Technology-Assisted Behavior Change:
Towards Sustainable and Energy-Efficient Transportation

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Introduction

Private car use continues to increase in most urban areas around the world...

Problems:
Traffic Congestion
Environmental Degradation
High Fuel Consumption
Over 6 billion gallons of fuel are consumed by congestion annually, not only wasting money but adding to air pollution.
CONGESTION IS HIGHLY NONLINEAR
CONGESTION IS INEFFICIENT
CONVENTIONAL VIEW

SUPPLY ACTIONS:
- Improve Operations through Flow Management
- Traffic Signals
- Ramp Meters
- Add Capacity

DEMAND MEASURES:
- Influence the Demand for Travel
- Travel Decisions: Route, Mode, Departure Time
- Activity Participation and Scheduling
- Auto Ownership
- Location Decisions
BUT

SUPPLY AND DEMAND INTERACT STRONGLY

BOTH DEPEND CRITICALLY ON BEHAVIOR OF SYSTEM USERS
HUMAN BEHAVIOR AT THE ROOT OF SYSTEM INEFFICIENCY

Cognitive and behavioral limitations of human drivers are at the root of system inefficiency.

Perception time lags, reaction times, and a natural tendency towards over-reaction under stressful situations or perceived risk result in volatility, congestion, instability, frustrating stop-and-go patterns, “phantom bottlenecks”, capacity loss, and other component- and system-level phenomena.
Behavioral considerations and attitudes of human drivers, households and logistics managers are at the root of fuel inefficient patterns.

- Activity patterns and resource allocation decisions reflect individual preferences and lifestyles acquired in times where fuel supply concerns were minimal.

- Different time frames for interventions—different impacts from short to medium to long runs.

- Small changes at the margin could have meaningful impact.
BEHAVIOR CHANGE IS ESSENTIAL

TRAVEL LESS

TRAVEL MORE EFFICIENTLY

– DO IT WITH A FRIEND

TRAVEL GREEN
3 MAIN TOOLS

OPERATIONAL CONTROLS (TRAFFIC)

REAL-TIME PERSONALIZED INFORMATION

DYNAMIC PRICING:
- Taxation
- Congestion Pricing
COMBINED APPROACHES

VALUE PRICING AND MANAGED LANES

Single Occupant Vehicles allowed to use HOV lanes for a toll

Toll rates vary based on traffic conditions or time of day so as to maintain high level of service on managed lane

Facilitated by AVI and automatic toll collection
BEHAVIOR CHANGE THROUGH TECHNOLOGY INTELLIGENT MANAGEMENT SYSTEMS
TWO MAIN AREAS FOR DEVELOPING TRANSPORTATION SYSTEM INTELLIGENCE

Realization I
Eliminate or reduce individual human error, and the system will operate more efficiently. Small changes in household and firm individual patterns could lead to significant gains in fuel efficient sustainable lifestyles.

Realization II
Monitor the state of the system at all times, and it would be possible to intervene and apply control actions-in real-time to best utilize available resources-
Technological Drivers

5 DEVELOPMENT TRENDS

Source: Qualcomm.com
Development trend # 1: Handset Capabilities, Wireless Internet

Precise Location Enables Wide Variety of LBS Apps

- **GAMING**
  - Interactive Gaming
  - GeoCaching
  - Location aware games for individuals/groups

- **PERSONAL SECURITY**
  - Roadside Assistance
  - Weather Warning
  - Child Finders
  - GeoFencing

- **ENTERPRISE**
  - Fleet Management
  - Asset Monitoring
  - Personnel
  - Productivity
  - **e-logistics**
  - **m-logistics**

- **POINTS OF INTEREST**
  - City Guides
  - Mobile Yellow Pages
  - Navigation
  - Traffic reroute

- **PEER-TO-PEER**
  - Buddy Groups
  - Dating
  - Geo-marked photo sharing
  - Mobile Blogging

- **COMMERCE**
  - Mobile Coupons
  - Customer Service
  - **m-commerce**
Example:  Sense Networks Inc.

*Citysense*

Tracking cell phone signals for social networking

→ travel pattern prediction
PROBE-BASED CONNECTED NAVIGATION SYSTEM:
Third-Party Private Subscriber ITS Service

TruTraffic
The most accurate and current traffic data

Routing: Choice is good.
Most portable GPS devices today offer you only a single route choice to your destination. Dash goes the extra mile by presenting up to three different routes to a destination, and uses its traffic information to calculate your Estimated Time of Arrival (ETA) for each route. The traffic-based arrival times you get from Dash are more accurate, helping you decide which route is best for you. Even after you've selected a route, Dash even automatically alerts you when traffic conditions change significantly.

Traffic snapshot
Dash can also give you a quick snapshot of traffic in your area. Our map views let you easily visualize current traffic conditions around your location on major and secondary roads. Additionally, traffic conditions on your route are easily identifiable by color. Dash uses accepted conventions to quickly convey traffic at a glance: stop-and-go traffic is red, moderate congestion is yellow, relatively uncongested is orange, and free-flowing roads are... you guessed it, green. If the lines are solid, they represent live traffic derived from the Dash Driver Network—the most timely and accurate source available. If they are dashed, the traffic data is either 3rd party sensor or historical data. As the Dash Driver Network grows in your area you'll see more and more of the dashed lines become solid. You've never had this much traffic information on the road before. And knowledge is power.
Satellite-based mobile asset tracking and communication: Tool for truck fleet management and freight tracking
Deployment Key Technologies: Field Elements

- AVI and E-Seal Readers (Overhead)
- E-Seal
- In-Truck AVI Transponder
- Disposable Electronic Container Seal
- Weigh-In-Motion (CVISN)
eSeal Readers at Border
Telemobility and Telelogistics

• Internet + mobility -->

TELEMOBILITY and

TELELOGISTICS

May entail changes in:

– Nature of the activities themselves (doing what?)
– Location/spatial characteristics of the activities
– Inter-person and inter-firm interaction in activities
– Process of activity generation and scheduling: more dynamic (real-time) activity generation and scheduling;
Development trend # 2: Inexpensive wireless sensor networks

Coming to markets near you in next few months...

Relative low cost and high performance of such systems would enable deployment at larger scale than envisioned originally.

In the limit, nano-scale sensors with massively parallel deployment.
Mobile units + wireless internet: 

Inexpensive wireless sensors

Provides particle (user-centric) views of system

Provides view from perspective of infrastructure or fixed assets

REAL-TIME INFORMATION
Explosion of real-time information on system state

⇒ Calls for methods geared for shorter term engineering and business applications

⇒ Calls for methodologies for real-time decision making under real-time information

REAL-TIME DECISION-MAKING METHODOLOGIES, e.g. DYNASMART-X for traffic estimation and prediction.

⇒ Calls for methods to extract knowledge from undifferentiated data

KNOWLEDGE EXTRACTION, e.g. through data mining
Development trend #3:

Network Simulation-Assignment Modeling for Advanced Traffic System Management

REAL TIME DYNAMIC TRAFFIC ASSIGNMENT SYSTEM

- Irvine network overview:
  - 326 nodes and 626 links.
  - 70 actuated-controlled urban intersections.
  - 61 traffic demand zones

- Morning peak period (4:00 AM – 10:00 AM)
- 30-second observation intervals on 19 freeway links
- 5-minute observation interval on 28 arterial links
Link Density Estimation and Prediction
EXAMPLE I: Consistent Anticipatory Travel Time Information Provision

WHAT WE KNOW

Information on currently prevailing conditions may not be effective: *overreaction, time lags, stochastic and dynamic variation*

Anticipatory information effective, but poses three challenges:

- capturing user responses to provided information: **CONSISTENCY**
- users care about reliability of information
- computation for large networks
EXAMPLE II: Anticipatory Pricing

INTRODUCE PREDICTION IN THE CONTROL LOOP

Subject to considerable academic development in the area of algorithm development and testing

Rapidly coming to market, in conjunction with asset tracking and management technologies

Prospect for tie-ins with predictive traffic management tools, e.g. DYNASMART-X
Example of Collaborative Logistics:

Vendor-management Inventories (VMI)

Online Inventory Routing Problem (OIRP)
Development trend # 5:
Peer-to-Peer Ad Hoc Networks (VANET)
MAKING THE CHANGE
THE ALTERNATIVE...??

Existing Mass Transit in Large Cities:
Crushing densities,
Crawling speeds

PUSHING THE LIMIT?
REINVENTING THE TRANSIT EXPERIENCE

THE PROMISE…
BUS RAPID TRANSIT (BRT)
OUR VISION FOR THE TC

• Pre-eminent think-tank and laboratory for cutting-edge transportation research “that matters” on a global scale

• Premier educational program in transportation systems

• Essential partner for novel, high-impact research

• Advance state of practice through mix of engaged application-driven research and fundamental advances
KEY RESEARCH AREAS (I)

- Real-time logistics and distribution, collaborative logistics, applications in urban environment
- Traffic systems congestion: management through real-time information, dynamic pricing, predictive control
- Safety, security and system vulnerability/resilience
- Humanitarian logistics and extreme events (evacuation, emergency response, panic…)
- Transport economics: aviation applications, public transit, freight transport
- Asset management systems: physical infrastructure—bridges, highways, transportation systems
DYNAMIC NETWORK MICRO-ASSIGNMENT WITH HETEROGENEOUS USERS
KEY RESEARCH AREAS (II)

• Energy, environment and sustainability
• Business Intelligence in travel and transportation industry
• Public-private roles and collaborative structures in infrastructure development, rehabilitation and management
• Travel behavior, human factors and marketing approaches to service and product design
• Large-scale systems, complexity: individual decisions and collective effects, agent-based simulation, adaptive optimization of stochastic dynamic systems
The Greening of Freight in Europe:
Assessing the Market Potential of New Services and Lower Barriers Using a Dynamic Intermodal Simulation Assignment Methodology

Coordinated Action Project
European Commission
6th Framework

2nd Annual National Freight Conference
5 December 2007
Facilitating interconnections

APPLICATION

THEORY

TC

METHODOLOGY

BEHAVIOR

MODELS
LIGHT AT THE END OF THE TUNNEL?

Thank you

Q & A

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