AV/AV: Our images

- Engaged and ready to reassume control
- In ready position – in case
- Completely detached
- Not there
Why bother?

Safety
33,561 highway deaths in 2012
5,615,000 crashes in 2012
Leading cause of death for ages 4, 11-27

Mobility
5.5 billion hours of travel delay
$121 billion cost of urban congestion

Environment
2.9 billion gallons of wasted fuel
56 billion lbs. of additional CO₂
What's available today
State of Play: OEMS/1\textsuperscript{st} Tier Suppliers

* Market driven
* Competitive
* Range of services
* Pre-compete co-op (CAMP, VIIC)
State of Play: USDOT CV Program

- Safety Orientation
- V2V research (DSCRC based)
- Safety Pilot: Ann Arbor – 2800 veh/73 miles instrumented: V2I/V2V
- ITS Test Beds
- Deployment-related studies
- NPRM - Mandate
- Guidance re V2I
States/Regions: State of Play

State DOTs/MPOs

* State Authorization legislation (6 states)
* AASHTO Footprint Analysis: scenarios, costs
* Pooled fund studies (includes NJDOT)
  * VDOT lead
  * Focused on apps, TMCs, deployment issues
* Up-coming: pilot demos: large-scale, multi-modal, multi-apps
Autonomy & Cooperation: Convergence

- Autonomous Unmanned Military Vehicles
- Autonomous Adaptive Cruise Control
- Cooperative Adaptive Cruise Control (CACC)
- Autonomous Warning Systems
- Electronic Emergency Brake Light
- Cooperative Collision Warning System
- Intersection Movement Assist
- Intelligent Speed Adaption
- Platooning
- Automated Highway Systems (AHS)

Key: Indicates DOT focus application for connected vehicles
Range of Applications: Autonomous vs. Connected

Interest in Semi-Autonomous Features Continues to Grow

V2I Safety
- Red Light Violation Warning
- Curve Speed Warning
- Stop Sign Gap Assist
- Spot Weather Impact Warning
- Reduced Speed/Work Zone Warning
- Pedestrian in Signalized Crosswalk Warning (Transit)

V2V Safety
- Emergency Electronic Brake Lights (EEBL)
- Forward Collision Warning (FCW)
- Intersection Movement Assist (IMA)
- Left Turn Assist (LTA)
- Blind Spot/Lane Change Warning (BSW/LCW)
- Do Not Pass Warning (DPNW)
- Vehicle Turning Right in Front of Bus Warning (Transit)

Agency Data
- Probe-based Pavement Maintenance
- Probe-enabled Traffic Monitoring
- Vehicle Classification-based Traffic Studies
- CV-enabled Turning Movement & Intersection Analysis
- CV-enabled Origin-Destination Studies
- Work Zone Traveler Information

Environment
- Eco-Approach and Departure at Signalized Intersections
- Eco-Traffic Signal Timing
- Eco-Traffic Signal Priority
- Connected Eco-Driver
- Wireless Inductive/Resonance Charging
- Eco-Lanes Management
- Eco-Speed Harmonization
- Eco-Cooperative Adaptive Cruise Control
- Eco-Traveller Information
- Eco-Ramp Metering
- Low Emissions Zone Management
- AFV Charging / Fueling Information
- Eco-Smart Parking
- Dynamic Eco-Routing (light vehicle, transit, freight)
- Eco-ICM Decision Support System

Mobility
- Advanced Traveler Information System
- Intelligent Traffic Signal System (I-SIG)
- Signal Priority (transit, freight)
- Mobile Accessible Pedestrian Signal System (PED-SIG)
- Emergency Vehicle Preemption (PREEMPT)
- Dynamic Speed Harmonization (SPD-HARM)
- Queue Warning (Q-WARN)
- Cooperative Adaptive Cruise Control (CACC)
- Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
- Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
- Emergency Communications and Evacuation (EVAC)
- Connection Protection (T-CONNECT)
- Dynamic Transit Operations (T-DISP)
- Dynamic Ridesharing (D-RIDE)
- Freight-Specific Dynamic Travel Planning and Performance
- Drayage Optimization

Road Weather
- Motorist Advisories and Warnings (MAW)
- Enhanced MDSS
- Vehicle Data Translator (VTI)
- Weather Response Traffic Information (WxTINFO)

Smart Roadside
- Wireless Inspection
- Smart Truck Parking

*Note that the data shown under Fully Autonomous Parking System in 2012 and 2013 was based on the interest in Automatic Park Assist System.*
Technologies

**DSRC:**
- High speed, reliable for safety apps
- V2V sees further: enhances safety/flow (bullwhip effect)
- Infrastructure: roadside, signal, security,
- Requires high % of equipped vehicles (time frame?)

**4GE, Cellular**
- Existing commercial infrastructure
- Adequate for mobility & environmental apps

**Hi-res mapping & markings**

**Technology combinations**
- Complimentary: some redundancy and enhancement
- Some apps specific requirements
### Value of V2V/V2I/V2X

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
</table>
| Dynamic Traffic Management      | - Dynamic traffic signs
- Traffic lights                                                                 |
| Real Time Traffic Information   | - Traffic jams
- Emergency vehicles                                                                 |
| Maps and Landmarks              | - Curvature
- Sign positions
- HD map                                                                        |
| Physical Infrastructure         | - Lane markings
- Signage
- Road boundaries
- Road friction
- Damage                                                                              |

- **Major Penetration -- 2030s**
- **Role of Retrofit/Aftermarket Devices?**
- **Costs: vehicle, security & V2I infrastructure**
- **Governance**
State Role: V2I Systems Architecture
Priority apps
* Market
* Policy

System – dependency
* Autonomous (sensor)
* V2I
* V2V

Complementarity vs. redundancy

Deployment Benefits
* Fleet penetration
* After-market?

Mix to capture early benefits
Current National Issues

National

1. Reality-based mix of apps/systems/players
2. Standards, priority applications commonality
3. Spectrum availability
4. Role of After-market devices

5. Time to benefits: mandate to penetration: technology context/mix
6. Risk management: privacy, security, liability
7. Entity to insure certification/security (business model/governance?)
8. Consumer acceptance re reliability, risk
9. Funding – how V2I infrastructure is funded
10. Emergence of new key players: OEM, Info/Services, Other
State Issues

* Authorization for automation (not NJ yet)
* Priority apps –related to deployment potential
* Timing coordination with federal efforts, OEM rollouts
* Readiness: big-data (traffic), TMCs, controller updates
* Pilot demonstrations program opportunity to jump start
* Choice of technologies (DSRC, 4G-LTE), reference architecture
* Infrastructure deployment, costs: building on ITS/TSM&O
* Early opportunities: fleets, enclaves, corridors
* Public-public and public private partnerships, ICMs?
State DOT Role:
CV Pilot Program Opportunities

Objectives:
* Real-world setting: measure benefits, deployment issues
* Spur deployment: multiple apps, multimodal,
* Deployment to become permanent

Schedule
* Regional Pre-Deployment Workshop/Webinar Series -- current
* 2014 RFI: NJDOT has responded with comments and indicating interest
* Solicitation for Wave 1 Concepts -- Early 2015
* Wave 1 Award(s) -- September 2015
* Solicitation for Wave 2 Concepts -- Early 2017
* Wave 2 Award(s) -- September 2017
* Pilot Deployments Complete -- September 2020
<table>
<thead>
<tr>
<th>Economic Impact, Scale and Incidence</th>
<th>Indirect Impact Mechanism</th>
<th>CV Application Direct Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased property values</td>
<td>Relative accessibility (time, cost), suburbanization, improved environment</td>
<td>improved travel time, reduced congestion, alternative use of time</td>
</tr>
<tr>
<td>Job creation and employment</td>
<td>industry accessibility/efficiency, support of new</td>
<td>Improved travel time, reliability, costs, capacity, accessibility</td>
</tr>
<tr>
<td>Household income</td>
<td>job creation, vehicle use costs, sharing,</td>
<td>Improved job access, services by mobility disadvantaged, car/ride-sharing</td>
</tr>
<tr>
<td>Intermodal efficiency</td>
<td>Improved accessibility/reduced operating costs – passenger, freight, transit, EV</td>
<td>Improved information</td>
</tr>
<tr>
<td>Reductions in infrastructure needs, costs</td>
<td>In-vehicle signing and lane keeping, reduction in parking costs</td>
<td>V2X-based in vehicle information and lane keeping, full automation</td>
</tr>
<tr>
<td>Improved systems management</td>
<td>Reduced incidents, improved advisories</td>
<td>Vehicle systems data regarding road condition, weather, probe data, route guidance</td>
</tr>
<tr>
<td>Reduction in law, medical costs</td>
<td>Reduction in law enforcement, medical insurance costs</td>
<td>Crash reduction</td>
</tr>
</tbody>
</table>
Bring the Future Forward Faster

Diagram showing: Consumers, Infotainment, Navigation, Convenience, Safety, Electronic Tolling, Security, Electric Vehicle Services, Vehicle Relationship Management, Fleet Management, PAYD Insurance, Third party businesses (e.g., insurance companies, fleet management, traffic concerns).