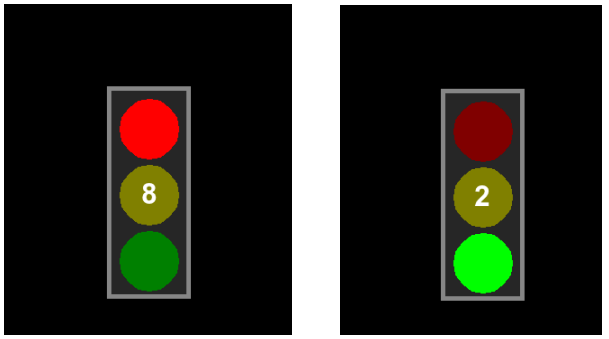
Technical Accomplishments and Progress

- Task 3.2: HMI concept development
  - HMI Display hardware for driving simulator procured
  - Display options created





Technical Accomplishments and Progress

- Task 4.1: Perform driving simulator study
  - Scenarios being programed on the driving simulator

- Task 4.2: Finalize HMI display algorithm and hardware
  - Hardware being shortlisted for in-vehicle HMI

Technical Accomplishments and Progress

- Task 4.3: System integration and validation on the prototype truck
  - Prototype vehicle identified
  - Started the DAS system development
- Task 5.2: Pilot test planning
    - Initiated discussion with Con-Way for obtaining 2 trucks for the pilot testing
    - Developing a fuel consumption measurement plan

Collaborations

- Subcontractors
  - UMTRI:
    - Collaborated on scenario exposure and impact analysis
    - Collaborated on driver interface development
  - ORNL:
    - Exchanged experience on previous heavy-truck related studies and truck fuel efficiency measurement
- Others
  - USDoT Michigan Test Bed (V2x Communication)
    - Helped on V2x communication integration
  - NavTeq
    - Collaborated on system design and map integration

Future Work

- Phase II
  - Down select and finalize driver interface
  - Finalize the prototype look-ahead system and integrate it onto pilot vehicles
  - Develop and verify the data acquisition system for the pilot vehicles
  - Pilot test vehicle preparation and validation of system
- Phase III
  - Pilot test
  - Technology evaluation

Summary

- Objective: Improve commercial fleet fuel efficiency by at least 2%
- A scenario-specific approach
  - A combination of advisory feedback and power control based on specific strategies for target scenarios to maximize fuel saving with minimum distraction
- Phase I completed, Phase II work is on-track and we are well positioned to continue the research in Phase III
  - Engaging with target end users to confirm the needs and to guide functional requirements development → paving the path for commercialization
  - Leveraging over 600k miles of naturalistic driving data from a previous study to identify high fuel consumption impact scenarios
  - Engaging with sensor and map suppliers to seek cost effective system design
  - Using the prototype truck to identify and address system design and retrofit risks upfront