2014 DOE Vehicle Technologies Program Review

Look-ahead Driver Feedback and Powertrain Management

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Project ID: VSS087

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Overview

Timeline

- Start: 10/2011
- Finish: 9/2014
- 70% complete

Budget

- Total project funding
  - DOE: $914k
  - Cost Share: $238k
- FY12 - $452k (DOE)
- FY13 - $341k (DOE)
- FY14 - $121k (DOE)

Barriers

- Driver acceptance
- Safety concerns
- Cost effectiveness

Subcontractors

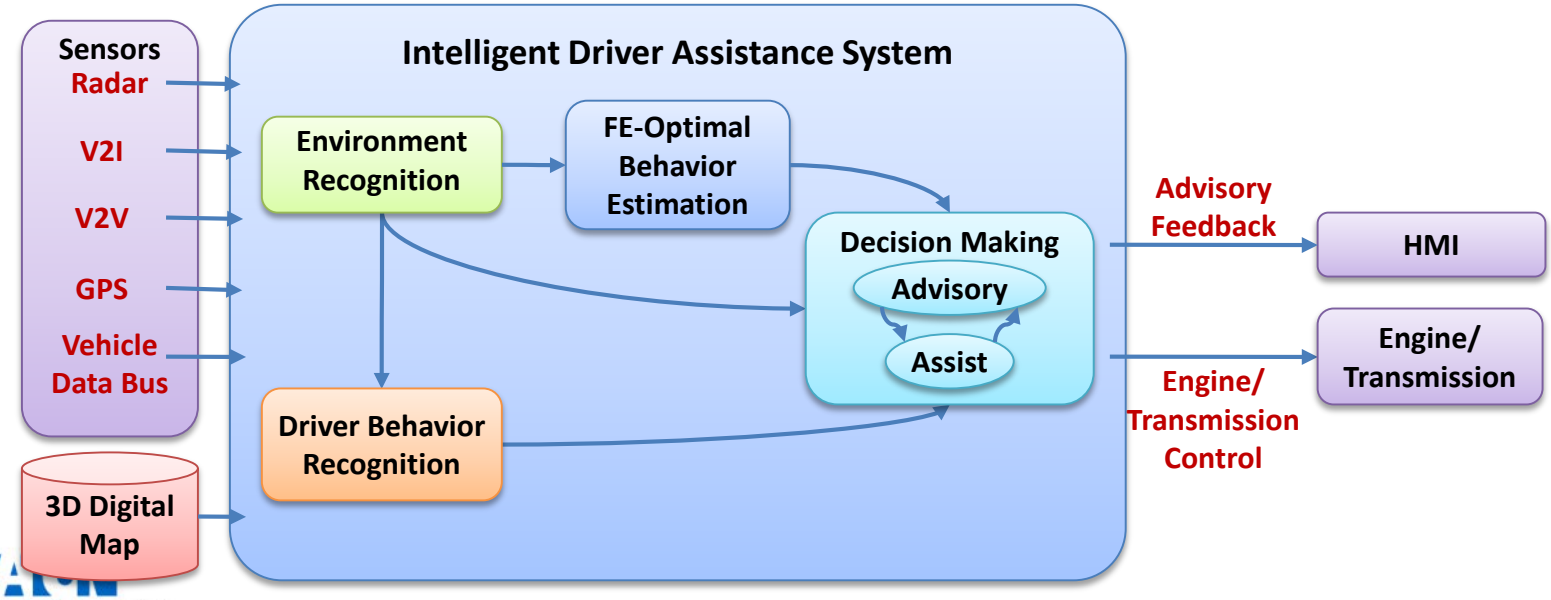
- UMTRI
  - Driver interface, pilot test
- ORNL:
  - Tech consulting & evaluation
- Con-Way Freight
  - End user

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
  - Vehicle integration and validation
- Phase 3 Goals
  - Pilot vehicle integration
  - Pilot test
  - System evaluation

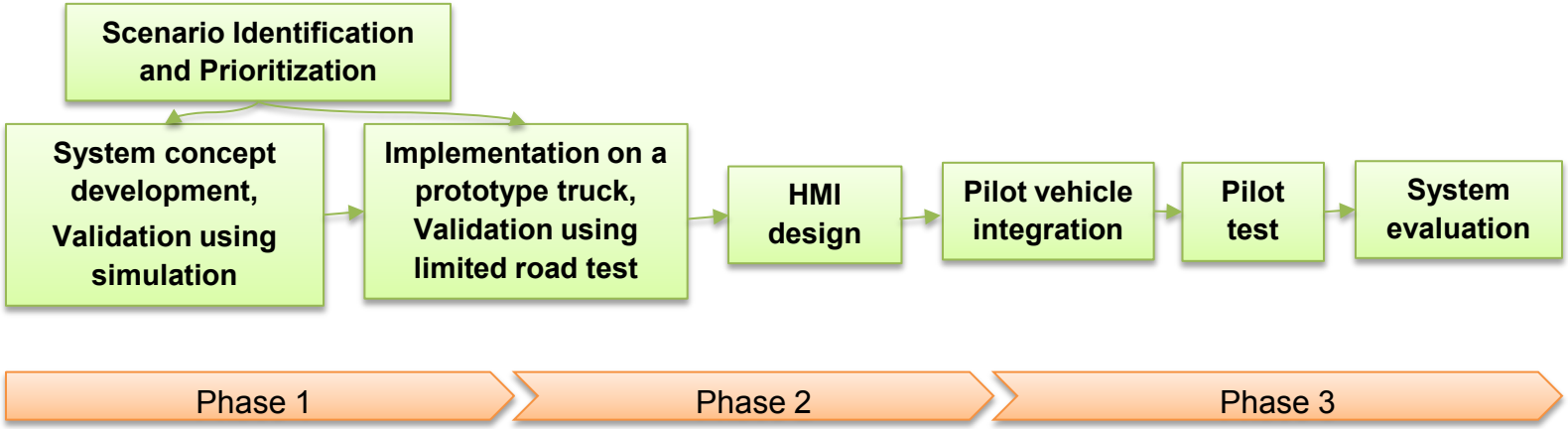
Approach

- 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



Technical Approach

- Model based control development
  - Scenario identification and prioritization based on IVBSS data
  - Use of simulation tools to develop and validate system concept
  - Implementation on a target platform and test using prototype vehicle
  - Conduct simulator study, design HMI
  - Pilot test preparation, vehicle integration, launch
  - Conduct pilot test
  - Data evaluation



Key Milestones in Phase I

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

Key Milestones in Phase II

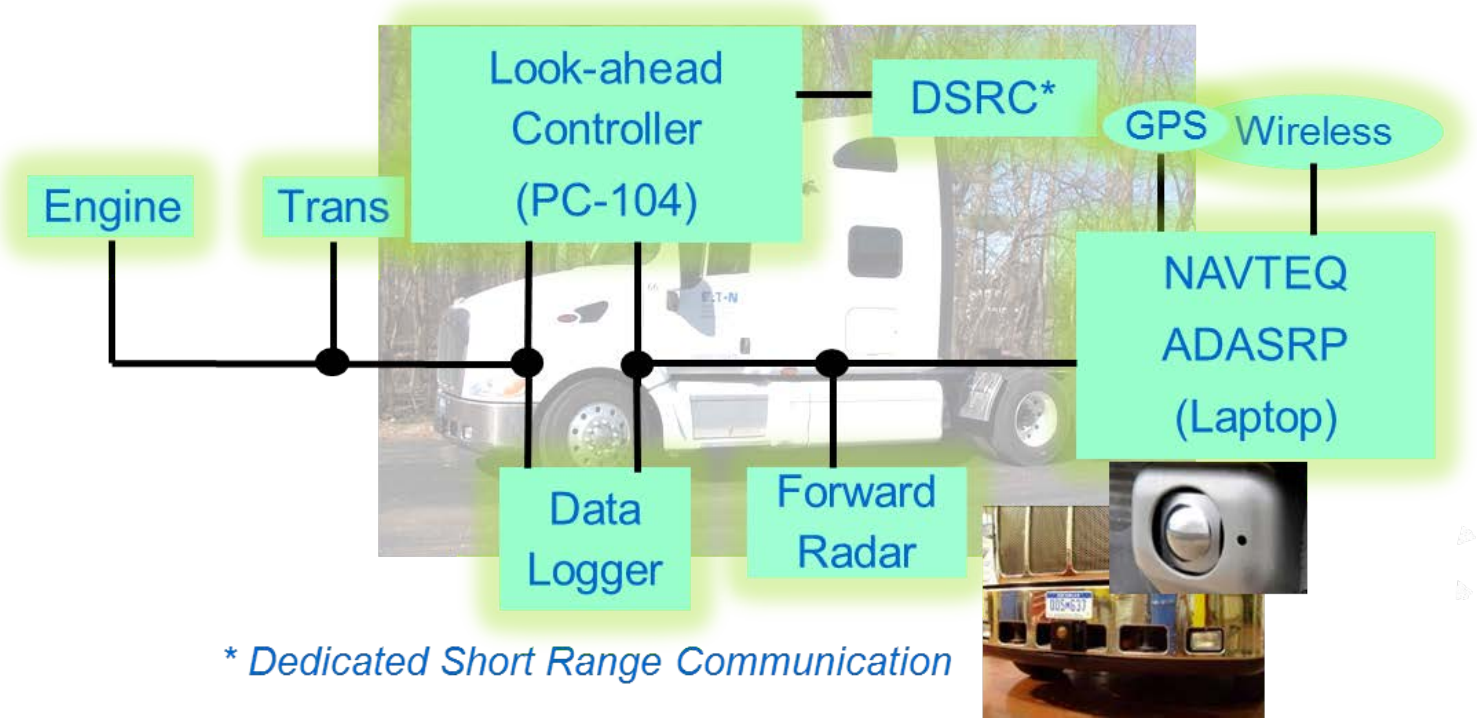
Month/ Year	Milestone or Go/No-go Decision	Status
6/2013	Milestone: Perform driving simulator study and down select Human-to-machine Interface (HMI)	Completed
6/2013	Milestone: In-vehicle HMI Algorithm and Hardware Development	Completed
6/2013	Milestone: Data Acquisition System Integration	Completed
11/2013	Milestone: System Integration and Validation on the Prototype Vehicle	Completed
12/2013	Milestone: Pilot Test Planning	Completed
12/2013	Pilot vehicle identified/fleet commitment secured	Completed
12/2013	Go/No-go: System functional on the prototype vehicle	Completed (4/2014)

Key Milestones in Phase III

Month/ Year	Milestone or Go/No-go Decision	Status
1/2014	Milestone: All hardware ready (DAS, System, Radar)	Completed (4/2014)
2/2014	Milestone: Legal agreement with Con-Way signed	Completed
3/2014	Milestone: Pilot test start	Delayed (expected: 6/2014)
6/2014	Milestone: Pilot Test finish	Delayed (expected: 9/2014)
9/2014	Go/No-go: Data analysis and report	TBD (expected: 12/2014)

Technical Accomplishments and Progress

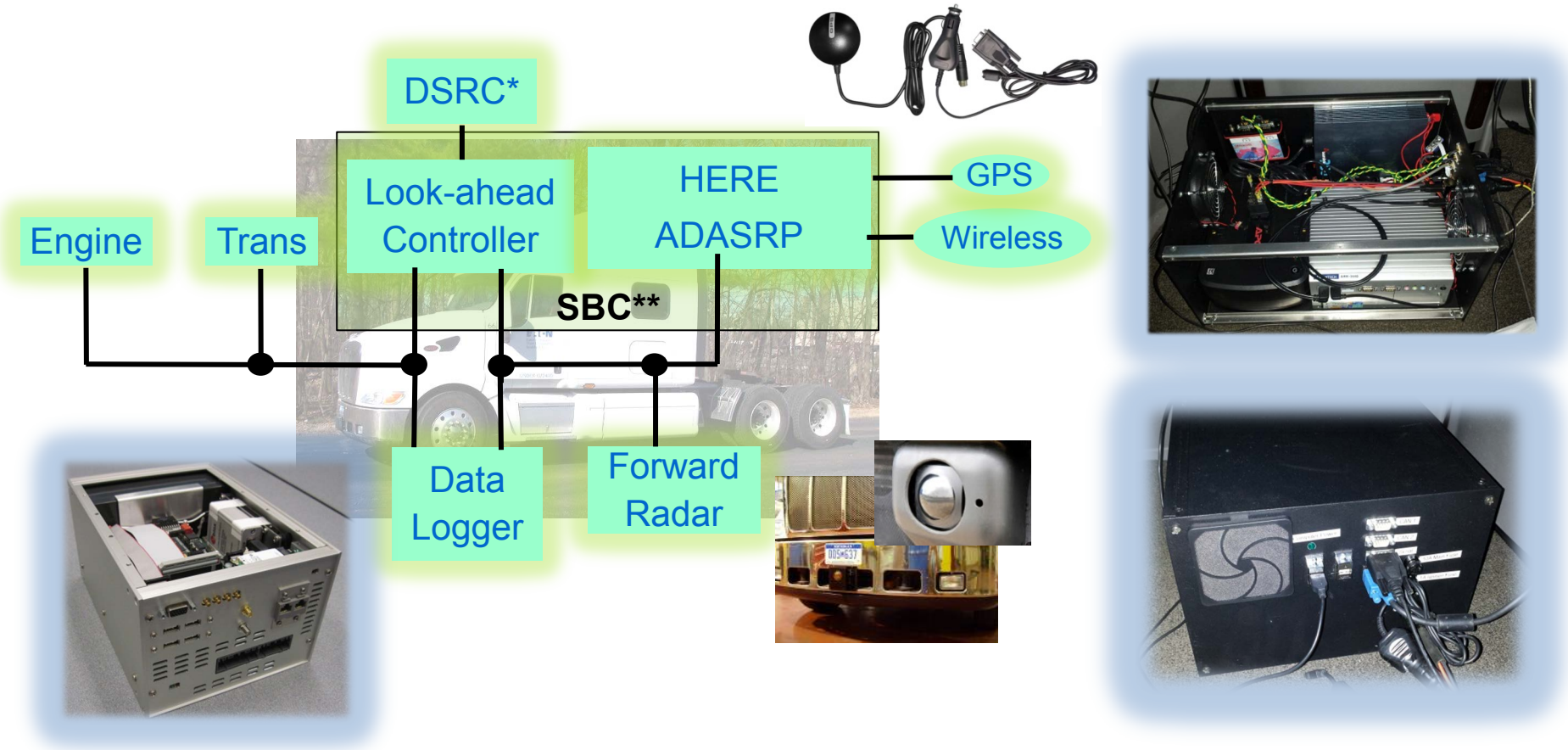
- Look-ahead System Development Technical approach
  - Gen 1 -> Gen 2 -> Gen 3



** Dedicated Short Range Communication*

Technical Accomplishments and Progress

- Gen 3

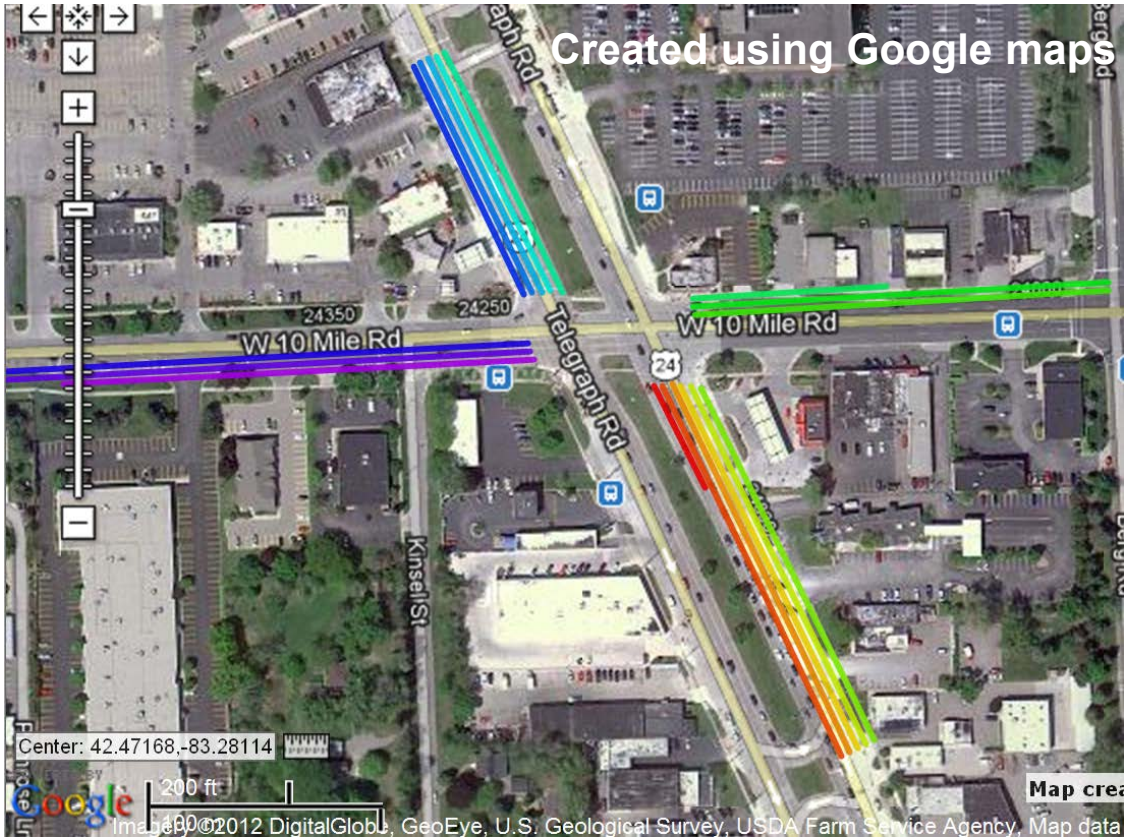


** Dedicated Short Range Communication*

*** Single board computer*

Technical Accomplishments and Progress

- Task 3.1: Look-ahead System Development
  - DSRC devices (for V2V and V2I communication) – integrated with the system and tested on Mi V2I test-bed



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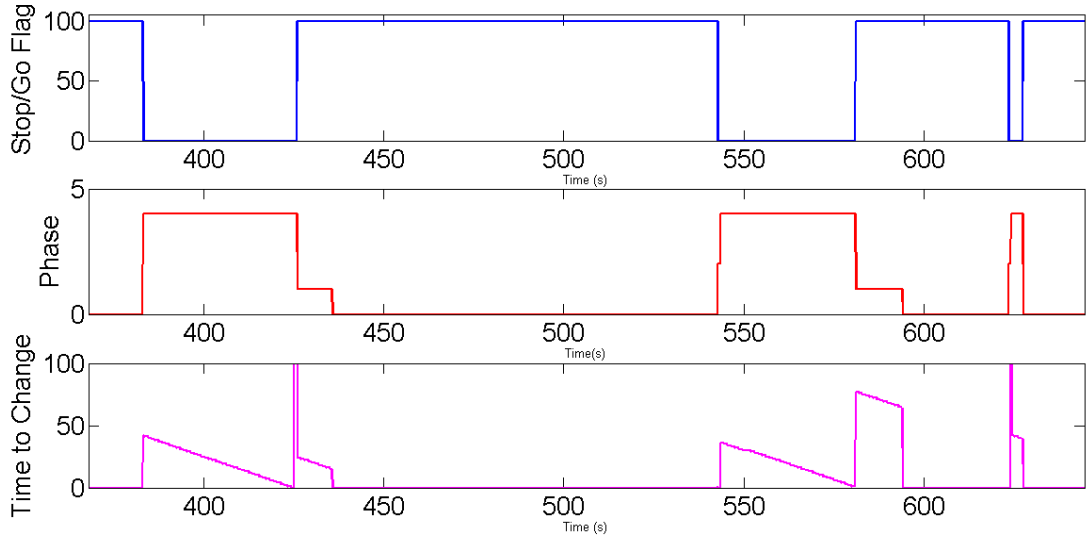
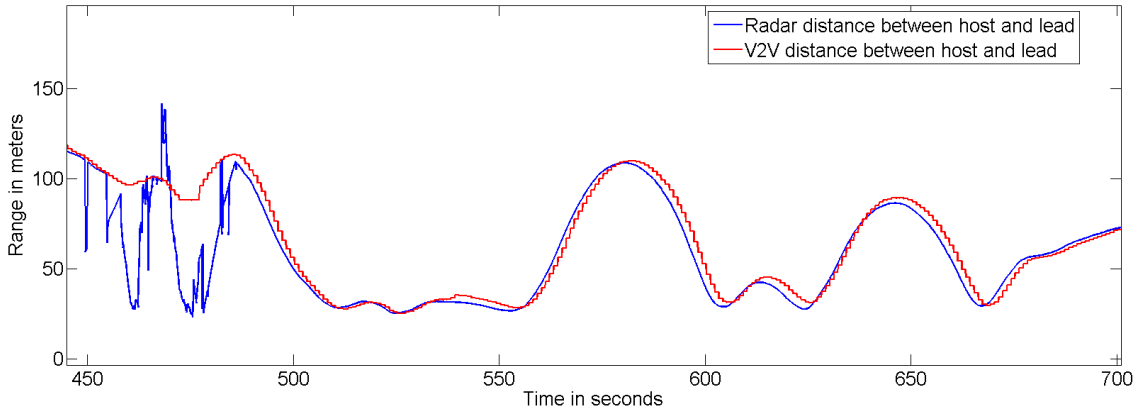
Technical Accomplishments and Progress

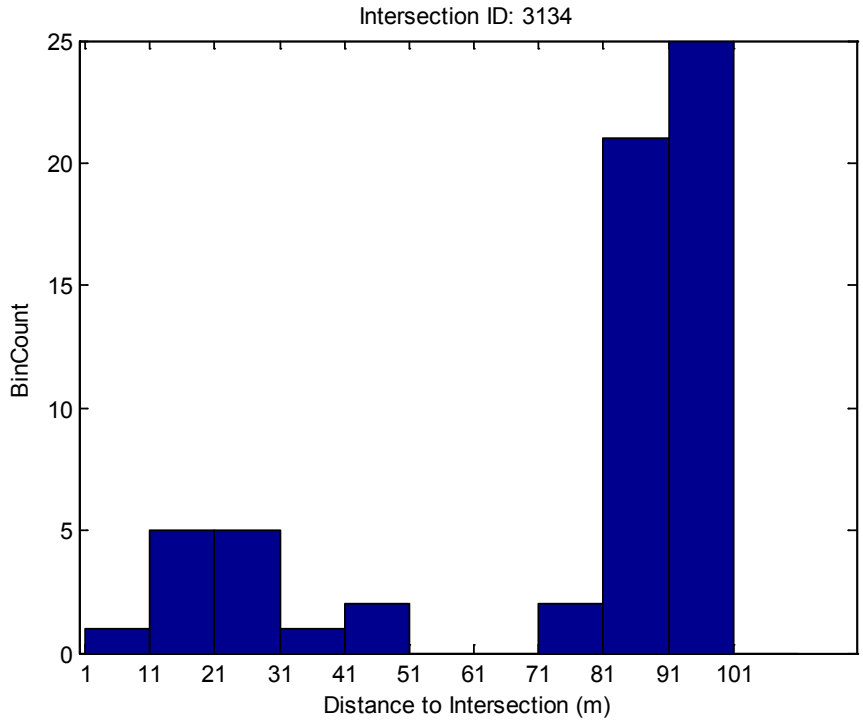
- V2I/V2V results

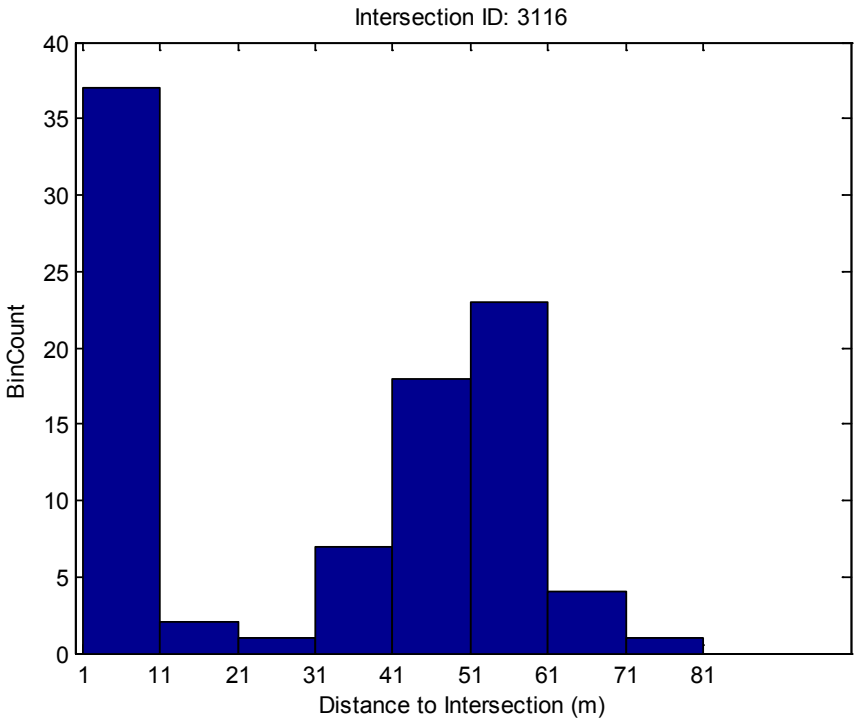




Technical Accomplishments and Progress

- V2I/V2V results





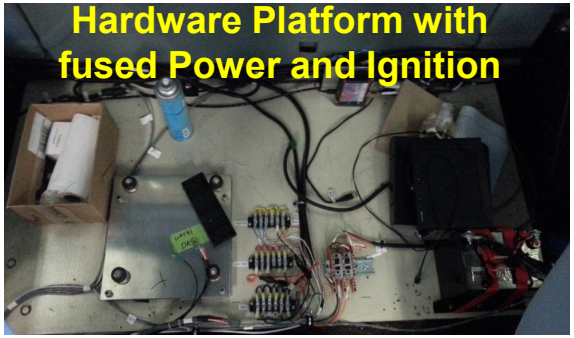
Technical Accomplishments and Progress

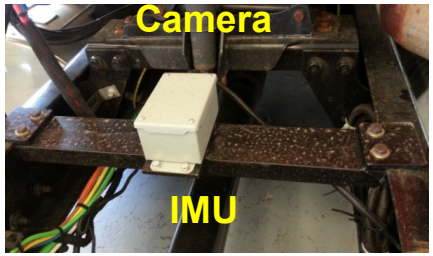
- Task 4.1: Perform driving simulator study
  - Driving simulator study conducted with 16 drivers
  - Simulator study report compiled and submitted

Task 4.2: Finalize HMI display algorithm and hardware V1 -> V2

Technical Accomplishments and Progress

- Task 4.3: System integration and validation on the prototype truck
  - System integrated and functional validation complete
  - Hardware ready for the pilot test – DAS, LPM, displays, radars, and other sensors



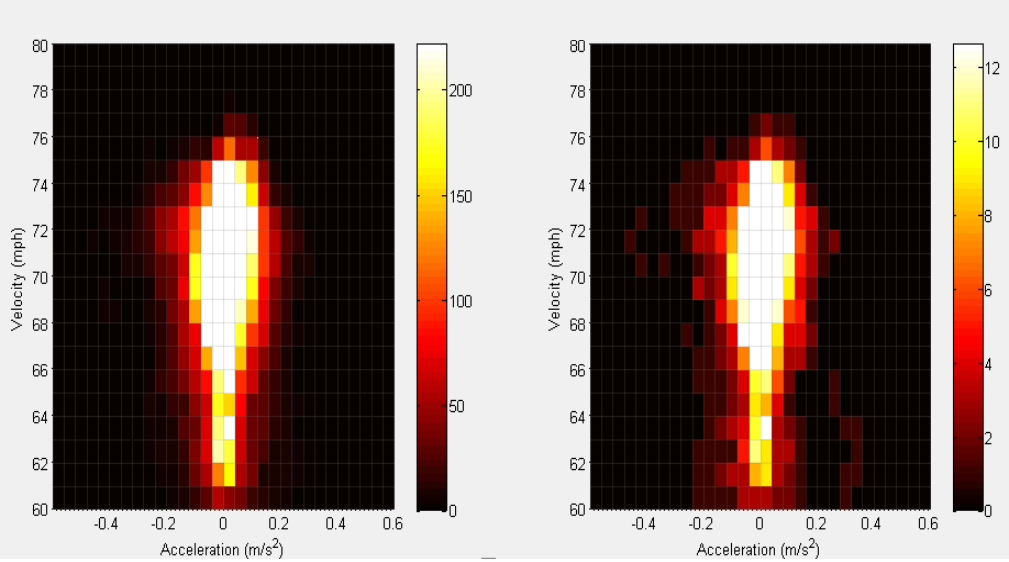


Technical Accomplishments and Progress

- Task 5.2: Pilot test planning
  - 2 Vehicles for pilot test procured by Con-Way
  - Con-Way has committed access to these vehicles
  - Legal documents in place, IRB in place
  - Trucks in operation, expected to log >30k miles before the pilot
  - Delay in start of pilot test -> Fuel blend change, trucks to accrue some miles before the pilot, technical snags with prototype vehicle, safety certification
- Safety evaluation being carried out by Eaton
  - Diagnostics for potential hazards/failure modes in place
  - Certification of modified TECU code as well as the system to be carried out
- Testing carried by Eaton (~1000 miles in total) confirms FE saving potential of 1% to 7%

Technical Accomplishments and Progress

- Assess FE based on fuel measurement, analysis of the changes to the drive cycles and modeling/simulation
- Statistical analysis of drive cycles with and without the LPM system
- Autonomie modeling to quantify fuel savings based on characterization of LPM impacts on drive cycle



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
  - HERE
    - Collaborated on system design and map integration

Future Work

- Phase III
  - Complete validation and safety certification
  - Pilot test vehicle preparation
  - Pilot test
  - Data download/weekly visit/maintenance
  - 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 and II completed. We are well positioned to continue the research and finish the work 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
  - Used the prototype truck to identify system design and retrofit risks upfront
  - System ready to be installed in pilot test vehicles

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