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Multi-Region Stakeholder Driven BEAM CORE Application

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2024 R&D 100 FINALIST

BEAM CORE Comprehensive Regional Evaluator

BERKELEY LAB

NREL

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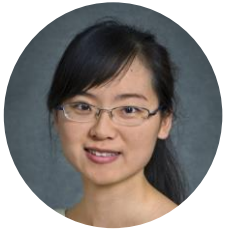

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Overview

Timeline

Project start date: October 1, 2023

Project end date: September 30, 2026

Percent complete: 50%

Budget

Total project funding: **$5,370,000**
(DOE Share: 100%)

FY25 project funding: **$1,780,000**

FY26 project funding: **$1,790,000**

Barriers and Technical Targets

Contributes to targets from VMSATT 2024 Roadmap: (1) existing models and tools have been developed to focus on individual vehicles over pre-defined driving cycles. The technologies considered require a new focus to be placed on specific models (e.g., human driver) and capabilities (e.g., multi-vehicle system simulation within an environment). EEMS-supported models (such as BEAM CORE, POLARIS, RoadRunner, and UrbanSim) are highlighted. There is prioritization of partnerships as a mechanism for technical information exchange, feedback, and suggestions for model application.

Partners

Technical project teams

- Berkeley Lab
- National Renewable Energy Laboratory

Current Active Stakeholder Partners/Collaborators

- San Francisco County Transportation Authority (SFCTA)
- Bay Area Metropolitan Transportation Commission (MTC)
- Puget Sound Regional Council (PSRC)
- City of Seattle, Department of Transportation
- California Air Resources Board (CARB)

Relevance

Objective

Directly contribute to EEMS strategic goal #3: Share research insights and coordinate and collaborate with stakeholders to support energy efficient local and regional transportation systems.

- Use BEAM CORE to identify opportunities for advanced freight technology strategies to shape local decision-making in Seattle and San Francisco. Identify efficiency, energy, cost and health outcomes.
- Deploy BEAM CORE modules for programmatic operations interfacing with multiple Metropolitan Planning Organization (MPO) travel demand models (TDMs). Advance the state of the art in MPO capabilities to identify opportunities for efficiency, cost-savings, and resiliency for travelers across the United States.

Impacts

- Informed innovative freight program design in San Francisco County and the City of Seattle.
- Advancement of multiple MPO modeling capabilities leveraging state of the art BEAM CORE modules.
- Demonstration of generalizable California deployment of BEAM CORE modules calibrated in all major CA MPO regions, as a proof of concept of how multiple BEAM CORE modules can be efficiently deployed and calibrated in any region in the United States.

Milestones
FY25

Task 1	Q1	Q2	Q3	Q4
SynthFirm: baseline fleet generation with electrification; FRISM: Preliminary results on EV tour planning and on-demand delivery; BEAM-Freight: Preliminary parking and charging infrastructure siting and initial results from on-demand delivery.	On Track		*	
SynthFirm: fleet generation with electrification + right-sizing; FRISM: finalizing EV tour planning and on-demand delivery capabilities; BEAM-Freight: test cases for curb management and sensitivity analysis of on-demand delivery.		On Track		*
Task 2	**Q1**	**Q2**	**Q3**	**Q4**
Calibrated SynthFirm/FRISM model using Seattle local data and initial documentation of the calibration process, designed to be as study area-agnostic as possible.	Done			
Fully documented pipeline for the adjustment and validation of SynthFirm/FRISM in Seattle and any region, including performance results for Seattle region.		On Track		*
Task 3	**Q1**	**Q2**	**Q3**	**Q4**
High-level overview of demonstration plan for upstream BEAM CORE module implementation in all major CA regions	Done			
Report out on stakeholder engagement socializing demonstration plan with CARB, MPOs, etc.		On Track	*	

* Quarter in which milestone documentation is due.

Approach

Task 1: Urban freight solutions

Local challenges and priority areas

San Francisco County

- Pollution from ports
- Congestion from on-demand delivery

City of Seattle

- Freight electrification
- Microhub and e-bike delivery
- Commercial vehicle loading zones

SynthFirm
Demand and asset

- B2B demand
- International trade and port operation
- Fleet composition (with alternative fuel vehicles)

FRISM
E-commerce and logistics

- E-commerce demand (including on-demand)
- Logistic channel and vehicle dispatching

BEAM-Freight
Congestion and impacts

- Traffic simulation for driving and parking
- Infrastructure siting
- Externalities (e.g., congestion, energy use, and emissions)

Approach

Task 2: Integration of BEAM CORE Capabilities in MPO Modeling Ecosystems

Objective:

- Integration of specific BEAM CORE modules into MPO modeling landscapes.

Impact:

- Expanded MPO capabilities.
- For PSRC in particular, the BEAM CORE platform implemented in this way could have immediate application in evaluating scenarios in PSRC's two major regional planning cycles, the Regional Transportation Plan and VISION 2050.

Current MPO partners:

- Puget Sound Regional Council (PSRC)
- Bay Area Metropolitan Transportation Commission (MTC)
- San Diego region (SANDAG)

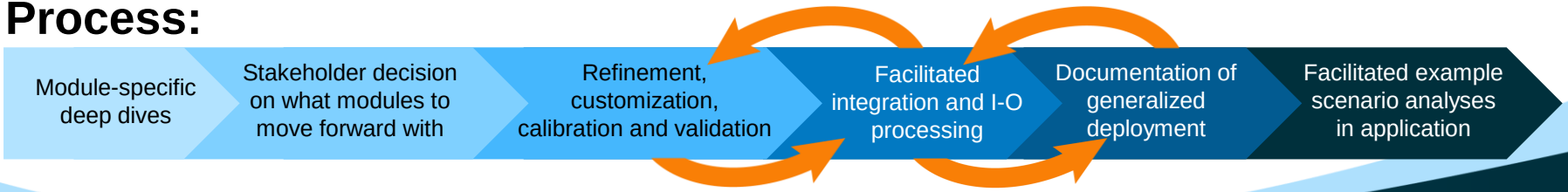
Further discussions underway with additional partners:

- Boston Region MPO
- Atlanta Regional Commission (ARC)

Additional deployment and stakeholder engagement activities

- Outreach
- Berkeley Lab I-Corps Lite Program

Process:



Approach

Task 3: Strategic Deployment of BEAM CORE

Objective:
Use California MPO regions as case studies/ demonstrations of BEAM CORE Core Tools (EEMS145) deployment of BEAM CORE modules (SynthFirm, FRISM, ATLAS and DEMOS)

Major CA MPO regions:

- Bay Area Metropolitan Transportation Commission (MTC)/ Association of Bay Area Governments (ABAG)
- Southern California Association of Governments (SCAG)
- San Diego Association of Governments (SANDAG)
- Sacramento Area Council of Government (SACOG)
- Fresno Council of Governments (FCOG)
- Kern Council of Governments (KCOG)
- Association of Monterey Bay Area Governments (AMBAG)
- Santa Barbara County Associations of Governments (SBCAG)

Ongoing stakeholder engagement

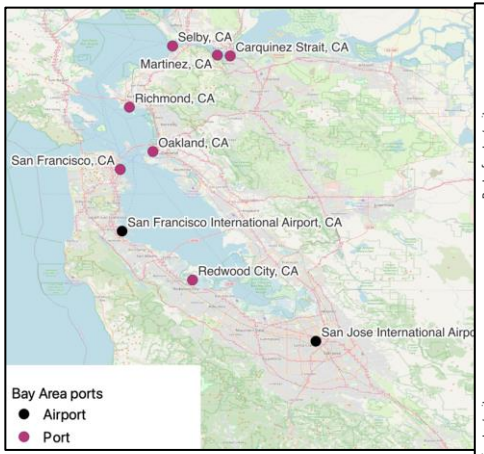
Technical Accomplishments

Task 1: Urban freight solutions

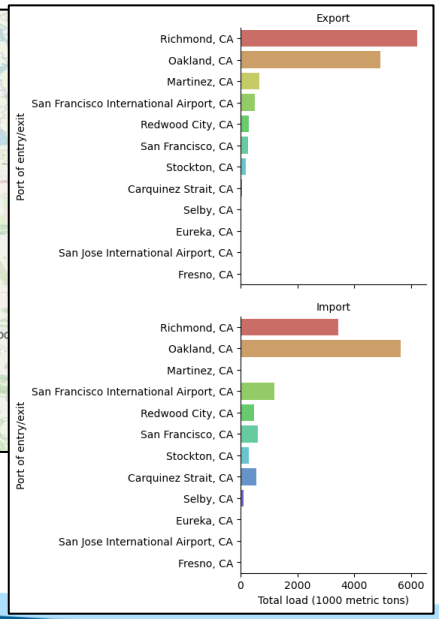
San Francisco County

International trade and port flow

Bay area ports

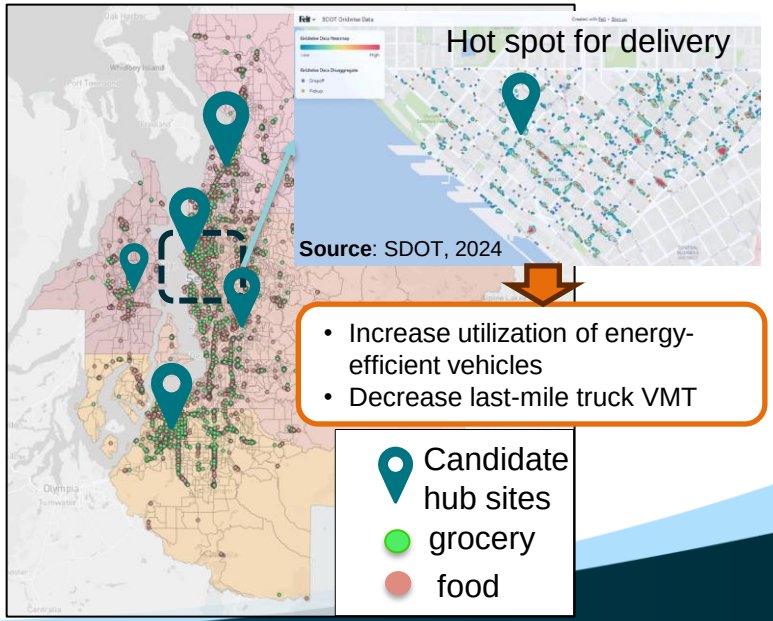


Annual truck load by port



City of Seattle

Loading zone and micro-hub planning

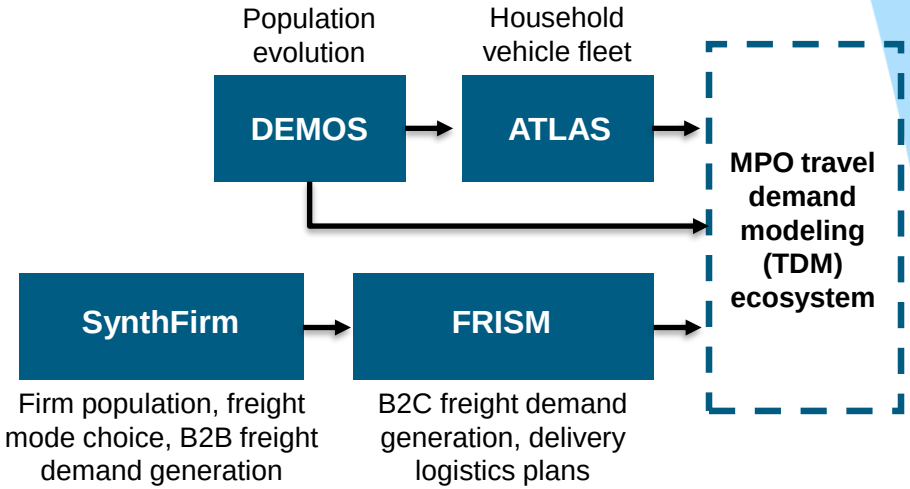


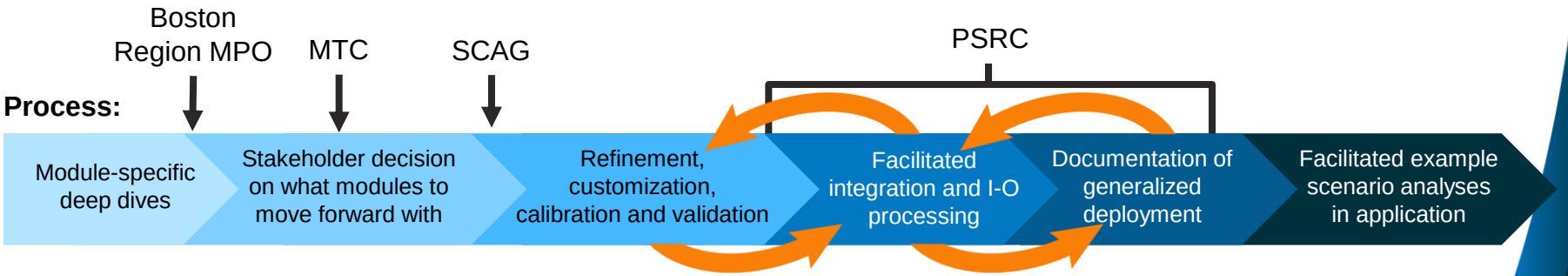
- Increase utilization of energy-efficient vehicles
- Decrease last-mile truck VMT

Technical Accomplishments

Task 2: Integration of BEAM CORE Capabilities in MPO Modeling Ecosystems

- Significant progress towards integration of SynthFirm and FRISM into **PSRC** SoundCast TDM.
- **MTC** is in the process of having a third party consulting firm assess DEMOS.
- **Boston Region MPO** is interested in exploring integration of SynthFirm and FRISM into their TDM.
- **SCAG** is evaluating the integration of DEMOS into their TDM.





Technical Accomplishments

Task 2: Integration of BEAM CORE Capabilities in MPO Modeling Ecosystems

> DEMOS, which utilizes microsimulation to account for lifecycle events, can offer valuable insights for MPOs' future growth forecasting processes… SCAG recognizes the significant role DEMOS can play in enhancing the analytical capabilities of its Activity-Based Travel Demand Model.

-SCAG Team

> Having such a powerful tool that hooks in directly with our activity-based travel model will move us much further along in our ability to better account for freight travel in our work... Seeing initial results from this project is exciting because we are starting to see how these advanced tools can capture the nuance of current conditions and provide more insight into possible futures as well.

-Brice Nichols, PSRC

Technical Accomplishments

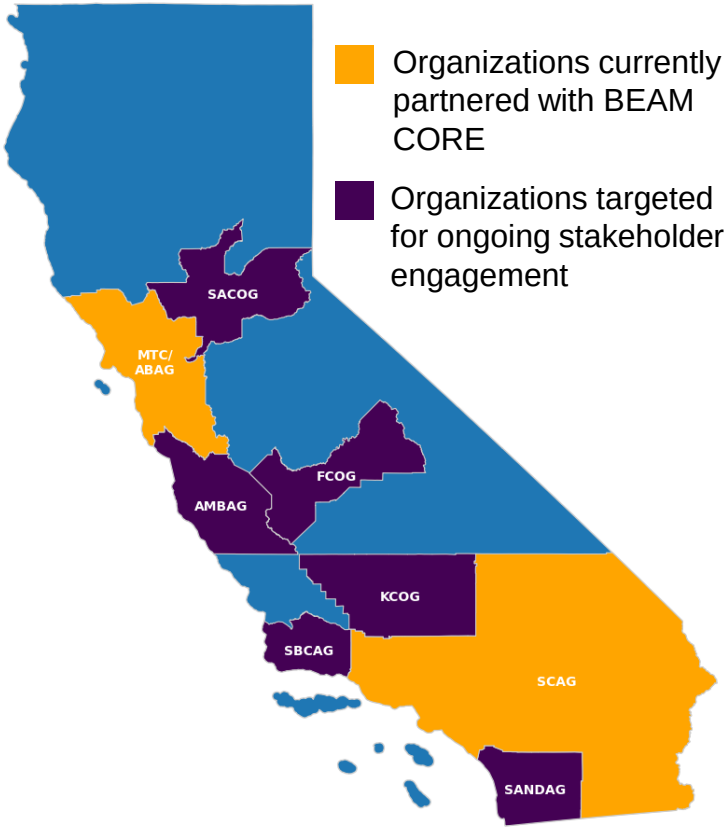
Task 3: Strategic Deployment of BEAM CORE

Organizations currently partnered with BEAM CORE:

- Bay Area Metropolitan Transportation Commission (MTC)
- Southern California Association of Governments (SCAG)

Organizations targeted for ongoing stakeholder engagement

- San Diego Association of Governments (SANDAG)
- Sacramento Area Council of Government (SACOG)
- Fresno Council of Governments (FCOG)
- Kern Council of Governments (KCOG)
- Association of Monterey Bay Area Governments (AMBAG)
- Santa Barbara County Associations of Governments (SBCAG)



Collaboration and Coordination

Multi-Laboratory Technical Research Partnership

Berkeley Lab is the prime lab, develops the BEAM, SynthFirm and ATLAS modules, and the PILATES computational software environment and leads the stakeholder engagement and coordination.

NREL develops DEMOS and FRISM and provides inputs from other supporting modules (FastSim and RouteE-Powertrain) for energy estimation in BEAM CORE. They also support on stakeholder engagement and coordination.

Deployment Stakeholder Partners

- **Bay Area MTC** is assessing DEMOS for potential integration into their modeling workflow.
- **SCAG** is evaluating integration of DEMOS into their modeling workflow.
- **CARB** is supporting on MPO engagement for CA statewide deployment demonstration.
- **Boston Region MPO** is assessing SynthFirm and FRISM for potential integration into their modeling workflow.
- **PSRC** is moving forward with integration of SynthFirm and FRISM into their modeling workflow.

Application Stakeholder Partners

- **SFCTA** is providing data and setting priorities for the San Francisco county studies.
- **City of Seattle** is providing data and setting priorities for Seattle studies.

Remaining Challenges and Barriers

- There are no major technical challenges. The technical work is proceeding as planned and on schedule.

- The only barrier to realization of the full vision for this project is bandwidth of deployment stakeholder partners. MPO and other agency staff have a lot of demands on their time and so ensuring we can make it as easy as possible for them to pilot adoption of BEAM CORE modules is critical. However, we cannot dictate what they are able to take on and so we have to be flexible and adaptive.

Proposed Future Research

In the final year and a half of this project the team will focus on success in the final phase of the work:

- Complete deployment and validation of BEAM CORE modules into deployment partner modeling ecosystems, enabling MPO staff to independently run scenarios leveraging BEAM CORE capabilities.
- Complete the San Francisco County and the City of Seattle studies and draft manuscripts documenting the results for journal submission.
- Demonstrate performance of newly generalized BEAM CORE modules (being developed under the BEAM CORE Core Tools project EEMS145) in all major MPO regions in CA, coupled with broader engagement with additional CA MPOs to socialize the opportunity for them to leverage these calibrated implementations.

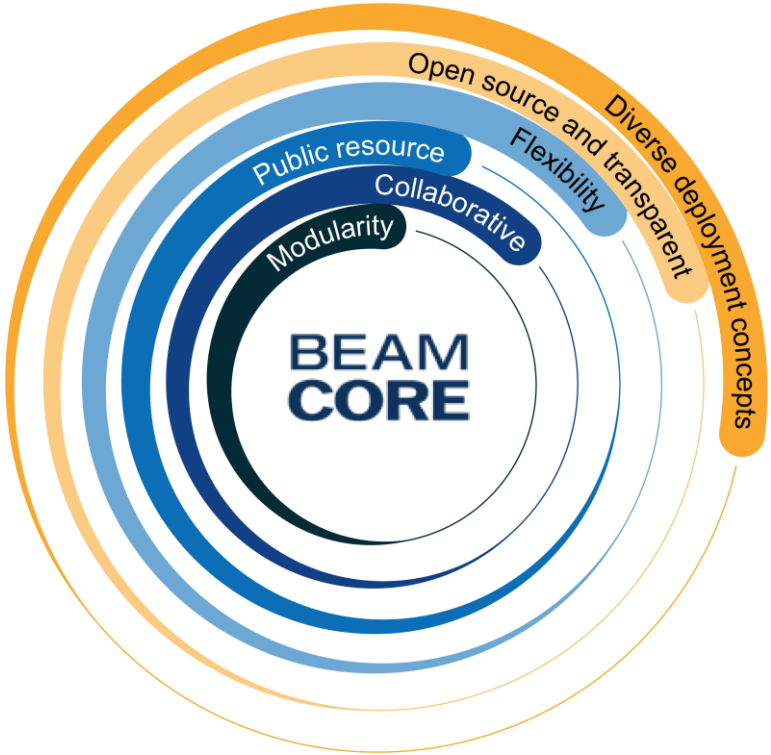
Any proposed future work is subject to change based on funding levels.

Summary

BEAM CORE is a state of the art, open source, flexible, modular set of integrated tools able to simulate a wide range of impacts of transportation systems technology, innovations, network design and management strategies, and more.

In this project, we bring the power of the 2024 R&D 100 Award Finalist BEAM CORE capabilities to benefit a wide range of local stakeholders.

Through targeted studies and coordinated deployment activities, this project takes a major step in realizing the vision and promise of BEAM CORE, leaning into the philosophy of modular flexibility, transparency, collaboration, and establishment of an open source public resource.



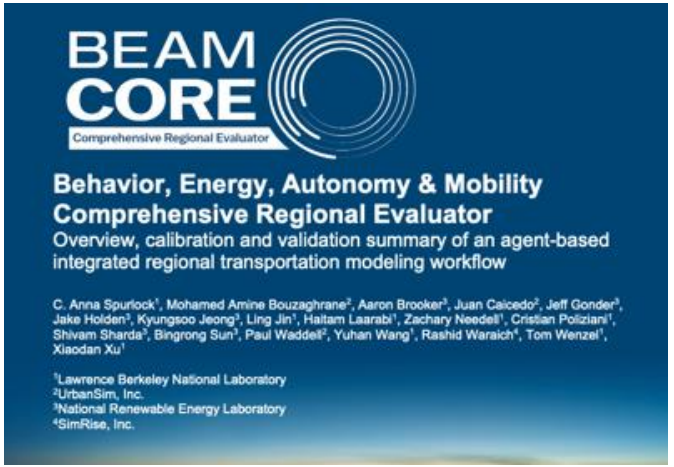
Technical Backup Slides

Where to learn more about BEAM CORE

Video Animations on BEAM and BEAM CORE

https://transportation.lbl.gov/beam/

Overview Report on BEAM CORE



https://transportation.lbl.gov/publications/behavior-energy-autonomy-mobility

Where to learn more about BEAM CORE

ATLAS - Automobile and Technology Lifecycle-Based Assignment

- Software citation: https://doi.org/10.11578/dc.20240618.2
- Primary technical documentation: Jin, et al. (2024). Technology progress and clean vehicle policies on fleet turnover and equity: insights from household vehicle fleet micro-simulations with ATLAS. *Transportation Planning and Technology*, 1–24. https://doi.org/10.1080/03081060.2024.2353784

SynthFirm

- Software citation: https://doi.org/10.11578/dc.20240621.2
- Recent technical documentation: Xu, et al. (2024). Teaching freight mode choice models new tricks using interpretable machine learning methods. *Frontiers in Future Transportation*, 5, 1339273. https://doi.org/10.3389/ffutr.2024.1339273

BEAM – Behavior Energy Autonomy Mobility

- Software citation: https://doi.org/10.11578/dc.20241024.2
- Primary technical documentation: Laarabi, et al. (2024). A Modeling Framework for Behavior, Energy, Autonomy and Mobility (BEAM). *Lawrence Berkeley National Laboratory Report*. https://transportation.lbl.gov/publications/modeling-framework-behavior-energy

PILATES - Platform for Integrated Land use And Transportation Experiments and Simulation

- Software citation: https://doi.org/10.11578/dc.20240613.2

FRISM – Freight Integrated Simulation Model

- Software citation: https://doi.org/10.11578/dc.20240910.28

DEMOS – Demographic Microsimulation

- Software citation: [Forthcoming]
- Primary technical documentation: Sun, et al. (forthcoming). Demographic Microstimulator for Integrated Urban Systems: Adapting Panel Survey of Income Dynamics to Capture the Continuum of Life. *Transportation Research Record*

Where to learn more about BEAM CORE

Other Integrated Software

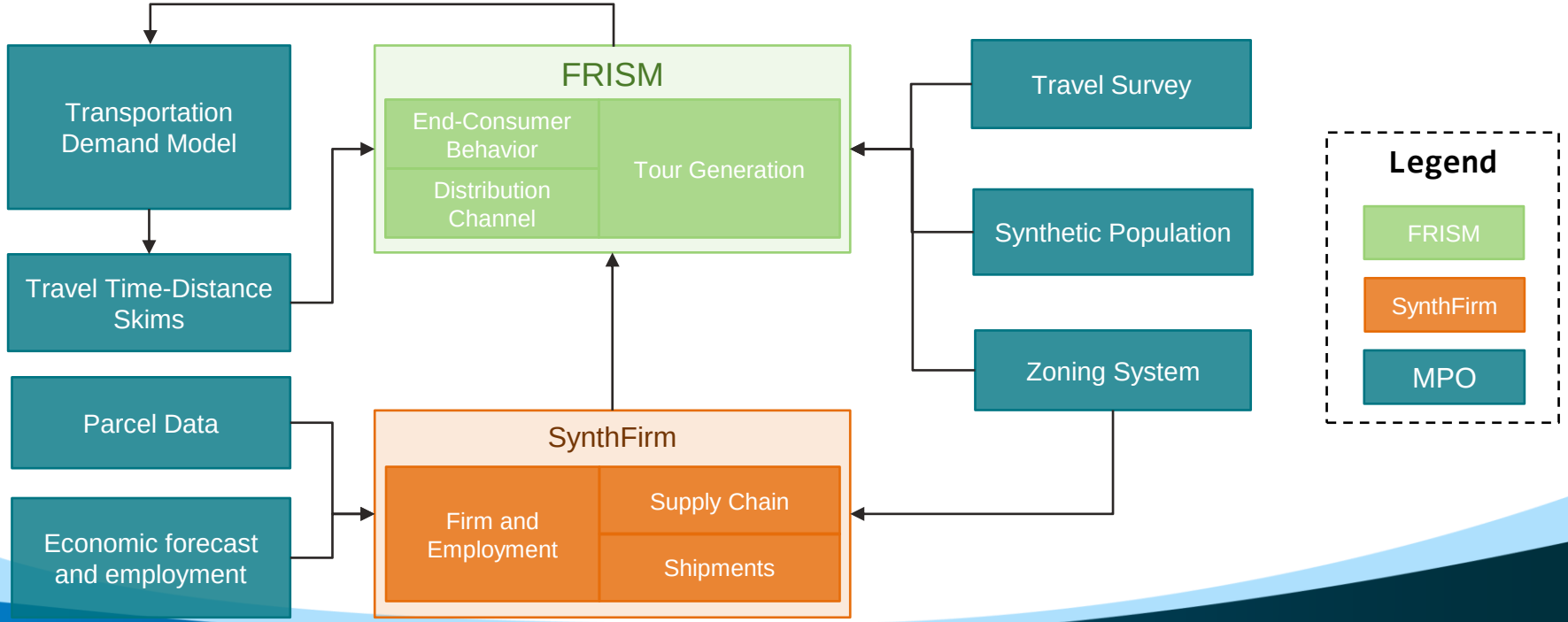
- ADOPT – Automotive Deployment Options Projection Tool. Learn more at: https://www.nrel.gov/transportation/adopt.html
- FASTSim – Future Automotive Systems Technology Simulator. Learn more at: https://www.nrel.gov/transportation/fastsim.html
- RouteE-Powertrain – Route Energy Prediction Model. Learn more at: https://www.nrel.gov/transportation/route-energy-prediction-model.html
- SynthPop – Learn more at: https://github.com/UDST/synthpop/tree/develop
- UrbanSim – Learn more at: https://www.urbansim.com/
- ActivitySim – Learn more at: https://activitysim.github.io/

Additional Publications

- Jin, L. et al. (2022). What makes you hold on to that old car? Joint insights from machine learning and multinomial logit on vehicle-level transaction decisions. *Frontiers in Future Transportation*, 3, 894654. https://doi.org/10.3389/ffutr.2022.894654
- Lazar, A. et al. (2021, December). Performance of the gold standard and machine learning in predicting vehicle transactions. In 2021 IEEE International Conference on Big Data (Big Data) (pp. 3700-3704). IEEE. https://doi.org/10.1109/BigData52589.2021.9671286
- Poliziani, C. et al. (2024). “Simulating Impacts from Transit Service Enhancements in the San Francisco Bay Area.” *Transportation Research Record*. https://doi.org/10.1177/03611981241292338
- Rezaei, N. et al. (in press). “Zooming in on virtual commutes: telecommuting impacts on mobility and sustainability.” *Transportation Research Part D*.

Technical Accomplishments

Task 2: More Detail on Integration Workflow for MPO(s) Integrating FRISM & SynthFirm



Technical Accomplishments

Task 2: More Detail on Integration Workflow for MPO(s) Integrating DEMOS