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Initial Assessment and Modeling Framework Development for Automated Mobility Districts
Energy Efficient Mobility Systems
SMART Mobility Consortium: Five National Laboratories

Multi-Year, Multi-Lab Effort (3 years, 5 labs)

- Energy implications of connectivity & automation
- Multi-modal transport of people and goods
- City-scale urban mobility models for planning
- Informed fueling infrastructure investments
- Understanding consumer mobility decisions
What is an Automated Mobility District (AMD)

An AMD is a campus-sized implementation of the connected/automated vehicle technology to realize the full benefits of a fully electric automated mobility service within a confined region on district.
Characteristics of an AMD

- Fully automated and driverless cars
  - Mix of on-demand and fixed route services
- Service constrained to a dense area
- Multi-modal access within/at the perimeter
- Personal vehicle use not prohibited, but discouraged
AMD Impact Perspectives

Larger Metropolitan Area

Intra-districts Impacts
- Mobility & energy use of AMD fleet
- Land use changes

Inter-regional Impacts
- Modal choice
- Route choice
- Activity choice

Boundary Issues / Effects
- Mode transfer / parking
- Boundary services
- Transportation networking companies, car sharing / rentals
AMD – Operational and Application Contexts

Operational Context

- On a captive guideway (traditional airport APM – restricted to guideway)
- Continuum of service / area / flexibility emerging.

Application Context

<table>
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<tr>
<th>Location</th>
<th>Military Base</th>
<th>Residential Community</th>
<th>University Campus</th>
<th>Neighborhood</th>
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<tbody>
<tr>
<td>Miramar Military Base (California)</td>
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<td>Babcock Ranch (Florida)</td>
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<td>Pena Next Station (Denver)</td>
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On existing road network (Full automation everywhere)
AMO Modeling Approach

Build on existing AMD analysis

- NREL authored IEEE Conference paper (Chen et al., 2015), an analysis of proposed automated mobility system on a university campus.

Develop a modeling framework and implement

- Assess mobility/energy impacts of AMDs
- Model development in SUMO & FASTSim

Exercise the model with partners either implementing AMDs, or seriously considering

Produce case studies replicable/transferable to other proposed sites
AMD Modeling

Where we are

Existing tools primarily emphasize on

- Limited capabilities to model AMDs
- The road network, with minimal to no consideration for ped/bike/transit
- Privately owned vehicles, but do not model shared economies
- Models built from traditional travel surveys
- Any others…

Where we want to be

The AMD modeling toolkit will

- Model the impact of AMDs on travel behavior
- Consider the interaction between different modal alternatives
- Capture private as well as shared economies in vehicles
- Are built from data based on field deployments
- Can quantify the energy and emission benefits
- Any others…
What is the AMD Modeling and Simulation Toolkit?

- A special generator submodel that plugs into an existing travel demand model for the region
- **Simulates** the ‘micro’ movements of various modes with the district
- **Considers** travel interactions between the district and the rest of the region
- **Quantifies** mobility and energy benefits of automated electric mobility service within the district
AMD Simulation Toolkit: Model Flow

**Travel Demand**
- Origin-Destination data from regional travel demand model
- Local surveys or counts
- Induced travel demand

**SUMO (Mobility Analysis)**
- SUMO – Simulator of Urban Mobility
- Carries out the network simulation of vehicles
- SUMO will output travel trajectories

**FASTSim (Energy Analysis)**
- FASTSim - Future Automotive Systems Technology Simulator
- FASTSim will output vehicle energy consumption
SUMO – Inputs and Outputs

• SUMO is an open source, microscopic and continuous road traffic simulation package

Inputs

• Regional traffic demand (transportation agencies)
• Road network and configurations (OSM, agency GIS, etc.)
• Automated and connected vehicle service configurations (number of automated vehicles, vehicle capacity)
• CAV Vehicle operational characteristics (average speed, acceleration, headways, etc.)

Outputs

• Network mobility metrics: average travel time (deadheading time), average travel distance, PMT, etc.
• Other scenario related metrics (best number of shuttles, best shuttle capacity, etc.)
• Detailed vehicle trajectories.
FASTSim – Inputs and Outputs

• Output from the SUMO model will be fed into the FASTSim Model

Inputs
• 1Hz vehicle travel trajectories under different vehicle operational characteristics
• Attributes of vehicles, e.g. length, vehicle type, powertrain type, etc.
• Battery & Charging characteristics, e.g. min / max SOC, roadway charging, etc. (if applicable)
• Vehicle passenger and cargo loads

Outputs
• 1Hz energy consumption of vehicles
• Temporal or spatial aggregated vehicle energy consumption
• Comparison of energy consumption based on different vehicle type and powertrain mix
• Other scenario related metrics (best mix of powertrain and vehicle type, best vehicle range for EVs etc.)
## AMD Simulation Toolkit: Array of Uses

- Test various operational configurations of AMDs (Fixed route, on-demand, mixed)
- Quantify performance metrics
- Energy analysis (e.g., best mix of powertrain and vehicle type)
- AMD impacts on travel to / from the district?
- Analysis of interconnected AMDs (intra-district, inter-district, and boundary travel)
- Minimum number of vehicles needed to satisfy demand
Future Work

- Develop a proof of concept AMD Simulation Toolkit
- Collect travel survey and vehicle operational data from a real-world AMD deployment
- Augment the modeling components of the toolkit with data from real work AMD deployments
- Integrate the AMD toolkit into a regional traffic model
- Quantify the mobility and energy benefits of AMDs
Questions/Comments