Commercial Vehicle Automation
Implications for Fuel Use and Emissions

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Energy and Environmental
Implications
of Automated Transportation

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Scope of Discussion

- Focus on the commercial vehicle – Class 8
- About automation of heavy trucks
- Fuel use and emissions reduction
- Longitudinal control
- Ancillary fuel and emissions benefits related to safety
Aerodynamic losses
Urban 4 – 10%
Interstate 15 – 22%

Engine losses
Urban 58 – 60%
Interstate 58 – 59%

Tire losses
Urban 8 – 12%
Interstate 13 – 16%

Inertial losses
Urban 15 – 20%
Interstate 0 – 2%

Drivetrain losses
Urban 5 – 6%
Interstate 2 – 4%

Auxiliary loads
Urban 7 – 8%
Interstate 1 – 4%

Aerodynamic power loss $C_d \times A \times V^3$

$\text{kinetic energy} = \frac{1}{2} mv^2$

Source: NAS 2010
Managing Energy

\[ \text{kinetic energy} = \frac{1}{2} mv^2 \]

80,000 lb truck (about 40 cars)
65 mph = 15.4 mega joules
30 mph = 3.26 mega joules

Vacillations between 30 and 65 mph consume 4 times more energy than those between 0 and 30 mph

Class 8 truck fuel bill $75,000 (72,000 liters)/yr
“Managed” congested traffic has benefits

- Stable flow (constant speed) is key – manage inertial losses
- Consider the fuel losses and emissions produced by the aggregated traffic stream due to unstable congestion
- Stable reduced speed flow reduces aerodynamic drag (less fuel required to cover the same distance)
- No effect on tire rolling resistance
- Safety risk greatly reduced in managed congested areas (delta V is small)
How safety improvements influence fuel consumption
## Average Annual Crashes, Injuries and Fatalities in USA

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Vehicle Crashes</th>
<th>Persons Injured</th>
<th>Persons Killed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Adverse</td>
<td>4,839,176</td>
<td>2,440,233</td>
<td>34,900</td>
</tr>
<tr>
<td>Adverse Weather</td>
<td>1,561,431</td>
<td>673,214</td>
<td>7,362</td>
</tr>
<tr>
<td>Total</td>
<td>6,400,607</td>
<td>3,113,447</td>
<td>42,262</td>
</tr>
</tbody>
</table>

Source: FHWA Pisano et al 2008
Possible V2X Solution
V2X and Automation Technology

Crash Vulnerability – *Truck striking rear-end collision*

Automated vehicles see hazards through *snow, rain and fog*
Economic Impact of Weather Related Crashes

- NHTSA estimates the total system cost of weather related crashes ≈ $50 Billion/year
- The cumulative annual delay exceeds 272 million hours (some % vehicle idle time).

Research question: What will automated longitudinal control yield in terms of system-wide fuel savings, emissions reduction and lives saved?
Concluding Comments

- Fuel consumption and emissions can be significantly influenced through longitudinal control in the congested environment.
- Reduced crash rates attributed to vehicle automation will diminish crash related congestion, idle time and resulting fuel consumption.
- Commercial vehicles represent a relatively small population having very high fuel consumption that will likely gain disproportionately large benefits through longitudinal automation.
Thank You!
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