The future of roads: projection for California

Sébastien Blandin
Systems Engineering, UC Berkeley

Center for Environmental Public Policy
May 2nd, 2011
Road traffic congestion

• Congestion in the US in 2009 (Urban Mobility Report, 2010)
  • $115 billion in wasted time and fuel
  • 4.8 billion hours of delay
  • Average traveler needs 25% more time than speed limit travel-time

• Federal Highway Administration trend
Congestion mitigation strategies

• Congestion
  • Supply is lower than demand

• Capacity increase
  • Roadway expansion
  • Variable speed limits
  • Incident management

• Demand adjustment
  • Mode shift
    • High-occupancy vehicle lanes
    • Public transportation saved 783 million hours in the US in 2009)
  • Temporal shift
    • Telecommuting
    • Ramp metering: Minnesota (2000), 22% reduction in travel-time
    • Dynamic toll system: Stockholm reduced traffic by 20%, wasted time by 25%
  • Spatial shift (routing directions)
Modeling, estimation and control

**Modeling**
- Computational representation of traffic phenomena
  - Microscopic (vehicular) or macroscopic (elements of flow) perspective
  - Physical principles and statistical assumptions

**Estimation**
- Combining observations with prior knowledge
  - Depends on types of measurements (fixed sensors, probe data)
  - Produces estimates stochastic by nature

**Control**
- Design of strategies for congestion mitigation
  - Microscopic: traveler information (congestion maps, routing directions)
  - Macroscopic: Traffic assignment (ramp metering, road pricing, variable speed limits)
Mobile Millennium

Data Visualization Framework (Multi color dynamic map displays)
Evaluation Framework (Compare Values, Average Values, Point Distributions)
Parallelization Framework (Distributed Processing, HPC, Spark)
Network and Geocoding (Class 1-4 Roads)
Database (Transactional Processing), Data Warehouse (ETL, Data Mining, Reporting)
Process Management (Monitoring, Production execution, etc)
From smart roads to smart drivers

• Spread of mobile and smart phones
  • Worldwide mobile phones market increased by 20% in Q1 of 2011
  • Close to **50% penetration rate** in the US

• Mobile sensing platform
  • Location-aware (GPS, WiFi)
  • Point-speed measurements (GPS)
  • Context-aware (microphone, camera)
  • Augmented reality using magnetometer

• Recommendation systems
  • Environmentally friendly driving style (DriveGain)
  • Social hotspots (Sense networks)
Ubiquitous sensing

PeMS loop detector stations
- Loop detectors
- Count and occupancy
- Localized in space

Mobile Millennium, GPS point speeds, July 29th, 2010
- Personal GPS
- Point speeds
- Distributed across the road network
Dynamic, adaptive and agile drivers

- Dynamic traffic control
  - Accurate real-time information (<5 minutes delay)
  - High-frequency update (>1 per minute)
  - Dynamic routing (Google: March 2011)

- Adaptive control (appropriate for stochastic systems)
  - Accounts for more complex criteria (reliability)
  - Personalized route recommendations

- Agile commute choice
  - Car-sharing (Zipcar, City CarShare)
  - Intermodal commuting (BayTripper)
  - Smart parking (StreetLine)
  - Location-based check-ins (Foursquare)

Fast route or reliable route?
The future of roads: projection for California

Sébastien Blandin
Systems Engineering, UC Berkeley

Center for Environmental Public Policy
May 2nd, 2011
Mobile Century experiment
- February 8th, 2008
- 10 miles, 100 cars, 100 GPS-enabled smartphones
- Proof of concept of added value of GPS data for traffic estimation
SOTA iPhone app

• iPhone application DriveTracker for San Francisco commuters
  • Real-time traffic conditions from Bayesian network model of individual link travel-times
  • 2626 links, mean and variance of link travel-time available for 40 time periods during the day (up to 15 minutes resolution)

• Communication scheme
  • Optimal policy is sent to the phone at origin
  • Policy update triggered on server-side if traffic conditions change significantly