ASPIRES: Airport Shuttle Planning and Improved Routing Event-driven Simulation

Qichao Wang, Ph.D.
National Renewable Energy Laboratory
2020 TRB Workshop on Traffic Simulation and CAV Modeling
November 16-18, 2020
• Background
• Data collection
• Modeling and Simulation
• Example Results
• Conclusions

ASPIRES is open-sourced now: https://github.com/NREL/ATHENA-aspires
Contributors

- Qichao Wang, Ph.D.
- Devon Sigler, Ph.D.
- Andrew Kotz, Ph.D.
- Zhaocai Liu, Ph.D.
- Kenneth Kelly
- Caleb Phillips, Ph.D.
Background

Airports are complex transportation hubs that coordinate the movement of passengers, goods, and services from the surrounding urban area.

ATHENA will leverage data streams to model and optimize the integration of new technologies at DFW airport and other transportation hubs.

Utilize DOE HPC Resources and Expertise to Optimize Operational Integration of New Technologies into the Nation’s Transportation Hubs

https://www.athena-mobility.org/
Background

• Shuttle bus optimization -> Simulation of the optimized route settings

• Functional requirements
  • Simulate the service level – represented by pax waiting time
  • Simulate the energy used – represented veh-miles and Gasoline gallon equivalent (GGE)
Data collection

• Demand
  • SPOT data / driver notes

• Travel time, distance, and energy consumption
  • CAN BUS logger
  • SUMO simulation
Discrete-event simulation

Event i: Finish loading passenger at the rental car center

Event i+1: Arrive at a terminal bus stop

Simulator jumps from one event to the next event to avoid going through the time when there is no event.
Modeling and Simulation

Resources:
- Passengers
- Vehicle energy (battery) level
- Chargers

Resource container:
- Vehicles: limited resources (seats)
- Bus stops: unlimited resources
- Charging station: limited resources (chargers)

Processes:
- **Passenger arrival**: non-stationary Poisson process (data from onboard SPOT system)
- **Vehicle movement**: time-dependent empirical distribution of travel time and energy consumption (calculated from bus powertrain data logged by onboard logger)
- **On-demand service**: based on pax # at bus stops
- **Charging**: decision based on battery level, whether the bus is being used, and whether the charging station is full
Run different scenarios by setting parameters. Allows parallel execution on HPC.

### Parameters to be set:

- RoutesFile
- RoutesFileFolder
- outputName
- StartingDayOfWeek
- SimTime
- doHotShot
- NumEVCharger
- TimeToCharger
- randSeed
- numEV
- OnRouteCharging
- ArrivalSFactor
- maxqueue
- doNightTimeOndemand
- NightTimeOndemandInterval
- doRegularOndemand
- numOndemand
- OnDemandCapacity
Simulation Results

Comparing the passengers waiting time distribution under different scenarios.

Heatmaps to show trade off between service (waiting time) and energy consumptions.
Capabilities

Research questions that ASPIRES can answer:

• Evaluation
• Optimization
  • Routes
  • Number of buses assigned
  • EV charging settings
  • On-demand policies
  • ...
• What-if scenarios
Conclusions

• Simulate shuttle operations
• Fast
• No calibration effort
• Extendable / Customizable
• Open source
  • https://github.com/NREL/ATHENA-aspires
Questions?

www.nrel.gov

Qichao.Wang@nrel.gov