CPS: Medium Collaborative Research: Smart Freight Transport Using Behavioral Incentives

Problem:

- Growing freight demand and its impacts

Challenges:

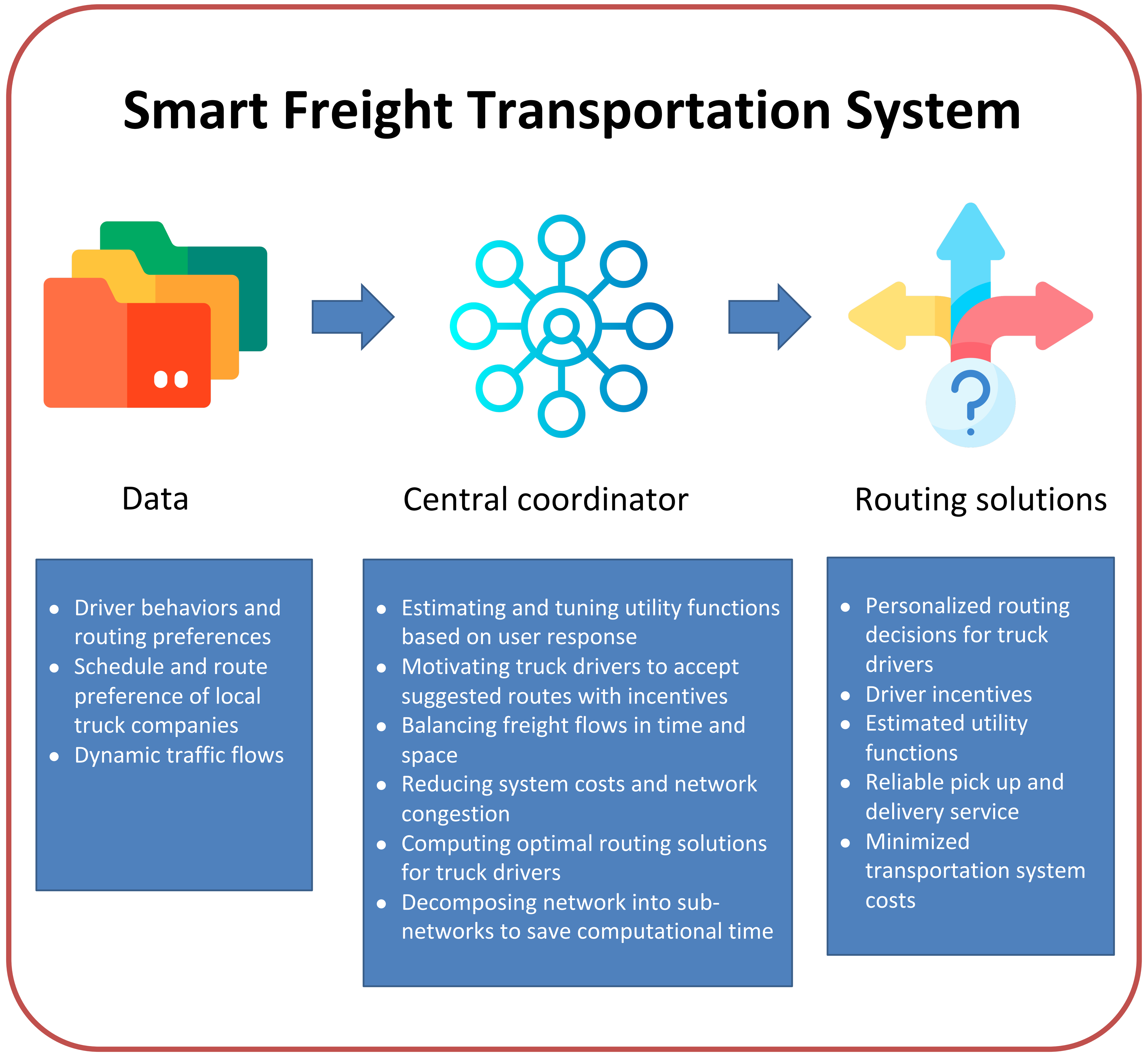
- How to optimize truck flows via a centrally coordinated freight routing system while taking into account user preferences.
- System vs user equilibrium: how to incentivize drivers to accept centrally coordinated routes
- Stochastic travel times: how to incorporate uncertainty and time dependence in optimization
- Other: Network scalability and minimized fleet size

Solution:

- Use CO-SiMulation Optimization (COSMO) approach as theoretical foundation
- Stated preference survey to estimate utility functions using machine learning; use results for developing incentives
- Chance-constrained model considering stochastic and time-dependent travel times; develop an exact solution method based on branch-cut-and-price
- Distributed COSMO method for dynamic routing in a large-scale area; decompose into several coordinated co-simulation sub-systems

Scientific Impact:

- Theoretical foundations of a new approach, SCOBE (co-Simulation Control and Optimization with Behavioral incentives) for a Coordinated Regional Freight Management (CRFM) system
- Expand optimization by minimizing a social cost function and maximizing user utility functions



PI	**Petros A. Ioannou,**	**ioannou@usc.edu**
Co-PIs	**Maged M. Dessouky,**	**maged@usc.edu**
	Genevieve Giuliano,	**giuliano@usc.edu**
Institution	**University of Southern California**	
Award #	**1932615**	
Award Date	**Sept. 30, 2019**	

Scientific Impact (cont.):

- Design network decomposition methods to address network scalability issues
- Improve reliability of pickup and delivery service under stochastic and time-dependent travel times
- Test theories about driver route choice behavior
- Determine the value of time (VOT) for drivers

Broader Impact:

- This project aims at reducing traffic congestion in dense urban areas, improving the reliability of pickup and delivery service, and providing efficient touring and routing decisions to truck drivers.
- A central coordinator can optimize freight movements and provide reliable and efficient solutions that benefit trucking companies, employee drivers, owner operators, recipients, and shippers.
- An educational program, Futures in Transportation (F.I.T), was developed and offered for local high school students.

Quantified Potential Impact:

- System cost reduced by over 20% by allowing truck reuse.
- Distributed co-simulation optimization method shows reduction of 18.5%-25.8% computational time with a 5.3%-14% loss of optimality.
- Incorporating stochastic and time dependent travel time in the algorithm improves the overall success rate of the routing solution from less than 20% to over 70%.