Integrated, Personalized, REal-time Traveler Information and Incentive Technology (*iPretii*) for Optimizing Energy Efficiency in Multimodal Transportation Systems

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Project Team

Key Personnel on the Technical Team

- **University of Maryland:** Lei Zhang (Project PI), Ali Haghani, Paul Schonfeld, Michael Pack, Xiaoli Nan, and Erkut Ozbay
- **Arizona State University:** Xuesong Zhou
- **North Carolina State University:** Nagui Rouphail, Chris Frey
- **University of Florida:** Yafeng Yin

Other Project Staff

- **Project Manager:** Katie Le
- **Tech to Market Managers:** Mark Franz, Chenfeng Xiong
- **Six Research Scientists, Three Software Developers**
- **Nine Graduate Research Assistants**

Partner Agencies

- **Maryland State Highway Administration:** Subrat Mahapatra
- **Others**

iPRETii

Nov. 2015~May 2018

Integrated,

Personalized,

REal-time

Traveler

Information and

Incentive

Project Objectives

- Develop the System Model (SM) and Control Architecture (CA) that can evaluate and optimize the effectiveness of personalized information and incentives in reducing transportation energy use
- Conduct extensive behavior research to design effective personalized incentives
- Quantify potential energy savings in the DC-Baltimore region through comprehensive simulation-based sensitivity analyses in the DC-Baltimore region
- Demonstrate that the SM and CA can be implemented in the real world with existing technologies or identify any technology gaps through field tests
- Engage public and private sector partners in technology development and commercialization.

Choices to Be Influenced

Modal shifts to transit and ride share Increase vehicle occupancy and reduce energy use. Modes include Bus, Light/ Metro/Commuter rail, Ride hailing/share, Personal vehicles.

Departure time choice Help *iPretii* users avoid congested periods on trips with flexible arrival time windows, and reduce peak-period demand and congestion for all travelers.

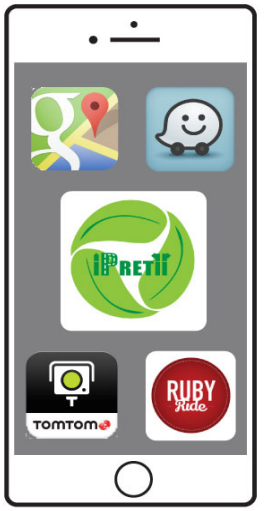
Pre-trip route choice Guide users to routes with less energy use before departure, and also reduce congestion and energy use on routes already congested for all travelers.

En-route diversion choice Guide users to routes with less energy use during their trips, and also reduce congestion and energy use on routes already congested for all travelers.

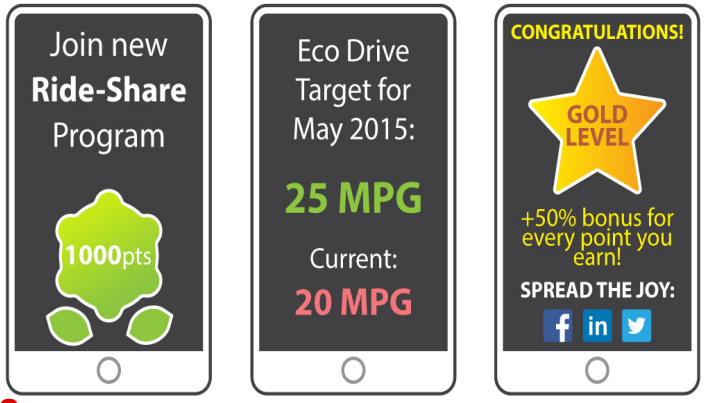
Driving style choices Incentivize users to practice eco-driving to reduce energy use.

Incentive Structure

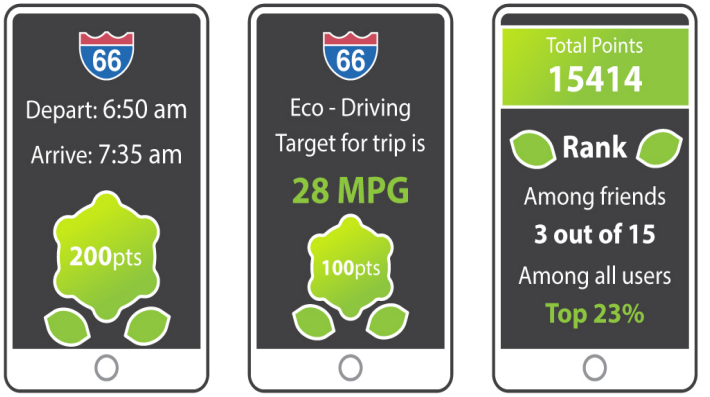
- Personalized information
- Customized incentives
- Loyalty program
- Gaming
- Social networking
- Peer influence



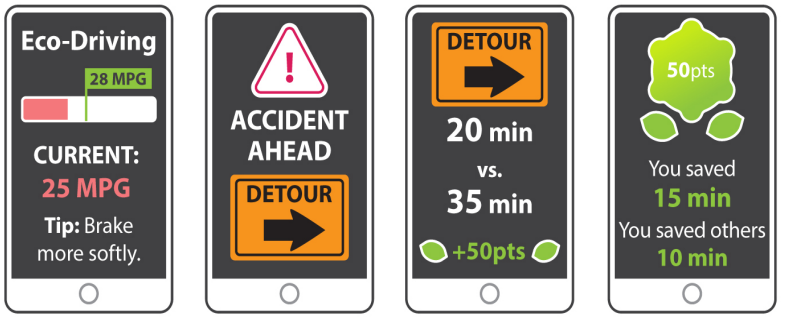
Long-Term Incentives



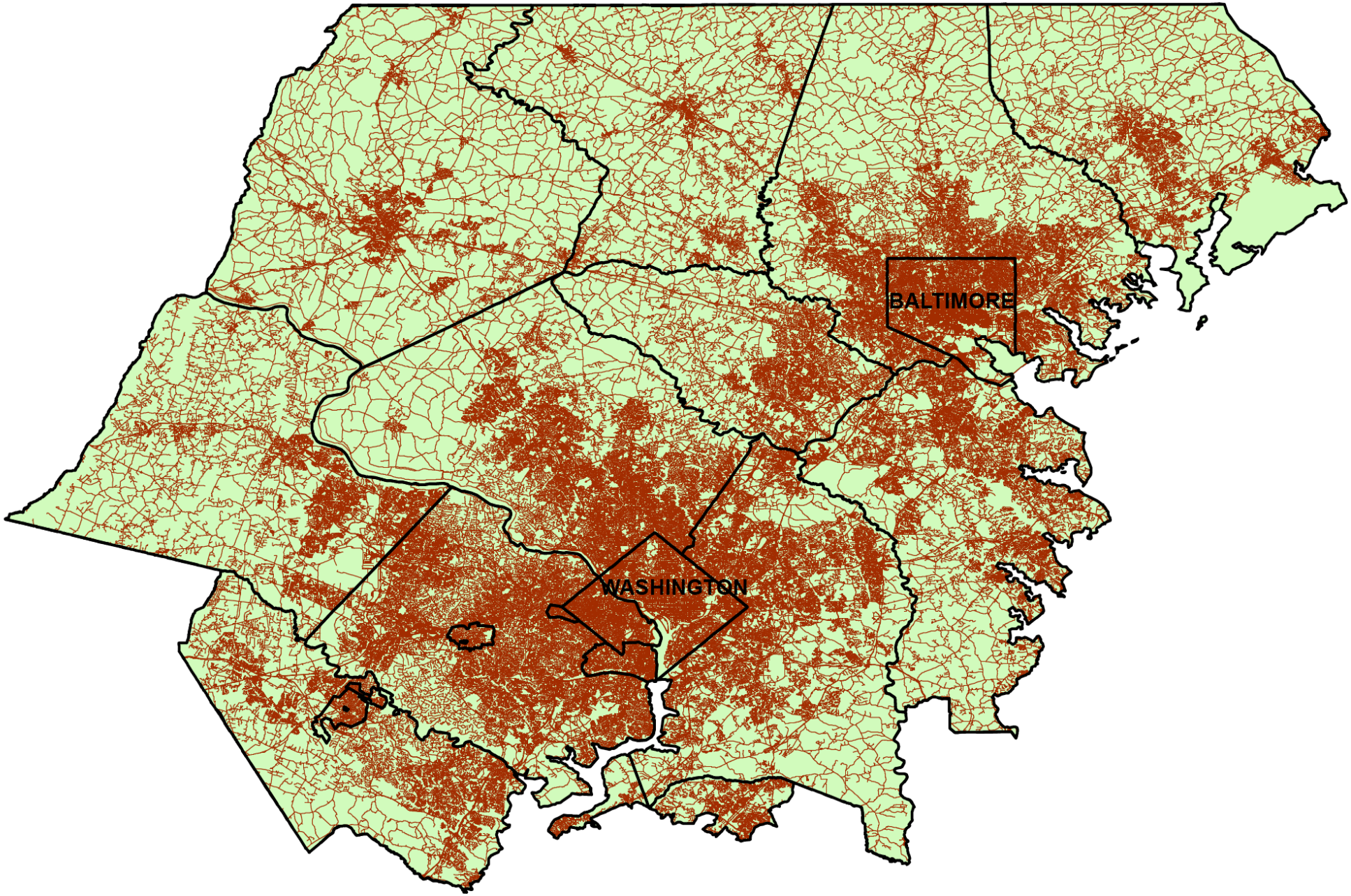
Pre-Trip Incentives



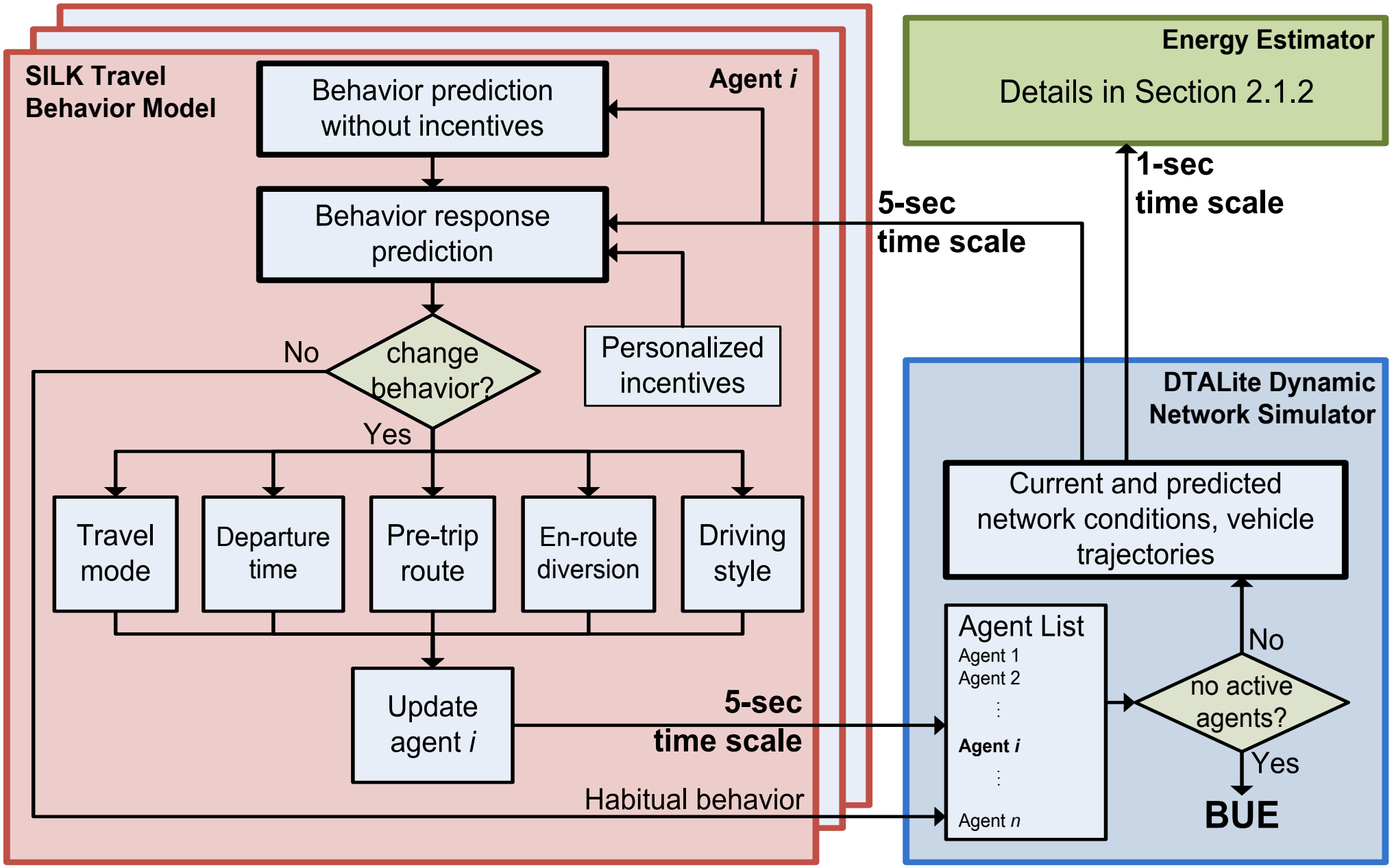
Real-Time Incentives



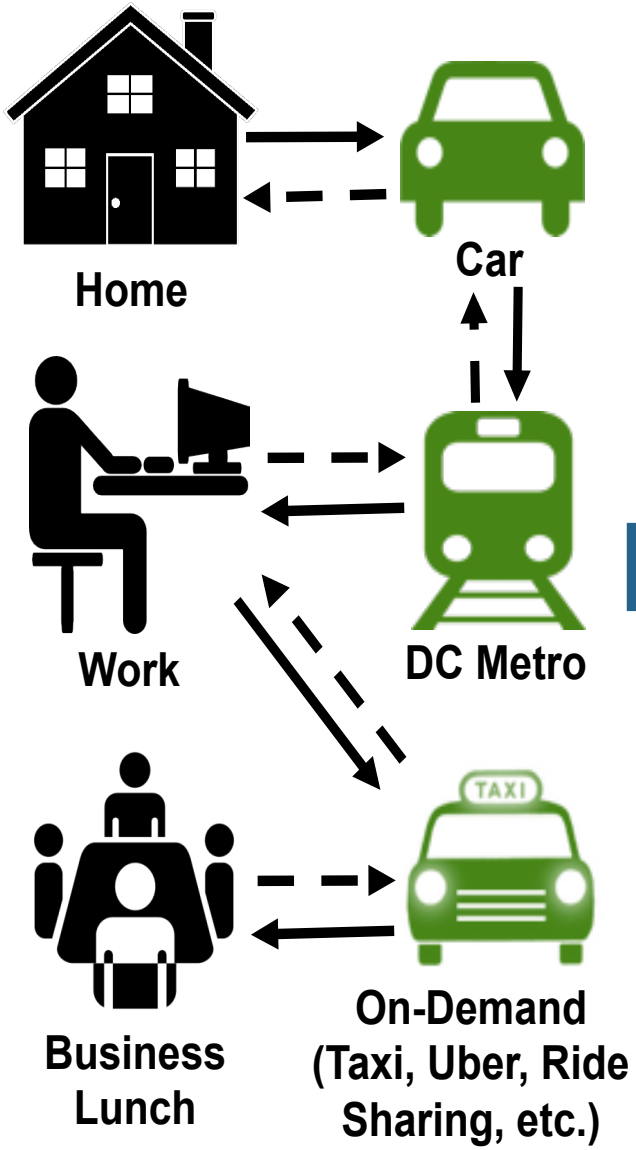
Study Area



System Model



Energy Use across Modes



Vehicle/Mode-Level Energy Use Estimation

IOV-Based Method

Data from SILK-DTALite Simulator e.g., vehicle specific power (VSP), Speed, Grade, Acceleration

EOV-Based Method

MOVES-Lite

Mapping Energy Used by Mode to Energy Used by Traveler

Whenever Possible: Real-time occupancy estimates based on CATT/WMATA data; Otherwise: Typical vehicle occupancy by route and time-of-day from MSTM

Rideshare vehicle occupancy and running distance without passenger from dynamic service optimization algorithms

Model Validation

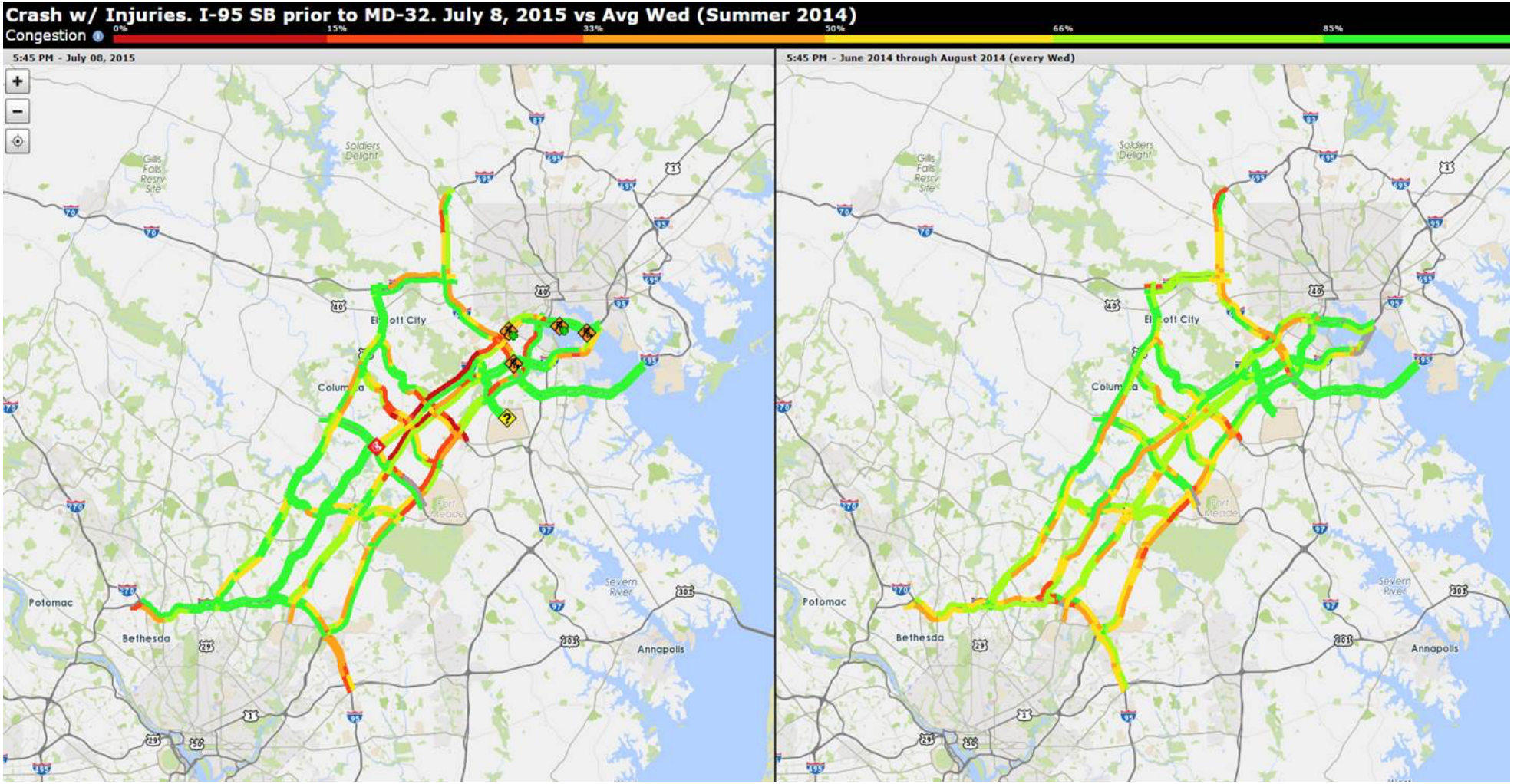
Agent-Based Behavior Model Individual and trip-level validation based on hit ratios and aggregate-level validation against existing data.

Travel Intent Prediction Individual and trip level validation against observed or reported trip purpose and trip destination data.

Dynamic Traffic Simulator Multiple levels of validation based on comparison of traffic counts, queue length and bottleneck locations, travel time, speed, and non-recurrent conditions.

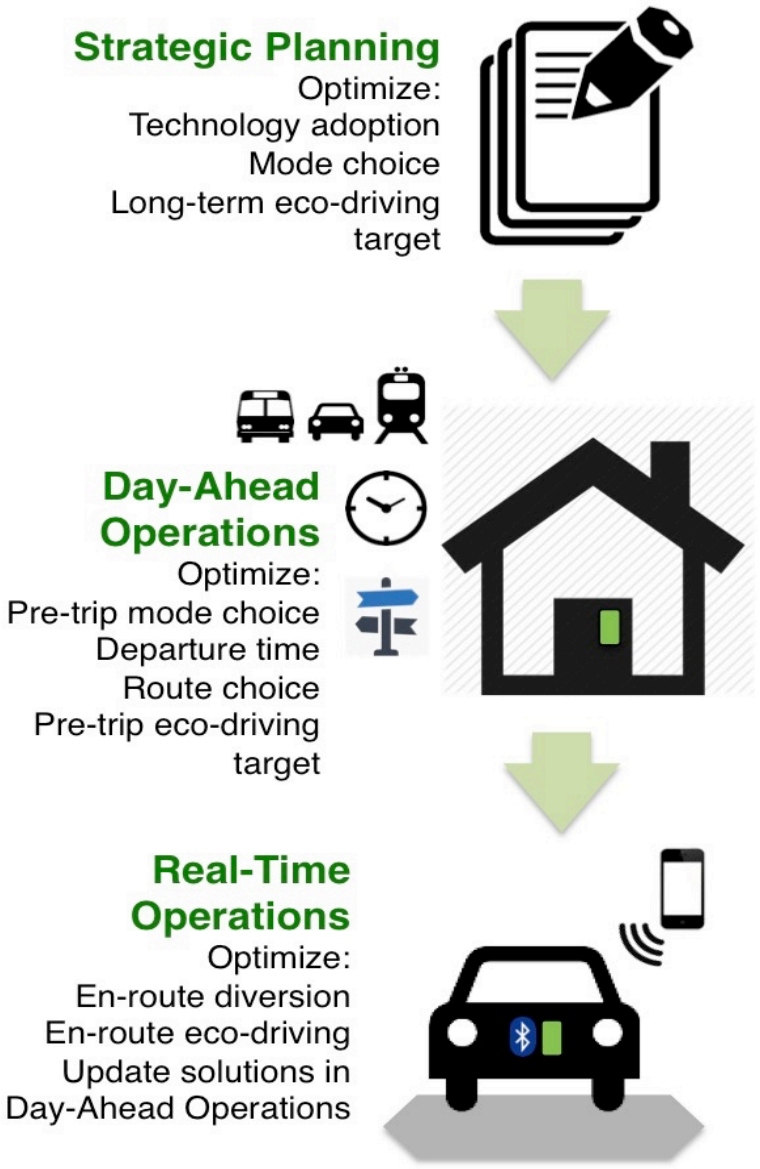
Energy Use Estimator Individual vehicle level validation for passenger vehicles, transit buses, rail locomotives, heavy duty diesel vehicles, hybrid electric vehicles; aggregate level validation against total energy use predicted with other methods; and validation of vehicle occupancy estimates for high-occupancy vehicles.

Validation w. Non-Recurrent Events



5:45 pm on July 8, 2015; 5:45pm on an Average Day

Control Optimizer



Control Decisions

- Whether or not to incentivize a particular user
- Which travel choice(s) to influence
- Type and intensity of personalized incentive to be delivered.

Key Performance Targets

- Computational efficiency
- Solution quality
- Robustness
- Redundancy and resilience
- Accomplishing control objectives with minimum resource

Behavior Research

Focus Groups

- Find the most effective incentives

Surveys and Lab Experiments

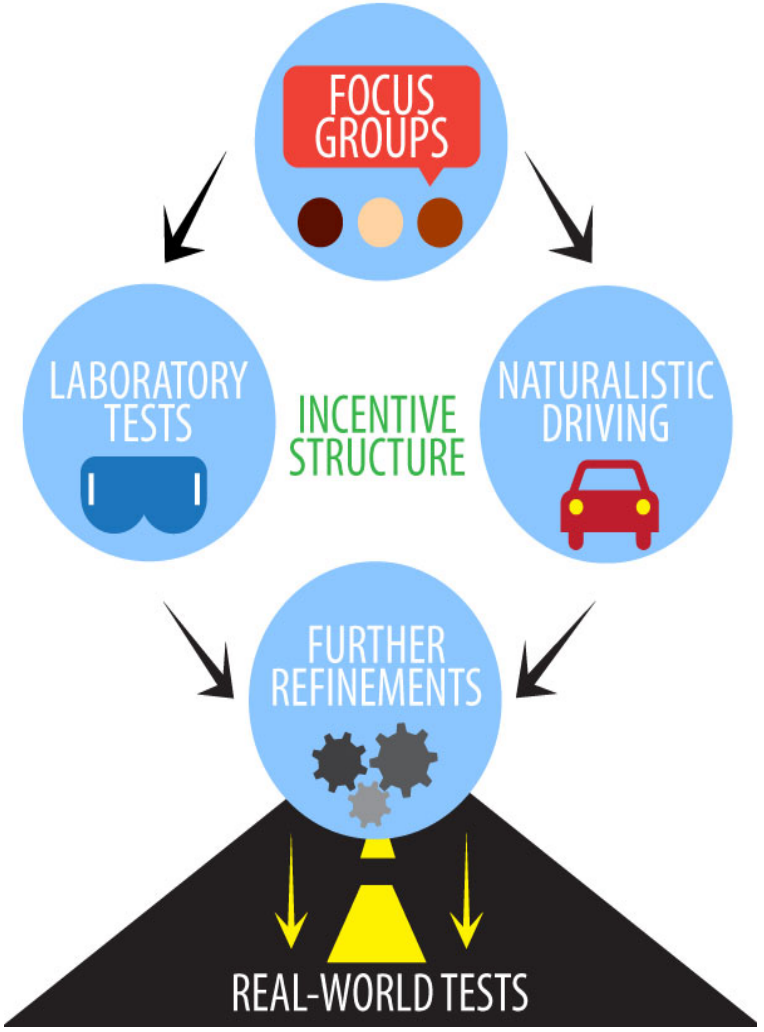
- How do travelers make decisions
- How will they adjust decisions with *iPretii* information and incentives
- Who will adopt the technology

Naturalistic Driving Tests

- Focus on driving styles

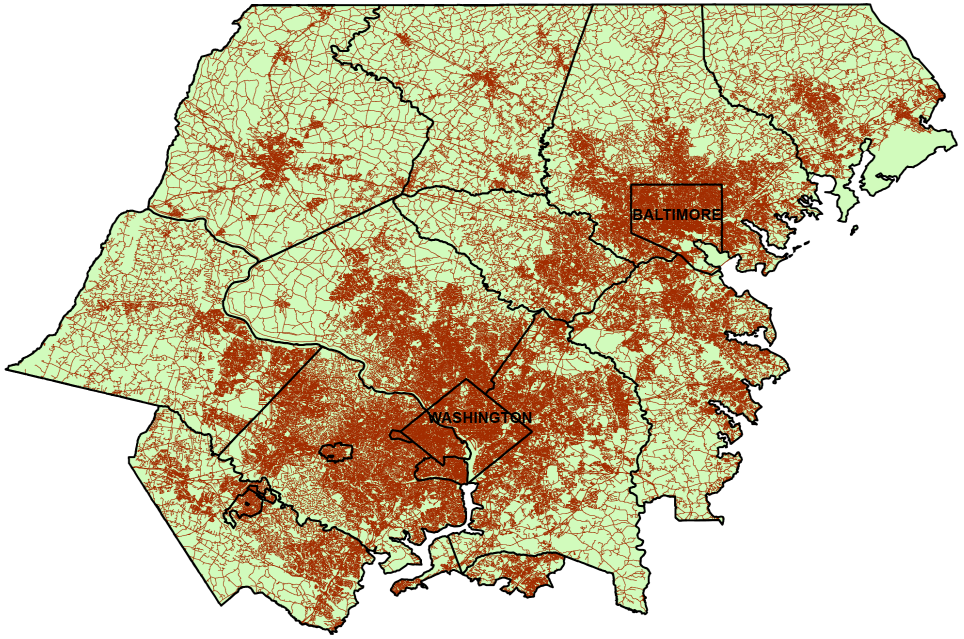
Real-World Tests

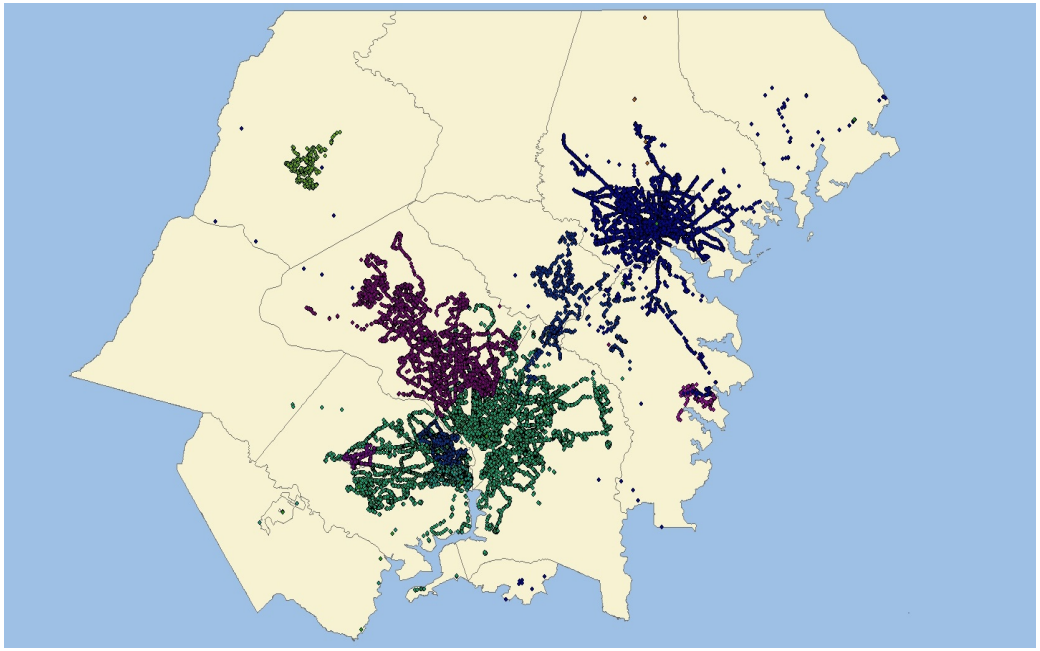
- Ensure technology readiness for implementation



Solutions to Data Challenges

- Multi-resolution transportation network and land use
- Develop a regional integrated model and then quickly focus into subareas or corridors for applications
- Reducing data collection and integration efforts for applications is necessary





Multi-resolution Multimodal Network

Data Items

- MSTM and MPO Planning Networks
- Maryland Centerline Network
- HERE NAVTEQ Network
- GTFS transit data
- INRIX and other UMD CATT data with TMC codes
- Traffic count data
- Traffic signal plans and (estimated) future signal plans
- Others: AirSage, freight, etc.

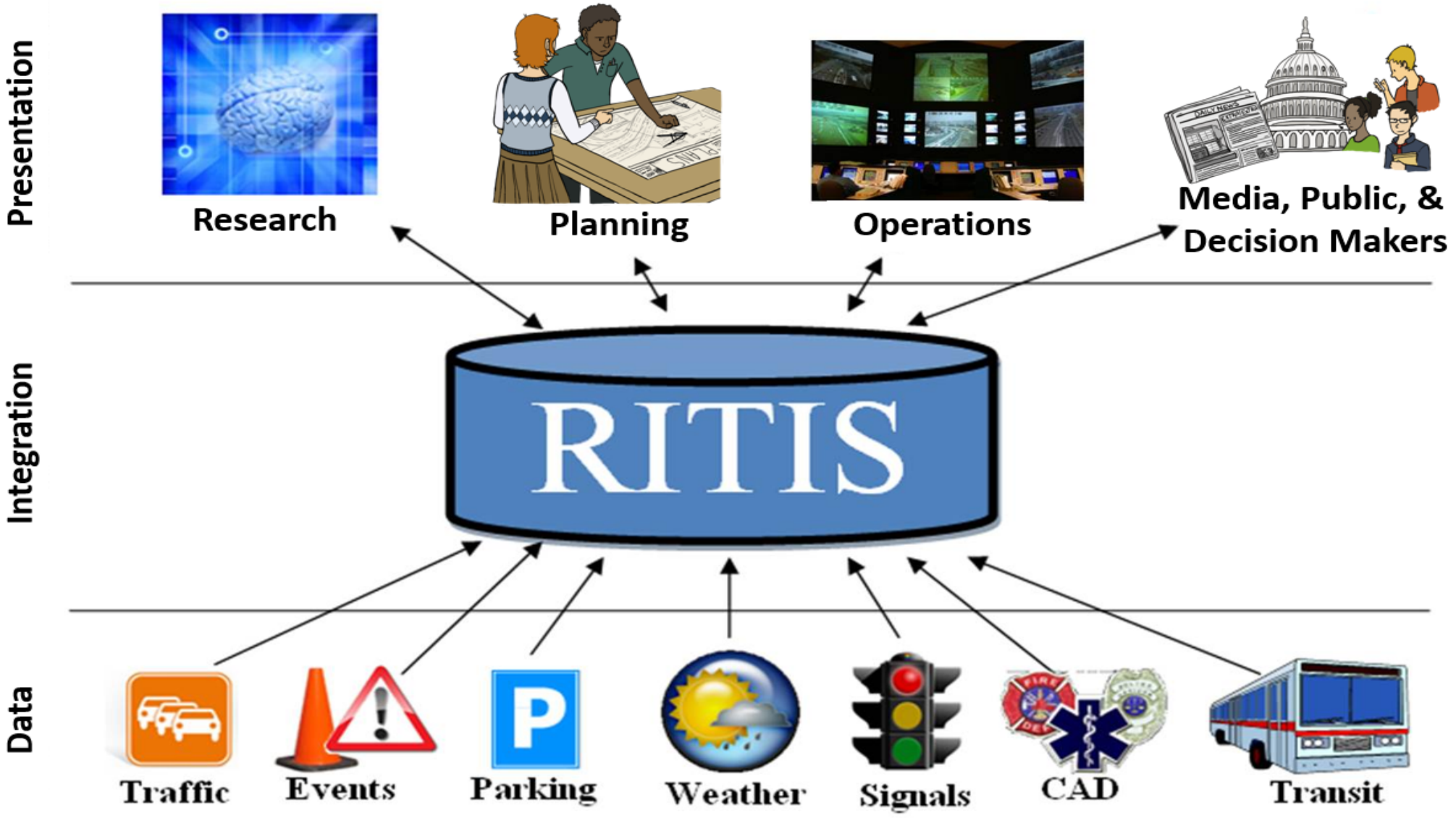
Objective

- Merge different networks into a comprehensive reference network and link different data sets to this reference network; features and links can be flagged on or off for various applications by different agencies

GTFS Data

	County	Agency (short of data)	With Paper schedule?
100% GTFS data	**District of Columbia**		
	Frederick Co.		
	Montgomery Co.		
	Baltimore Co. and City		
	Arlington Co.		
> 50% GTFS Data	**Anne Arundel Co.**	Young Transportation Service	With paper schedule
	Howard Co.	Commuter Buses of Howard County	No paper schedule
	Prince George's Co.	TheBus (Prince George's County)	With paper schedule
	Harford Co.	Harford County Transportation Service (HCTS)	No paper schedule
	City of Alexandria	ATRANS	No paper schedule
	Fairfax City and County and Falls Church City	Silver Line Bus Service	With paper schedule
< 50% GTFS Data	**Calvert Co.**	Calvert county government (bus)	With paper schedule
		Para Transit Services / ADA	No paper schedule
	Charles Co.	VanGO	With paper schedule
	St. Mary's Co.	STS transit bus	With paper schedule
	City of Fredericksburg	FREDericksburg Regional Transit (FRED)	With paper schedule
	City of Manassas, and Manassas Park and Prince William Co.	Potomac & Rappahannock Transportation Commission (PRTC): Commuter and Local Bus	With paper schedule
	Stafford Co.	FRED	With paper schedule
No GTFS Data	**Carroll Co.**	CARROLL AREA TRANSIT SYSTEM (CATS)	No paper schedule
		Butler Mobility	With paper schedule
	Clarke Co.	Not known	No paper schedule
	Fauquier Co.	Virginia Regional Transit (VRT)	With paper schedule
	King George Co.	Not known	No paper schedule
	Loudoun Co.	Virginia Regional Transit (VRT)	With paper schedule
	Spotsylvania Co.	FRED	No paper schedule
	Jefferson Co.	Not known	No paper schedule

UMD CATT Lab Data Hub



Technology Demonstration

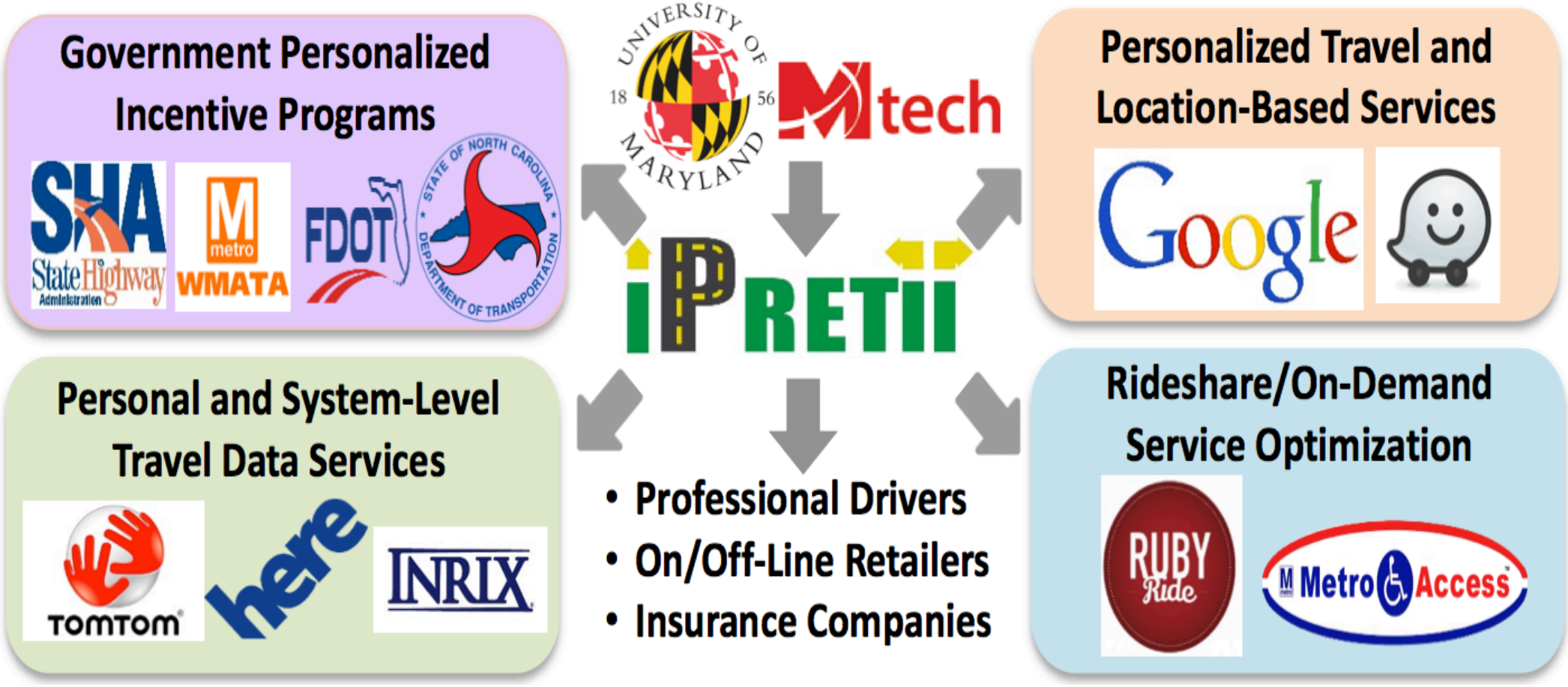
Completed

- I-95 corridor incident management: En-route diversion
- I-270 corridor work zone: En-route, Departure Time
- ICC time-of-day toll road impact: Departure time, Route
- Montgomery County cumulative land development impact study: Departure time, Route
- Prince George's Plaza TOD study: Modal shift, Route

Ongoing

- I-270 corridor congestion mitigation (Maryland SHA)
- I-95 express toll lane dynamic pricing (Maryland SHA)
- I-295 Integrated Corridor Management (FHWA)
- Optimal work zone planning and operations (SHRP2)
- Integrated advanced demand and DTA modeling (SHRP2)
- Real-time traveler information and incentives (DOE)

Technology to Market



Discussion Items

How could this DOE project benefit agencies in the DC-Baltimore region?

- Synergy with existing travel model programs, New model capabilities, data sharing, etc.

Partnership opportunities

- Technology transfer
- Technology commercialization
- Real-world tests funded by DOE
- Etc.

Comments and suggestions to the project team