Traffic Monitoring and Control Systems and Tools

Roberto Horowitz
Professor
Mechanical Engineering
PATH Director

Carlos Canudas de Wit

Director of Research at the CNRS
NeCS Team director

Grenoble France

Pravin Varaiya
Professor in the Graduate School
EECS

University of California, Berkeley

Traffic Monitoring and Control Systems and Tools

- Information flow in ITS
- TOPL at UC Berkeley
- Grenoble Traffic Lab

Real-time Information flow in ITS

Technology

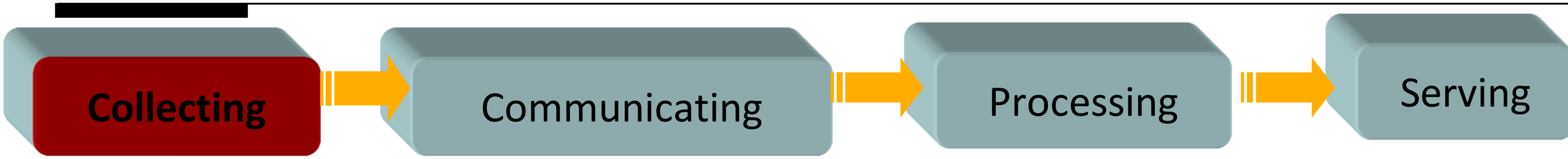
The data deluge

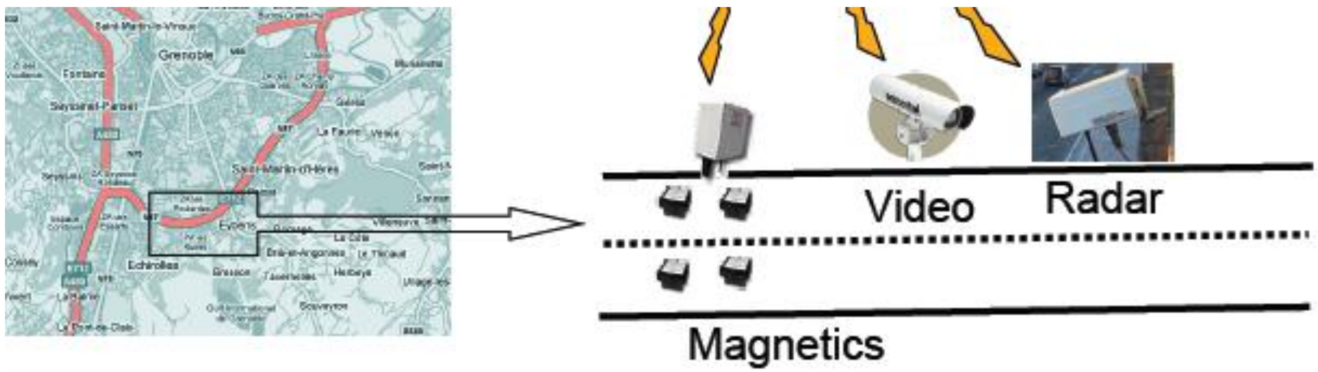
Businesses, governments and society are only starting to tap its vast potential

Feb 25th 2010 | From *The Economist* print edition

Real-time Information (ICT) flow

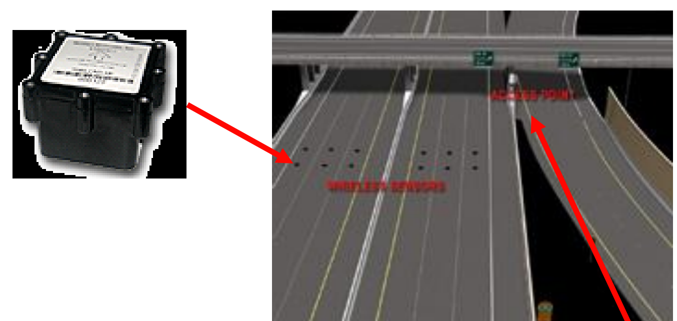
Information collection: measures, filter & aggregate real-time information

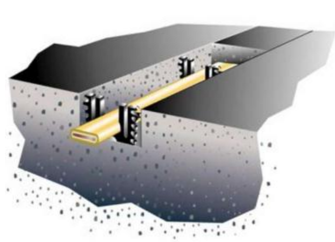




Large offer in new sensor technologies:

- Wireless,
- Heterogeneous,
- Richness,
- Mobile





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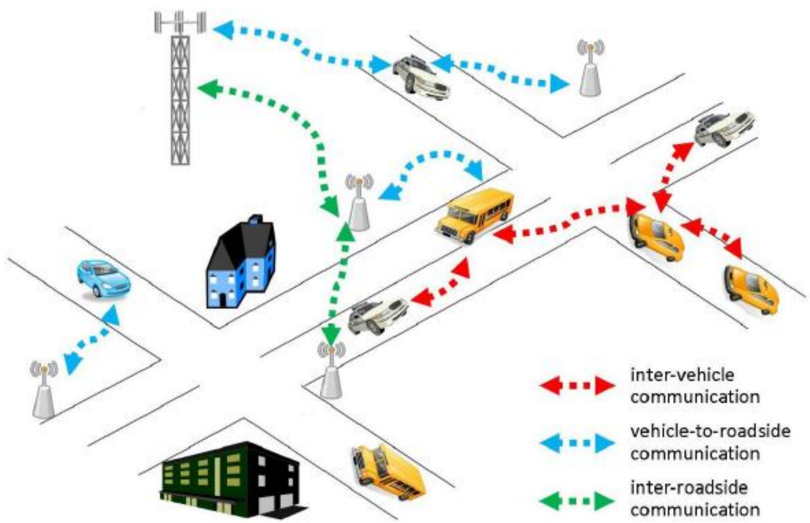
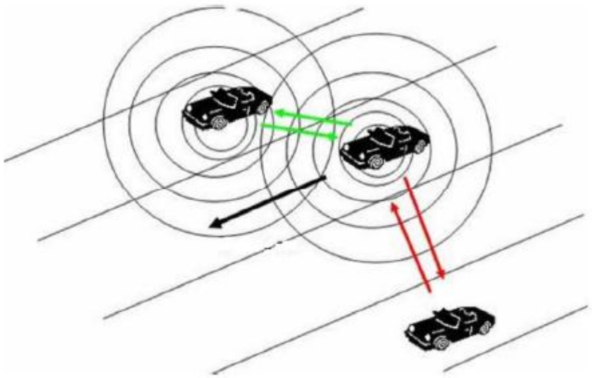
Communicate Information; build ups a information flow from sensors to system

Collecting → **Communicating** → Processing → Serving



New communication Technologies will open opportunities:

- Vehicle-to-Vehicle communications,
- Vehicle-to-Infrastructure,
- Infrastructure-to-Vehicles,
- Information to users



Processing (controlling) Information: brings add value at the brut information

Collecting → Communicating → **Processing** → Serving

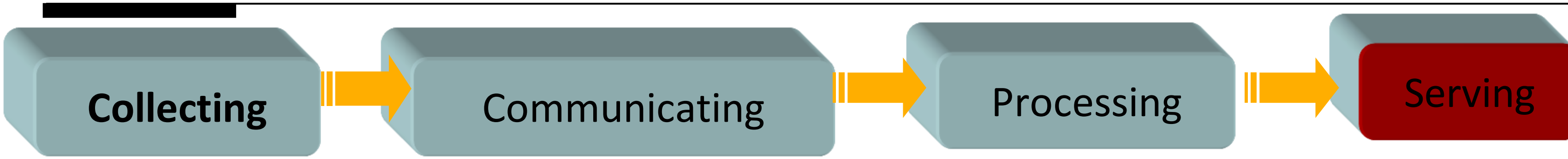
Ramp metering control:

- Products already in use are not optimal,
- Decentralized,
- Room for a lot of improvements

Variable velocity control:

- Under investigation,
- Relay on “Soft” actuators (drivers),
- High potentially

Information serving: services to users



The results of the processed information is transformed into user services:

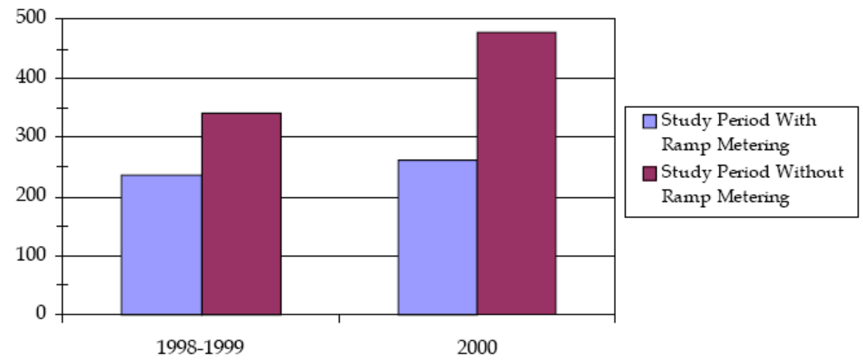
- Desktop applications,
- Mobile phones,
- On-board navigation devices,
- Traffic control centers

Expected impact & Benefits of using feedback control

Table ES.1 Annual Benefits of the Ramp Metering System (Year 2000 Dollars)

Performance Measure	Annual Benefit	Annual $ Savings
Travel time	25,121 hours of travel time saved	$247,000
Travel time reliability	2,583,620 hours of unexpected delay avoided	$25,449,000
Crashes	1,041 crashes avoided	$18,198,000
Emissions	1,161 tons of pollutants saved	$4,101,000
Fuel consumption	5.5 million gallons of fuel depleted	($7,967,000)
Total annual benefit		**$40,028,000**

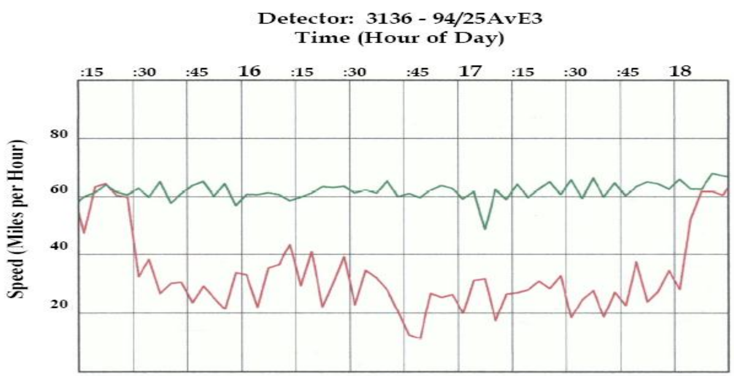
ure ES.6 Crash Occurrence in the "With Meters" and "Without Meters" Study Periods (for Metered Freeways in the Morning and Afternoon Peak Periods)



Expected Benefits

- Decrease traveling time
- Regularity
- Reduce accidents
- Decreases stop-go behavior
- Reduce emission of pollutants
- Minimize fuel consumptions

ure ES.5 Example of Increased Speed Variability (I-94 Corridor Location)



Condition	Date	Field	Sample	Volume
Meters off	Mon, Oct 16, 2000	25′	100%	25,181
Meters on	Mon, Oct 9, 2000	25′	100%	25,294

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From Cambridge Systematics for the Minnesota Department of Transportation 2001

Traffic Monitoring and Control Systems and Tools

- Information flow in ITS
- TOPL at UC Berkeley
- Grenoble Traffic Lab

TOPL (Tools for Operations Planning)

TOPL TEAM

Gunes Dervisoglu
Gabriel Gomes
Roberto Horowitz
Alex A Kurzhanskiy
Xiao-Yun Lu
Ajith Muralidharan
Rene O. Sanchez
Dongyan Su
Pravin Varaiya

TOPL PI's

Roberto Horowitz
Professor
Mechanical Engineering
horowitz@berkeley.edu

Pravin Varaiya
Professor
EECS
varaiya@eecs.berkeley.edu

Supported by grants from Caltrans and National Science Foundations

Motivation

- **2007 USA Traffic Congestion Caused:**

• 4.2 billion hours of additional travel time

• 11 billion litters of additional fuel

Congestion delay in California:

- 500,000 veh-hrs/day
- will double in 2025

San Francisco I-80 Bay-shore morning commute

What is TOPL? (Tools for Operational Planning)

TOPL provide tools to

- specify actions for traffic corridor operational improvements:
  - ramp metering, incident management, traveler information, and demand management;
- quickly estimate the benefits of such actions

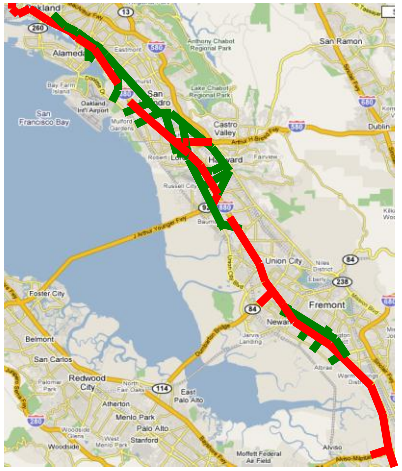
TOPL is

- based on macro-simulation models that are
- automatically calibrated using traffic data
- can be extended for real time traffic monitoring, prediction and control

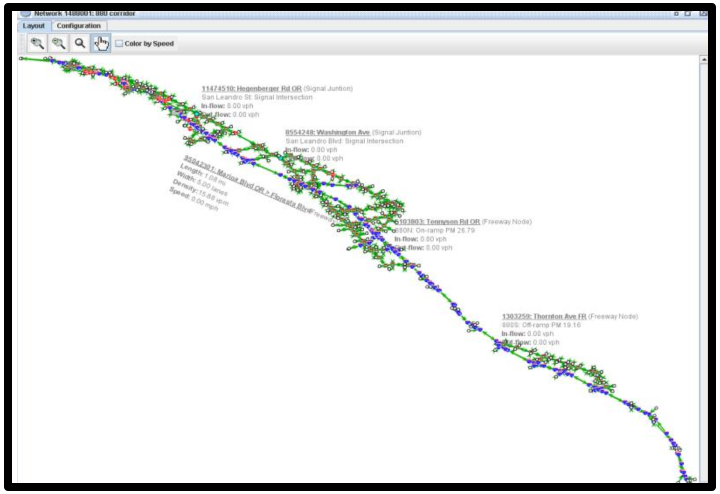
R. Horowitz and P. Varaiya
Automatic modeling of freeway corridors

Help Caltrans achieve a 55% reduction in traffic congestion by 2025

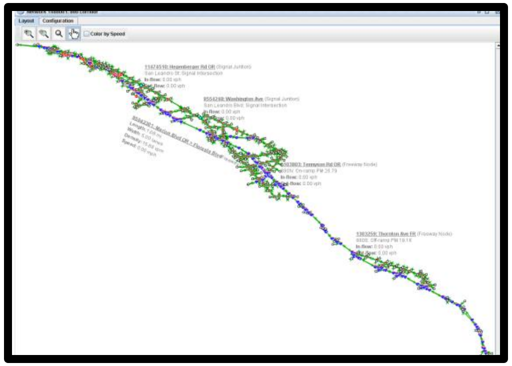
Select & “prune” corridor from Google maps



Import corridor freeway and arterial topology into the AURORA simulator

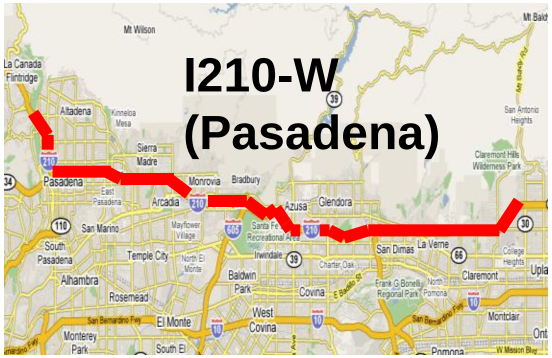


Use PeMS traffic data for automatic
- model calibration
- imputation of missing detector data

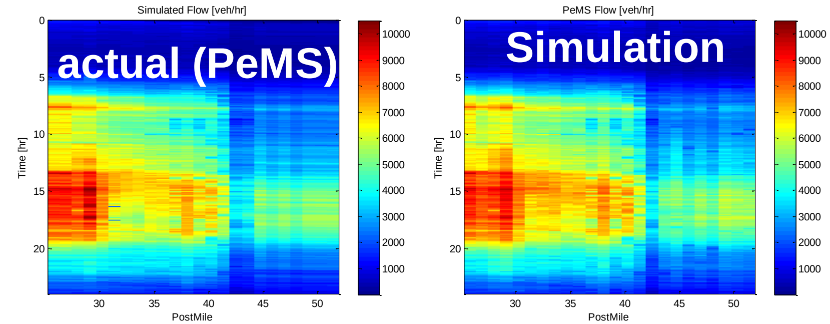


Perform traffic operation control simulation studies and test enhancements:
- ramp metering, variable speed limits
- incident management,
- traveler information,
- demand management, etc.

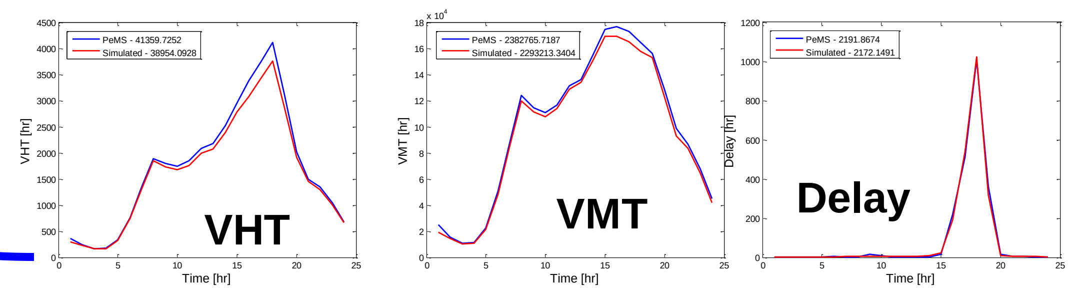
Examples: I210-W (Pasadena, CA) and 880-N (Bay Area)

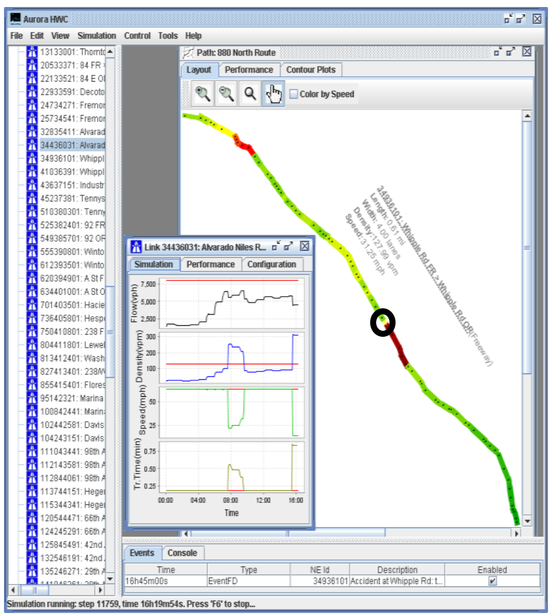


Flow contours (PeMS vs simulation) <5% error

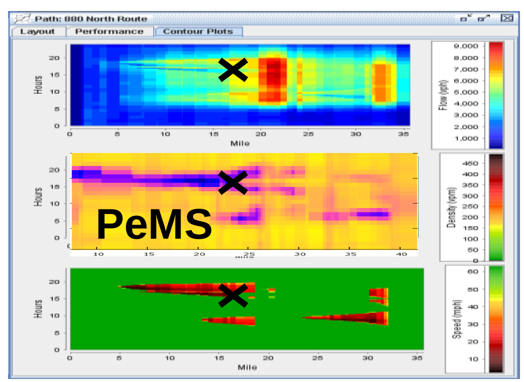


Performance Measurements (PeMS vs simulation)

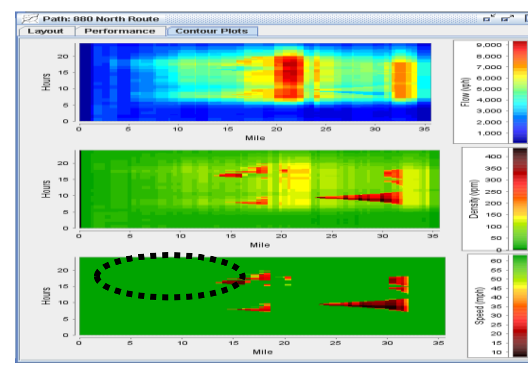




I880-N Accident simulation



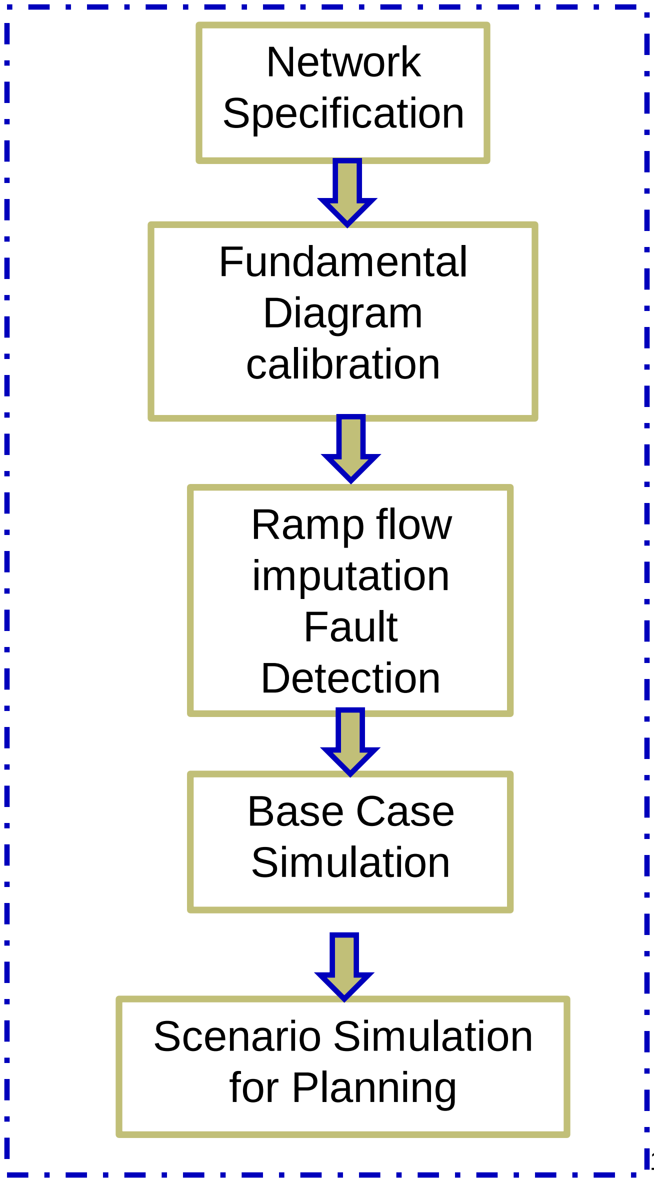
Simulation vs PeMS



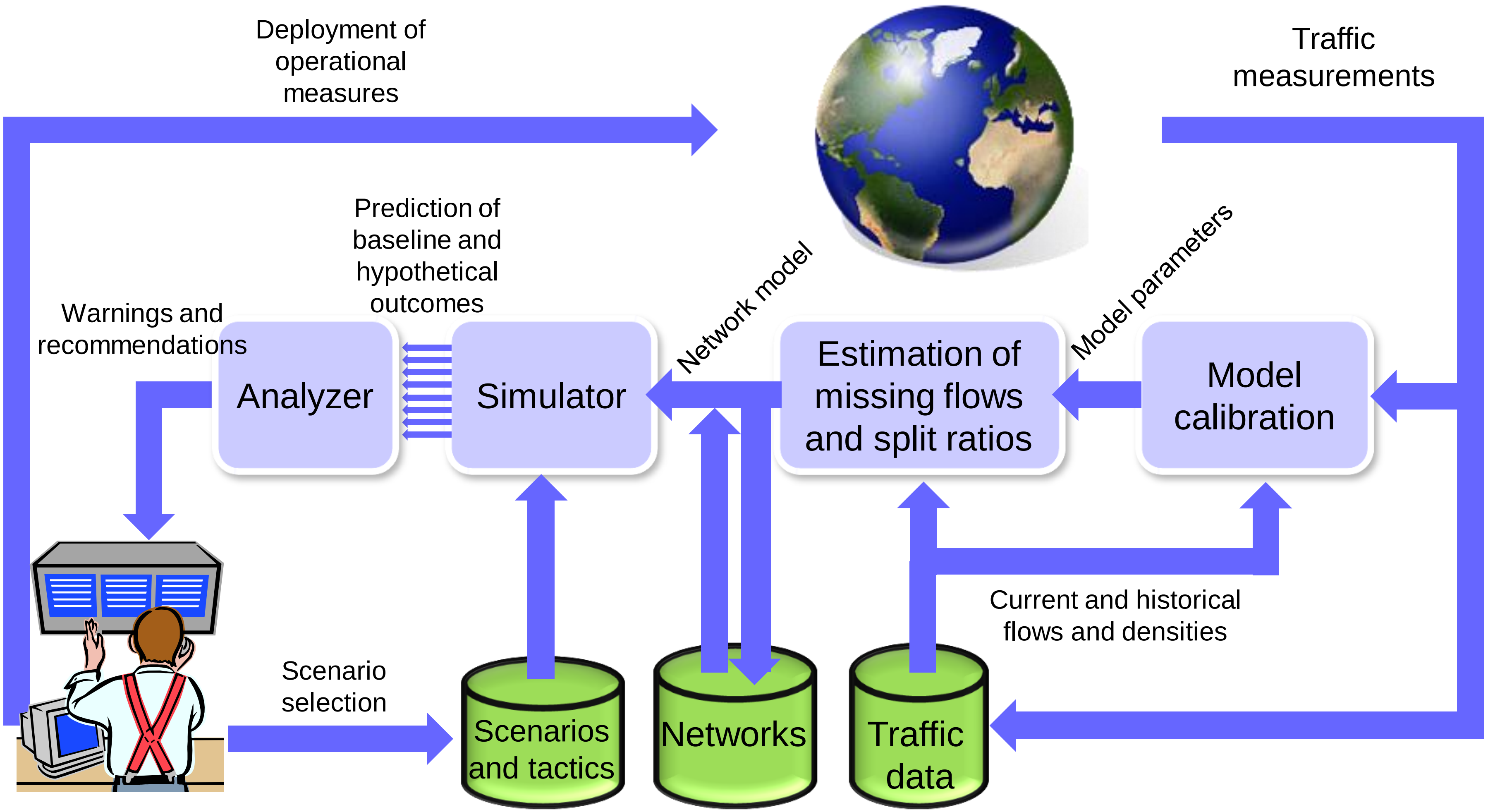
Traffic-responsive Ramp metering

Some details of TOPL Self-Callibration Procedure

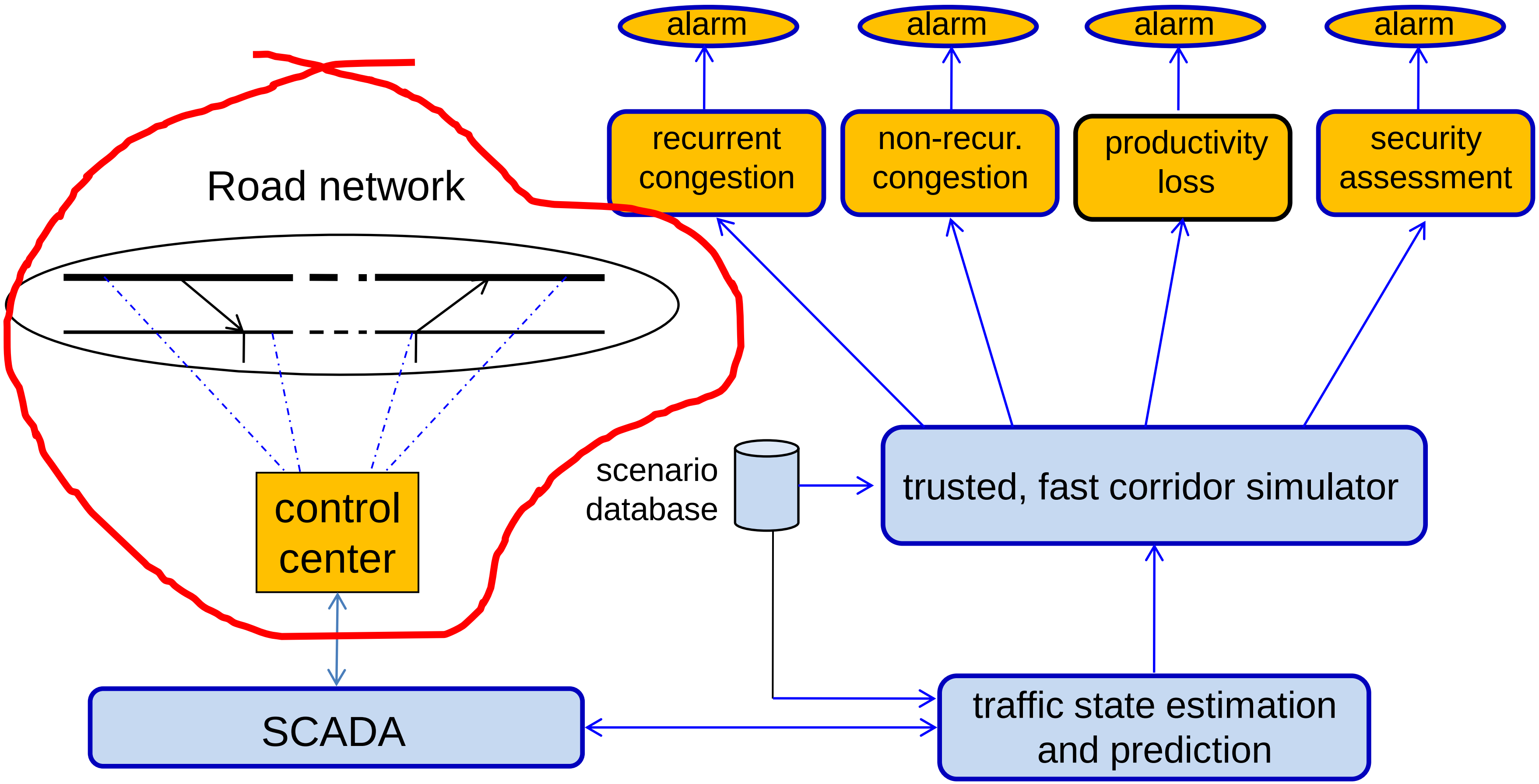
- Specify Freeway Network
  - Eg: I-210 EW , I-880S, I-80E
- Data
  - PeMS (Perfromance Measurement Systems) - Data archive
  - Aggregate flow, density and Speed data from loop detectors
- Perform TOPL procedures for operations planning/ benefit assessment



A decision support structure for ATM

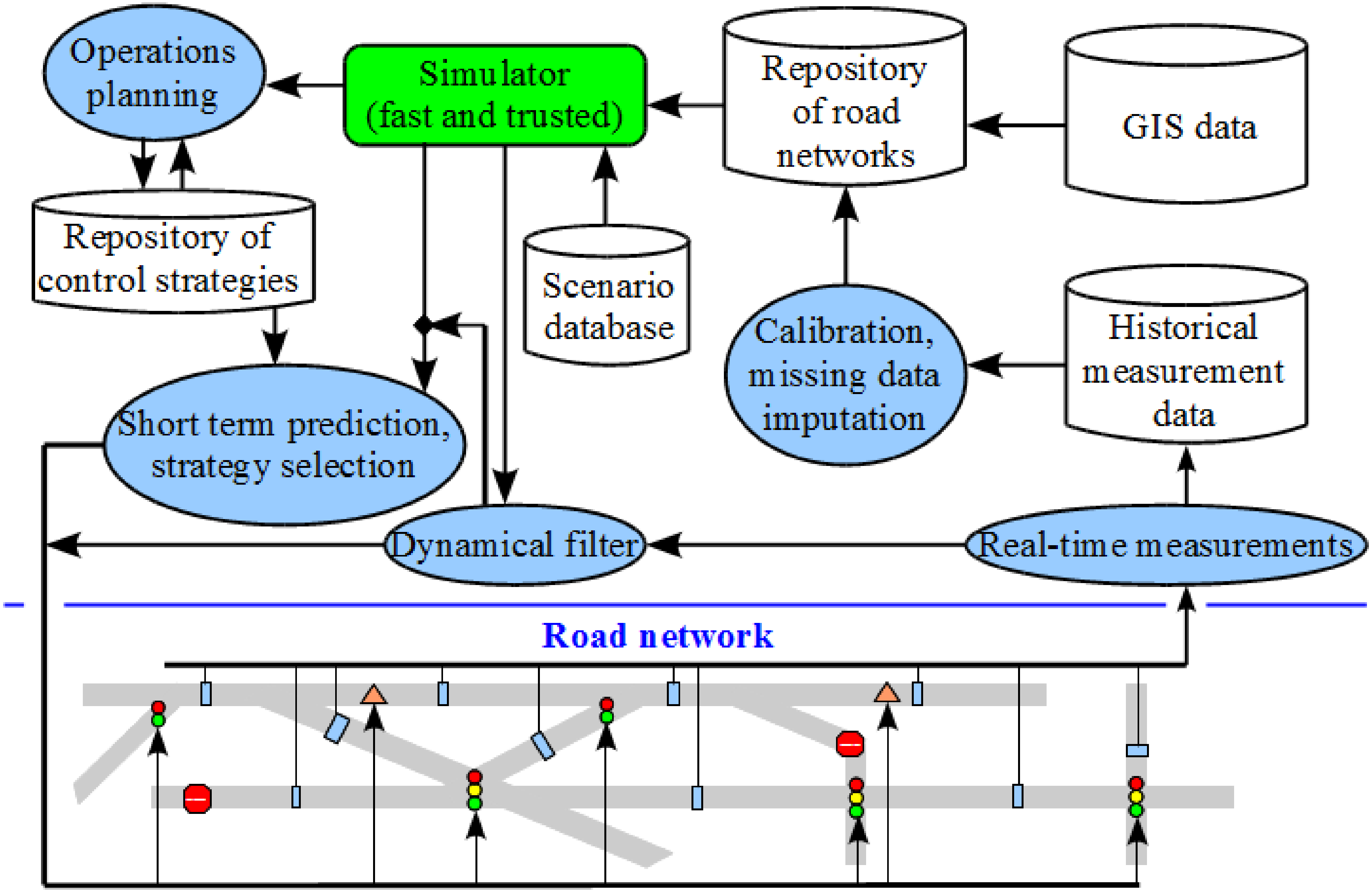


Towards a Smart Corridor TMC

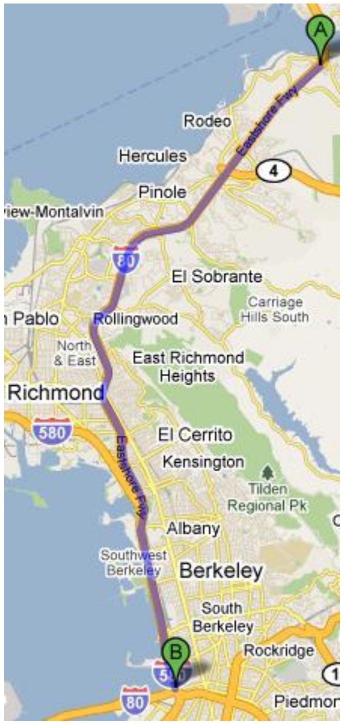


Supervisory Control And Data Acquisition

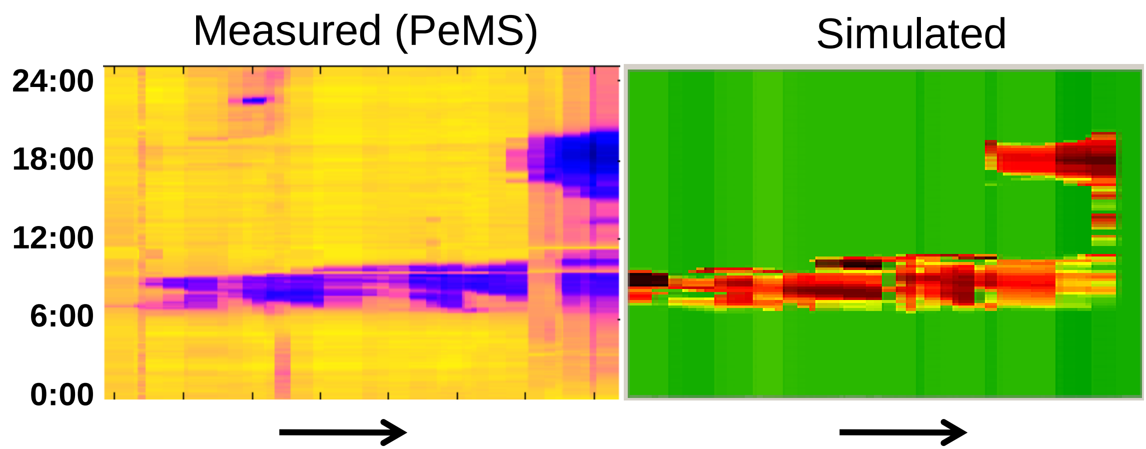
ATM Workflow



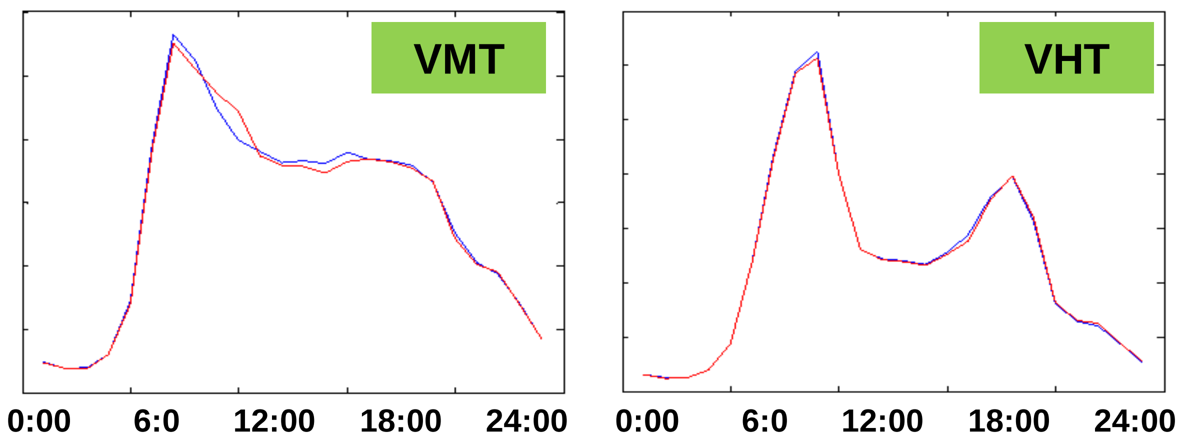
Example I-80 W, 01/14/09



Speed contours



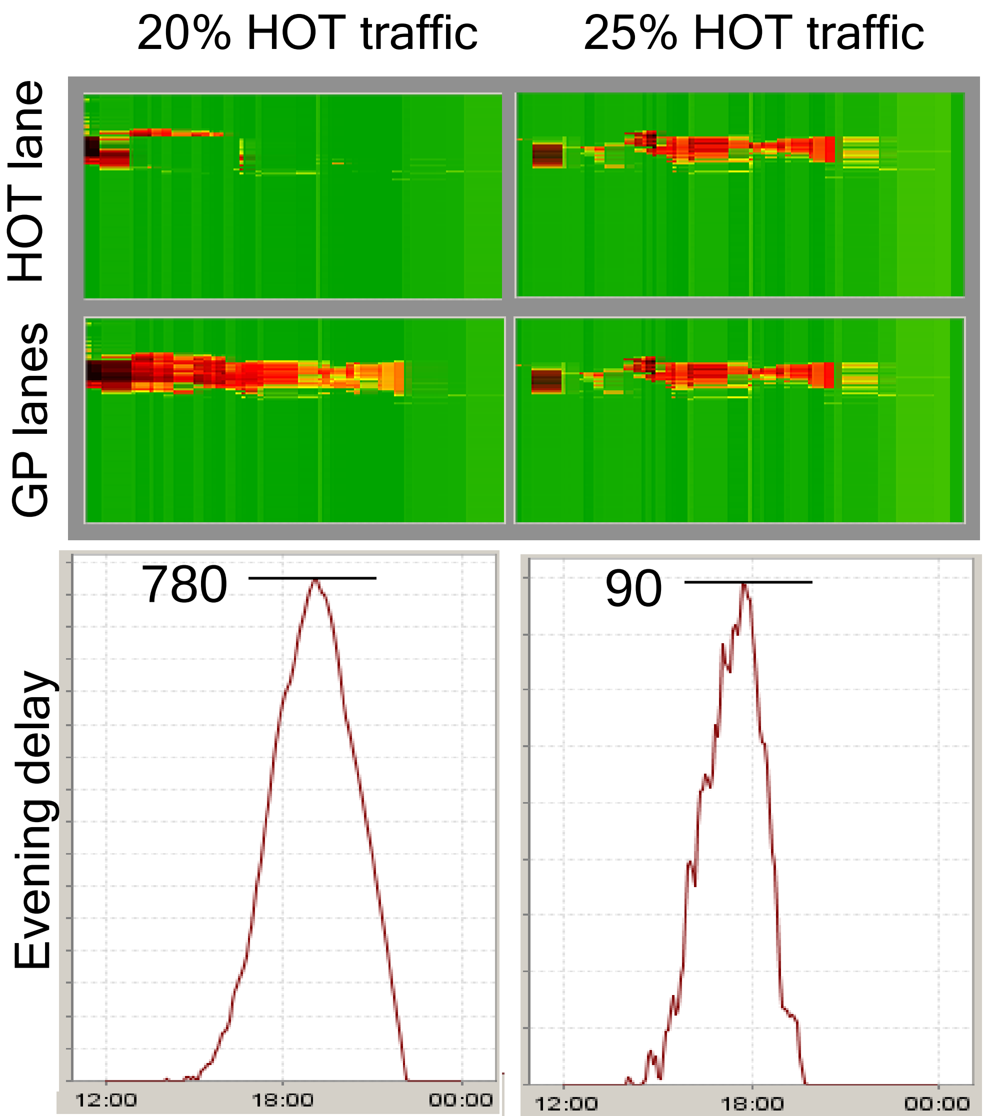
Performance measures



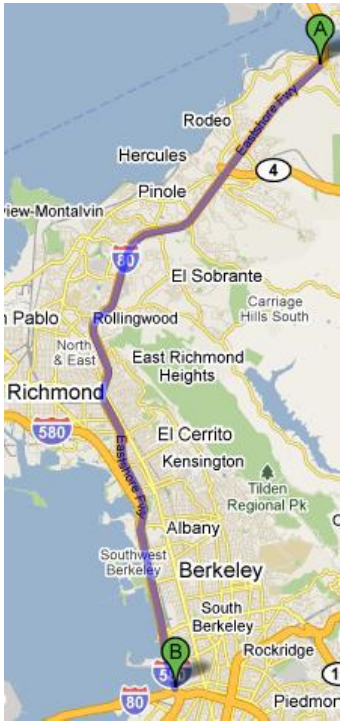
Measured (PeMS)
Simulated

Example: HOT lane management

- Changes in % traffic in HOT lane produce changes in total delay.

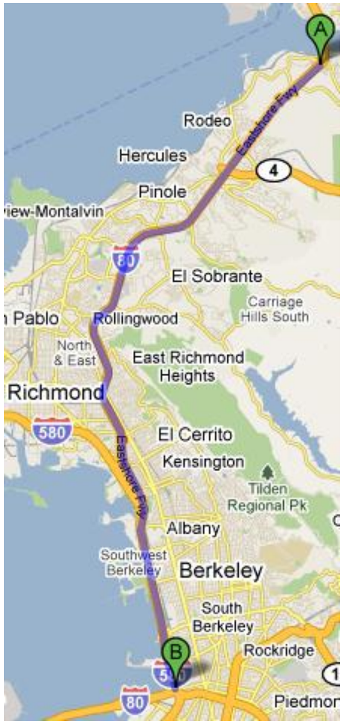


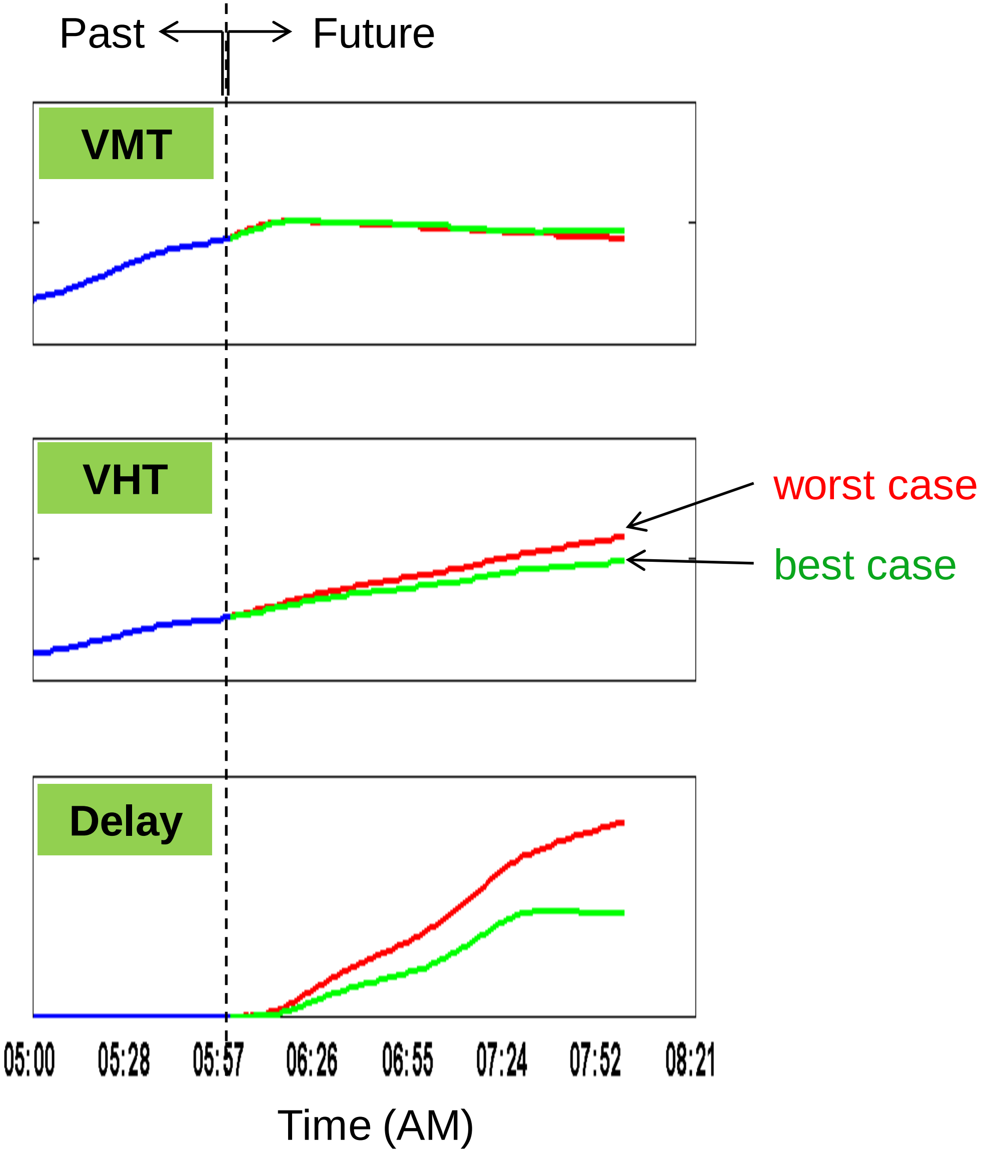
Example I-80 W, 01/14/09 Best/worst case prediction



- Current time 6:00 am
- Prediction horizon: 2 hours
- Uncertainty: 1% in capacity, 2% in demands

Example I-80 W, 01/14/09 Best/worst case prediction





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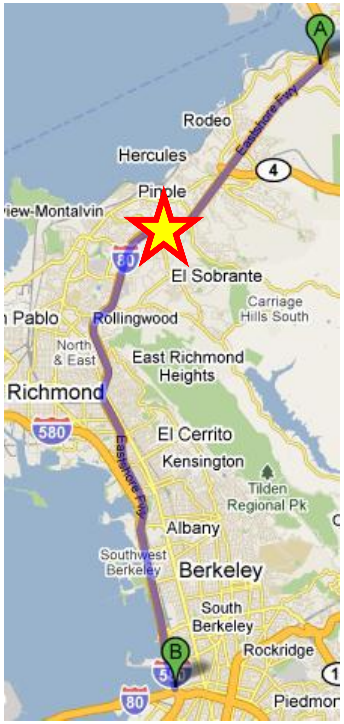

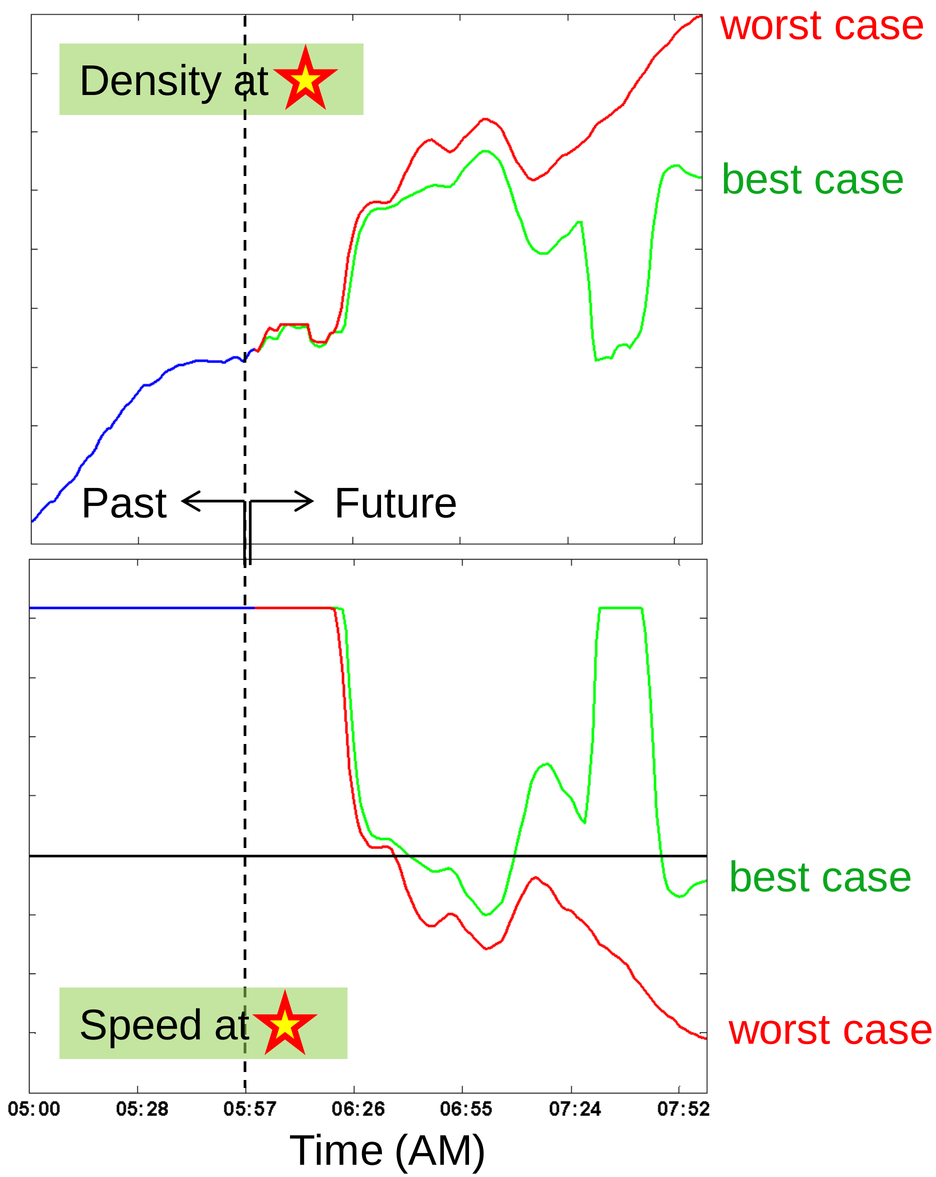

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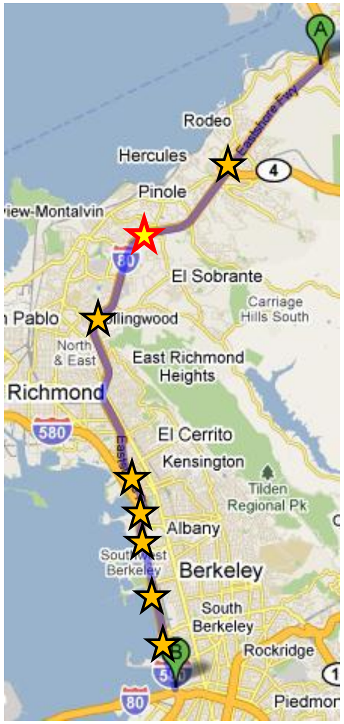
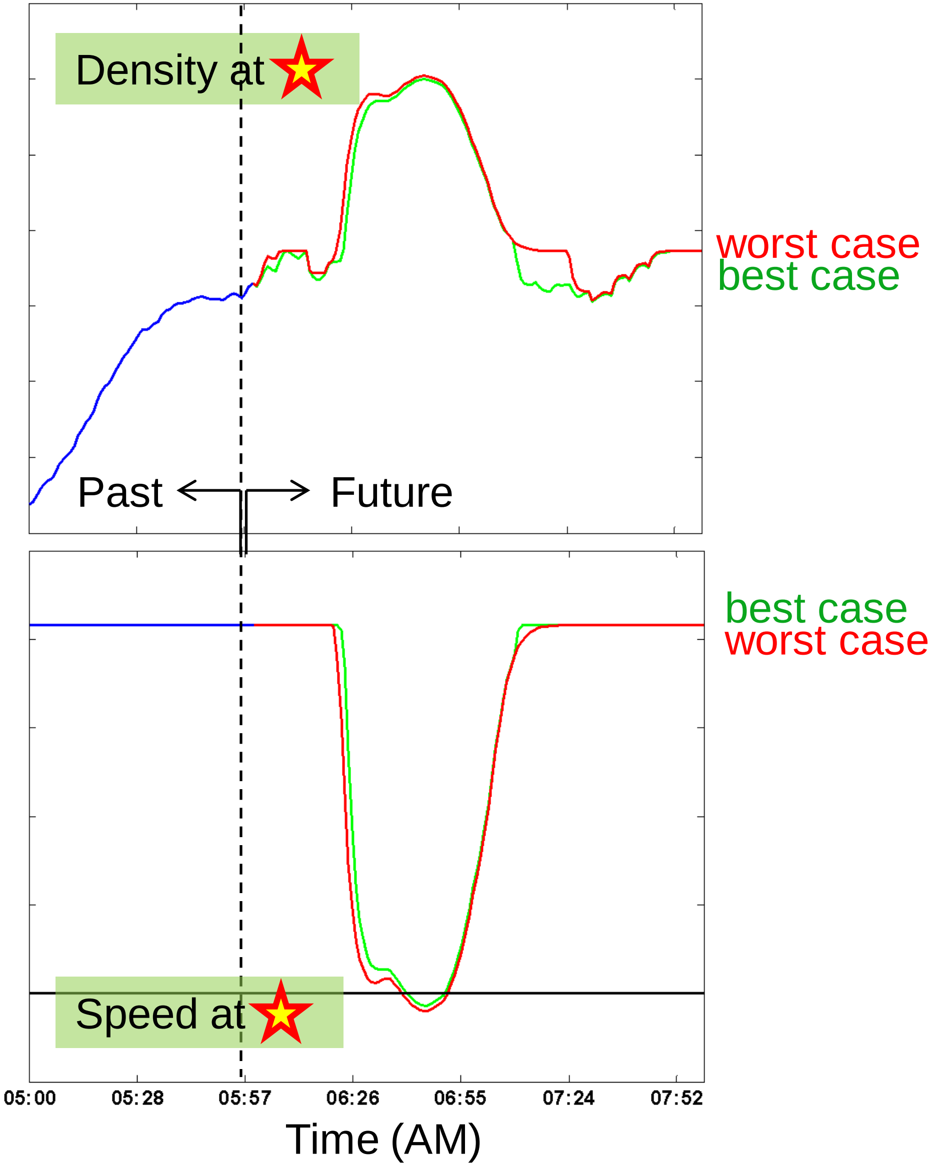
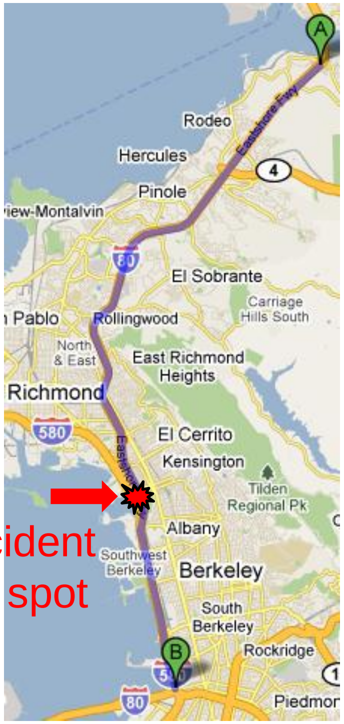


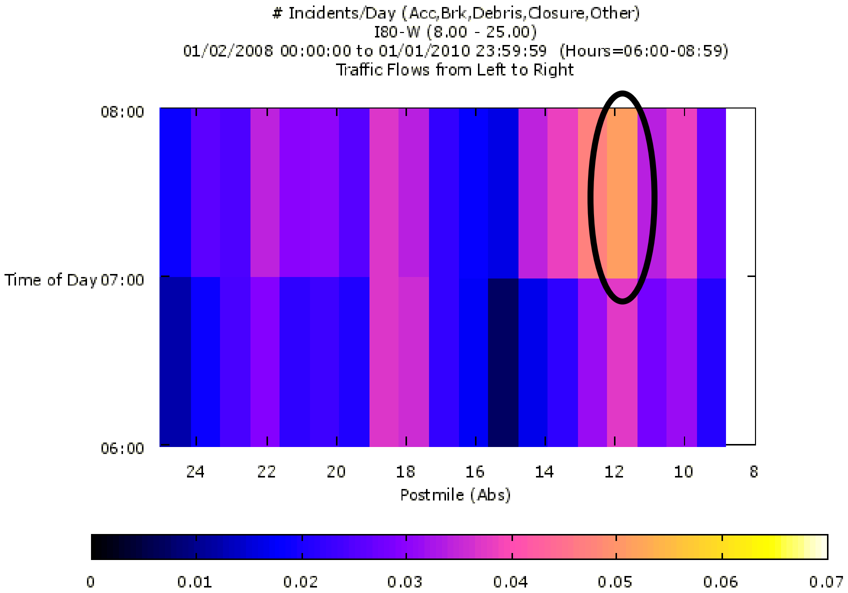
Ramp metering at ☆



Example I-80 W, 01/14/09 Accident hot spot



accident hot spot

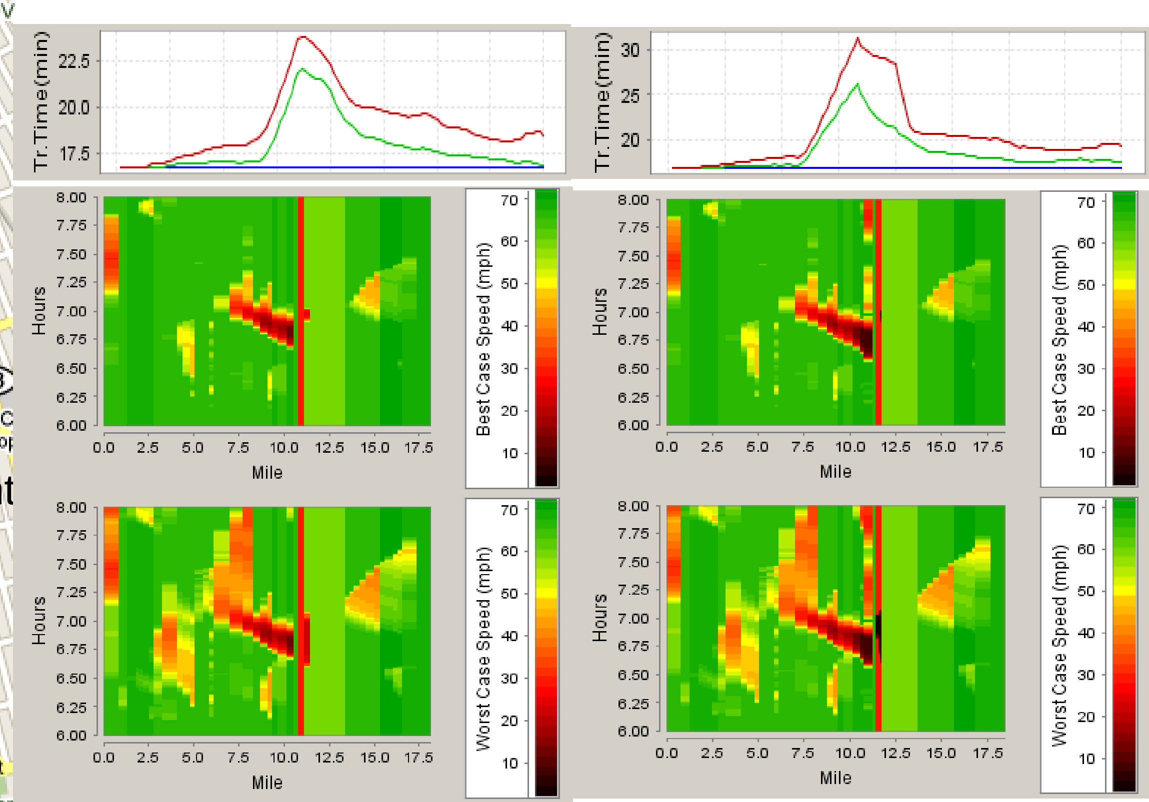


I-80 West accident strategy 4: ALINEA and VMS detour

- ALINEA + queue control: upstream of accident
- VMS Detour: 10% use Carlson and Central junctions to 580 EB

Carlson route

Central route



Traffic Monitoring and Control Systems and Tools

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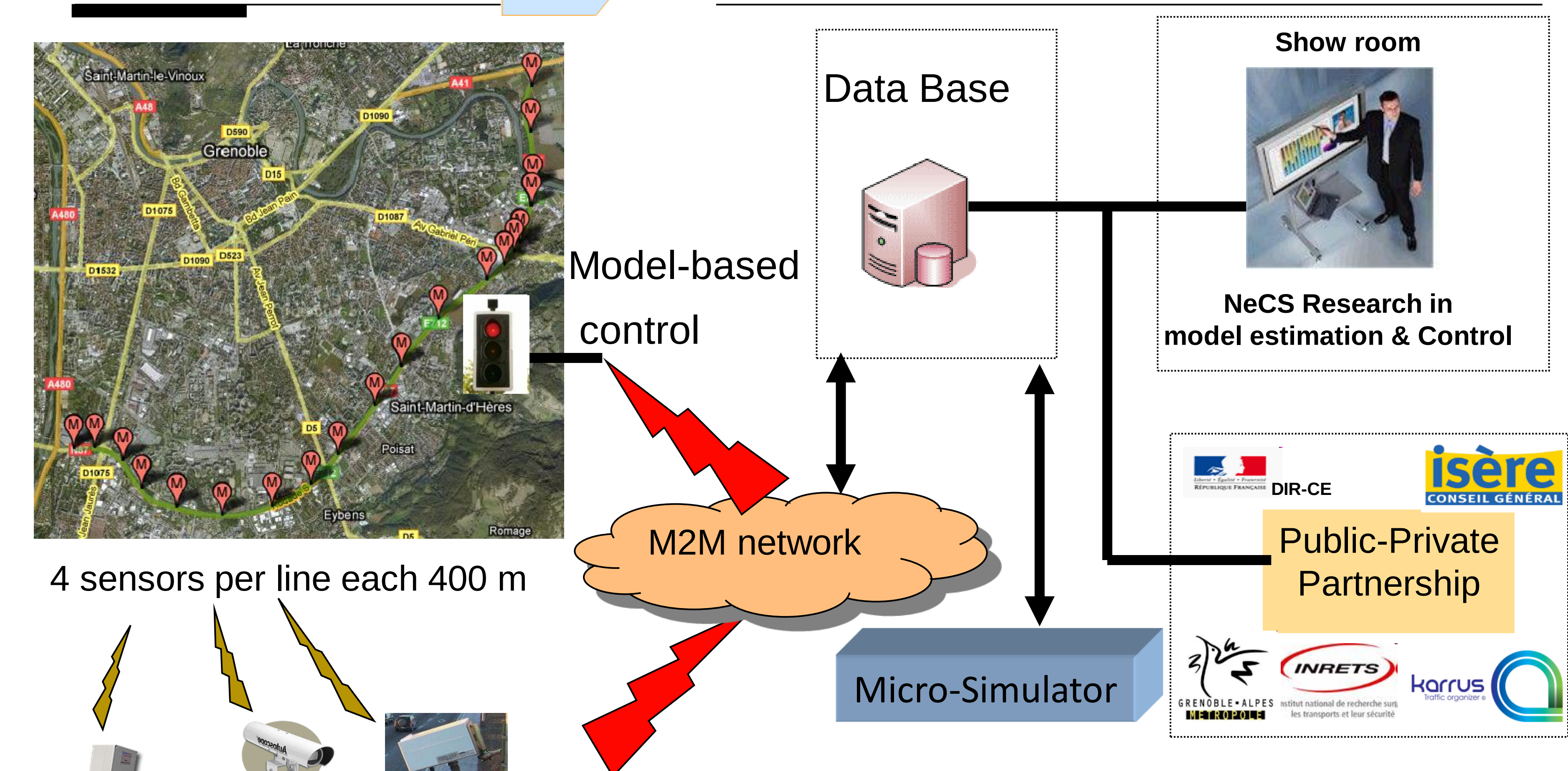
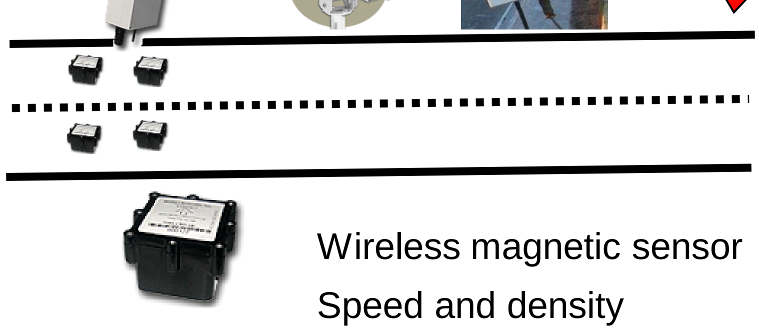
GTL is a WSN data collection platform for real-time traffic modeling, prediction and control

Grenoble
Traffic
Lab





- A national center of traffic data collection
- Multi-purposes data exploitation (model, prediction, control, statistics, etc.)
- Public Partnership: INRETS, DIR-CE, CG38, Metro,
- Research transfer to KARRUS-ITS (Grenoble start-up)

Long-term GTL Strategy

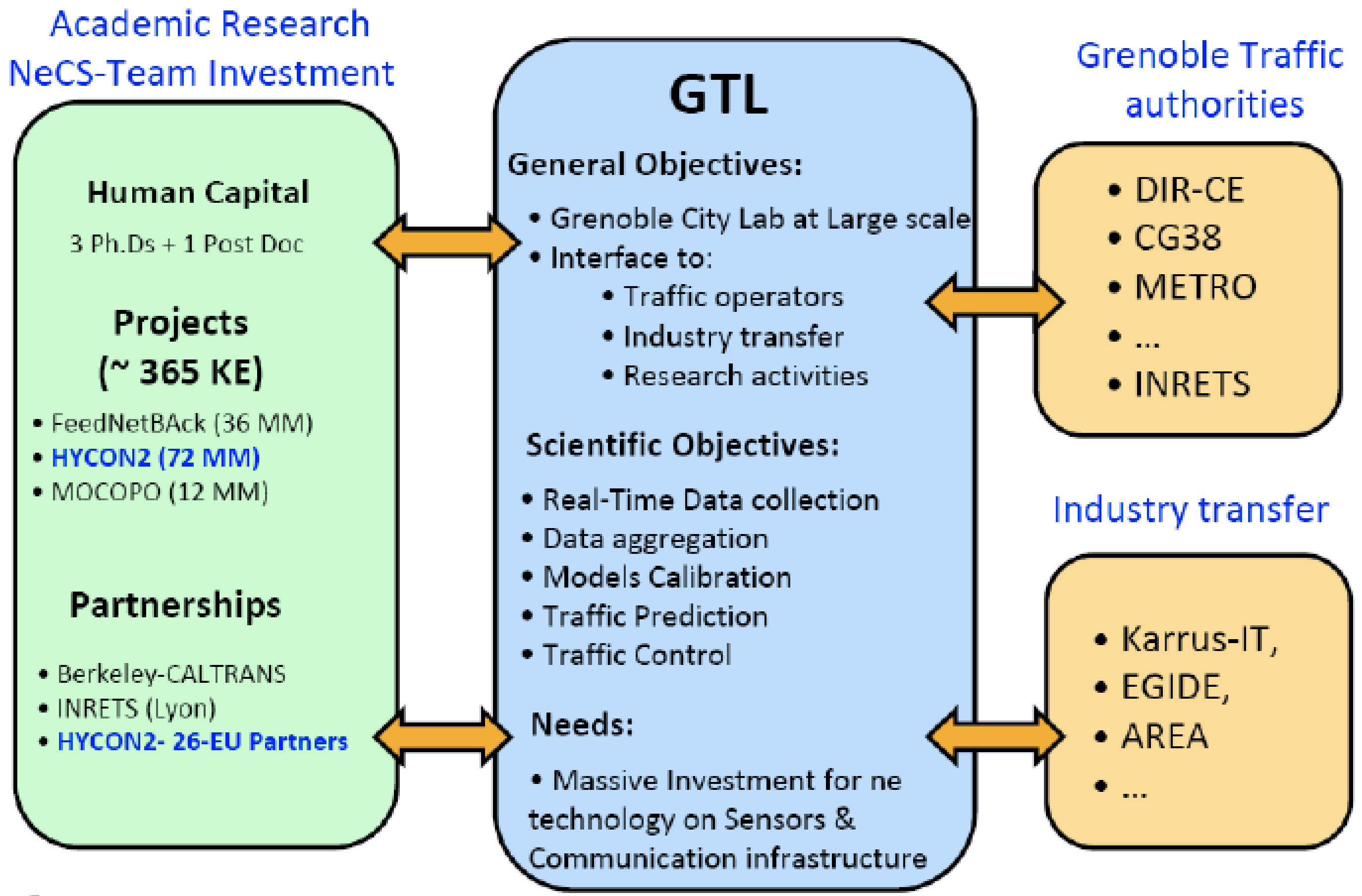


Fig.3 This figure show the role and position of the GTL in connection with the NeCS team activities, and its interrelation with the academia, the governmental traffic authorities and industry.

Context: Grenoble south ring, wireless sensor networks