The future of roads: projection for California

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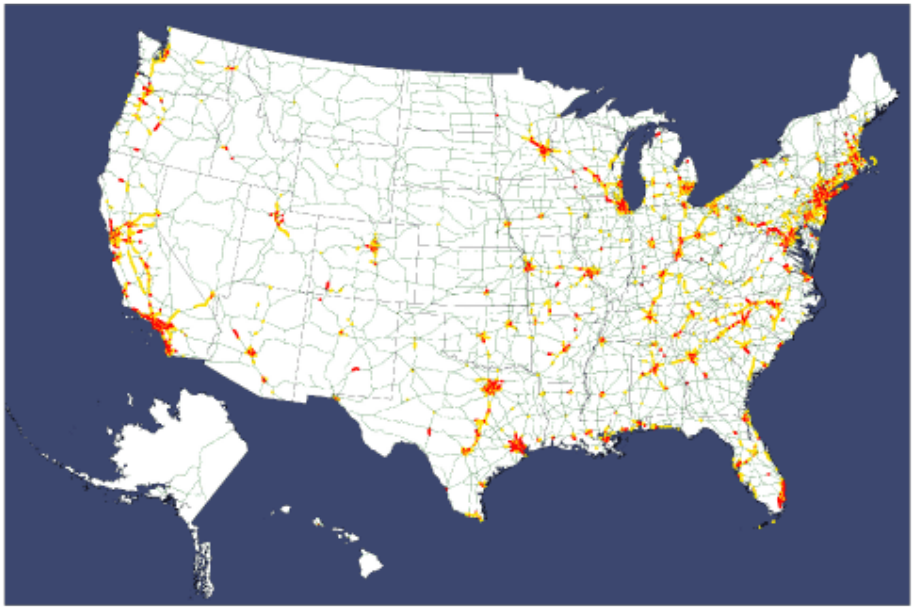
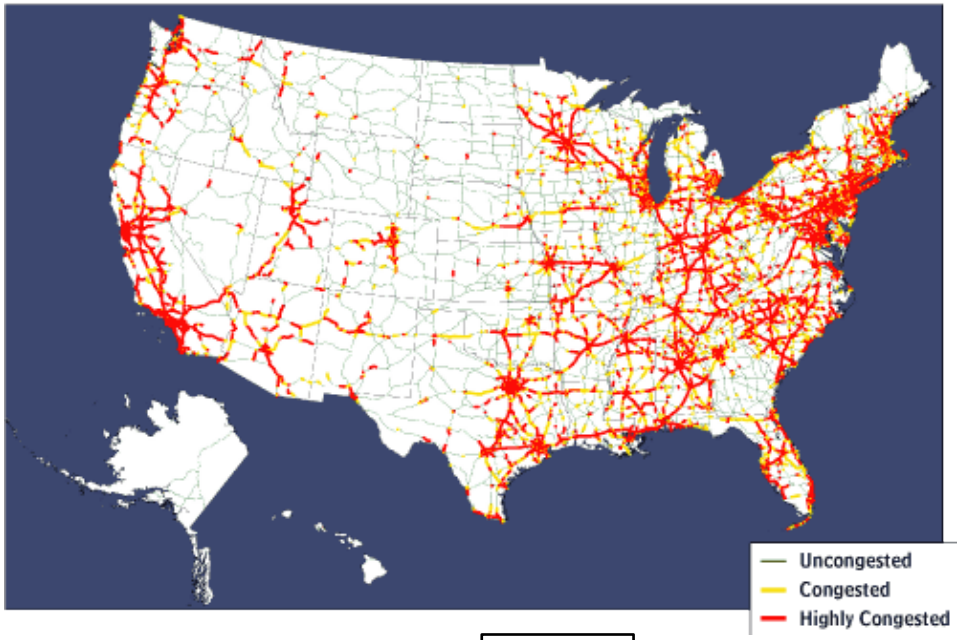
Road traffic congestion

- 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 Admistration trend



2002



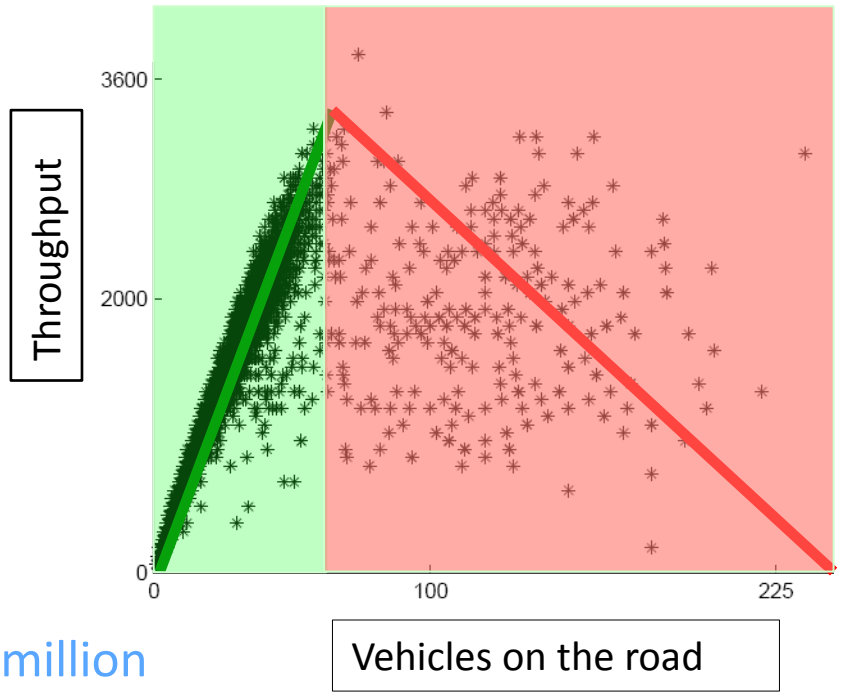
2035

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

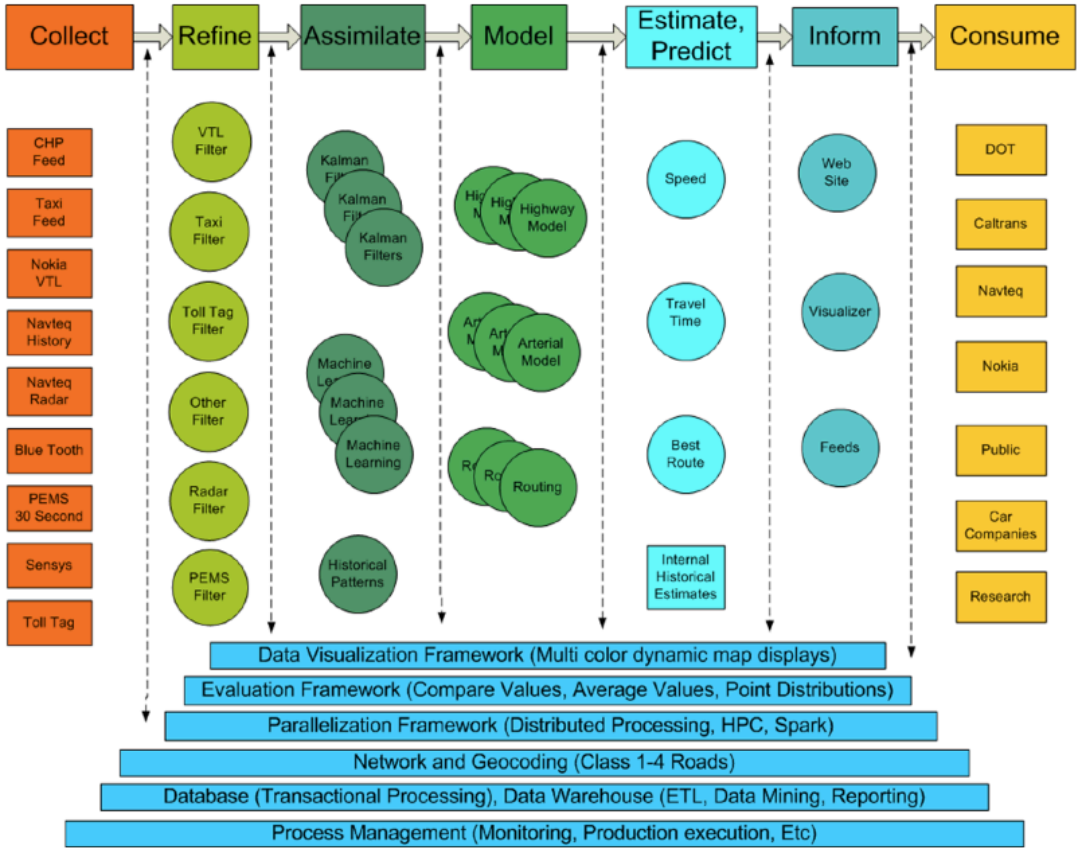
Estimation

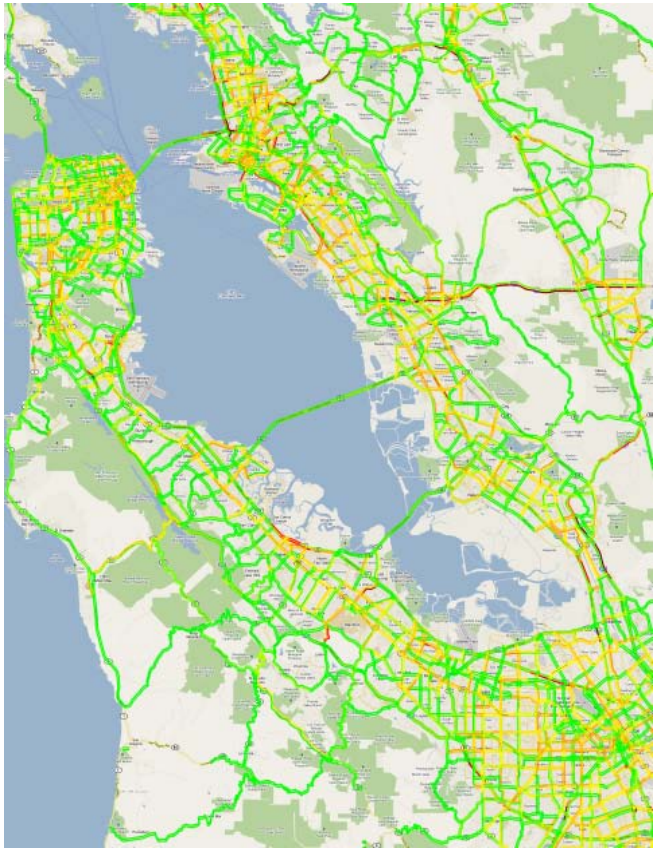
- Combining observations with prior knowledge
  - Depends on types of measurements (fixed sensors, probe data)
  - Produces estimates stochastic by nature

Control

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

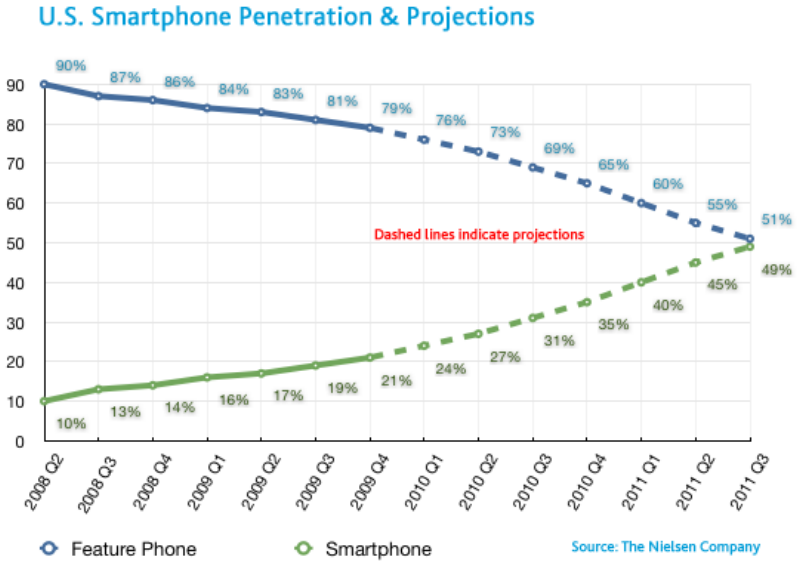
Mobile Millennium





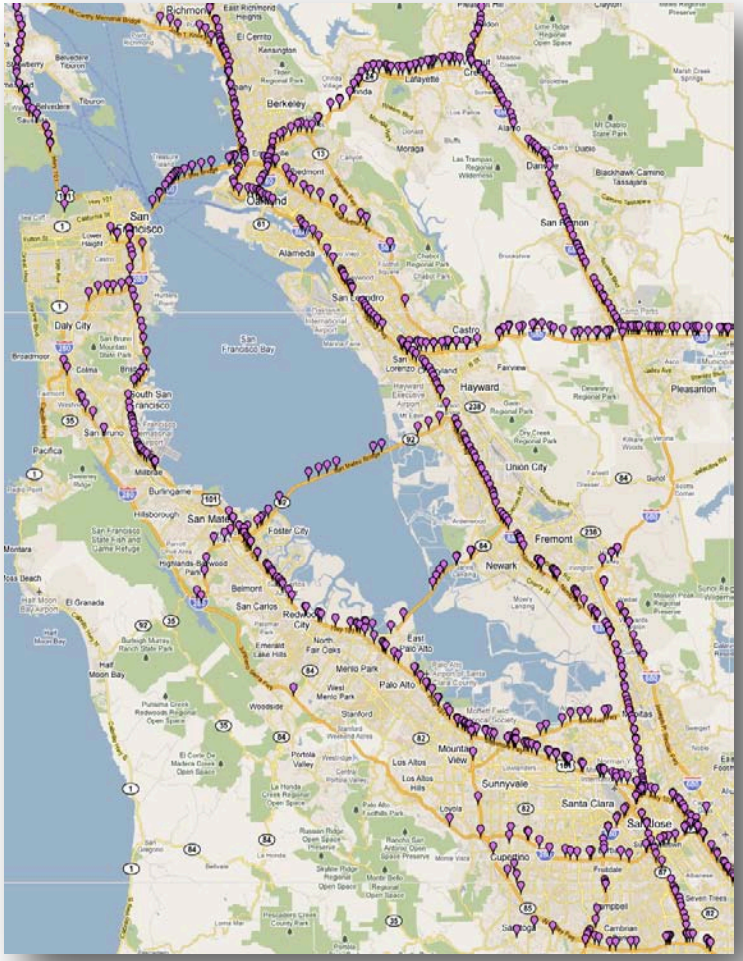
From smart roads to smart drivers

- 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

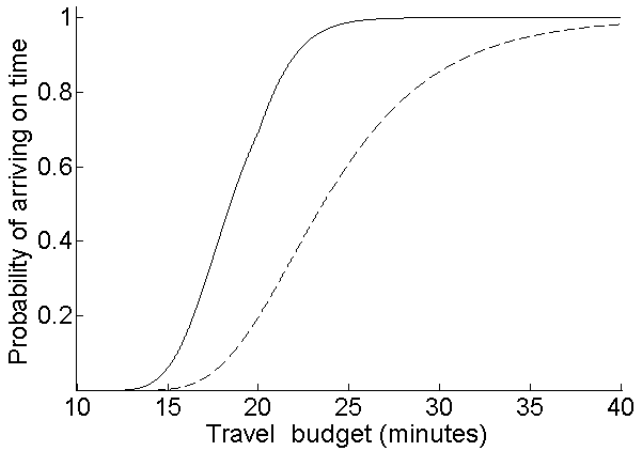
Dynamic, adaptive and agile drivers

- 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 ?



zipcar
wheels when you want them

CITYCARSHARE
A Bay Area nonprofit

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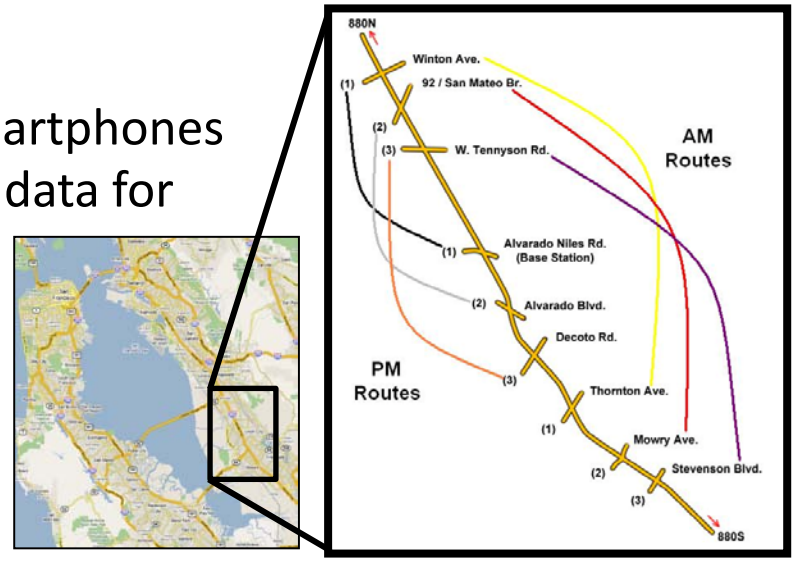
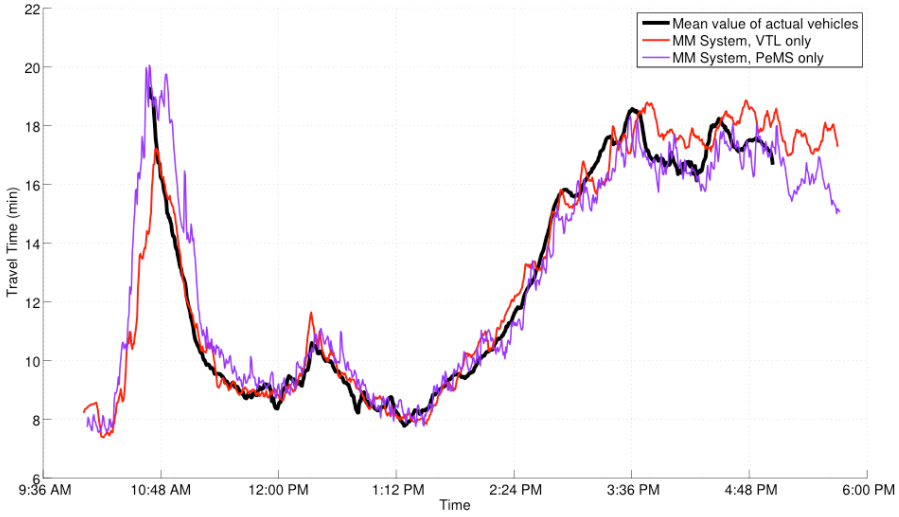
v-PDE on a network: Mobile Century experiment

- 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