U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

CONNECTIVITY | Energy Efficient Mobility Systems

Energy Efficient Mobility Systems (EEMS) Program, Vehicle Technologies Office

October 26, 2023






Vehicle Technologies Office (VTO)

On-Road

Batteries

- Research new battery chemistries, reduce battery cost, increase energy density, increase life

Electrification

- Increase energy density of power electronics, reduce charge time

Materials Technology

- Increase efficiency of light-, medium-, heavy-duty vehicles

Mobility Systems

- Increase convenience and effectiveness of transportation system as a whole

Off-Road, Air, Marine, Rail

Electrification

Hydrogen/Fuel Cells

Advanced Powertrains

Net-Zero Carbon Fuels

- Ensure that hard-to-electrify sectors can transition to clean fuels
- Optimize high-efficiency engines and emission control systems that can use low GHG, renewable fuels such as advanced biofuels, hydrogen, and e-fuels
- Integrate electrified and hybrid powertrains into vehicles to further reduce GHG emissions

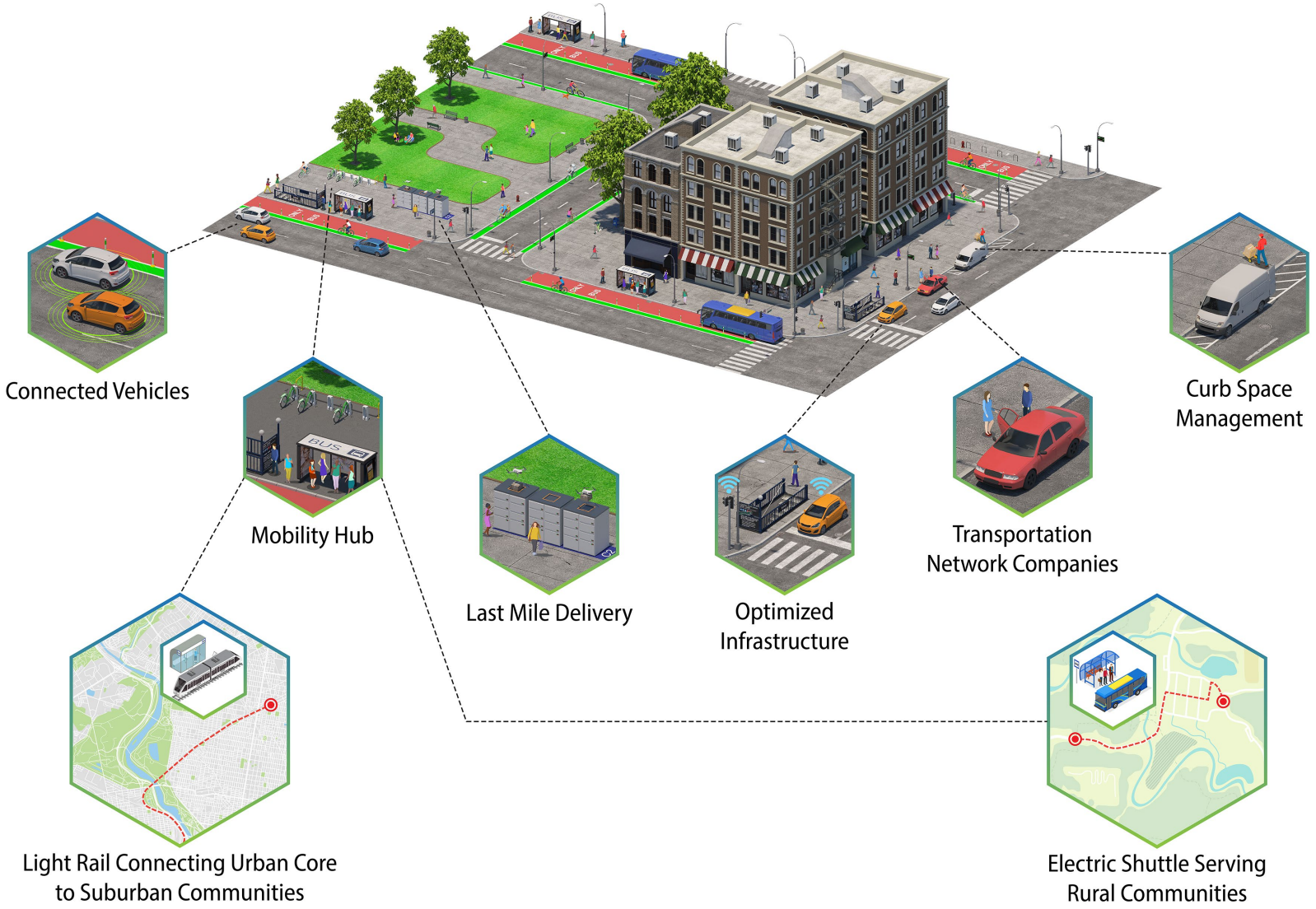
Technology Integration

Clean Cities
U.S. Department of Energy

What we do: EEMS expands R&D beyond component vehicle design

What we do: EEMS as a mobility system of systems

EEMS looks at the transportation system holistically as a system of systems to support VTO's goal of decarbonizing the transportation sector.



Key Research Areas/Initiatives

EEMS promotes the transition to decarbonizing transportation and mobility systems by improving efficiency, increasing convenience, and/or lowering cost through:

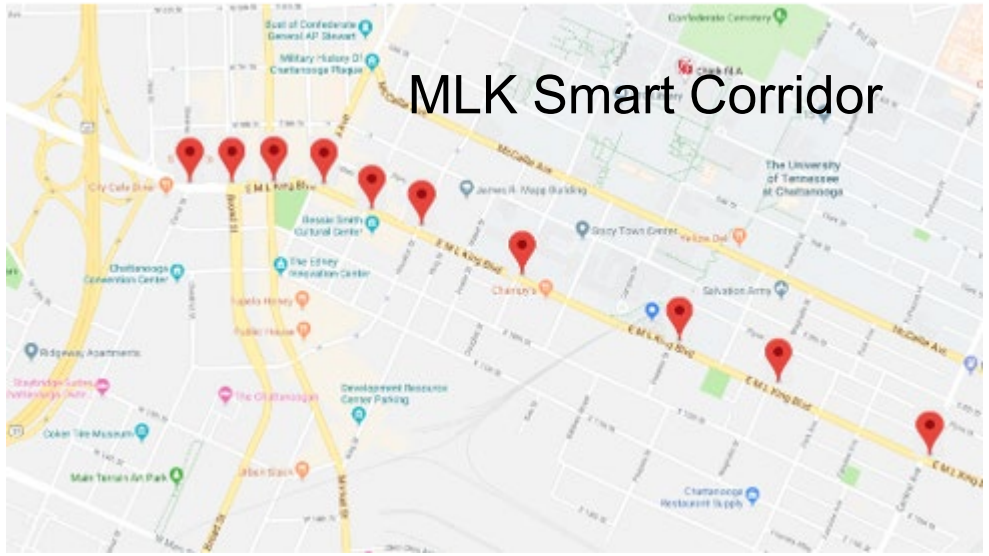
- Early-stage R&D at the vehicle, traveler, and system levels
- Creating new knowledge, tools, insights, and technology solutions that increase mobility energy productivity for individuals and businesses

Technologies:

- Systems energy impacts across multimodal mobility systems
- CAVs (including CAVs controls and CAV modeling in cities)
- Systems approaches to infrastructure planning (i.e., EV, transit, freight/delivery)
- Mobility systems approaches to grid integration of electrified mobility
- Interaction between land use and mobility
- Mobility systems approaches to grid integration
- Micromobility
- Public transit
- Characterization of vehicle and infrastructure communications technologies
- Sensing/computing energy demand
- "Everything-in-the-loop" aka XIL simulation
- Core tools and models

Connectivity Projects: integrated vehicle and signal controls

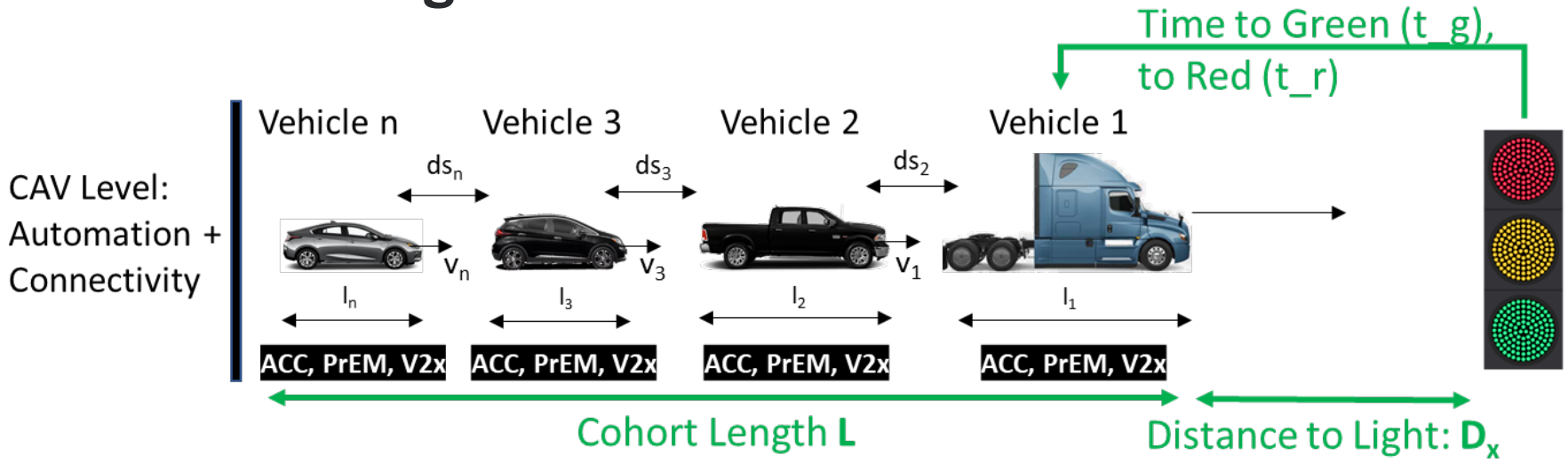
UTC: Developing an Energy-Conscious Traffic Signal Control System for Optimized Fuel Consumption



- **Optimization**
  - Global optimization of the corridor via signal coordination
  - AI
    - Object detection
    - Optimization of the corridor
    - Real time data on traffic flow and traffic state
- **Data**
  - Multiple uses
- **Partnerships**
  - Key to success

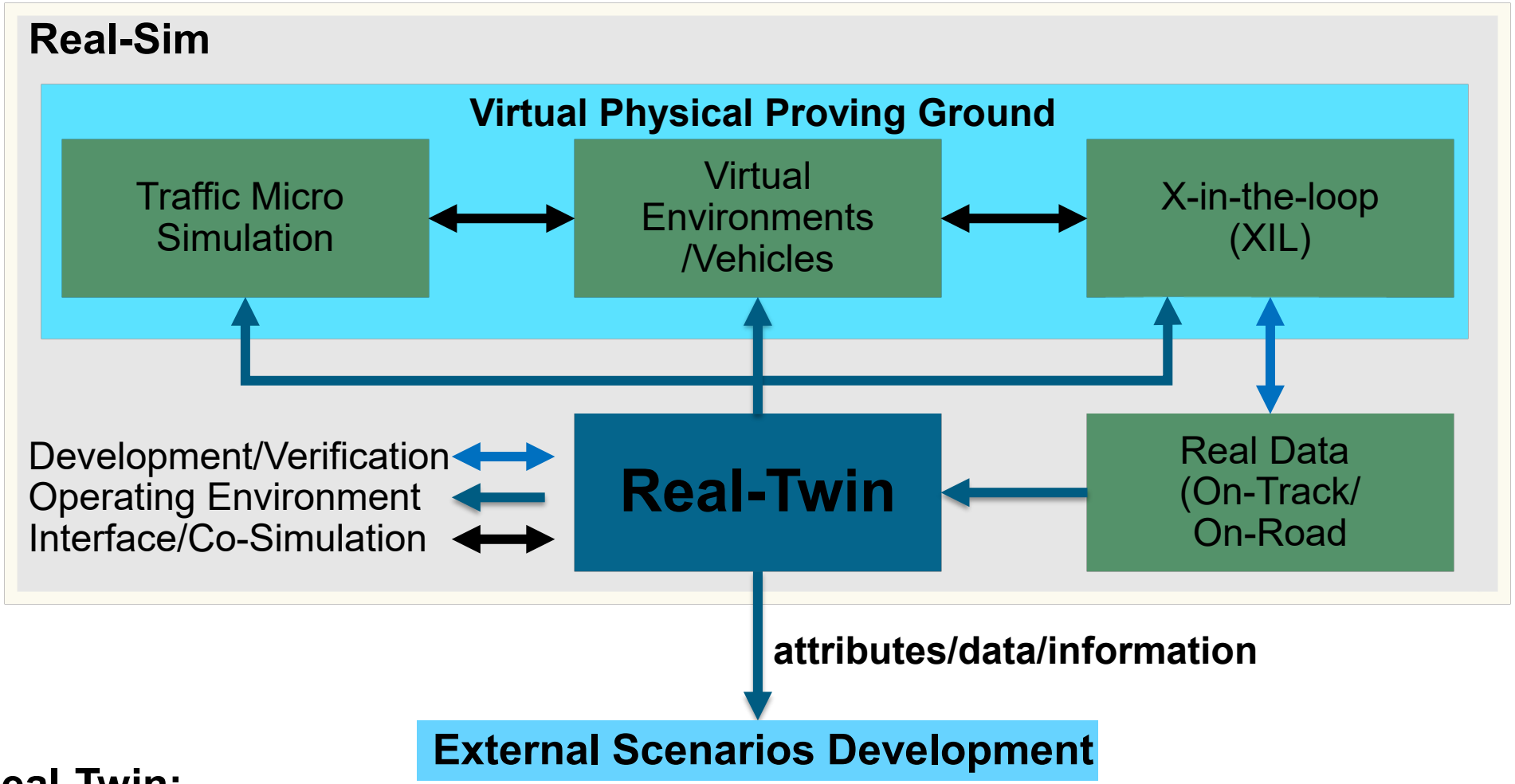
Connectivity Projects: integrated vehicle and signal controls

MTU: Cooperative Automated Cohort Driving on Connected Arterial Infrastructures



- **Approach**
  - CAV Cohort:
    - Group of closely spaced vehicles that will share data and act as a cohesive unit: e.g. 3-4 LD's and 1 HD
  - AI methods
    - cohort dynamic coordination and/or individual vehicle powertrain/propulsion coordination
    - Scenario space exploration
  - Tested
    - Simulation – digital twin, multiple road types
    - Test track

Connectivity Projects: Scenarios and Simulation

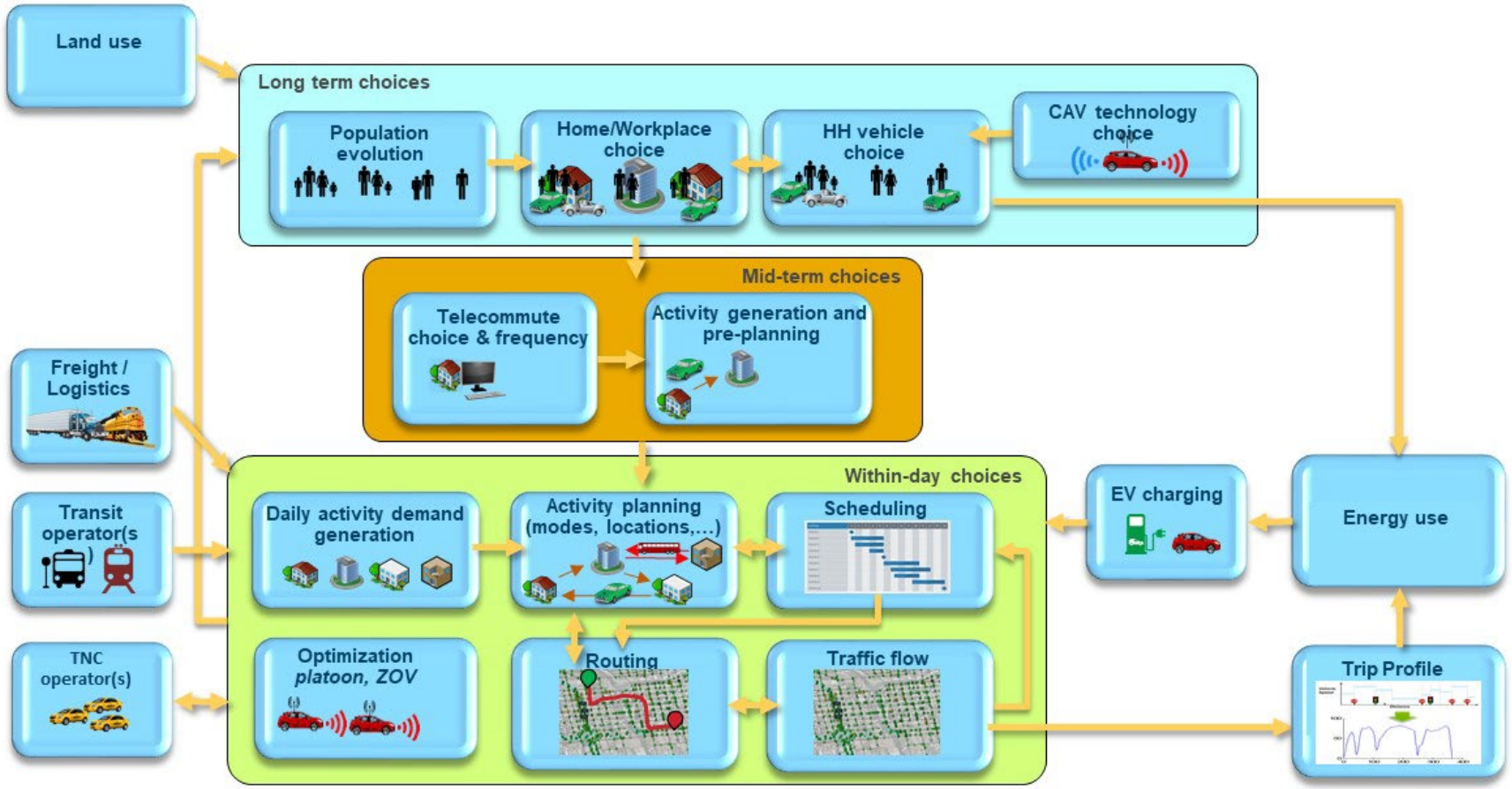


Real-Twin:

- A realistic scenario elements and attributes generation capability that ingests ***real*** data
- Provides a ***twin*** for analyzing decarbonization opportunities and evaluating mobility objectives

Connectivity Projects: Scenarios and Simulation

Agent Based Transportation System Modeling



At metropolitan or regional level

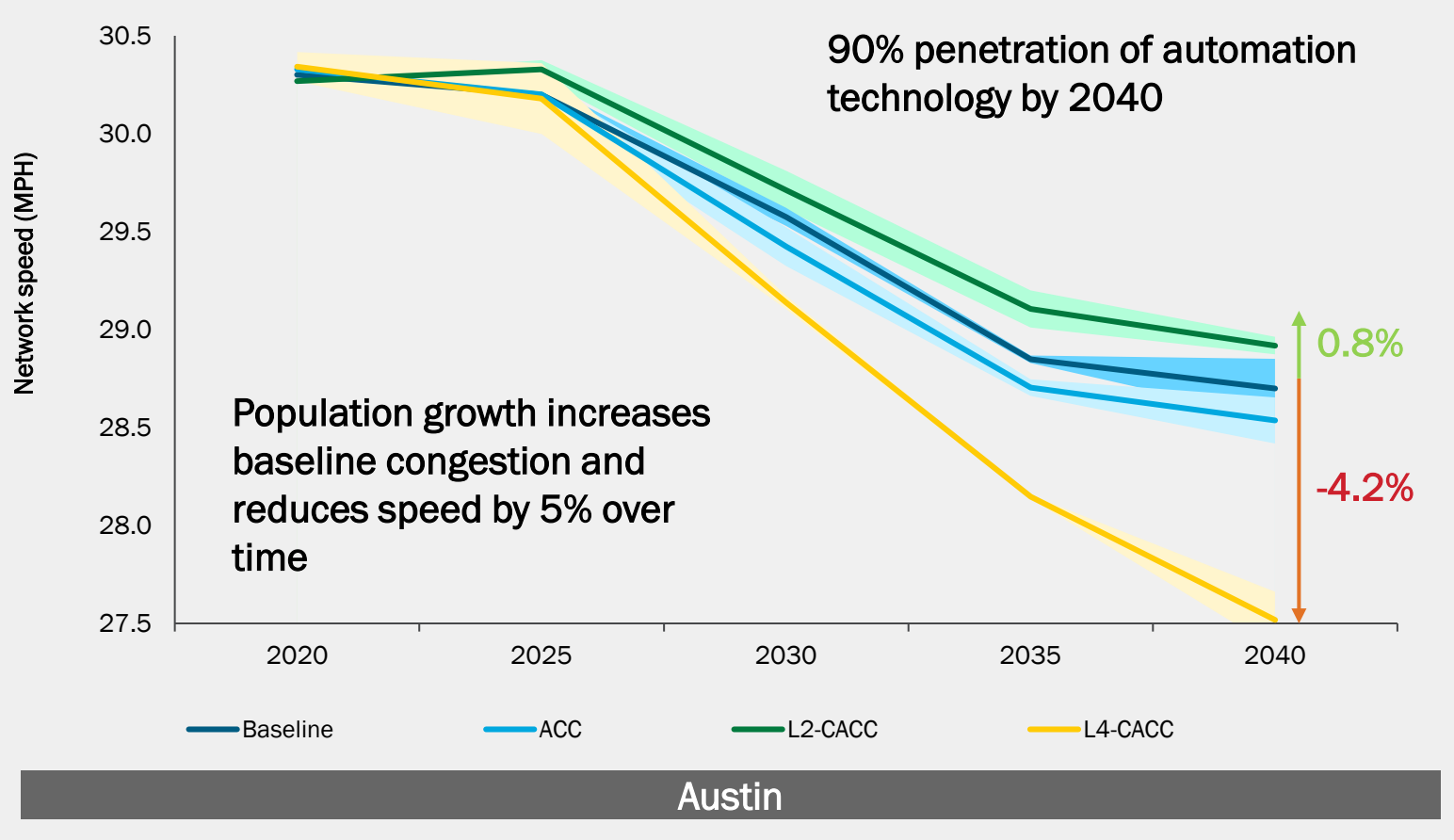
- Explore policy-driven mobility futures
- Explore technology-driven mobility futures
- Multi-modal, incorporating land use change, advance vehicles, freight, transit, etc

Connectivity Projects: Scenarios and Simulation

CACC can improve mobility at low levels of automation

- **Impacts over time show evolution of land use, mobility under:**
  - Adaptative cruise control (ACC)
  - Cooperative adaptive cruise control (CACC)
  - CACC level 4 automation (L4)
- **L2 increases network performance but L4 reduces speeds by 5% and increases highway VMT by 7% due to increased travel from lower VOT**

- Planners should account for higher congestion and slower travel speeds in a future with highly automated highway driving



Connectivity Project: Transit/multi-modal

- **FY23 FOA transit**
  - To develop and demonstrate mobility-system level approaches to improve the efficiency and convenience of public transportation
  - In proposals, saw creative use
    - Connectivity incorporating fixed route transit, MOD, signals, etc
    - Optimization algorithms
    - Automation
    - Personalization/customization
  - Saw strong commitments to
    - Stakeholder engagement
    - Equity and serving the whole community
    - Partnership with transit agencies
  - Award announcements expected soon!

Connectivity and Blueprint for Transportation Decarbonization

Improve Community Design and Land-use Planning

Prioritizing land-use decisions and community design solutions that prioritize access

Increase Options to Travel More Efficiently

Expanding options to enable shifts in more efficient vehicles and transport modes

Transition to Zero Emission Vehicles and Fuels

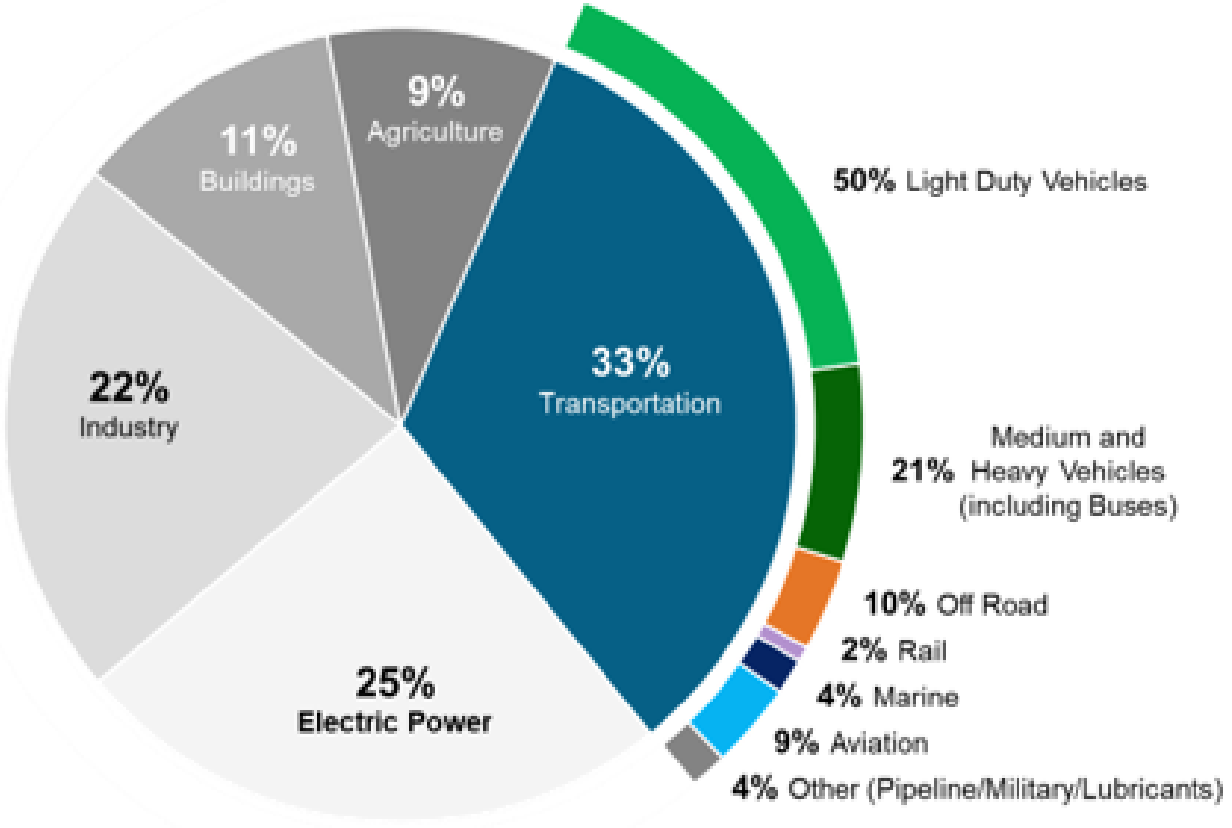
Deployment of zero-emission vehicles, fuels and associated infrastructure

Connectivity

Backup slides

Vehicle Technologies Office (VTO): Mission and Scope

2021 U.S. GHG Emissions

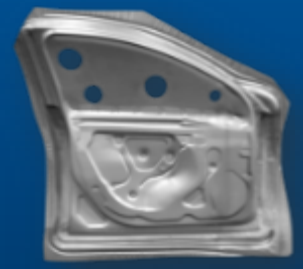


Aviation and marine include emissions from international aviation and maritime transport. Fractions may not add up to 100% due to rounding.

ON-ROAD (Light/Medium/Heavy Vehicles)

Batteries & Electrification

Materials Technology



Mobility Systems

Demonstration and Deployment

Clean Cities

Air, Marine, Rail

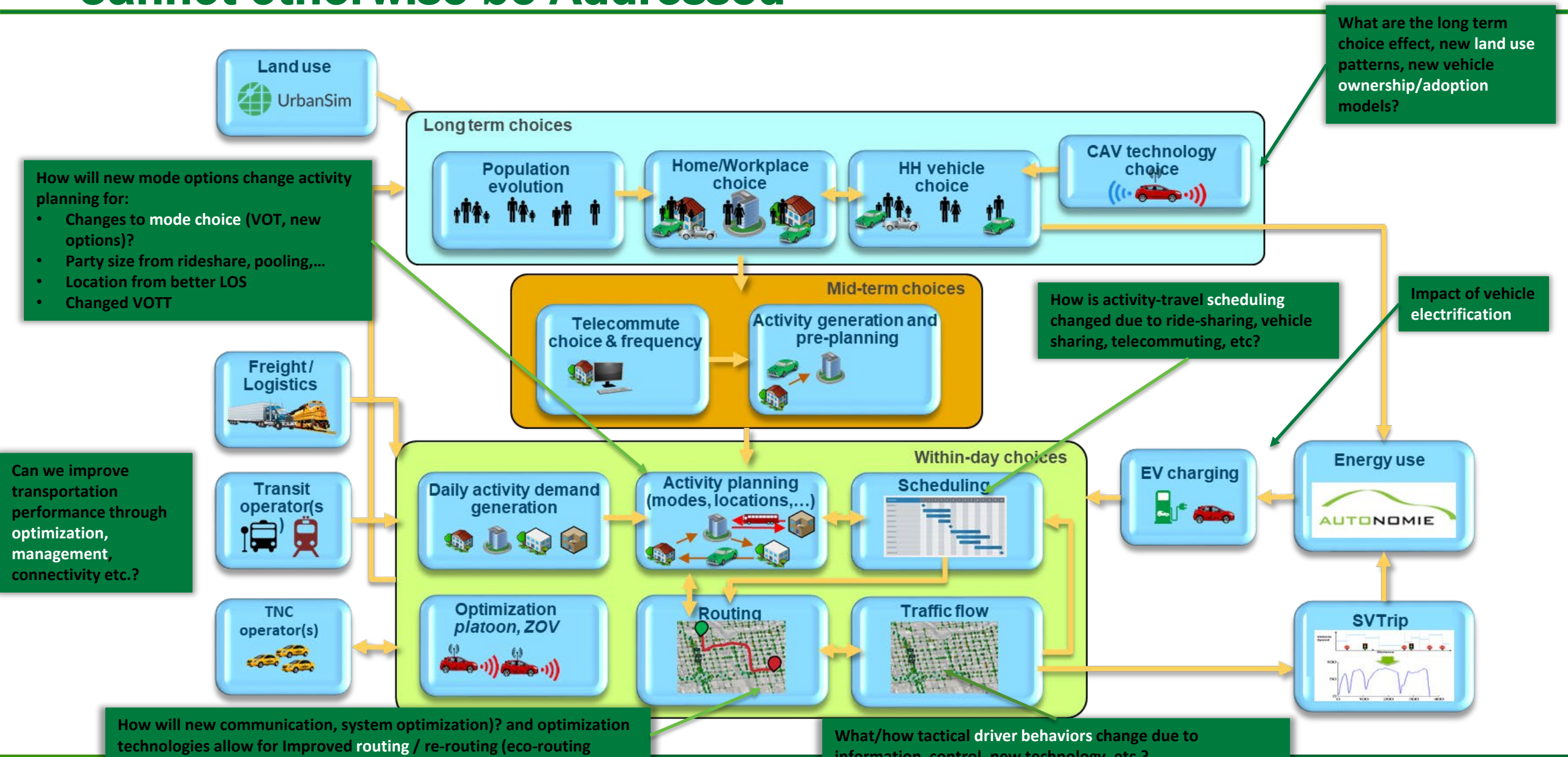
R&D for On/Off-Road MD/HD Vehicles

Bio and Alternatives

H2@Scale U.S. Department of Energy

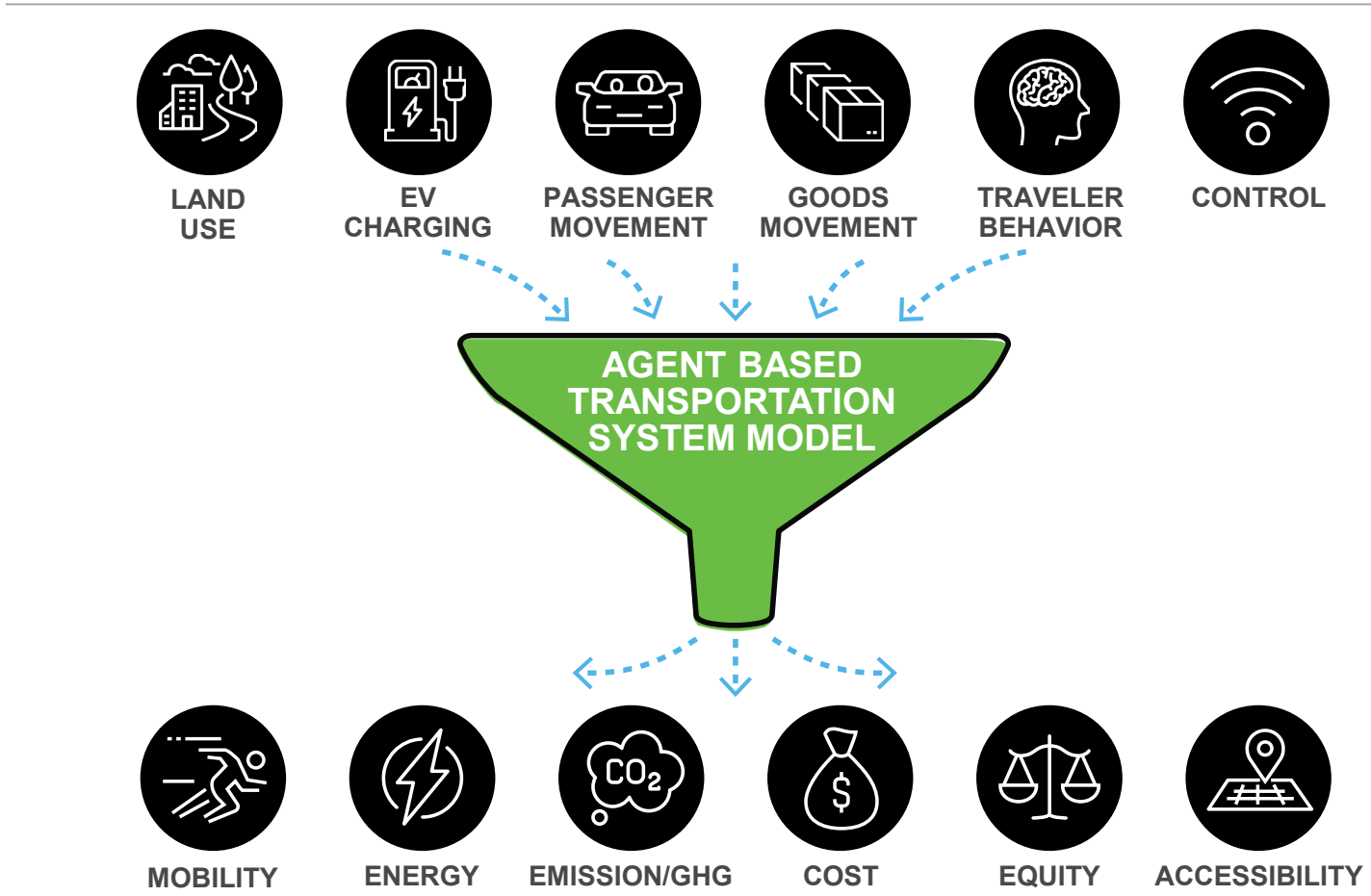
Hydrogen impacts

...Allows us to Explore Many Impacts of SMART Mobility that Cannot otherwise be Addressed



Large number of metrics considered simultaneously

Multi-fidelity end-to-end modeling workflow, provides unique insights by quantifying the impact of individual technologies and policies across the entire transportation system.



SMART Mobility Snapshot

Webinar topics included Transit, Ridehail, Micromobility, Drones, CAVS, Intelligent Transportation Systems, Freight, and Electrification!

- The SMART Mobility Webinar series successfully concluded in August 2023.
- Over the past 8 months, we have shared more than 125 insights with our stakeholders across a wide range of focus areas.
- Close to 1500 people have attended one or more event!
- National Laboratories only counted for 8% participants. Other participants were DOTs (local, regional and national), MPOs were extremely well represented, and notable presence from OEMs and the main transportation consultants.