Energy and Automation Workshop

E1: Impacts of Connectivity and Automation on Vehicle Operations

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April 23, 2014
Comprehensive approach to fuel savings

System
- V2V
- Efficient route

Vehicle
- Driver behavior
- Look-ahead

Powertrain
- Engine integr.
- Downspeeding

Transmission
- Architecture
- Dry sump
- Light weight
Background: IVBSS - Large variation in FE
“Best” driver outperformed “good” driver by 11%-30% on MPG

US DoT funded project:
- 10 months
- 10 Class 8 trucks
- Manual transmission
- Con-way’s best drivers
- Highly repetitive routes

Fuel economy results by driver

Con-way Line Haul
- "Best"
- 10 drivers
- 540,000 miles
- 11% MPG spread

P&D
- "Best"
- 10 drivers
- 80,000 miles
- 30% MPG spread

© Microsoft MapPoint 2009
Data analysis by UMTRI and Eaton

Con-way Line Haul Class 8 Routes, IVBSS data
Look-ahead system framework

* HMI – Human Machine Interface
Prototype Vehicle Implementation

* Dedicated Short Range Communication

** Single board computer
Look-ahead: Grade Adaptation
I-696/I-96 and Southfield Fwy routes

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Grade Adaptation augments cruise control

Slowing on the uphill
Preemptive acceleration

<table>
<thead>
<tr>
<th>Trip</th>
<th>Tractor</th>
<th>Trip length (miles)</th>
<th>Average speed system on, mph</th>
<th>Average speed system off, mph</th>
<th>Speed difference, mph</th>
<th>Saving on whole trip, %</th>
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</thead>
<tbody>
<tr>
<td>Sf to Howell to Sf</td>
<td>Blue (no trailer)</td>
<td>68.28</td>
<td>58.29</td>
<td>60.06</td>
<td>-1.77</td>
<td>6.96</td>
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<td>White (no trailer)</td>
<td>68.75</td>
<td>57.52</td>
<td>58.31</td>
<td>-0.36</td>
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<td>51.28</td>
<td>52.40</td>
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<td>68.04</td>
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<td>White (70k lb)</td>
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<td>56.83</td>
<td>58.14</td>
<td>-0.58</td>
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</table>
Look-ahead: Vehicle-2-Infrastructure

RSE – Roadside Emitters
DSRC – Digital Short-Range Communication
SPaT – Signal Phase and Timing
GID – Geographical Identifier

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SPaT use for Look-ahead
Currently broadcast distance too short

Distance to intersection

Time (s) x 10^4

Distance (ft.)

0 200 400 600 800

0 1.4 1.5 1.6 1.7 1.8 1.9 2 2.1 2.2

Red
Yellow
Green

Time (s) x 10^4

Distance to Intersection (ft.)

Preview (m) Predicted Fuel Savings (L)

300 0.09
1000 0.31
3500 0.56
Look-ahead: V2V vs Radar

- Good correlation, delay can be filtered out
- Future research: enhanced in lane determination, especially on curves
Fuel Efficient routes and P/T options

- Fuel consumptions predictions for specific routes, driver behavior
- Analytics tools for energy efficient routes
Summary

• Energy efficiency gain is available at multiple levels

• Automation vs augmented driving