Automation is in the Eye of the Beholder: How it Might be Viewed by the Traffic Engineer

ITE and ITSA Luncheon, Oakland, March 20, 2014

Jim Misener, jmisener@gmail.com
415.335.9252
Agenda

• Connected Vehicles
  • Dedicated Short Range Communications and Steps to Deployment
  • Making it Local: Prospect Silicon Valley (San Jose)
  • Implications

• Automation: Self-Driving, Autonomous, Connected?
  • Hyperbole
  • Definitions
  • Challenges
  • Transformative Impacts

• Implications (Summary)
Connected Vehicles
Dedicated Short Range Communications
A Very Quick Tour

- **DSRC was designed for the 5.9GHz ITS band**
  - Licensed under FCC Part 90 and 95
  - Defined in 802.11p
  - Standardized application layer messages (SAE)

- **DSRC V2I Use Cases**
  - Safety
    - Intersections
    - Curve Overspeed
  - Mobility
  - Environment

  *See Connected Vehicle Pilot Deployment Program, RFI (12 March) + USDOT Connected Vehicle Affiliated Testbeds*

- **DSRC V2V Use Cases**
  *V2V Use Cases Address 82% Crash Types*
  - Emergency Electronic Brake Lights (EEBL)
  - Forward Collision Warning (FCW)
  - Blind Spot Warning/Lane Change Warning (BSW/LCW)
  - Do Not Pass Warning (DNPW)
  - Intersection Movement Assist (IMA)
  - Left Turn Assist (LTA).
A multi-mile network of combined auto/rail streets provides a unique setting for:

- traffic analytics,
- connected vehicle communications,
- vehicle-signal interactive controls,

and other innovations addressing congestion and safety in transportation systems.
Sequence: DSRC Rulemaking through Deployment

1. February, 2013: Research that leads to NHTSA “mandate” by end of Obama Administration
   
   We are here...

2. 2014: Commercial heavy vehicle decision

3. 2015: Federal Highway Administration provides “guidance” to State and local road owner and operators

Post-Decision Activities

- Execute test plan for spectrum sharing
- Research Questions
  1. Applications Performance Requirements (to standards)
  2. Certification
  3. Security Framework
  4. Vehicle-Only or Vehicle + Aftermarket Devices
- Perhaps 2 – 4 year timeline for production vehicles
  - 10 – 20 M vehicles/year
Implications

• Transition from legacy systems (good and bad)
  • Capital: new signal controllers
  • Maintenance and Operations: technology, training
  • New Operational Concepts: More data, ability to control at smaller time intervals and smaller areas
  • Revenue?

• Data and liability
  • Cyber security: scalable, updatable, security credential management system
    • Privacy, trackability, enforcement considerations abound
  • Data ownership
  • Liability?

• Testing, certification, licensing
• Business models?
Automation

Self-Driving?
Autonomous?
Connected?
There are Optimistic Timelines...

...probably based on different definitions of “self driving cars”

Automated driving – examples of press releases

“Audi will sell self driving cars within this decade.”

http://www.spiegel.de/auto/aktuell/automatisiertesfahren-2025-fahren-autos-selbststaendig-a-873582.html

“Ford predicts self-driving, traffic-reducing cars by 2017”

“Volvo: Traffic jam assistance is coming in 2014“

“… automated driving functions monitored by the driver … could, on the other hand, be one of the very next evolutionary steps in driver assistance system.”
https://www.volkswagen-media-services.com/medias_publish/ms/content/de/pressemitteilungen/2010/11/08/
Increasing Level of Automation → Increasing Benefits

Societal Benefits

- Improved safety (not all roads)
- Congestion and fuel efficiency benefits are conjecture (latent demand)

Limited Self-Driving (NHTSA Level 4)

- Improved safety
- Congestion and fuel efficiency benefits still conjectural → Shared use vehicles or “transportation as service” would lead to change

Full Self-Driving (SAE Level 5)

- Greatly improved safety
- Significant environmental benefits
- Radical design changes: lightweight vehicles, different road types

Individual Benefits

- Increased comfort, convenience, safety and accessibility
### NHTSA and SAE Levels of Automation

*We are already part way there...*

<table>
<thead>
<tr>
<th>SAE level</th>
<th>SAE name</th>
<th>Narrative definition</th>
<th>NHTSA level</th>
<th>Steering and throttle controlled by...</th>
<th>Road environment monitored by...</th>
<th>Primary responsibility and fallback system is...</th>
<th>Example sensing needed (applicable systems)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Automation</td>
<td>Full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems</td>
<td>0</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>Forward Obstacle Detection (Forward Collision Warning)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lane/Road Detection (Lane Departure Warning)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intersection Obstacle Detection (Collision Warning)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blind Spot Warning (Enabler)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sign Detection (Enabler)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Headlight Control</td>
</tr>
<tr>
<td>2</td>
<td>Driver Assistance</td>
<td>Driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>1</td>
<td>Driver and ADAS System</td>
<td>Driver</td>
<td>Driver</td>
<td>Forward Obstacle Detection (Forward Collision Avoidance)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lane/Road Detection (Lane Keeping)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intersection Obstacle Detection (Collision Avoidance)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blind Spot Warning (Enabler)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sign Detection (Enabler)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Headlight Control</td>
</tr>
</tbody>
</table>

Current systems aimed at vehicle safety comprise Level 0 (no) or Level 1 (single function) automation.
The Peloton System

- **Individual Truck Safety**
  - Radar + Automatic braking

- **Driver Assistive Platooning**
  - Next level of cruise control
  - Fuel Savings from aerodynamics
  - Enhance driver awareness -- video link

- **Platooning Network Operations Center**
  - Coordination of linking opportunities
  - Trucks can only link when it is safe
    - Safe road, traffic, weather
    - Safe driver and truck systems
    - Safe truck pairing/ordering (relative weights & braking ability)
<table>
<thead>
<tr>
<th>SAE level</th>
<th>SAE name</th>
<th>Narrative definition</th>
<th>NHTSA level</th>
<th>Steering and throttle controlled by...</th>
<th>Road environment monitored by...</th>
<th>Primary responsibility and fallback system is...</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td><em>Driving mode</em>-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task*</td>
<td>2</td>
<td>System</td>
<td>Driver</td>
<td>Driver</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td><em>Driving mode</em>-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene*</td>
<td>3</td>
<td>System</td>
<td>System</td>
<td>Driver</td>
</tr>
</tbody>
</table>

Level 2 automation available today (example: Mercedes S Class). These features will move to the mass market within a few years.
There is still a long way to go...

<table>
<thead>
<tr>
<th>SAE level</th>
<th>SAE name</th>
<th>Narrative definition</th>
<th>NHTSA level</th>
<th>Steering and throttle controlled by…</th>
<th>Road environment monitored by…</th>
<th>Primary responsibility and fallback system is…</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>High Automation</td>
<td><em>Driving mode-</em> Performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene*</td>
<td>4</td>
<td>System</td>
<td>System</td>
<td>System</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>Full-time performance by an automated driving system of all aspects of the <em>dynamic driving task</em> under all roadway and environmental conditions that can be managed by a human driver</td>
<td></td>
<td>System</td>
<td>System</td>
<td>System</td>
</tr>
</tbody>
</table>

Level 4 (example: “Google automation”) is conjectured to be available 2020 by some...and in over 15 years by others. Issues are profound:

- **The “Human Problem”**
  Transition of control (black line) to human driver and system reliability are big questions.

- **The “Robot Problem”**
  SAE Level 5 obviates this difficult problem but brings in new issues of extremely high reliability.
Challenges

Technical
• In-vehicle: by-wire control (throttle, brake, steering), data and electrical architectures
• Sensors: low-cost, compact scanning and perception needed
• Maps: high-resolution near-real time maps
• Communication?
  • Is an automated vehicle an autonomous vehicle?
  • Connectivity challenges span the spectrum: Vehicle-to-vehicle safety vs. provision of real time maps

Reliability and Resiliency
• To what level of functional safety?
• What about hackers?

Human Factors: Transition of control

Institutional, Societal and Commercial
• What if it’s attractive? Induced demand...arterial bottlenecks...
• What if it’s unattractive? High cost and small market penetration
• Liability and tort issues
• Licensing
• Certification
• Mixed traffic vs. dedicated lanes?
World’s First Robotic Traffic Jam
Potential Transformative Impacts

Travel Demand and Mode Shift

• Fits shared economy paradigm
  • Realizes transportation as a service and enables demand-responsive transit feeder and last mile services
  • Land use impact: supports high density development

• Fits needs of older populations
  • Allows personal transportation for elderly → enables aging in place
  • Land use impact: supports urban sprawl

• Enables sustainable, long-distance commutes
  • Land use impact: supports urban sprawl
  • May unleash latent demand for local and regional travel

• Makes long distance and local goods movement more efficient
Potential Transformative Impacts

Civil Infrastructure

• **Limited Access Roads**
  • Dedicated freight lanes
  • Dedicated (narrow) automated vehicle lanes
  • New or separated facilities...or rehabilitated facilities with increased capacity
    Opportunity for wireless charging
  • Need for breakdown lanes
  • Improved geometrics, not bounded by driver perception-reaction and design speeds

• **Arterials and Secondary Roads**
  • Separation of other road users (e.g., pedestrians, pedacyclists)
  • Increased need for real-time wireless connectivity?

• **Parking**
  • Key questions - Does travel demand increase or decrease? Will there be shared, multi-occupant travel?
  • Automated operation and small lot footprints

• **Transit:** Key question – can automation resolve “last mile problem” and increase travel demand for this mode?

• **Other**
  • Special pavement for high volume lanes
  • Supplemental roadside sensors (weather, enhanced sensor installations for non-line of sight)
Implications (Summary)

- Is this an evolution from Connected Vehicles, or are automated vehicles a different idea?
- Is there a safety proposition?
- How does induced demand figure into this?
- New paradigms/"modes": PRT, DRT, car sharing / station cars, dedicated lane operation
- Business models to build special roadway features and to operate
  - Dedicated lanes? Narrower lanes? Special-purpose facilities?
  - Check-In, Check-Out
  - Merge, Diverge
  - Other interfaces (3000+ vplph interface to arterials)
- Testing, certification, licensing
- Cyber security

Technology can be a companion to policy and incentives.
Technology is not a panacea.
Thank You

Jim Misener, jmisener@gmail.com
415.335.9252