Identification and Modeling of Next Generation Traveler Guidance Systems

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Navigation Assistance

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- ABI research predicts GPS navigation devices growth from 140 million devices in 2007 to over 600 million by 2012
- In a recent survey of 22 experts, GPS and Personal Travel Assistant were ranked highest among emerging transportation technologies for congestion reduction in the next twenty years
  (Technology Scan project for NYMTC)

But the important question is what sort of navigation assistance should be provided?

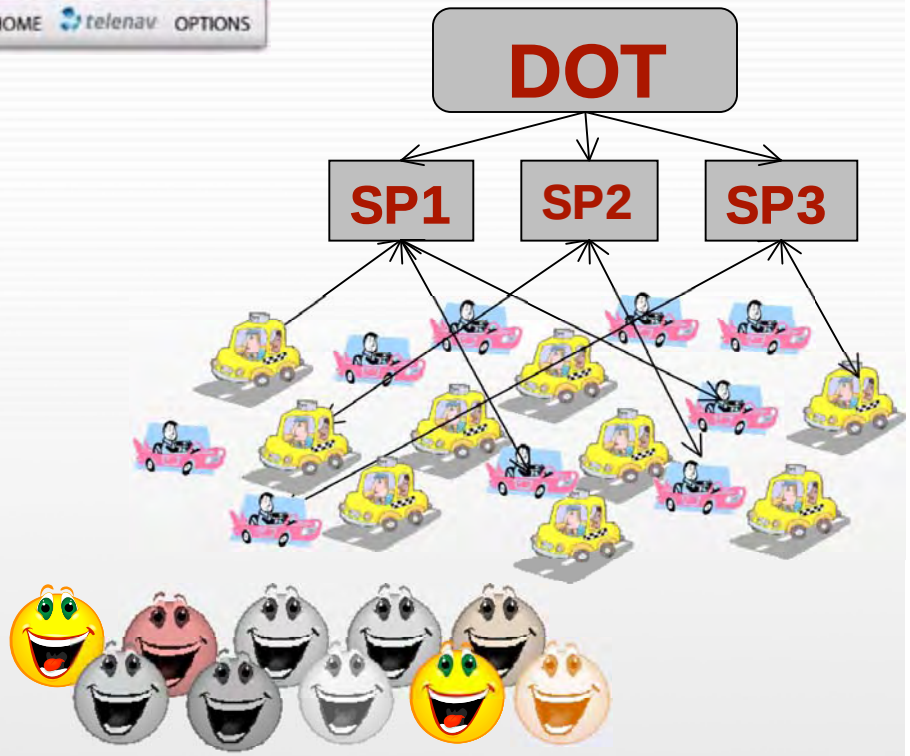
Current State-of-the-art: Advanced Traveler Information Systems

- On road sensors, few vehicular probes
- Centralized consolidation
- Dissemination through broadcasts (VMS, web, phone)
- Mostly reactive, few predictive – not proactive
- Traffic info (overload?); very little guidance

Paradox: Reactive information induces congestion
Predictive information – not tested

Next Generation TGS Characteristics

- Prescriptive guidance; not descriptive information
- Distributed architecture in a competitive market.
- Multi-dimensional choice optimization accounting for heterogeneity and personal preferences
- Ideal system state based user-optimal guidance that is both fair and efficient to ALL.



Next Generation TGS Characteristics

- The proposed TGS will address the following objectives:
  - Any-time, any-where, any-mode services
  - Account for individual preferences including multi-criterion objectives
  - Share burden of infrastructure investment with private industry & consumers
  - Avoid problems arising from reactive and predictive information such as concentration, overreaction, and inconsistency
  - A more direct control for the network manager in terms of controlling supply-side parameters.

USDOT ITS Vision Statement 15 years in future

- *"Commercial entities, in the form of "Information Service Providers", or ISPs, have been built upon the early public sector foundations of ITS. These ISPs provide value-added services, by collecting data from various sources and creating valuable information products and services that consumers now see as just as necessary as their TV, on-line computer, and telephone services."*

We propose a 3-tier distributed architecture:
DOTs / Supply managers
Service providers
Users / travelers

Centralized System Architecture

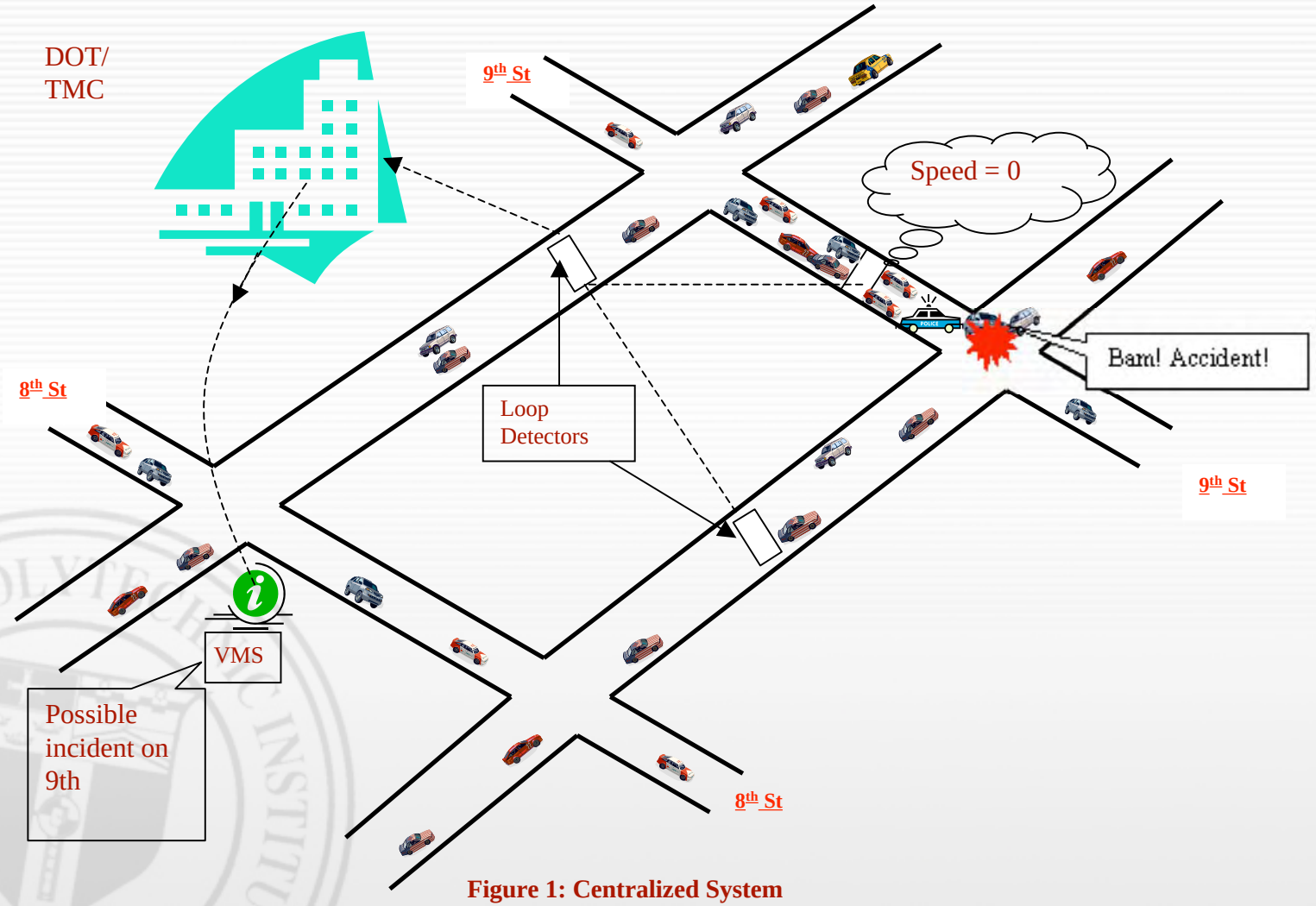


Figure 1: Centralized System

Decentralized System Architecture

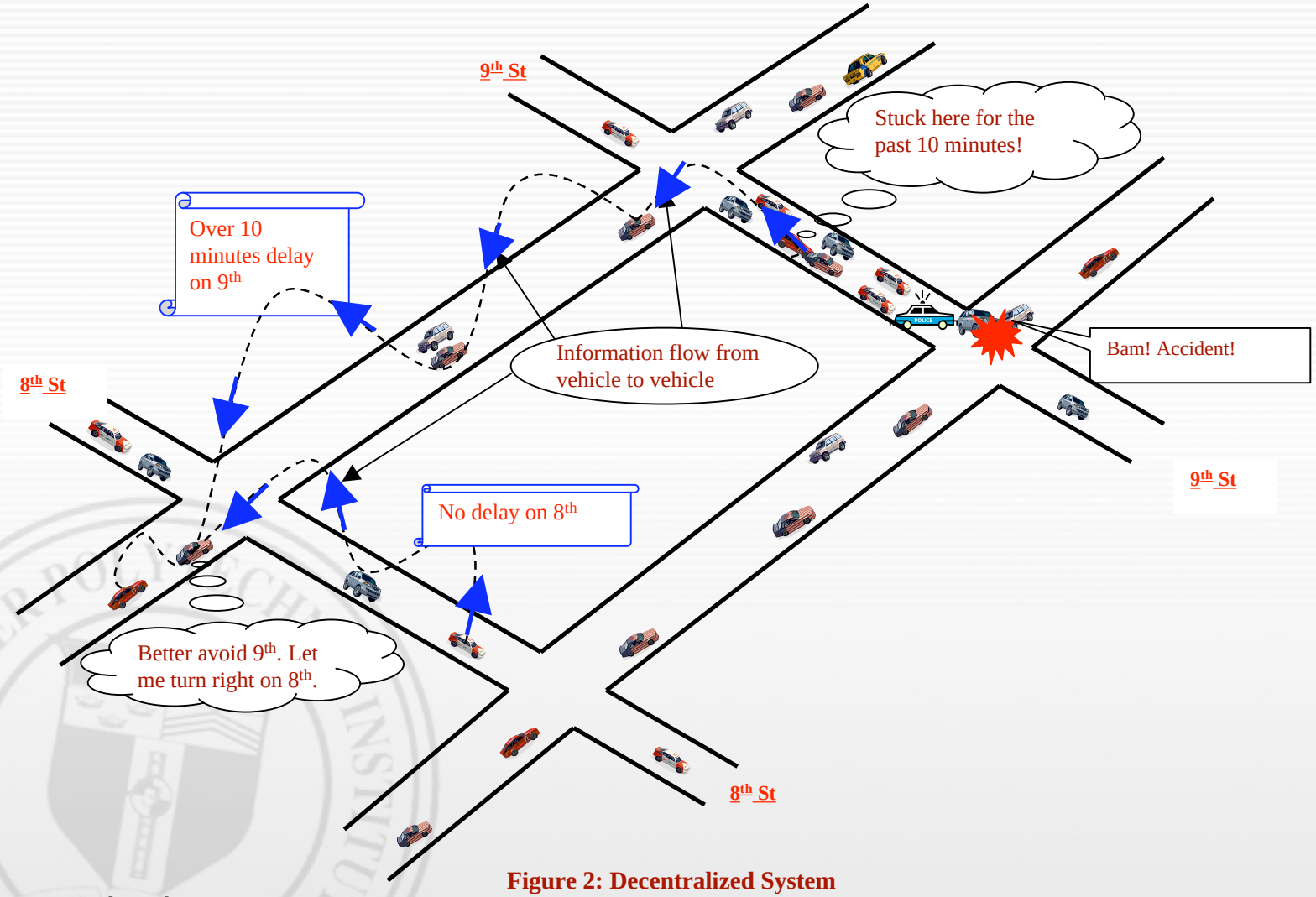


Figure 2: Decentralized System

Next Generation TGS: Distributed Architecture

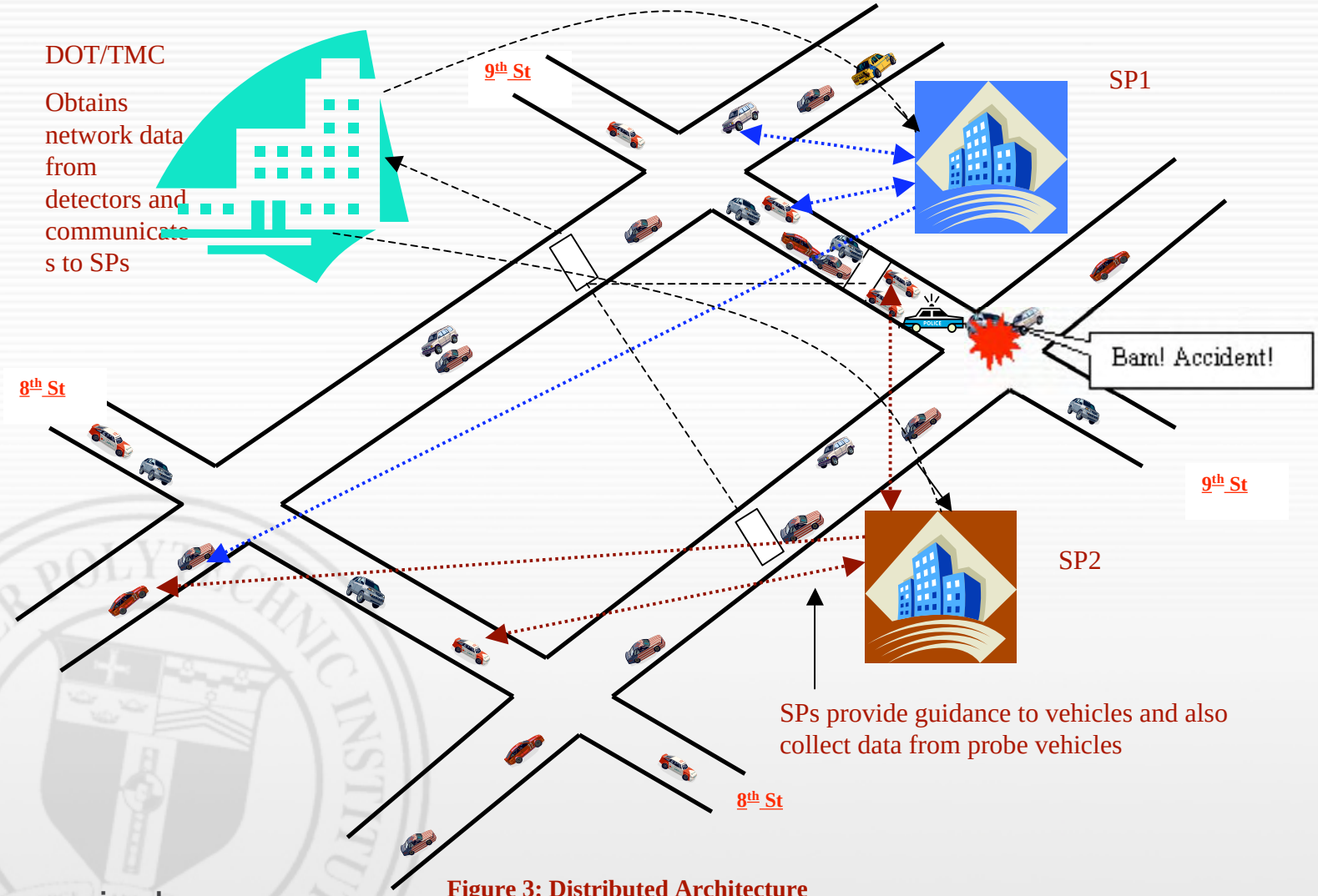


Figure 3: Distributed Architecture

Next Generation TGS: Multi-dimensional choice

- Travel choice decisions
  - whether or not to travel,
  - what activities to participate in,
  - where to engage in the activities (destination),
  - when to depart,
  - how long to engage in each activity,
  - which mode and route to choose
- Decisions influenced by
  - personal preferences,
  - degree of congestion on the network (decision of others),
  - comfort and cost of the mode,
  - stochastic disturbances on the network,
  - availability of parking etc.

Model framework

- Multi-dimensional choice process
  - activity location, duration, mode, and route
- Multi-criterion equilibrium assignment based on generalized utility measures over an extended network framework similar to Supernetworks – Activity-Travel Networks
- User optimal decisions instead of user equilibrium (selfish decision) or system optimal

Model Framework – Activity-Travel Networks

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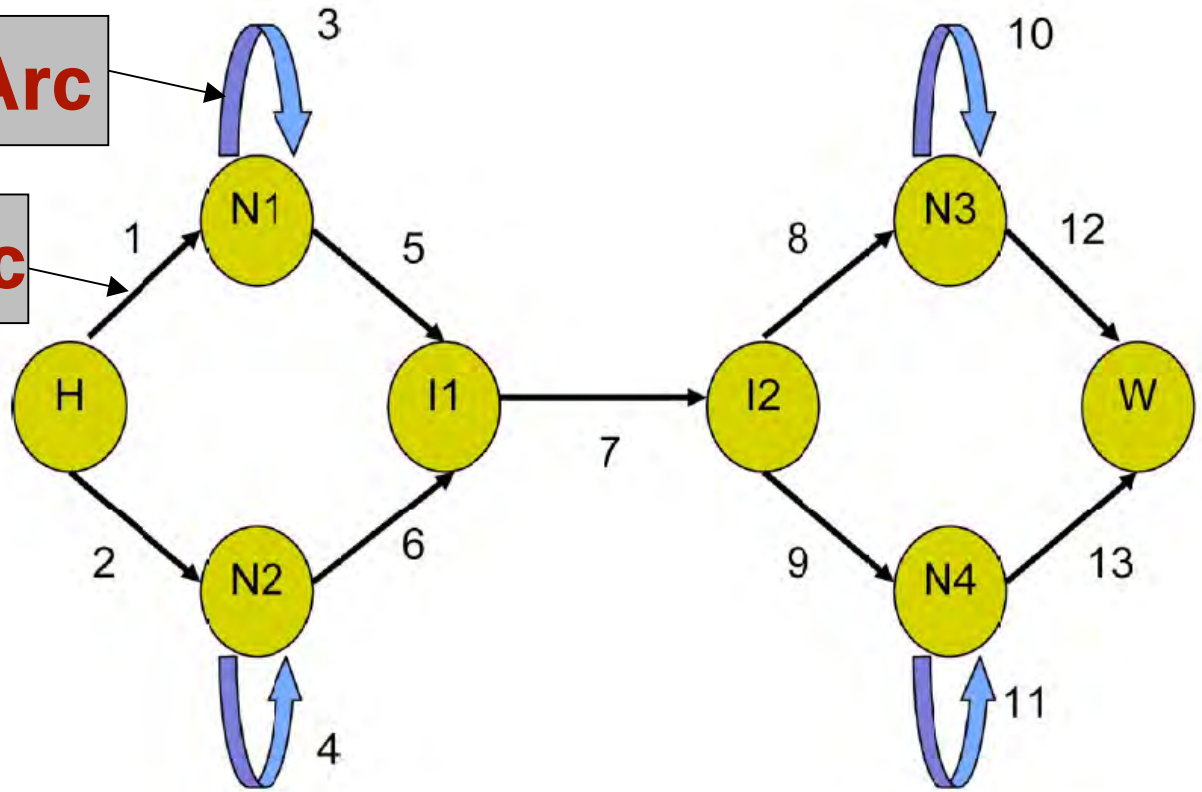
Activity Arc

Travel Arc



Choosing a route is analogous to choosing an activity location, duration, time of participation and travel route

Solution Framework – Algorithm B-Dynamic

- Each individual chooses the activity-travel sequence that provides the maximum utility
- Novel algorithm obviates path enumeration – likely to be much faster compared to existing solution algorithms
- Can implement warm starts – ideal for real time guidance computation
- Accounts for multi-dimensional choice

Next Generation TGS: Future Implementation

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- Requires public sector support for ISPs to start
- Requires private sector to take risks (initially)
- We need a clear demonstration of scalability (modeling as well as operational demonstration)
- Device, human-device interaction are key practical issues that need to be addressed
- Can support variety of ideal transportation goals, such as
  - Guidance based on multi-modal network,
  - “Green” Guidance (multi-objective),
  - Get closer to decisions that truly maximize welfare (through dynamic pricing, dynamic network control etc.)

Questions?

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