Planning for the Future(s)

The FDOT Initiative to Develop Guidance about LRTP Impacts of ACES
E: Electric - Vehicle using one or more electric motors for propulsion

C: Connected - Vehicle having systems linked to other devices to improve safety or efficiency

A: Automated - Vehicle capable of guiding itself with little or no human input

S: Shared-use - Vehicles used (not necessarily owned) by more than one person or organization
Levels of Automation

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
</tr>
</tbody>
</table>

- **No Automation**: Driver controls all functions.
- **Driver Assistance**: Most functions controlled by driver. Some basic functions done automatically.
- **Partial Automation**: Adaptive cruise control, lane assist, emergency breaking.
- **Conditional Automation**: Multiple functions done automatically. Driver must be ready to take control.
- **High Automation**: Automatic steering, maintaining speed & stopping.
- **Full Automation**: No driver necessary. All driving modes fully automated.

*Source: Society of Automotive Engineers*
ACES are coming ... when?

Based on your knowledge of ACES, when do you think they will have a significant impact on your region? (select the answer that best applies)

- 1-5 years
- 6-10 years
- 11-15 years
- 16-21 years
- More than 21 years

Adoption speed affected by:
- Availability
- Cost of features
- Local socio-economic factors
- Ownership and preferences
- Fleet turnover
- Needed infrastructure upgrades
- Liability & other legal issues
- Wildcard issues – social, economic, political, etc.

Source: October 2017 Online Survey of Florida MPOs
Florida Activities
The FDOT ACES policy guidance

• Develop planning guidance regarding potential ACES impacts to consider during future LRTP updates.
• Help Florida MPOs/TPOS and local governments account for local ACES impacts in upcoming LRTP updates.
How the guidance is being developed

- Literature Review
- MPO Survey and Interviews
- Scenario Planning
- Travel Demand Model Testing
Key guidance elements

Please rank the following in terms of information or guidance you may need to better assess future transportation technology impacts?

- Goals and Objectives
- Mode Use Impacts
- Project Prioritization
- Project Needs Identification
- Public Engagement
- Socioeconomic data
- Traffic Operations
- Transportation Revenue
- Travel Demand Modeling

Source: October 2017 Online Survey of Florida MPOs
ACES-driven scenario planning

- Engages more diverse stakeholders
- Illustrates land use/transportation trade-offs
- Expands informed decision-making
- Helps develop performance measures and evaluate different policies’ impacts on targets
- Explores broad array of livability issues
**FHWA 2035 CV/AV Scenarios**

**Enhanced Driving Experience**
- Managed Autonomous Lane Network: AV lane networks
  - AV travel is considered to a large-scale lane network with significant consumer adoption
- Ultimate Driver Assist: Ultra-Connectivity
  - AV adoption stalls, CV becomes ubiquitous

**Slow Roll**
- Slow Roll: Minimal Plausible Change
  - Accounts for advances in safety technology, TSMO and mobility services

**Driver Becomes Mobility Consumer**
- Niche Service Growth: High AV/CV in certain cases
  - Niche applications for CV/AV dominate the landscape
- Competing Fleets: Automated TNV fleets compete
  - Level-4 AV is safe for most trips but are dominated by competing fleets
- RoboTransit: Automated mobility-as-service
  - Strong public-private partnership for system optimization

**Trajectories towards CV/AV advancements**

**TODAY**

<table>
<thead>
<tr>
<th>Scenario Name</th>
<th>Connectivity</th>
<th>Scale Ratings Automation</th>
<th>Cooperation</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow Roll</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Minimum plausible change; nothing beyond currently available technology and investments already in motion</td>
</tr>
<tr>
<td>Niche Service Growth</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Innovation proliferates, but only in special purpose or “niche” applications</td>
</tr>
<tr>
<td>Overall System</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Niche Services</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>CV technology progresses rapidly, but AV stagnates</td>
</tr>
<tr>
<td>Ultimate Traveler Assist</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Competing Fleets</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>TNC-like services proliferate rapidly, but do not operate cooperatively</td>
</tr>
<tr>
<td>Managed Automated Lane Network</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Certain lanes become integrated with CV and AV</td>
</tr>
<tr>
<td>Overall System</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>AV lanes</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>RoboTransit</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>On-demand shared services proliferate and integrate with other modes via cooperative data sharing, policies, and infrastructure</td>
</tr>
</tbody>
</table>

Source: Scenario Planning for Automated Vehicles, November 6, 2017
Integrating ACES into the Planning Process

Six FHWA Scenarios → Public & Stakeholder Input → Community Goals & Objectives → MPO Specific Scenarios

Typical ACES Supportive Projects

Travel Demand Forecasting → Performance Measures → Specific ACES Supportive Projects

Long-Range Transportation Plan

Vehicle Fleet Mix Ranges → Community Goals & Objectives
### ACES Supportive Projects

<table>
<thead>
<tr>
<th>Category</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Maintenance</td>
<td>Lane marking improvements/maintenance for machine vision</td>
</tr>
<tr>
<td></td>
<td>Pavement Lane marking maintenance improvements for safe automated vehicle operation improvements</td>
</tr>
<tr>
<td></td>
<td>Pavement maintenance</td>
</tr>
<tr>
<td>Travel Lanes (Capacity)</td>
<td>Conversion of on-street parking to other uses</td>
</tr>
<tr>
<td></td>
<td>Designation/planning of AV-only limited access arterial lanes or AV only transportation zones</td>
</tr>
<tr>
<td>Curb Management (Shared Mobility)</td>
<td>Designated pick-up/drop-off zones</td>
</tr>
<tr>
<td></td>
<td>Curb space value capture policy plans</td>
</tr>
<tr>
<td>Parking (Land Use/Urban Design)</td>
<td>Activity center master plans to guide conversion of parking</td>
</tr>
<tr>
<td></td>
<td>Conversion of public parking facilities</td>
</tr>
<tr>
<td></td>
<td>ACES parking priority</td>
</tr>
<tr>
<td></td>
<td>Electric vehicle charging stations and related support systems</td>
</tr>
<tr>
<td>Transit (Trunk and Feeder)</td>
<td>Transit plans to guide investments in urban corridors</td>
</tr>
<tr>
<td></td>
<td>Dedicated high-occupancy AV expressway and arterial lanes</td>
</tr>
<tr>
<td></td>
<td>Mobility hubs</td>
</tr>
<tr>
<td></td>
<td>First/last mile or paratransit partnership opportunities</td>
</tr>
<tr>
<td>Freight (Long-Haul and Local)</td>
<td>Dedicated AV truck corridors</td>
</tr>
<tr>
<td></td>
<td>Suburban/weigh station truck terminals</td>
</tr>
<tr>
<td></td>
<td>Intermodal terminal automation</td>
</tr>
<tr>
<td></td>
<td>Lane management and restrictions planning</td>
</tr>
<tr>
<td>Smart Cities (Internet of Things)</td>
<td>V2I roadside units</td>
</tr>
<tr>
<td></td>
<td>Traffic signal prioritization and interconnects</td>
</tr>
<tr>
<td></td>
<td>Transportation operations management centers/upgrades</td>
</tr>
<tr>
<td></td>
<td>Transportation data processing centers</td>
</tr>
<tr>
<td></td>
<td>Fleet management facilities</td>
</tr>
</tbody>
</table>
Use Cases of Vehicle Automation

Level 2-3
- Cars and Light Trucks
- Vans and Buses
- Heavy Trucks

Level 4-5
- Cars and Light Trucks
- Low Speed Shuttles
- Taxis
- Van/Bus
- Urban Delivery
- Heavy Trucks
Level 2-3  **Cars and Light Trucks**

- Largely household ownership
- Shared use limited to rental fleets, ridesourcing, and carsharing

Source: Tesla (tesla.com/modelx)
1 – Driving systems increase need for lane marking maintenance.

2 – Connected vehicle lanes on highways facilitate platooning, increasing capacity.

11 – Easier driving on freeways and in traffic increases tolerance for longer commutes.

12 – Electrification reduces cost of vehicle operation, promoting more and/or longer trips.

26 – Remote parking capability expected to allow for smaller parking spaces.

27 – Electrification likely to increase need for chargers at homes and destinations.

33 – Remote parking expected to reduce need for physical proximity of parking and uses. Reduced emphasis on parking availability near main entrance contributes to more walkable site design.

44 – Broad adoption may reduce crash rates.
Level 2-3 Heavy Trucks

- Largely fleet ownership

1 – Driving systems increase need for lane marking maintenance.
2 – Connected vehicle lanes on highways facilitate platooning, increasing capacity.
13 – Improved working conditions may reduce truck driver shortage, leading to diversion of some shipments from rail to truck.
14 – Platooning and electrification expected to reduce fuel consumption, reducing costs and potentially leading to diversion of some traffic from rail to truck.
44 – Broad adoption may reduce crash rates.
Level 4-5 **Cars and Light Trucks**

- Largely household ownership
- Shared use limited to rental fleets and carsharing

Source: Mercedes Benz (mbusa.com/mercedes/future/model/model-All_New_F015_Luxury)
### Cars

<table>
<thead>
<tr>
<th>Road Design Impacts</th>
<th>VMT Impacts</th>
<th>Parking Impacts</th>
<th>Urban Form Impacts</th>
<th>Other Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>26</td>
<td>33</td>
<td>44</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>27</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Driving systems increase need for lane marking maintenance.
2. Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3. Connected vehicle lanes at arterial intersections may increase capacity.
4. Road construction, emergencies, and other temporary conditions require fleet operators or subscription services to divert vehicles to other routes.
12. Electrification reduces cost of vehicle operation, promoting more and/or longer trips.
15. Fully automated driving may reduce disutility of travel, promoting more and longer trips.
16. Greater mobility for non-driving populations increases demand for travel.
17. Reduced parking cost in remote lots may divert trips in dense urban centers from transit to auto.
26. Remote parking capability expected to allow for smaller parking spaces.
27. Electrification likely to increase need for chargers at homes and destinations.
33. Remote parking expected to reduce need for physical proximity of parking and uses, potentially contributing to more walkable site design.
34. Remote parking allows for conversion of parking lots and structures in urban centers, as well as some residential garages, to other uses.
44. Broad adoption may reduce crash rates.
Level 4-5 Taxis

- Almost exclusively public or private ridesourcing fleets

Source: Business Insider (businessinsider.com/gms-first-autonomous-car-will-be-electric-and-launch-on-lyft-2016-7)
<table>
<thead>
<tr>
<th>Road Design Impacts</th>
<th>VMT Impacts</th>
<th>Parking Impacts</th>
<th>Urban Form Impacts</th>
<th>Other Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Driving systems increase need for lane marking maintenance.</td>
<td>16 – Greater mobility for non-driving populations increases demand for travel.</td>
<td>30 – On-demand mobility services likely to reduce car ownership and demand for both residential and destination parking.</td>
<td>35 – Reduced parking demand expected to lead to conversion of parking lots and structures in urban centers, as well as some residential garages, to other uses.</td>
<td>44 – Broad adoption may reduce crash rates.</td>
</tr>
<tr>
<td>2 – Connected vehicle lanes on highways facilitate platooning, increasing capacity.</td>
<td>19 – Automation likely to reduce cost of taxi services, shifting demand from buses to smaller vehicles.</td>
<td>36 – Parking areas near main entrances likely to transition to pick-up/drop-off areas.</td>
<td>45 – Reduced car ownership likely to have transformative impacts on automobile-dependent industries, including manufacturing, repair, driving, and insurance.</td>
<td>46 – New jobs created in mobility service control centers, vehicle fleet maintenance facilities, and support services.</td>
</tr>
<tr>
<td>3 – Connected vehicle lanes at arterial intersections may increase capacity.</td>
<td>20 – Reduced cost of mobility expected to increase number of trips.</td>
<td>37 – First-mile/last-mile services support consolidation of transit stops into high-amenity stations in major urban corridors.</td>
<td>38 – Fleet service centers likely to emerge on fringes of urban centers.</td>
<td></td>
</tr>
<tr>
<td>4 – Road construction, emergencies, and other temporary conditions require fleet operators or subscription services to divert vehicles to other routes.</td>
<td>21 – More efficient smartphone-based dispatching likely to offset some VMT growth with less deadhead compared to human-driven taxis.</td>
<td>46 – New jobs created in mobility service control centers, vehicle fleet maintenance facilities, and support services.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 – Increased need for curbside drop-off areas.</td>
<td>30 – On-demand mobility services likely to reduce car ownership and demand for both residential and destination parking.</td>
<td>35 – Reduced parking demand expected to lead to conversion of parking lots and structures in urban centers, as well as some residential garages, to other uses.</td>
<td>45 – Reduced car ownership likely to have transformative impacts on automobile-dependent industries, including manufacturing, repair, driving, and insurance.</td>
<td>46 – New jobs created in mobility service control centers, vehicle fleet maintenance facilities, and support services.</td>
</tr>
</tbody>
</table>
Level 4-5  

**Vans and Buses**

- Almost exclusively public or private transit fleets

Source: Daimler (daimler.com/innovation/autonomous-driving/future-bus.html)
### Level 4-5 Vans and Buses

<table>
<thead>
<tr>
<th>Road Design Impacts</th>
<th>VMT Impacts</th>
<th>Parking Impacts</th>
<th>Urban Form Impacts</th>
<th>Other Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>22</td>
<td>30</td>
<td>39</td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>30</td>
<td>39</td>
<td>47</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
<td>30</td>
<td>39</td>
<td>48</td>
</tr>
</tbody>
</table>

1 – Driving systems increase need for lane marking maintenance.

8 – Dedicated road space in major urban corridors provides priority to high occupancy vehicles and may facilitate high degree of automation sooner.

22 – Reduced transit operating costs allow more frequent service in major urban corridors.

23 – Reduced transit operating costs may support fixed route services in lower density settings, such as connections between suburban campuses and transit corridors.

30 – On-demand mobility services likely to reduce car ownership and demand for both residential and destination parking.

39 – Dedicated transit priority corridors encourage transit-supportive development patterns around stations.

47 – Mix of public and private transit operators likely as taxi companies aggregate trips into larger vehicles in major urban corridors.

48 – Transit automation may reduce demand for bus drivers, potentially offset by increased service frequency in major corridors and new control center jobs.
Level 4-5 Urban Delivery

- Almost exclusively fleet ownership
- Many variations likely depending on cargo

Source: Wired (wired.com/story/ford-self-driving-pizza-delivery-dominos/)
1 – Driving systems increase need for lane marking maintenance.
2 – Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 – Connected vehicle lanes at arterial intersections may increase capacity.
9 – Increased need for curbside and off-street loading zones.
10 – Low-speed delivery vehicles share space with pedestrians, requiring new intersection control systems in urban centers and potentially wider sidewalks.
12 – Electrification reduces cost of vehicle operation, promoting more and/or longer trips.
24 – New business models built on low-cost driverless delivery likely to generate demand for more trips.
38 – Fleet service centers likely to emerge on fringes of urban centers.
42 – Transition to on-demand delivery likely to further reduce demand for traditional brick-and-mortar retail uses, especially outside urban centers.
44 – Broad adoption may reduce crash rates.
51 – Retail industry continues transition from selling physical goods to providing individualized services and experiences in urban shopping centers.
52 – Food service industry may transition to more delivery-based business models.
Level 4-5 Heavy Trucks

- Almost exclusively fleet ownership

Source: Auto Blog (autoblog.com/2015/05/06/freightliner-inspiration-truck-first-autonomous-semi-nevada)
Level 4-5 Heavy Trucks

1. Driving systems increase need for lane marking maintenance.
2. Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3. Connected vehicle lanes at arterial intersections may increase capacity.
12. Electrification reduces cost of vehicle operation, promoting more and/or longer trips.
25. Automation reduces operating costs, leading to diversion of some traffic from rail to truck.
32. Less use of human drivers for long-haul trucking reduces demand for truck plazas near highway interchanges.
43. Truck terminals needed near highway interchanges to transfer loads between large trucks and urban delivery vehicles.
53. Trucking industry jobs may shift from driving to fleet control centers, vehicle maintenance, and logistics hubs.
Close-up: Electric Vehicles

Florida State Transportation Trust Fund
Fiscal Year 2015 – 2016 Receipts in $Millions

- **Other**: $2,447 M (35%)
- **Rental Car Surcharge**: $1,115 M (16%)
- **Miscellaneous Revenue**: $2,178 M (31%)
- **Reimbursement/Turnpike**: $31 M (0.4%)
- **Documentary Stamps**: $35 M (0.4%)
- **Joint Participation Agreements/Other Reimbursements**: $35 M (0.4%)
- **Motor Vehicle Fees**: $16 M (0.2%)
- **Fuel Taxes**: $3 M (0.04%)
- **Federal Aid**: $2 M (0.03%)

Note: “Other” category includes interest on investments, aviation fuel taxes, reimbursement of expressway authorities, and reimbursement of DOT-owned toll facilities.

Source: Florida Dept. of Transportation
EV Share of Vehicle Fleet, 2040

Conditions affecting EV impact:

- Policy
- Incentives
- Declining vehicles cost
- Range and recharging limits
- Charging supply
- Competition from existing or alternative technologies
EVs and their impacts

Conditions affecting EV impact:

- Policy
- Incentives
- Declining vehicles cost
- Range and recharging limits
- Charging supply
- Competition from existing or alternative technologies
Alternative revenue models

**OReGO**
First large road usage charge program in US. Opt-in participants pay 1.5 cents per mile.

**California Road Charge**
Pilot program initiated through CalSTA that included 5,000 volunteers.

**Nevada Field Test**
Included 40 participants in a pay-at-the-pump system (not reliant on collection of location data).

**Minnesota Road Fee Test**
DOT tested road usage revenue program that relied on smartphone GPS data for collection and transmittal of mileage data for 500 participants.
Adapting existing models

Two models adapted based on regional characteristics and model type:

Gainesville
• Traditional 4-Step Model with mode choice and transit
• Area includes a mid-size urban area and a major university

North East Florida Regional Planning Model (NERPM)
• Activity Base Model
• Large multi-county area with diverse population
Adapting existing models

Socioeconomic Data Considerations

1. Shifts in Population components (i.e. aging population)
   - Older populations
     - less likely to embrace technology
     - more likely to have enhanced mobility

2. Shifts in Land use
   - The “Amazon” effect
   - Shift from Commercial Employment (SIC 50-55) to
     - Industrial Employment (SIC 01-39)
     - Service Employment (SIC 40-49, 60-93)
Adapting existing models

• Shift in average trip lengths
  • Use of AVs increases tolerance for longer trips
  • More impact on home-based work trips in areas with higher office employment

• Changes in capacity
  • Restricted to limited access and high-level arterial facilities
  • Limited on arterials by separation of bike/ped facilities.
Adapting existing models

• Changes in out-of-vehicle times (terminal times)
  • AVs decrease out-of-vehicle time from vehicle to destination
  • More likely in Downtown areas or areas with remote parking

• Changes in transit ridership
  • Ride sharing or transportation network companies (e.g., Uber)
  • Focus shift to premium transit
Next steps
Questions and discussion

Source: Mercedes Benz
(mbusa.com/mercedes/future/model/model-All_new_f015_luxury)

Source: Buick Avista Concept interior