Xerox: Connected Autonomous Vehicles (CAV) and Mcity

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Technology Policy and Strategy

ITS Maryland
22 Sept 2016
Xerox — A New Class of Solutions Provider

- ACS Founded in 1988 – Acquired by Xerox in 2010
- Recognized FORTUNE 500 company
- $22 billion in annual revenue
- Reaches 160 countries
- Diverse client base
- 130,000 employees
**Transportation Overview**

**Deep Presence Across Multiple Verticals**

Focus On Six Core Markets

<table>
<thead>
<tr>
<th>Tolling</th>
<th>Public Transport</th>
<th>Photo Enforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-street Parking</td>
<td>Off-street Parking</td>
<td>Commercial Trucking</td>
</tr>
</tbody>
</table>

**End-to-end Service Capabilities**

<table>
<thead>
<tr>
<th>Systems Integration</th>
<th>Turn Key Solutions</th>
<th>Back Office Solutions</th>
<th>Violations Processing</th>
<th>Infrastructure Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Multi-modal, multi-agency, multi-payment integration</td>
<td>• Electronic toll lanes</td>
<td>• Customer services centers</td>
<td>• Capture most types of roadway violations</td>
<td>• Build-operate-transfer (BOT) projects</td>
</tr>
<tr>
<td>• Enterprise level software development</td>
<td>• Transit ticketing</td>
<td>• USD$ billions collected and processed annually</td>
<td>• License plate recognition systems</td>
<td>• Equity investments</td>
</tr>
<tr>
<td>• End-to-end technology integration</td>
<td>• GPS-based asset management</td>
<td>• Business analytics</td>
<td>• Processing</td>
<td>• Long-term concessions</td>
</tr>
<tr>
<td>• Etc.</td>
<td>• Photo enforcement</td>
<td>• Data warehousing</td>
<td>• Past due collections</td>
<td>• Revenue sharing arrangements</td>
</tr>
<tr>
<td>• Etc.</td>
<td>• Parking revenue</td>
<td>• Etc.</td>
<td>• Etc.</td>
<td>• Etc.</td>
</tr>
</tbody>
</table>

**TSG Projects in more than 30 Countries**

**TSG Sales Offices Across 12 Countries***

**Americas**
- Washington DC, US
- Edmonton, CA
- Toronto, CA
- Lima, Peru
- Santiago, CL
- Mexico City, MX

**Europe**
- Paris, FR
- Valence, FR
- Zurich, CH
- Bern, CH
- London, UK
- Milan, IT
- Madrid, ES

**Middle East**
- Dubai, UAE

**Asia**
- Beijing, CN

*Over 20 sales offices across the US.*
Future of Transportation
How Could Things Go Differently

• “If I had given my customers what they asked for, it would have been a faster horse”
  - Henry Ford

• “If Amazon can deliver packages to my house via drone, isn’t it a matter of time before they figure out how to transport a 200 pound person via drone?”
  - Roger Millar, Washington State DOT
Transportation Trends & Topics

- Connected Vehicles
  - NHTSA Notice of Proposed Rulemaking (NPRM)

- Autonomous Vehicles
  - White House Policy Announcement on 20 September 2016

- Xerox and Mcity

- AASHTO and the Vehicle To Infrastructure Deployment Coalition (V2IDC)

- Other Trends Not Covered Here:
  - Road Use Charging, Nationwide Toll Interoperability, Ride Sharing Services (Uber, Lyft), Car Sharing Services (Car2Go, ZipCar, Reach Now)
DSRC Developments
### Data Informing NHTSA Decision on NPRM

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crashes Prevented</td>
<td>439,332</td>
<td>615,359</td>
</tr>
<tr>
<td>Lives Saved</td>
<td>987</td>
<td>1,366</td>
</tr>
<tr>
<td>Injuries Prevented</td>
<td>305,131</td>
<td>417,613</td>
</tr>
<tr>
<td>Damaged Vehicles Saved</td>
<td>536,869</td>
<td>746,357</td>
</tr>
</tbody>
</table>

- Annual Data provided by NHTSA at USDOT Workshop, June 12, 2016
- Estimated annual savings = $54.7 B to $73.4B
**Connected Vehicles: US states & cities conducting connected vehicle research**

<table>
<thead>
<tr>
<th>MIDOT</th>
<th>NYCDOT</th>
<th>THEA/FDOT</th>
<th>Wyoming DOT</th>
<th>CDOT</th>
<th>US DOT Smart Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann Arbor &amp; SE MI</td>
<td>New York City</td>
<td>Tampa</td>
<td>Interstate 80</td>
<td>Denver</td>
<td>Seven Finalists</td>
</tr>
</tbody>
</table>

- **USDOT Safety Pilot Deployment**
- **Ann Arbor & SE Michigan**
- **M City**
- **Auto & Tier Suppliers collaboration**

- **USDOT Connected Vehicle Pilot Deployment Award**
- **10,000 vehicles, 30+ intersections**
- **$20 million**

- **USDOT CV Pilot Deployment Award**
- **Toll road connector into downtown Tampa feeder**
- **$17 million**

- **USDOT CV Pilot Deployment Award**
- **Rural uses of CV capability**
- **Commercial vehicle platooning**
- **$5 million**

- **RoadX program by CDOT**
- **$20 million grant by Colorado to deploy CV technologies**
- **Save lives, improve throughput and sustainability**
- **$50 million Award**
- **$5 million**

**USDOT Defines Connected Cities:** “Working vision” incorporates and expand connected transportation to ensure that connected transportation data, technologies and applications – as well as connected travelers – are fully integrated with other systems across a city, and fulfill their potential to improve safety, mobility and environmental outcomes in a complexly interdependent and multimodal world that supports a more sustainable relationship between transport and the city.
Autonomous Vehicle Guidance
Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety
Guidance
## Self-Certification Framework For AV

**Figure I: Framework for Vehicle Performance Guidance**

<table>
<thead>
<tr>
<th>Scope &amp; Process Guidance</th>
<th>Guidance Specific to Each HAV System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test/Production Vehicle</strong></td>
<td><strong>Describe the ODD (Where does it operate?)</strong></td>
</tr>
<tr>
<td>FMVSS Certification/Exemption</td>
<td>Geographic Location</td>
</tr>
<tr>
<td>HAV Registration</td>
<td>Roadway Type</td>
</tr>
<tr>
<td><strong>Guidance Applicable to All HAV Systems on the Vehicle</strong></td>
<td><strong>Object and Event Detection and Response</strong></td>
</tr>
<tr>
<td>Data Recording and Sharing</td>
<td>Speed</td>
</tr>
<tr>
<td>Privacy</td>
<td>Day/Night</td>
</tr>
<tr>
<td>System Safety</td>
<td>Weather Conditions</td>
</tr>
<tr>
<td>Vehicle Cybersecurity</td>
<td>Other Domain Constraints</td>
</tr>
<tr>
<td>Human-Machine Interface</td>
<td><strong>Fall Back Minimal Risk Condition</strong></td>
</tr>
<tr>
<td>Crashworthiness</td>
<td>Normal Driving</td>
</tr>
<tr>
<td>Consumer Education and Training</td>
<td>Crash Avoidance - Hazards</td>
</tr>
<tr>
<td>Post-Crash Vehicle Behavior</td>
<td><strong>Driver</strong></td>
</tr>
<tr>
<td>Federal, State and Local Laws</td>
<td><strong>System</strong></td>
</tr>
<tr>
<td>Ethical Considerations</td>
<td><strong>Testing and Validation</strong></td>
</tr>
<tr>
<td></td>
<td>Simulation</td>
</tr>
<tr>
<td></td>
<td>Track</td>
</tr>
<tr>
<td></td>
<td>On-Road</td>
</tr>
</tbody>
</table>
SAE Automation Levels

- At SAE Level 0, the human driver does everything;
- At SAE Level 1, an automated system on the vehicle can sometimes assist the human driver conduct some parts of the driving task;
- At SAE Level 2, an automated system on the vehicle can actually conduct some parts of the driving task, while the human continues to monitor the driving environment and performs the rest of the driving task;
- At SAE Level 3, an automated system can both actually conduct some parts of the driving task and monitor the driving environment in some instances, but the human driver must be ready to take back control when the automated system requests;
- At SAE Level 4, an automated system can conduct the driving task and monitor the driving environment, and the human need not take back control, but the automated system can operate only in certain environments and under certain conditions; and
- At SAE Level 5, the automated system can perform all driving tasks, under all conditions that a human driver could perform them.

Highly Automated Vehicles are Levels 3-5 which are the vehicles covered by the USDOT guidance
Key Takeaways: AV Guidance

• System will rely on manufacturers self-certifying and submitting to NHTSA

• NHTSA has authority over aftermarket vehicle safety equipment or retrofit safety devices under the Federal Motor Vehicle Safety Standard

• NHTSA also has authority over off-board software or data that is used as part of vehicle safety systems

• NHTSA recommends that states should engage to support safety inspections but policy setting for AVs should be at federal level
What Is Xerox Doing?
Mcity: Grand Opening 20 July 2015
M City Grand Opening –
20 July 2015
Xerox and Mobility Transformation Center

- Xerox and Mobility Transformation Center
  - Pillar 1: Mcity
    - Controlled test environment
    - Test location for Connected Vehicles and Autonomous Vehicles
  - Pillar 2: Connected Michigan
    - Extending the controlled test to the highways and streets of Southeast Michigan
  - Pillar 3: Autonomous Michigan
    - Developing systems to support Autonomous Vehicles
Vehicle-To-Infrastructure Deployment Coalition: Membership and Structure

V2I DC Concept

• A single point of reference for stakeholders to meet and discuss V2I deployment related issues

V2I DC Approach

• USDOT asked AASHTO, ITS America and ITE to collaborate on organizing and managing the coalition

http://www.transportationops.org/V2I/executive-committee
V2I DC is Organized into 5 Technical Working Groups (TWGs)

V2IDC Executive Committee

- TWG 1: Initiatives
- TWG 2: Research
- TWG 3: Partners
- TWG 4: Guidance
- TWG 5: Standards

USDOT
- ITS JPO
- FHWA
- FTA
- NHTSA
<table>
<thead>
<tr>
<th>TWG</th>
<th>Chair</th>
<th>Co-Chair</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWG 1: Initiatives</td>
<td>Bill Legg, WSDOT</td>
<td>Joe Averkamp, Xerox</td>
</tr>
<tr>
<td>TWG 2: Research</td>
<td>Greg Larson, Caltrans</td>
<td>Rob Bertini, Cal Poly</td>
</tr>
<tr>
<td>TWG 3: Partners</td>
<td>Matt Smith, MDOT</td>
<td>Roger Berg, Denso</td>
</tr>
<tr>
<td>TWG 4: Guidance</td>
<td>Faisal Saleem, MCDOT</td>
<td>Navin Katta, Savari</td>
</tr>
<tr>
<td>TWG 5: Standards</td>
<td>Ed Seymour, Texas A&amp;M</td>
<td>Gary Duncan, Econolite</td>
</tr>
</tbody>
</table>
Vehicle-To-Infrastructure Deployment Coalition

- Focus On Four Key Applications:
  - Intersection Safety: Signal Phase and Timing
    - SPaT Challenge!
  - Work Zone Safety
  - Curve Overspeed Warning
  - Approaching End of Queue Alerts
Signal Phase and Timing Challenge: More Expected From AASHTO

The National Connected Vehicle Deployment Challenge
20 SPaT Intersections in 50 States by 2020

The Challenge:
To Challenge state and local public sector transportation infrastructure owners and operators to cooperate together to achieve deployment of DSRC infrastructure with SPaT broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each state by January 2020.
Summary: Things We Think We Know For Certain

- Costs of equipment will continue to decline: cameras, storage, transport----labor becomes a larger consideration
- Commercial wireless networks will continue to expand and subscriber counts will grow
  - 378 million wireless subscriber connections in the US
  - 116% of the US population count
- 1/3 of all new subscriptions are for vehicles, likely to continue
- Things that appear likely: DSRC mandate by NHTSA, some solution for band sharing
- Autonomous Vehicles Soon……NHTSA Guidance Still Fresh
How Could Things Go Differently

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Thank you

- Joe Averkamp, Xerox

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