Infrastructure Impacts of SMART Technology: Data Analyses on Energy Use

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2018 DOE Vehicle Technologies Office Annual Merit Review
June 19, 2018

Project ID # EEMS054

ENERGY EFFICIENT MOBILITY SYSTEMS PROGRAM INVESTIGATES

MOBILITY ENERGY PRODUCTIVITY

THROUGH FIVE EEMS ACTIVITY AREAS

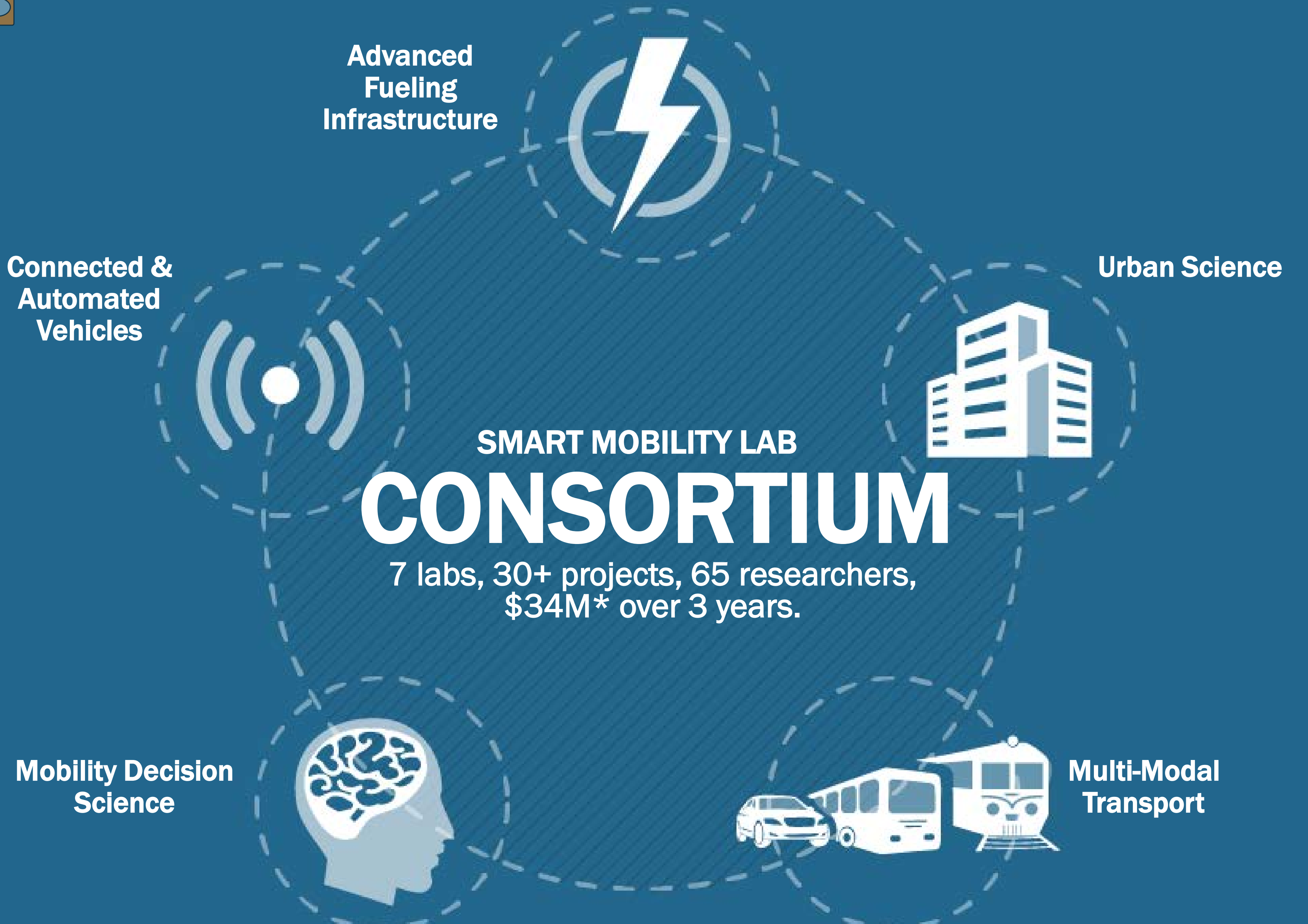
Advanced R&D Projects

Living Labs

Smart Mobility Lab Consortium

Core Evaluation & Simulation Tools

HPC4Mobility & Big Transportation Data Analytics



*Based on anticipated funding

Overview

Timeline

- Project start October 2017
- Project end September 2019
- 25% complete

Budget

- FY2018 – Requested: INL $180K; NREL $50K
- FY2019 – Proposed: INL $180K; NREL $50K

Barriers

- Accurately measuring the transportation system-wide energy impacts of connected and automated vehicles
- Determining the value and productivity derived from new mobility technologies
- Expansive community of relevant stakeholders

Partners

- National Renewable Energy Laboratory
- Data Partner: Carnegie Mellon University – Mobility Data Analytics (MAC)
- Data Partner: UCLA Smart Grid Energy Research Center (SMERC)
- Data Partner: Denver Regional Council of Governments (DRCOG)
- Data Partner: Smart Cities Challenge Finalists Airports

Relevance and Objectives

- Relevance:
  - New mobility technologies are persuading cities to change infrastructure to adapt
  - How will infrastructure changes happen? Mobility of the Future
- Objective:
  - Develop analysis model to estimate impacts of infrastructure changes (parking and land uses) with the implementations of TNCs, EVs/AVs, and other SMART technologies (e.g. automated-only roadways, auto-valet parking, AMDs, ICTs):
    - Energy consumption – reduction on vehicles and energy shift correlations
    - Productivity – ACES
    - Affordability – efficiency and convenient mobility options
    - Travel choices – transit over vehicle use and parking

Multi-Criteria Performance (Adapted from Isaac, 2016)	**(-)**	**(+)**
Energy/Vehicle Miles Traveled	↑	↑↓
Urban Sprawl / Congestion	↑	↓
Parking Requirements	No change	↓
Low-Income Mobility	↓	↑
Safety	↑	↑
Roadway Maintenance	↓	↓
City Revenues (e.g., parking)	↓	↑

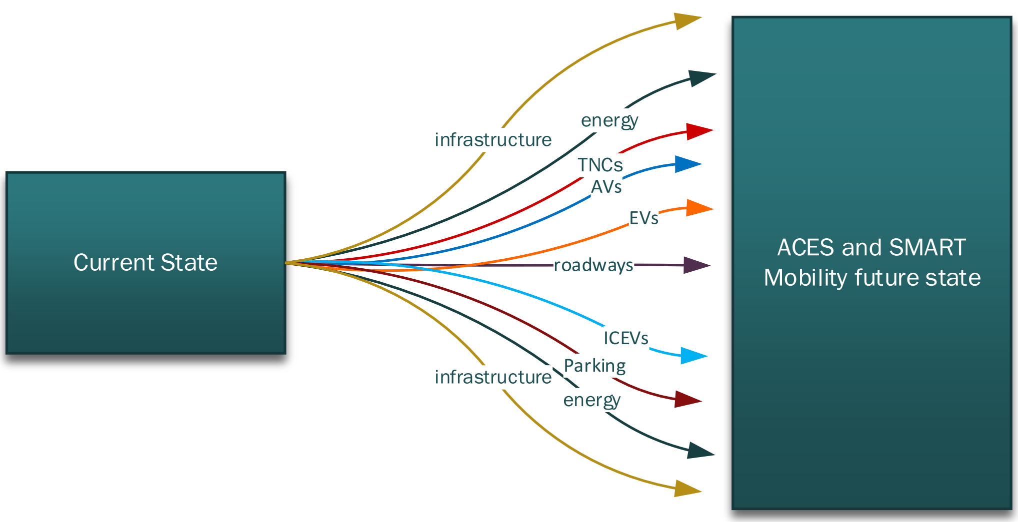
[Sources: Adapted from *Driving Towards Driverless: A Guide For Government Agencies*, 2016, L. Isaac, 2016; US DOT/Census]

Relevance

- Methods for Initial Energy Analyses for Smart City Finalists
  - Informing TNC Design for/near Airports & Intermodal Transportation Facilities
  - Baseline metrics as estimates of existing surface level parking lots in downtowns
  - Utilize estimates for energy analyses of land use density/residential density
  - Forecast energy impacts from parking conversion to new land uses or new densities

Risks and Benefits:

- Increase or decrease congestion
- Land use and infrastructure reuse
- Measures and key indicators of parking
- Urban blight avoidance
- Encouragement of MaaS across urban-scapes for energy



"… per-capita daily energy demands decrease with increased resident and employment density." Nichols & Kockelman, *Journal of Transportation and Land Use*, 8 (3): 1-15, 2015

Milestones

Date	Milestones	Status
January 2018	Milestone: Identify data opportunities for measuring parking demand, revenue, energy use, infrastructures	Complete
March 2018	Milestone: Preliminary analytics framework; strategic partners and stakeholders identified	On going
April 2018	Milestone: Begin acquire parking demand data (airports, surface parking, revenue, energy use, etc.)	On track
July 2018	Milestone: Baseline data for pre-smart technology	On track
August 2018	Milestone: Collect data from smart technology deployment data partners	On track
September 2018	Go/No-go: Finalize analytical framework; test data into analytic framework	On track
FY2019	Milestone: Analyze parking data in terms of energy impacts to cities infrastructure	On track
FY2019	Milestone: Document findings and develop strategic roadmap for mobility—infrastructure—energy forecasting	On track

Approach

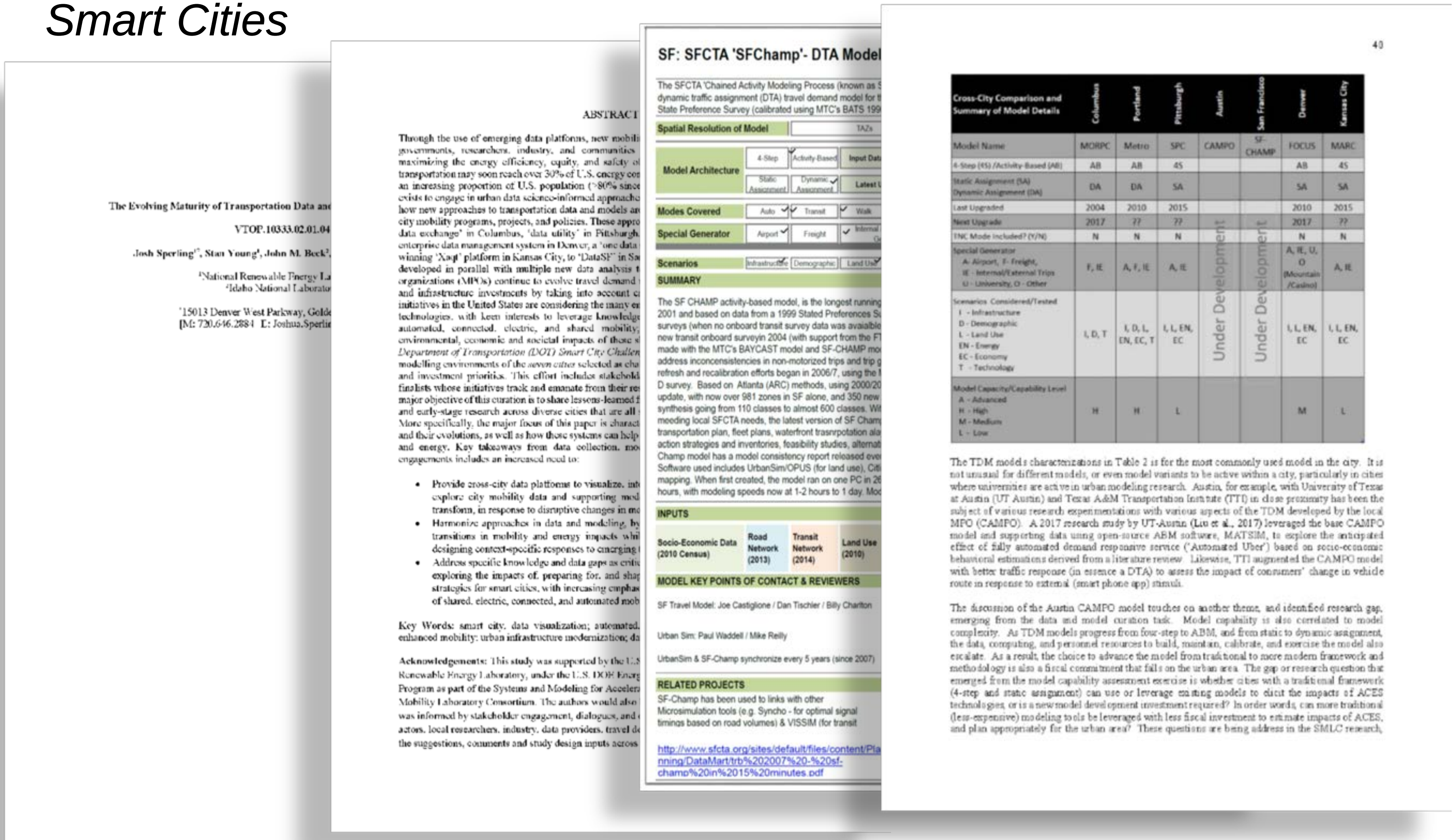
- Formulate framework, model/analyses parameters from literature
  - trends, forecasts, scenarios etc.
  - data input criteria for use
- Define baseline analytics to perform & identify partner cities & stakeholders
  - San Francisco, Denver, Portland, Pittsburgh, Kansas City, parking app, university partner
- Secure appropriate data sets
  - Energy uses, land use, TNCs, and smart)and models parameters from cities, MPOs, and other agencies
- Perform data analytics on the validated (existing and newly created) parking, land use, and energy data sets
- Decision Point: October 2018 – baseline framework

Approach continued

- Highest energy benefit by changing urban-scape infrastructure
- Case studies perspectives
  - Parking management by employers
  - Chauffer services, TNC priority
  - Maas, not parking, is the new form of commuting
- Parking availability to drive mobility decision choices – energy shift
- Infrastructure:
  - Generation
  - Transmission
  - Distribution
  - Parking
  - Commuting
  - Land use
- Leverage data from various sources to measure possible for energy impacts

Accomplishments

- *The Evolving Maturity of Transportation Data and Models Across Smart Cities*



Accomplishments

- Literature searches

Accomplishments

- Data collection

Airport Data Reveal How Quickly We are Adapting to New Mobility

Recent studies have indicated that both air travel and ride-hailing (e.g., Uber, Lyft) services are on the rise across cities in the United States and globally. By 2035, global air travel demand is expected to double (within just a 20-year period), and tens of billions in new airport infrastructure investments and modernization upgrades are expected.

For U.S. cities with larger regional airports –such as Denver, San Francisco, Portland, and Kansas City– the number of recorded airport passengers has been rising steadily, from approximately 115M in 2011 to approximately 146M in 2017 (Figure 1). This represents an annualized growth rate of 3.8% for these airports, with a doubling time of approximately 18 years (even faster than global air travel demand projections). Today, air travel represents over 9% of total U.S. transportation energy use (EIA 2016), with a 567% increase (from 309 to 1,752 petajoules) in jet fuel and aviation-related gasoline consumption from 1960 to 2015 (BTS 2016).

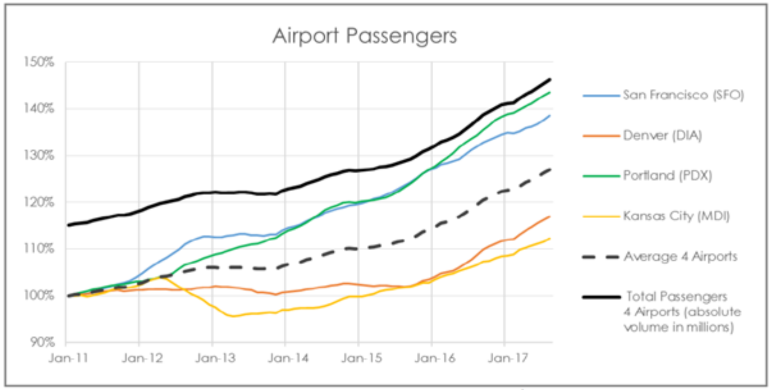
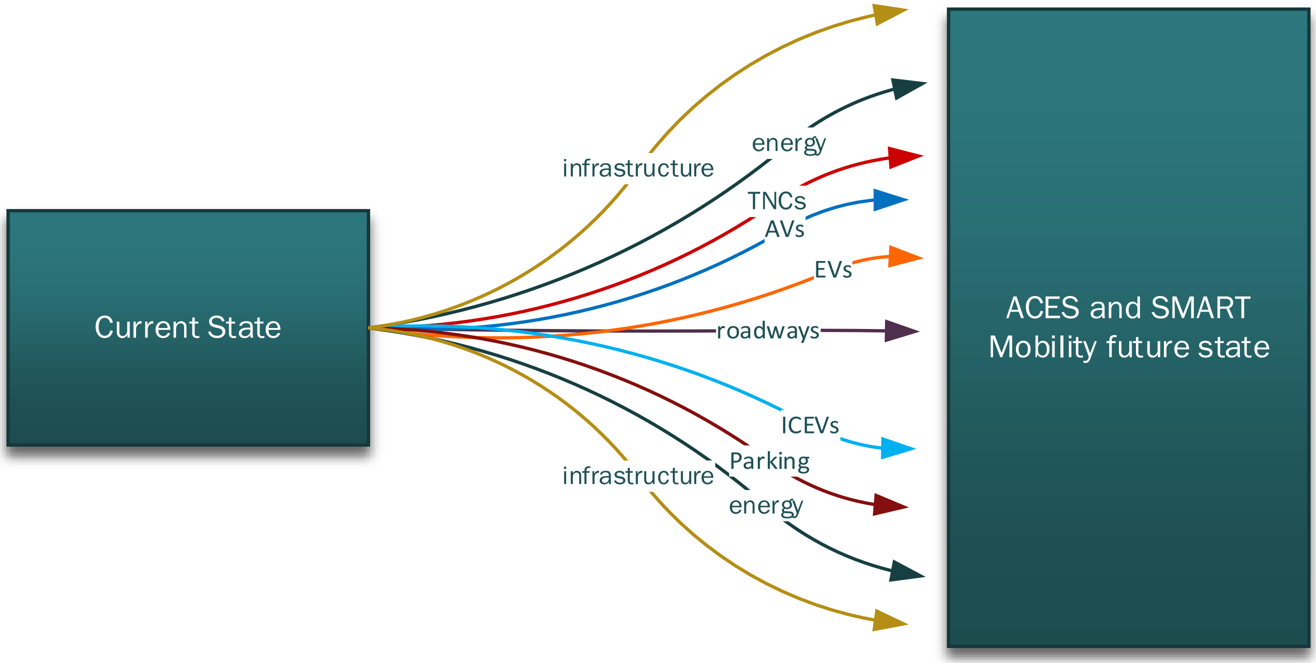


Figure 1. Airport passengers[1]

[1] Notes: Total airport passengers (enplaned + deplaned). All airports indexed to January 2011 as baseline (100%). Twelve-month running average, each month. Airports have mass transit service, except for Kansas City.

Accomplishments

- Framework



Responses to Previous Year

- In FY17 this task was included under Urban Science Task 2.1
- In FY18, split into two separate tasks, Urban Science Task 2.1.1 and Urban Science Task 2.2.1
- Responses from FY17 are address in Task 2.1.1 AMR presentation
- For FY2018, this task is considered new

Collaborations and Coordination

Co-Principal Investigator on Infrastructure Energy Impacts of SMART Technology

Airport Data Partners

Mobility Data Analytics Center – Urban Infrastructure Interdependency

Aerial Imagery Infrastructure Datasets

Campus Parking Infrastructure Data

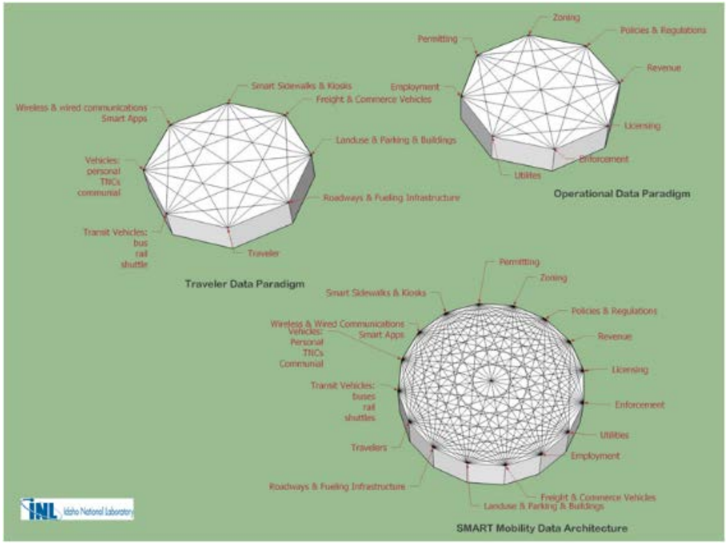
Higher Education Commuting Trends

Remaining Challenges and Barriers

- Availability and uniformity of parking infrastructure data
- Need to define data parameters – future ties to SMART Mobility Data Architecture
- Accurately measuring the transportation system-wide energy impacts from infrastructures changes
  - Parking changes
  - Commuter options
  - ACES based MaaS
  - Energy Data as a Service (EDaaS) uniformity and availability

Proposed Future Research

- FY2018
  - Finish literature review
  - Solidify partners
    - DRCOG aerial imagery data
    - CMU Mobility Data Analytics Center
    - UCLA SMERC campus parking data
  - Energy data parameters for infrastructure impacts
- FY2019
  - Analytic framework and analyses
    - Energy changes
    - Congestion/VMT reduction and energy impacts
  - Mobility Metric integration
  - SMART Mobility Data Architecture



Any proposed future work is subject to change based on funding levels.

Summary

- Initial literature review
  - Parking infrastructure changes indicate opportunity reduce VMT and energy shift
  - ACES and TNCs are changing the urban-scape infrastructure
  - Energy shift from E → e^- is inconclusive on energy increase or decrease
- Strategic stakeholder partnerships can lead to better understanding of framework parameters
- Ties to other SMLC Tasks are beneficial in data sharing and value of understanding the complexity of the System of Systems nature of integrated transportation networks
- Clarity is needed in understanding the empirical real-world data available for infrastructure/energy analytics