What is an AV?
Trends and Outcomes

- Safety
- Vehicle Miles Traveled (VMT)
- Sprawl
- Parking
- Energy
- Air Quality
- Public Health
- Equity
- Accessibility
How AVs Operate

**CAMERAS**
Cameras gather visual information from the road and traffic control and send them to the controller for processing.

**LIDAR**
LiDAR sensors bounce lasers off of detected objects. LiDAR can detect road lines and assets and differentiate objects.

**RADAR**
Radar sensors bounce radio waves off detected objects. Radar cannot differentiate objects.

**GPS UNIT**
The GPS unit identifies the precise position of the vehicle and aids in navigation.
# SAE Levels of Automation

<table>
<thead>
<tr>
<th>SAE level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering and Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Fallback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>the 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>Human driver</td>
<td>Human driver</td>
<td>Human driver</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>the 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>Human driver and system</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>the driving mode-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>System</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>the driving mode-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>System</td>
<td>System</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>the driving mode-specific 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>System</td>
<td>System</td>
<td>System</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>All driving modes</td>
</tr>
</tbody>
</table>
Levels Depend on Circumstances

Critical implications:

- Human operator expectations, “re-engagement”
- Where certain vehicles can safely operate
Tesla doesn't stop, hitting the trailer and traveling under it.

1. Trailer turns left in front of the Tesla.
2. Tesla veers off road and strikes two fences and a power pole.

Florida
May 2016
Tesla, March 2017
Uber, March 2017
Breadth, Complexity, Edge Cases

AUTOMATED VEHICLES IN WISCONSIN
(An) AV Timeline

- **2015**
  - driver assistance common
  - some partial automation available to consumers

- **2020**
  - limited / conditional AVs widely available to consumers

- **2025**
  - autonomous shared mobility fleets

- **2030**
  - high automation required in all new vehicles

- **2035**
  - human operation is the exception in many places

- **2040**
  - transition to driverless largely complete
  - fleet turnover continues…

- **2100**

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- Any estimate is debatable
- We are only at the beginning of a long transition period
Federal AV Policy

- Released Sep 20, 2016
- Updated Sep 12, 2017
- Voluntary guidelines
  - Not regulations
- Level 3+ Only
- 12 Safety Elements
- Guidance for State Policy
<table>
<thead>
<tr>
<th></th>
<th>NHTSA’s 15 Safety Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System Safety</td>
</tr>
<tr>
<td>2</td>
<td>Operational Design Domain</td>
</tr>
<tr>
<td>3</td>
<td>Object and Event Detection and Response</td>
</tr>
<tr>
<td>4</td>
<td>Fall Back (Minimal Risk Condition)</td>
</tr>
<tr>
<td>5</td>
<td>Validation Methods</td>
</tr>
<tr>
<td>6</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>7</td>
<td>Vehicle Cybersecurity</td>
</tr>
<tr>
<td>8</td>
<td>Crashworthiness</td>
</tr>
<tr>
<td>9</td>
<td>Post-Crash <strong>ADS</strong> Behavior</td>
</tr>
<tr>
<td>10</td>
<td>Data Recording and Sharing</td>
</tr>
<tr>
<td>11</td>
<td>Consumer Education and Training</td>
</tr>
<tr>
<td>12</td>
<td>Federal, State and Local Laws</td>
</tr>
<tr>
<td>13</td>
<td>Privacy</td>
</tr>
<tr>
<td>14</td>
<td>Registration and Certification</td>
</tr>
<tr>
<td>15</td>
<td>Ethical Considerations</td>
</tr>
</tbody>
</table>
USDOT AV Proving Grounds

- Peer network
- Advise government
- Validate industry
- Awarded January 2017

...no funding
Ten Designated AV Proving Grounds
Range of RDT&E Environments

- Simulation
- Lab
- Closed Track
- Controlled Demo
- Limited Facility
- Public Roads

Automated Vehicles in Wisconsin
AUTOMATED VEHICLES IN WISCONSIN

TESTING FACILITIES

1. ROAD AMERICA
   Elkhart Lake, WI

2. MILWAUKEE AREA FACILITIES
   City of Milwaukee and UW-Milwaukee

3. MGA RESEARCH GROUP
   Burlington, WI

4. MADISON AREA FACILITIES
   City of Madison, Epic, Manelli Communications, and UW-Madison

5. CHIPEWAA VALLEY REGIONAL AIRPORT
   Eau Claire, WI

PROPOSED AV CORRIDORS

- **MadMSP Corridor**
  WisDOT, MnDOT

- **Sheboygan to Milwaukee Corridor**
  WisDOT

- **Burlington to Milwaukee Corridor**
  WisDOT

- **MRCM Corridor**
  WisDOT, iDOT, IL Tollway
Wisconsin Facilities

Full Scale Driving Simulator

UW-Madison College of Engineering

SBEL
Simulation Based Engineering Lab

TOPS
TRAFFIC OPERATIONS & SAFETY LABORATORY
Wisconsin Facilities

MGA Research, Burlington

400 acres, private and secure, numerous testing capabilities
Wisconsin Facilities

Road America, Elkhart Lake

- Road track: 4.05-mile length, 30-foot width
- 1-mile combo paved-dirt track
- 12+ miles off-road
- 10+ miles access roads
- Major race events and media presence
Wisconsin Facilities

- Corporate Campuses
- UW-Madison Campus
- City of Madison
Connected Park Street Corridor

- Piloting CV technology to improve:
  - Safety
  - Mobility
  - Bus on-time performance
  - Equity
- V2I, V2V, V2X
- Madison and Wisconsin as the Upper Midwest hub for CV & AV development
Committee on Automated and Connected Vehicles

- May 2017 EO #245
- Sept 2017 Kickoff
- June 2018 Report Due
- Members:
  - Government: WisDOT, WSP, WEDC, Assembly, Senate, Iowa Co Sheriff, Insurance Commissioner
  - Academic/Nonprofit: UW-Madison, Tech Council, ABATE
  - Industry: MGA, Roadview, Waymo, Uber, Tesla, AAM, Global Automakers, Dealers Assn, Harley, Schneider, HNTB

“the removal of barriers to the testing and deployment of automated and connected vehicle technology in Wisconsin”
Level 4 Shuttle Demonstration
Next Week
Stay Engaged

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