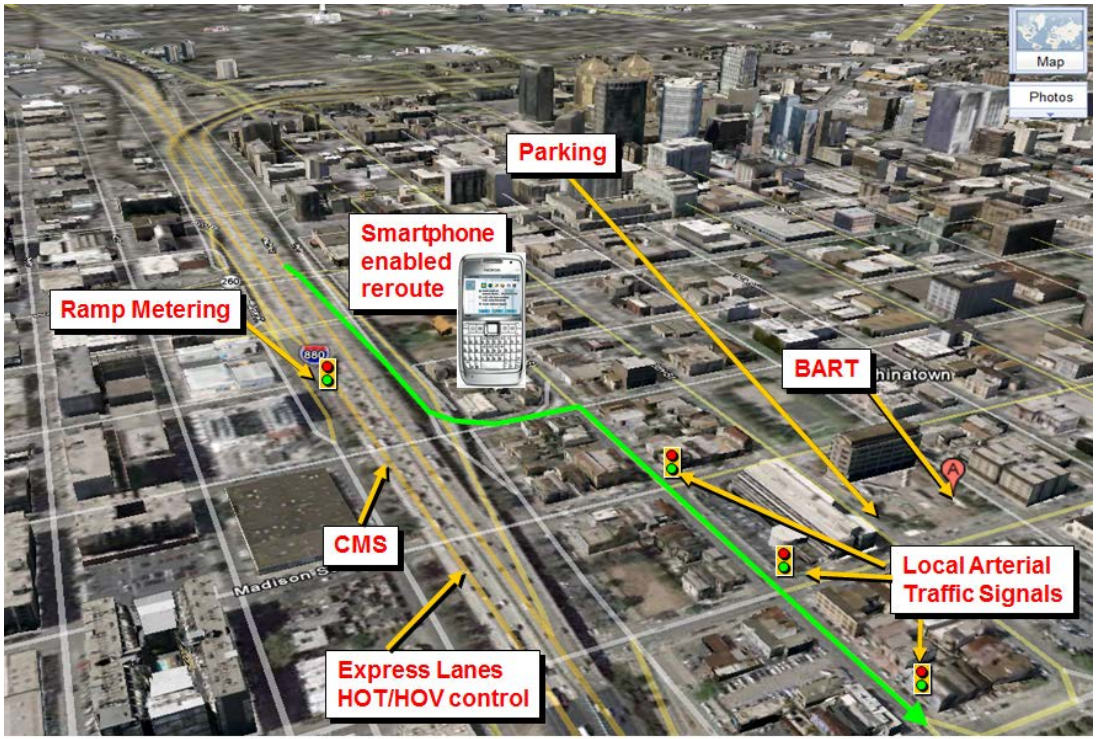
California Connected Corridors: Vehicles, Information, and People Pilot



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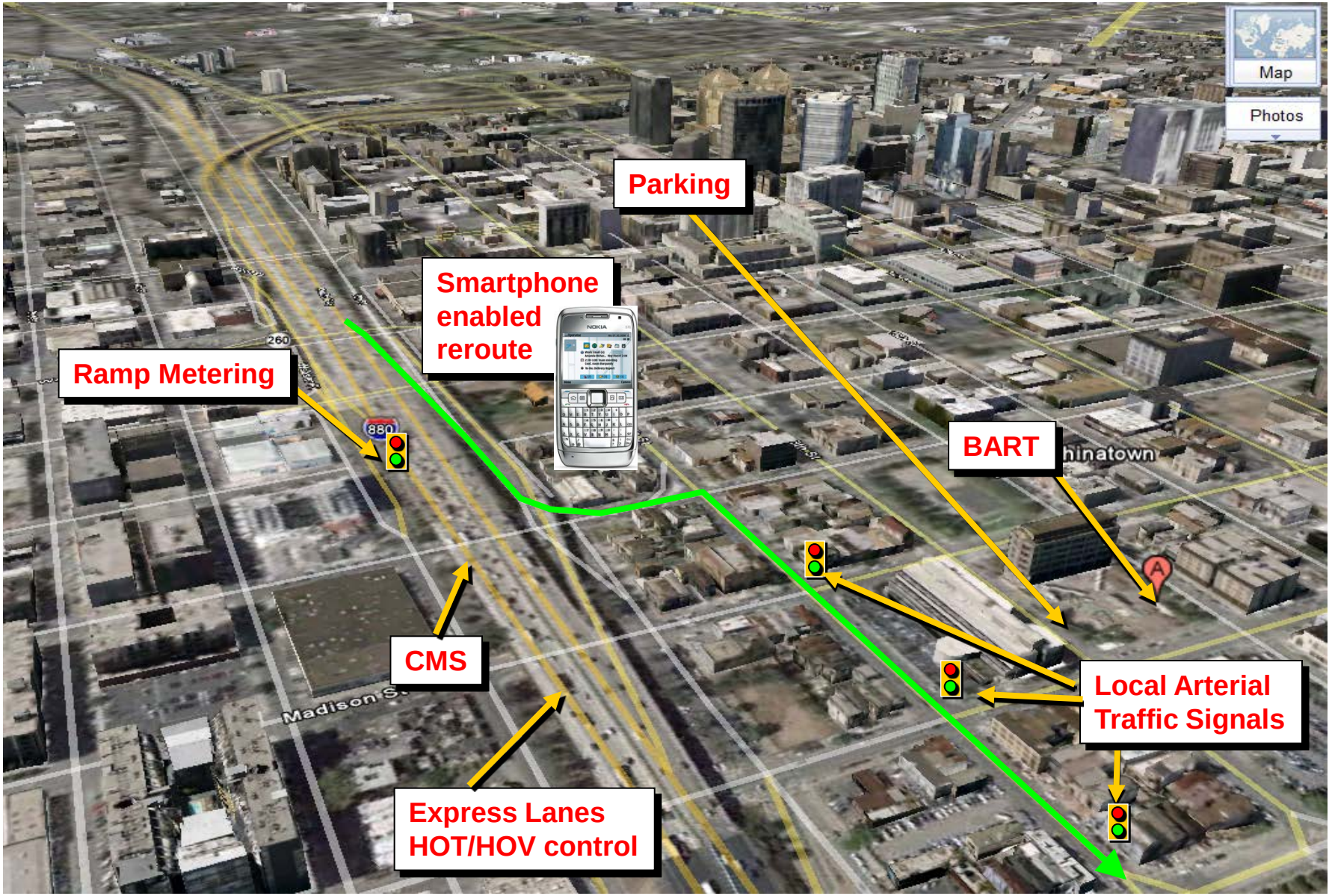
A graphical illustration of ICM



Institutional architecture for connected corridors

Caltrans, TMC, MPO(s), Counties actuation infrastructure
- Metering
- CMS
- HOV/HOT

Transit agencies
- BART
- Buses
- Carpool, zipcar, etc.

Operational commands

Real-time access, data

CC system

Real-time access, data

Advisories
Commands
Travel info

Services
Real-time access
Data

Collaborative commuters
- Web apps
- Mobile apps

Sensing infrastructure
- Loops (PeMS)
- FasTrak

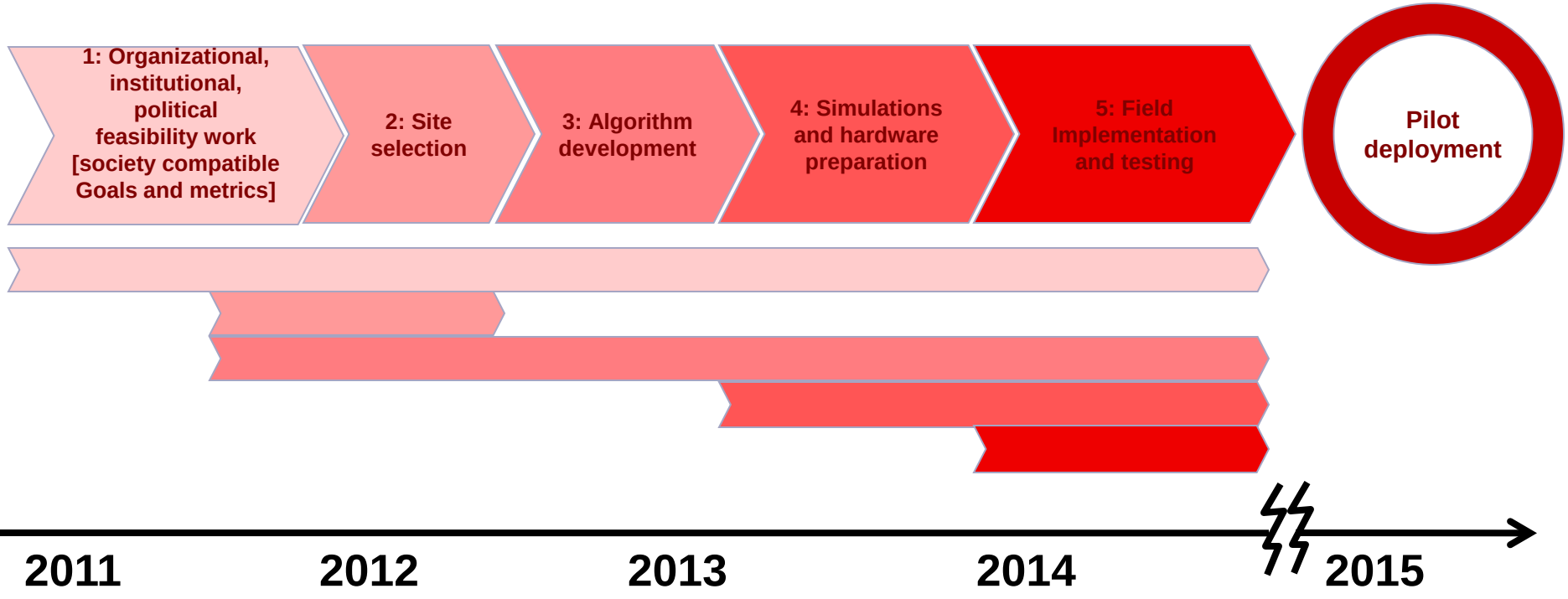
Industry partners
- Data agreements
- Services (backend, front end)

Process for the implementation of the pilot

Three fundamental aspects to cover for pilot deployment

- **Organizational: Are proper components available (meters, support systems, shoulders, etc.)**
- **Institutional: Statutory framework needs to be worked out. Authorization needs to be obtained.**
- **Political: Is corresponding measure politically acceptable?**

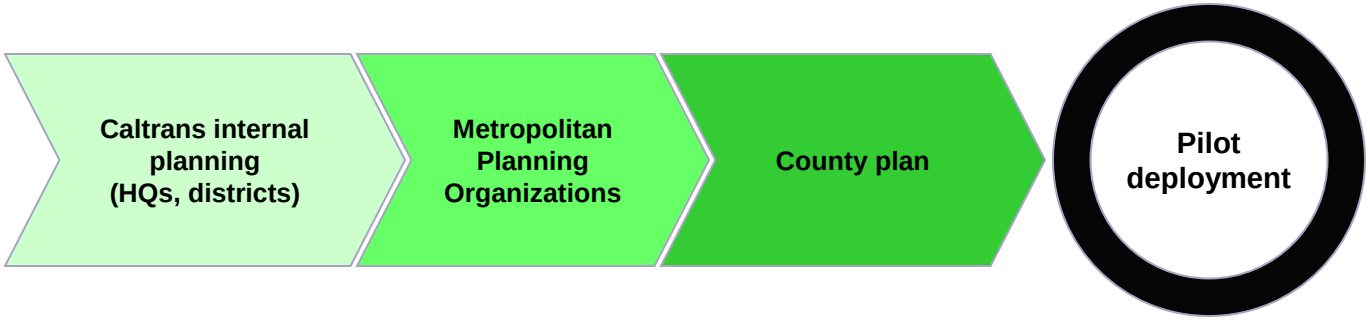
5 stages of research and technology deployment and piloting



Implementation milestones

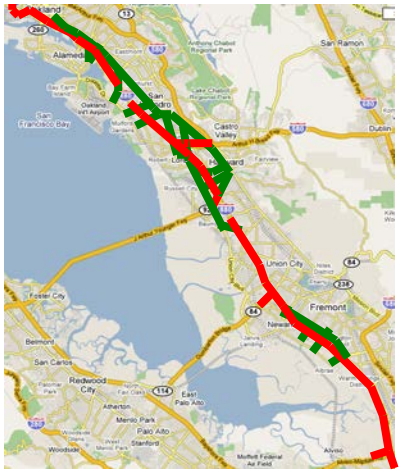
Three step process to field deployment

- Caltrans internal planning (headquarters and districts)
- Corresponding regional Metropolitan Planning Organizations (MPOs): integration with their regional plan
- County plan (sales tax measures)

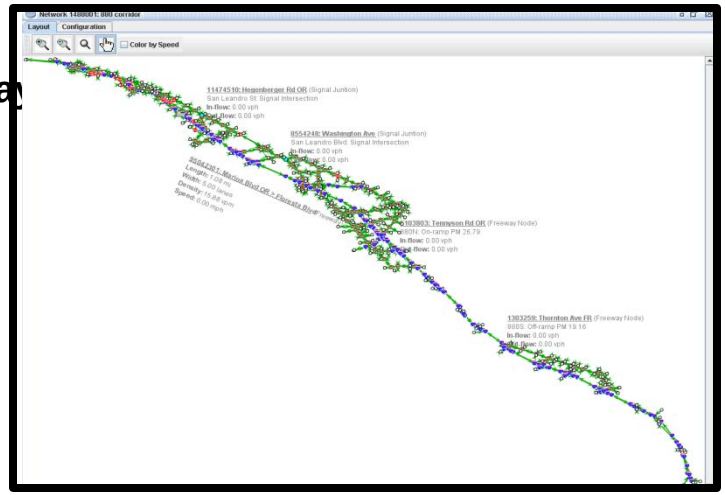


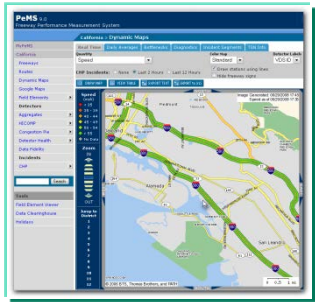
Using the tools developed by the PATH TOPL program

Select & "prune" corridor from Google maps



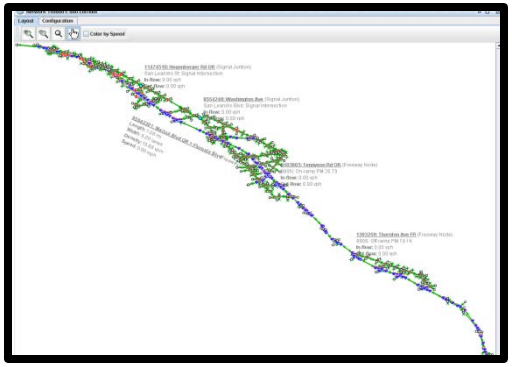
Import corridor freeway and arterial topology into a macroscopic CTM-based simulator





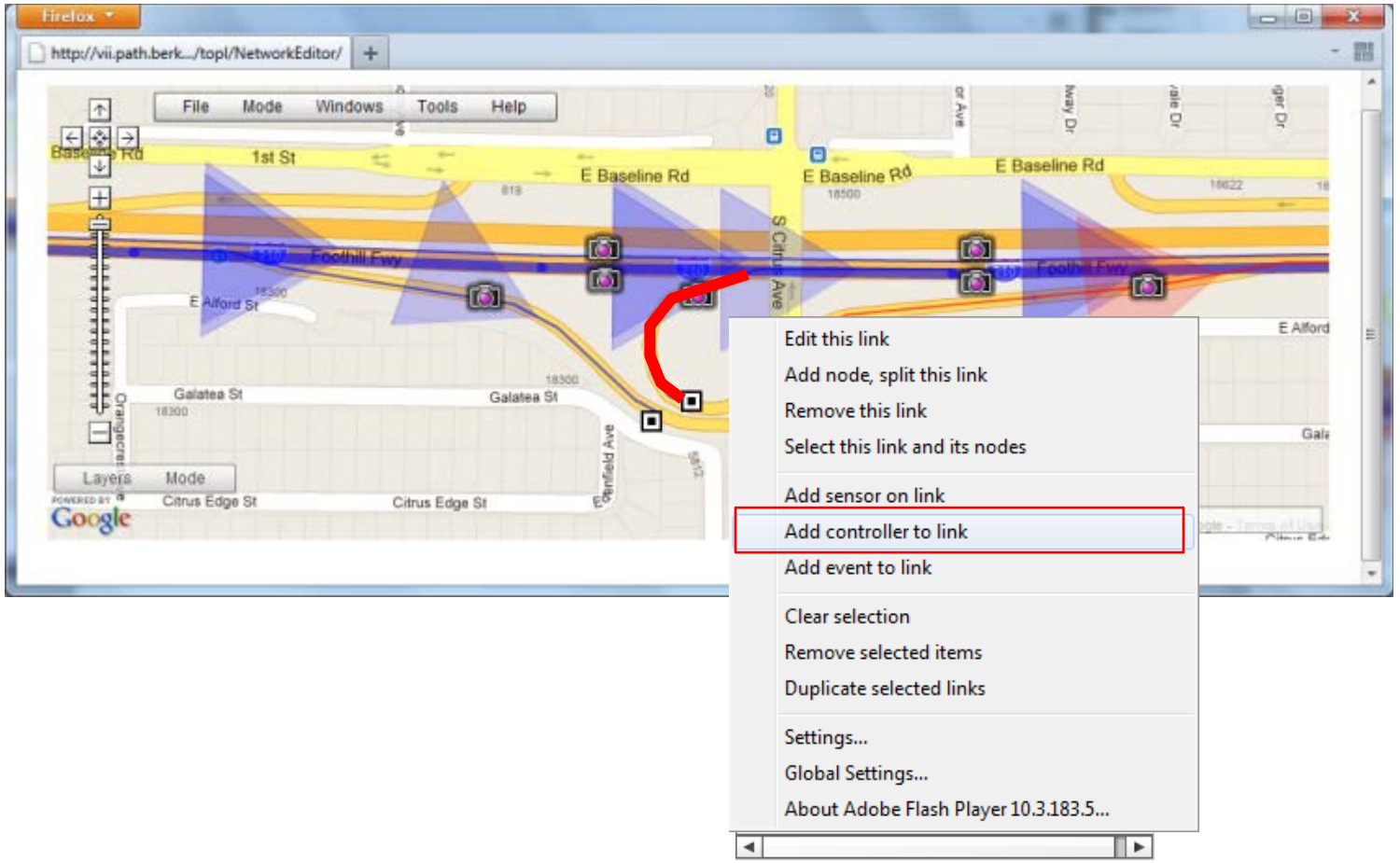
Use PeMS traffic data for automatic
- **model calibration**
- **imputation of missing mainline and ramp data**

Perform traffic management simulation studies on diverse scenarios and test enhancements:
- **ramp metering, variable speed limits**
- **incident management,**
- **traveler information,**
- **demand management, etc.**

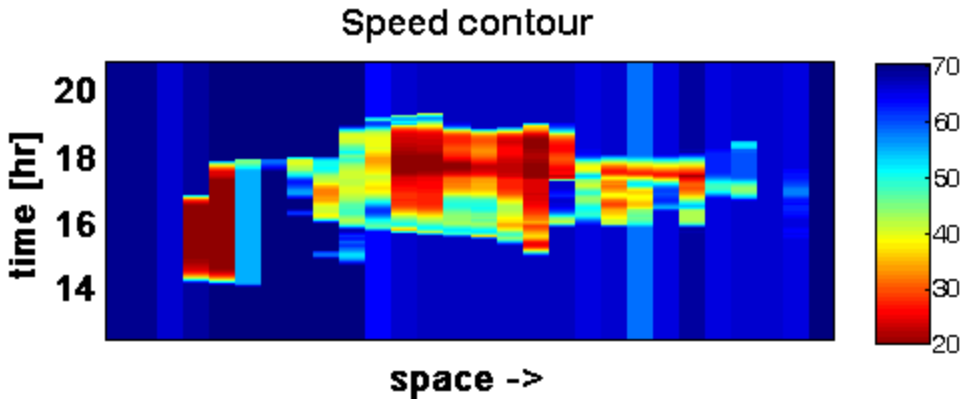


Ramp metering

- **Simulation capabilities a variety of ramp metering algorithms**
  - **ALIENA, HERO, SWARM, TOD, TOS, Traffic responsive, etc.**
  - **Queue overrides.**

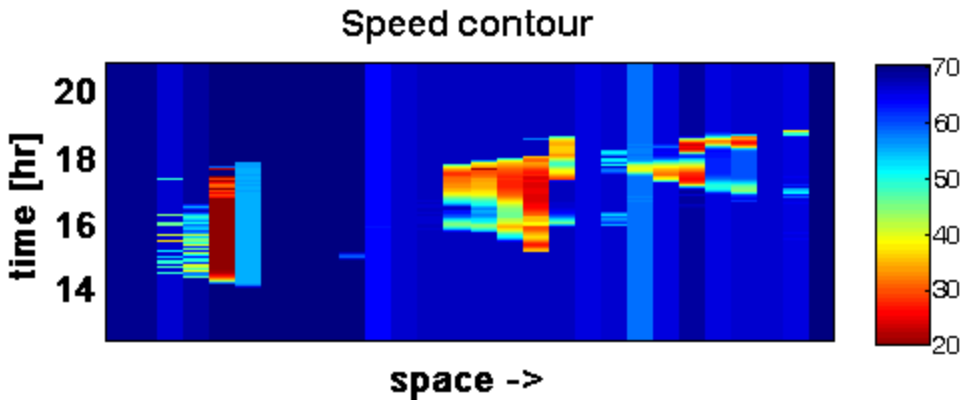


I-80E Queue limit parametric study.



Velocity Contours : I 80 E 20 Aug 2008

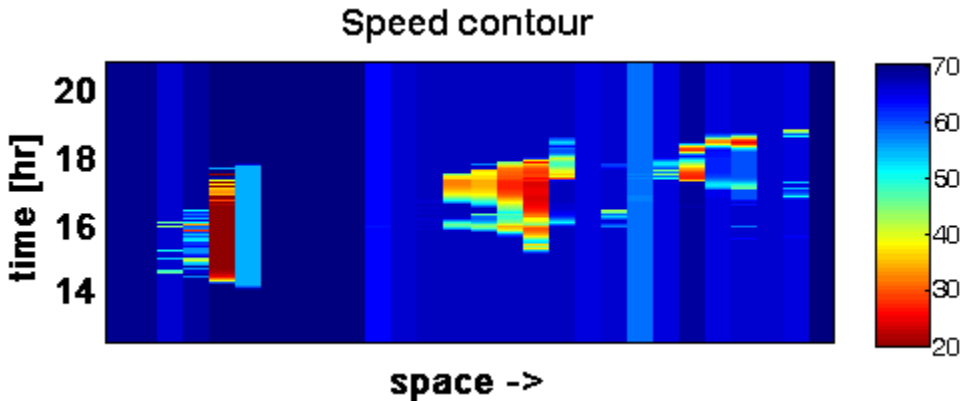
NO RAMP METERING



RAMP METERING:

Current ramp storage limits

Delay Reduction: 15.3%



RAMP METERING:

Current ramp storage limits
+ 35 vehicles extra storage

Delay Reduction: 17.3%

2008 → 2012: web 2.0 on wheels

Emergence of the mobile internet

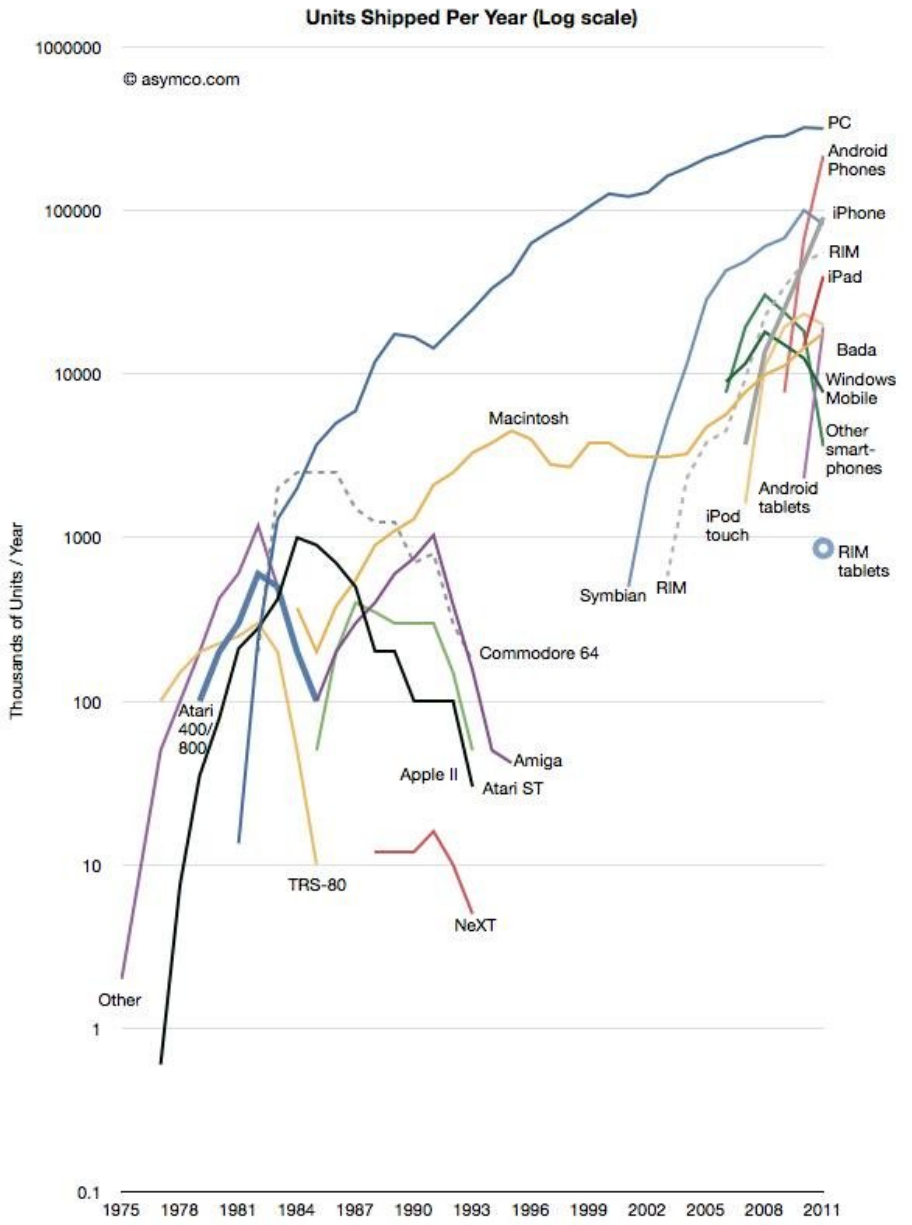
- Internet accesses from mobile devices skyrocketing
- Mobile devices outnumber PCs
- 4 billion phones on earth
- 1 billion smartphones on earth

Sensing and communication suite

- GSM, GPRS, WiFi, bluetooth, infrared
- GPS, accelerometer, light sensor, camera, microphone

Smartphones and Web 2.0

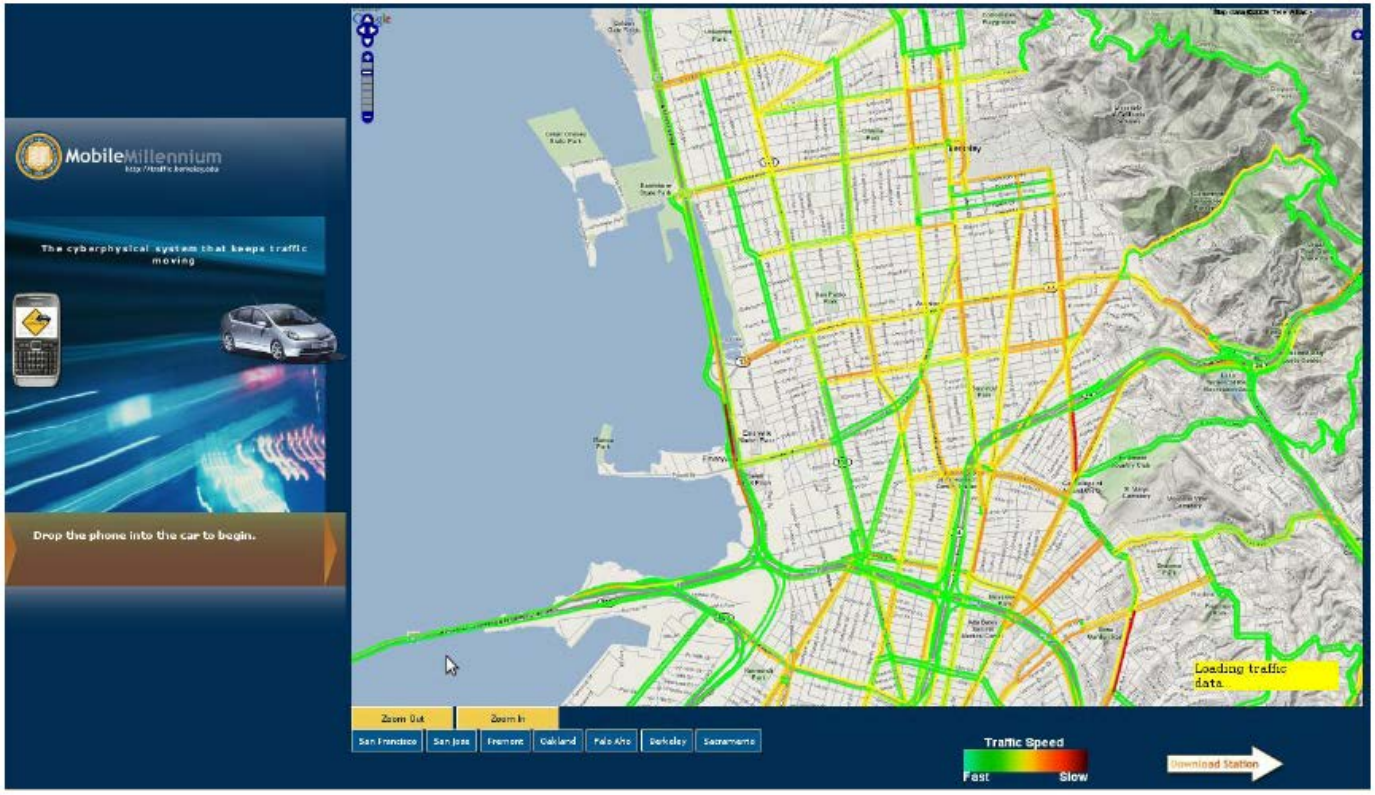
- Context awareness
- Sensing based user generated content



Mobile Millennium as an example of consortium

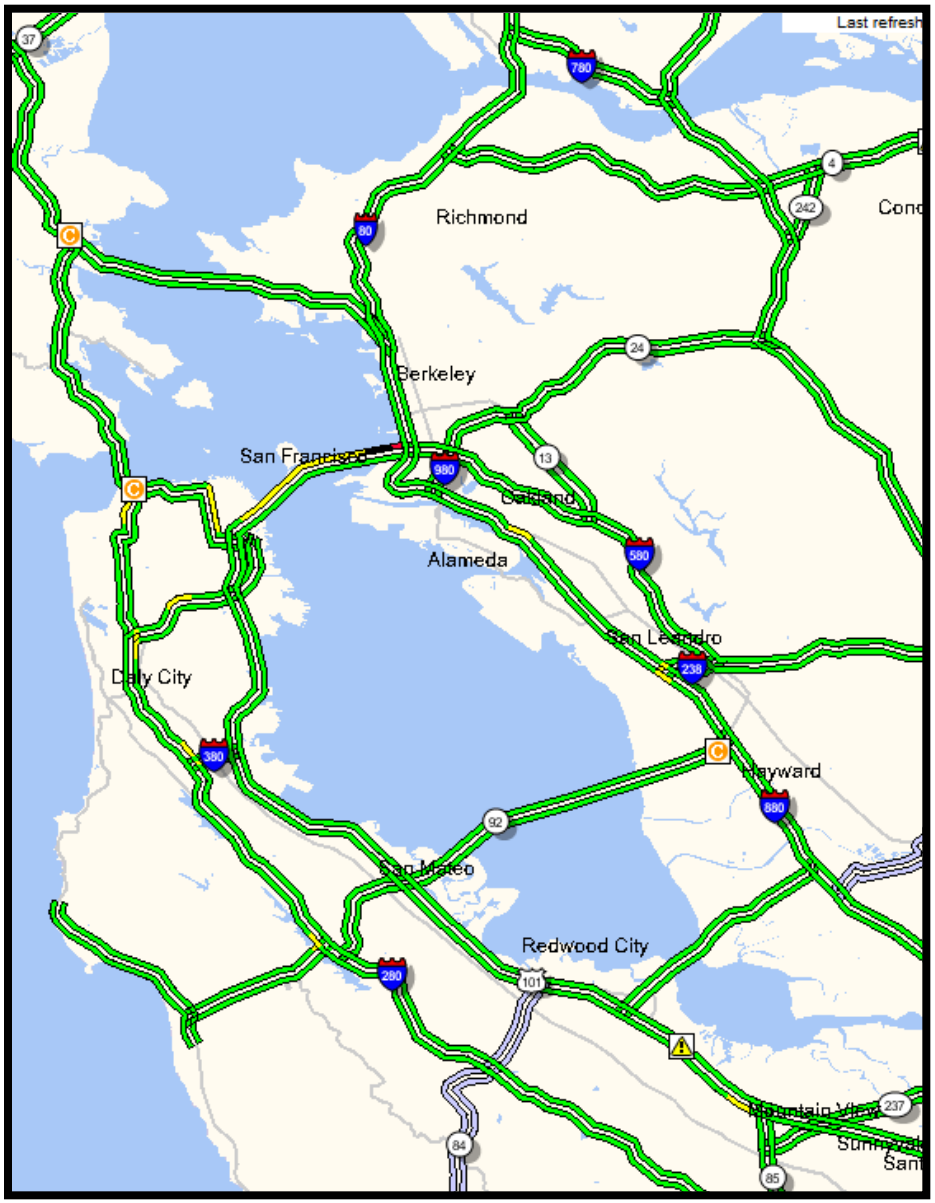
A novel prototype system launched in 2008

- **Funded by California DOT (DRI), US DOT, Nokia, NAVTEQ, NSF**
- **Initially, 5000 downloads of the FIRST Nokia traffic app worldwide**
- **Today: gathers about 60 million data points / day from dozen of sources (smartphones, taxis, fleets, static sensors, public feeds)**
- **Provides real-time nowcast (soon forecast) of highway and arterial traffic, provide routing and data fusion tools.**



2007

2009


Last refresh
Richmond
Berkeley
San Francisco
Oakland
Alameda
San Leandro
Daly City
Hayward
San Mateo
Redwood City
Mountain View
37
780
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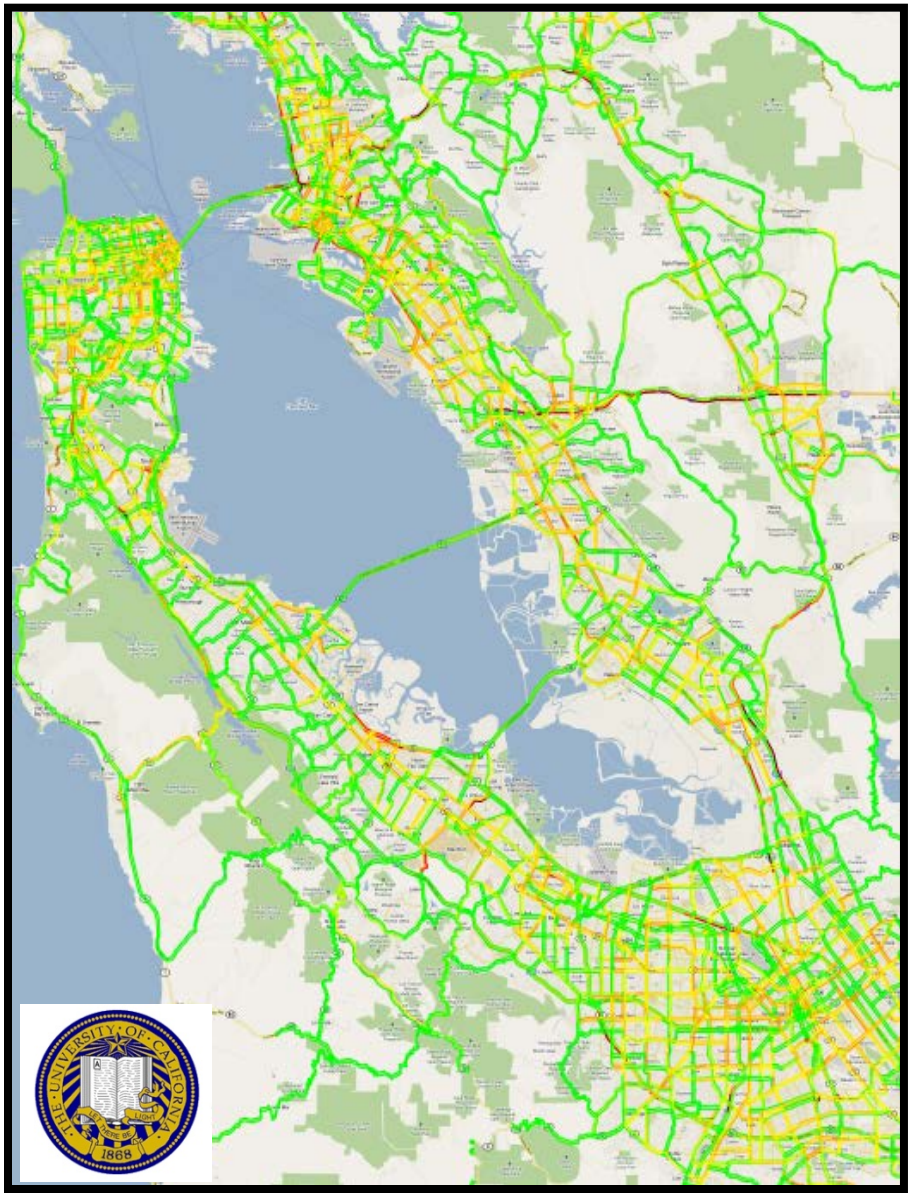
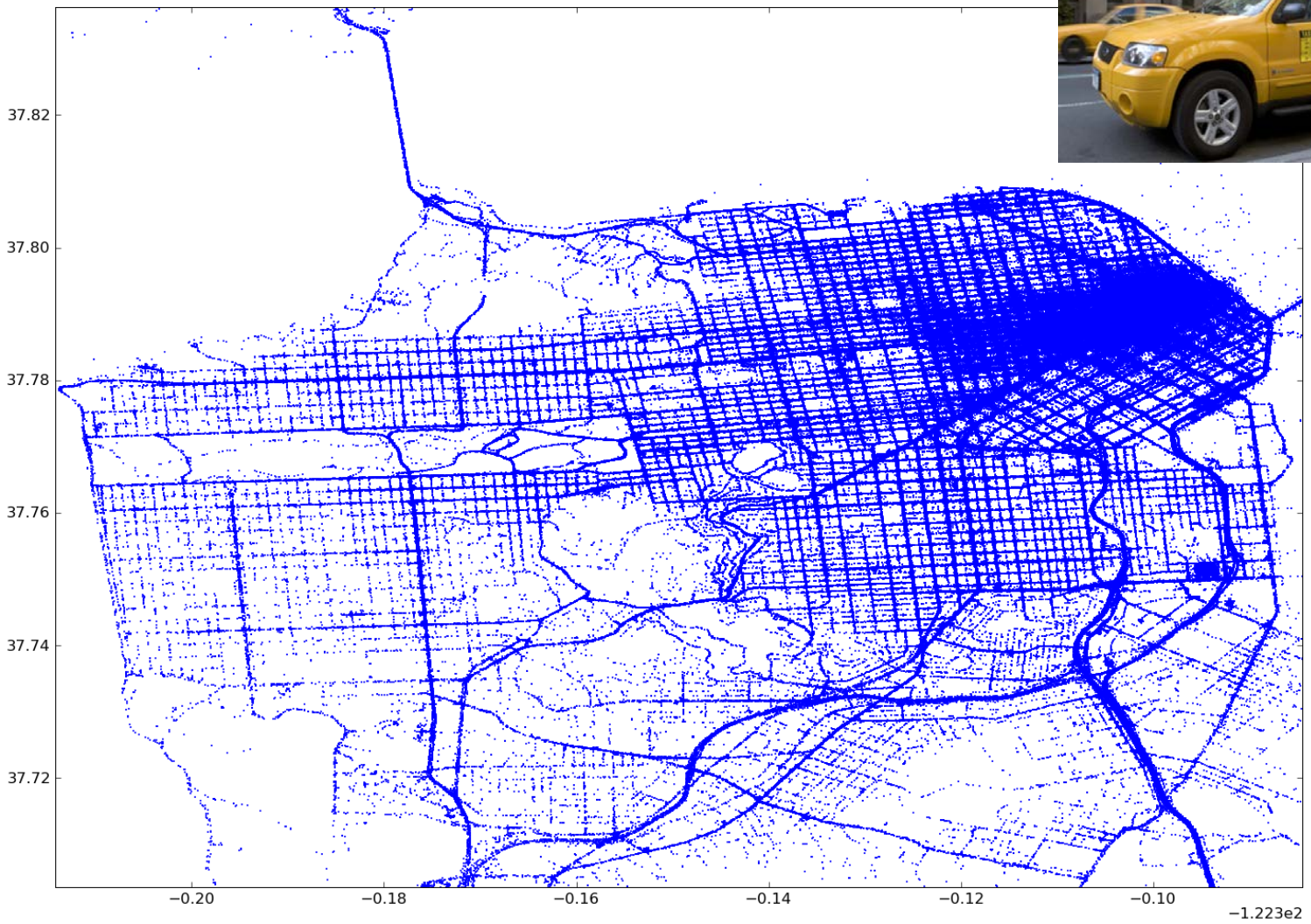
580
238
880
92
380
280
101
237
84
85



One day of Mobile Millennium data (SF taxis)



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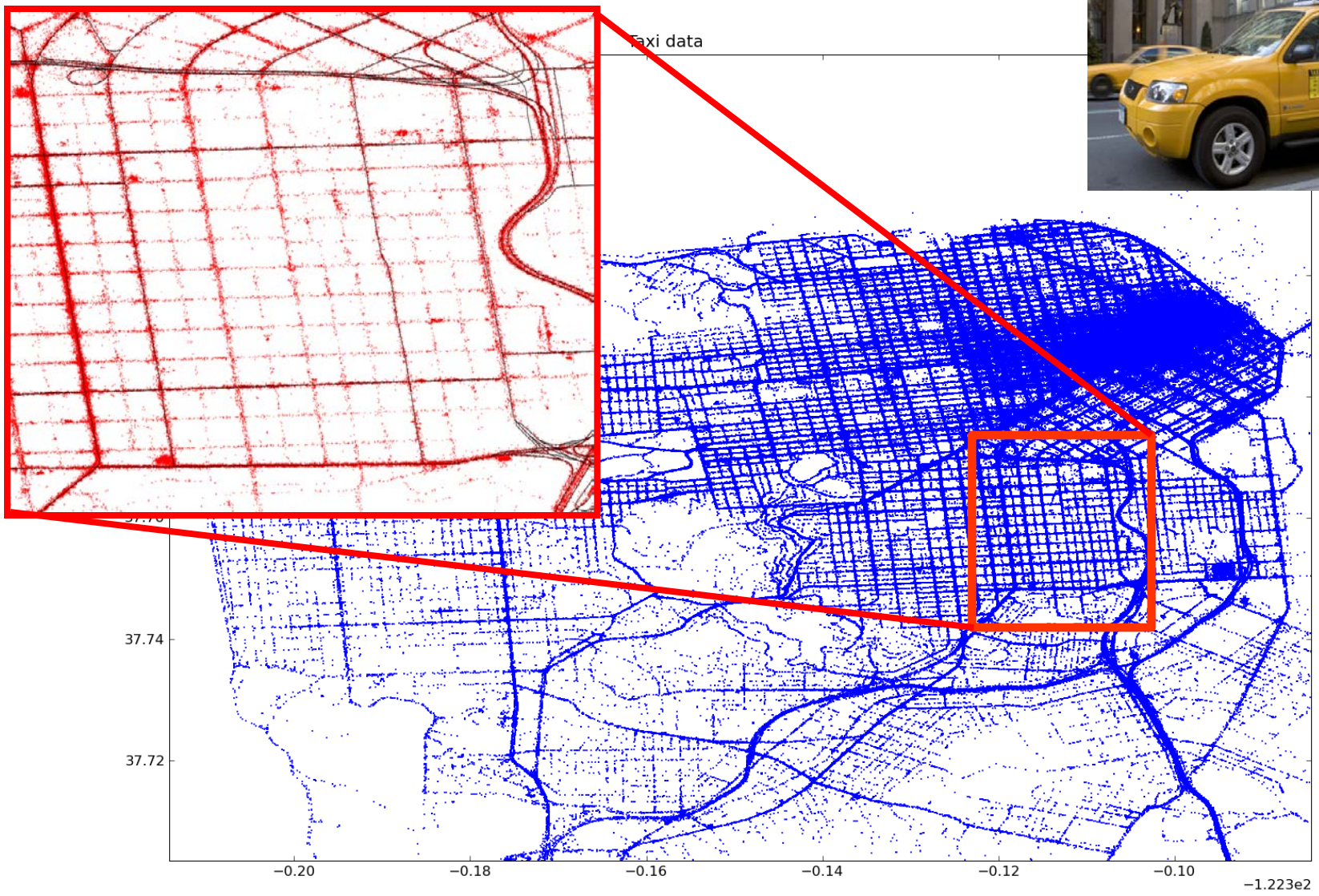

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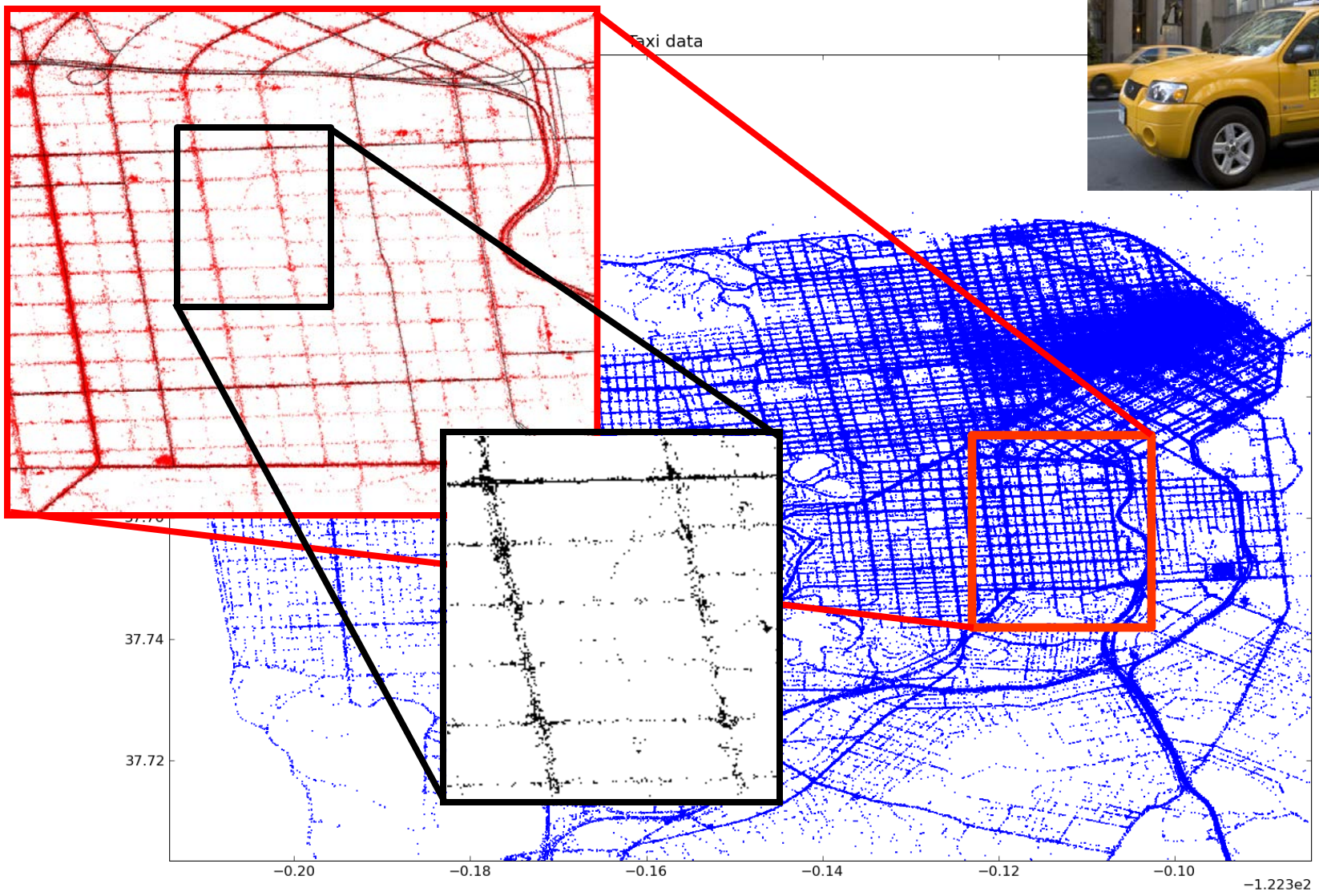

One day of Mobile Millennium data (SF taxis)

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One day of Mobile Millennium data (SF taxis)

Partners of the Mobile Millennium consortium

Caltrans

RITA U.S. Department of Transportation Research and Innovative Technology Administration

NOKIA Connecting People

University of California

Rutgers The State University of New Jersey

POWERED BY NAVTEQ TRAFFIC

TEKES

WINLAB WIRELESS INFORMATION NETWORK LABORATORY

telenav

California Center for Innovative Transportation

iTRiS

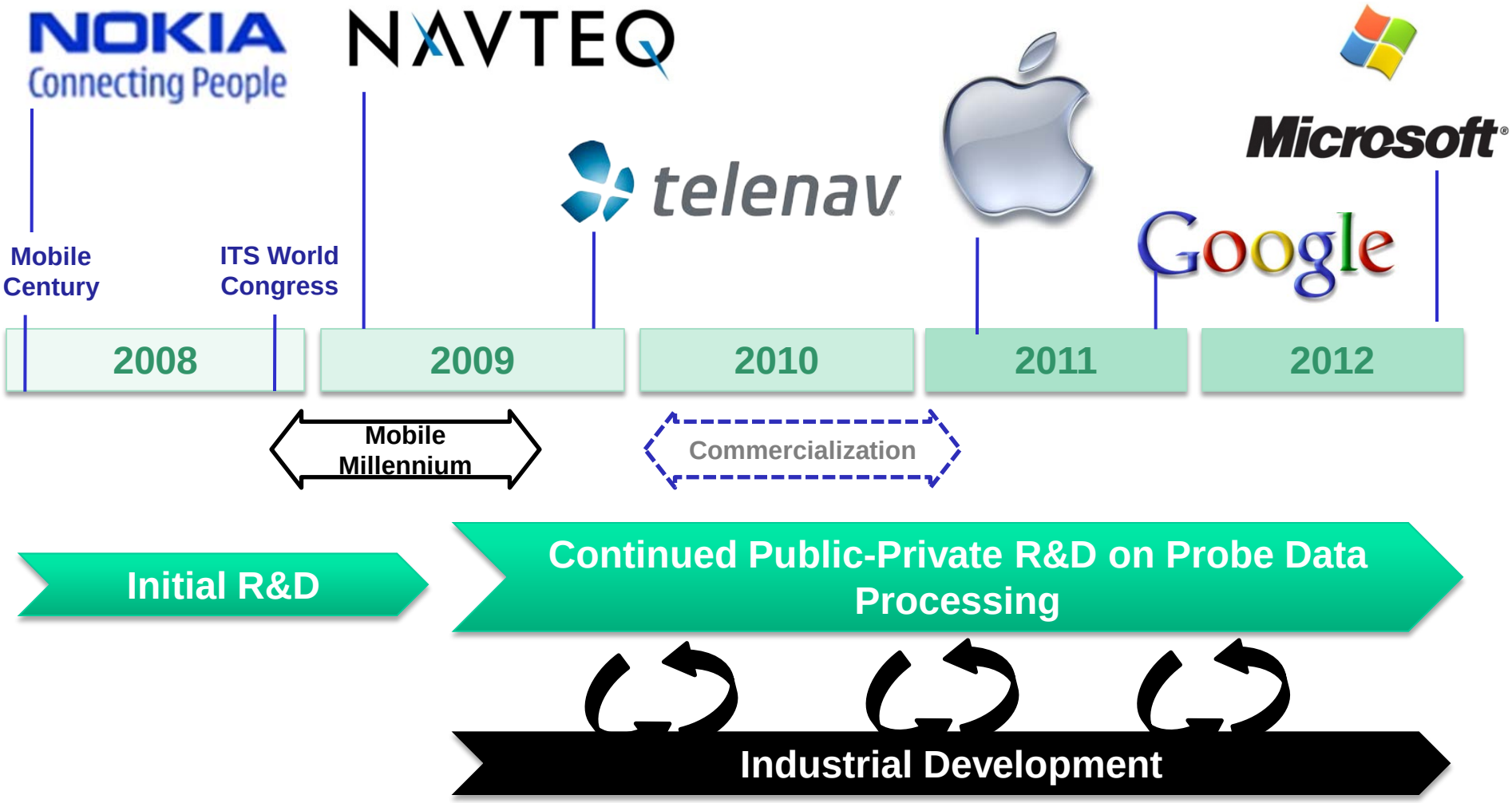
Institute of transportation studies

RENAULT

New Cities Foundation

LAGRANGIAN SENSOR SYSTEMS LABORATORY

Project timeline



Connected Corridors Consortium: members

1. Institutional leadership: PATH, UC Berkeley

2. Associated institutes and Universities:
   1. CITRIS
   2. UC Davis
   3. Univ. of Illinois
   4. INRIA (France)

Connected Corridors: consortium members

Funding members:

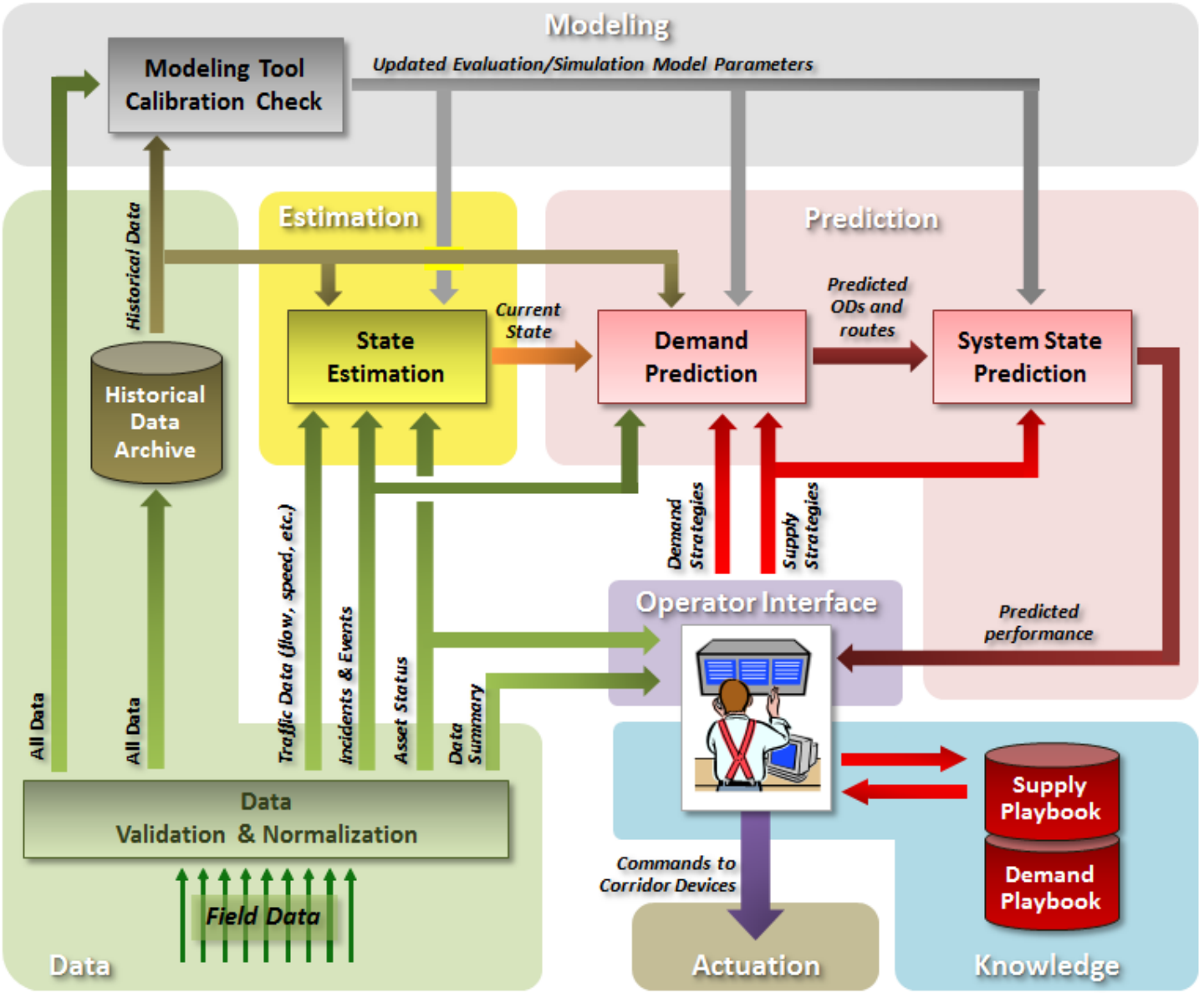
1. California DOT
2. Google
3. Ericsson
4. Nokia
5. NAVTEQ
6. Telenav
7. New Cities Foundation

Connected Corridors: consortium members

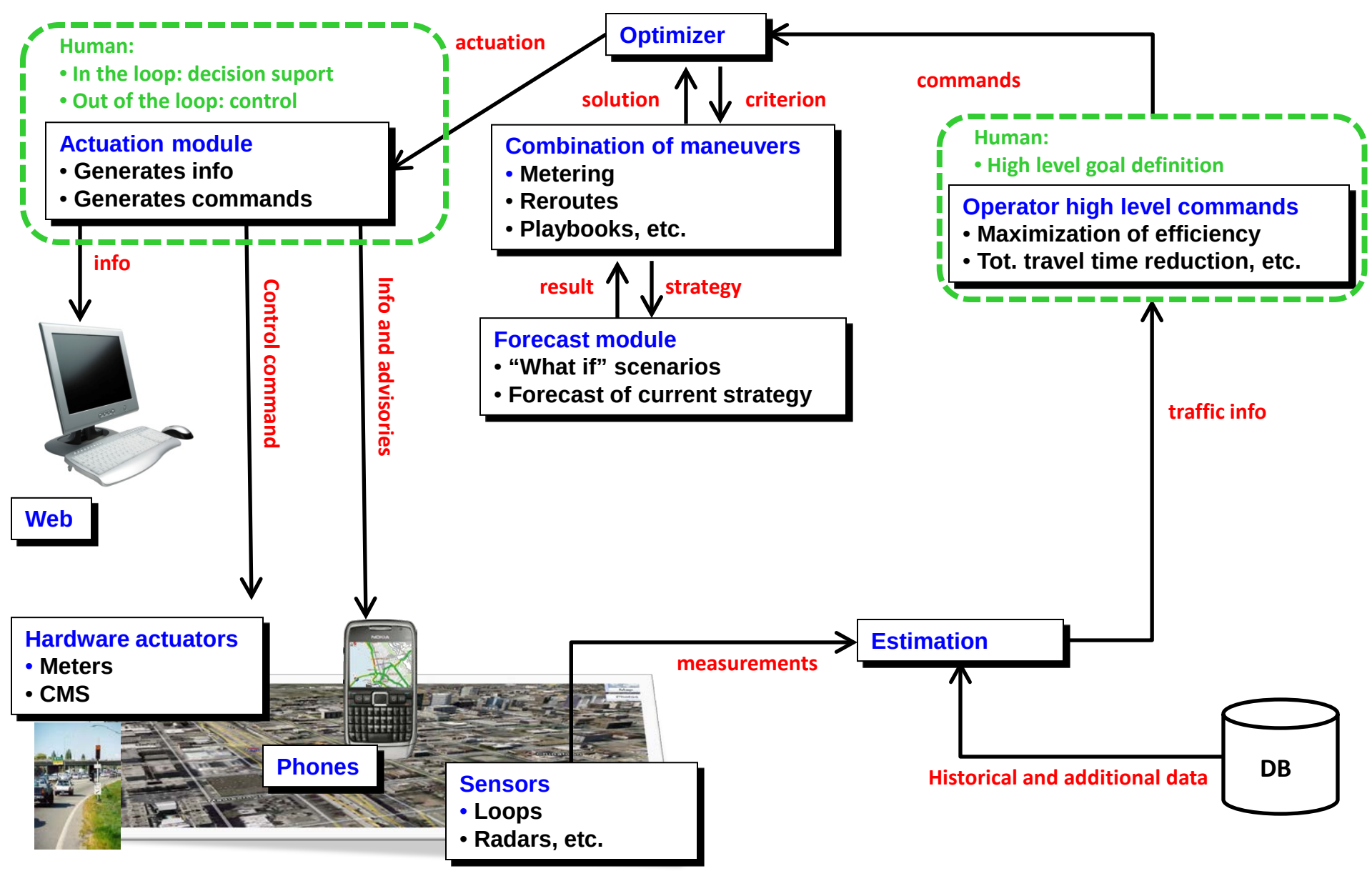
Associated members

1. Waze
2. Roadify

Building a decision support system



Information / control actuation flow



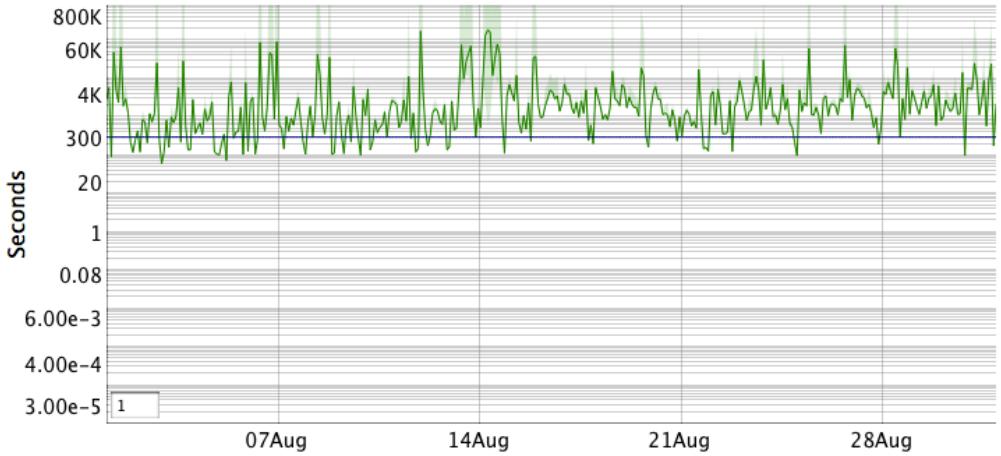
Leveraging Hybrid Traffic Data

The Connected Corridor Consortium will use novel types of data

- **Unprocessed data (“dust”, “raw”) probe data**
- **Data can be used to enhance traffic estimates on freeways**
- **Data will be used for places with no detectors (arterials)**
- **Data will be integrated into decision support tool**

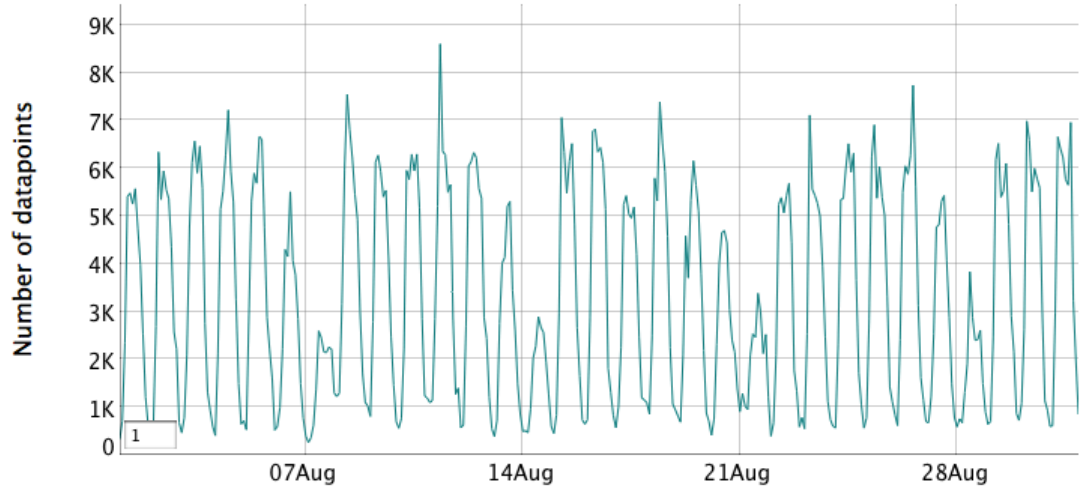
Leveraging Hybrid Traffic Data

Transmission delay

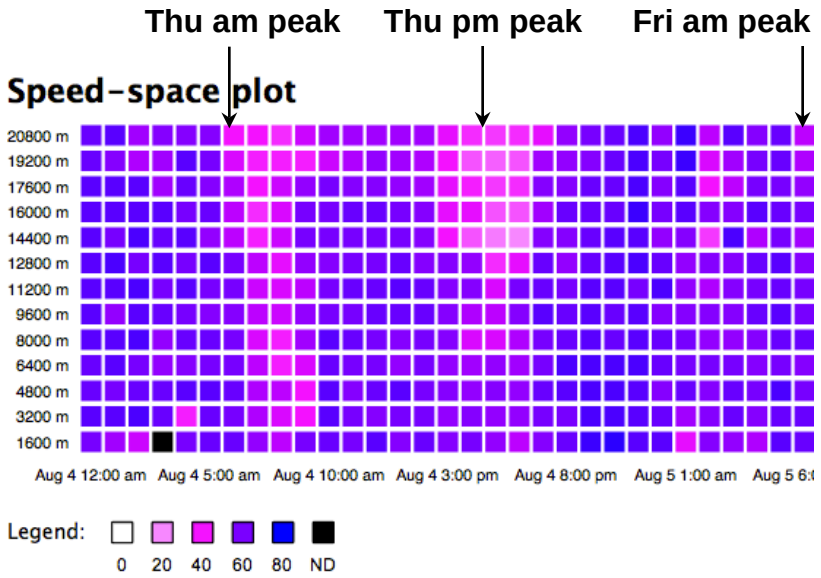


The amount of time that elapses between the device recording its location and the corresponding record being inserted into the database, in seconds. Line is the average; shaded area represents a standard deviation on either side of the average. Data aggregated every two hours.

Time coverage



The total number of data points at the time specified on the *x*-axis. Data aggregated every two hours.



Speed
–Thursday rush hour peaks clearly visible
–Friday am peak much less pronounced

Time coverage
–As expected, data volumes drop at night
–Midday drop in data volumes on weekends due to fleet data sources
–Sundays particularly low on data (Aug 7, 14, etc)

Leveraging social networks

The Connected Corridor Consortium will rely on social networks

- **Partnerships with major players in the ecosystem (e.g. Waze)**
- **Use of novel types of data (contextual, text based)**
- **Use of incentivization (not only through information)**
- **Behavioral response analysis**

Connected corridor of the future: hardware interface

An integrated approach to corridor management includes

- **Interfacing hardware and approaches which have worked in isolation**
- **Using tools which were not used before for management**
- **Creating a coordination layer among tools which are traditionally operated by different jurisdictions**

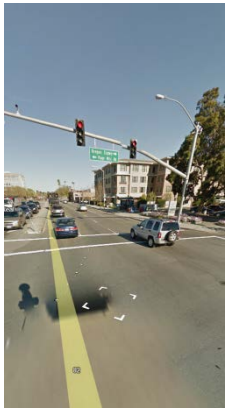
Tolling

Metering

Variable speed limits

Special lane use

HOT



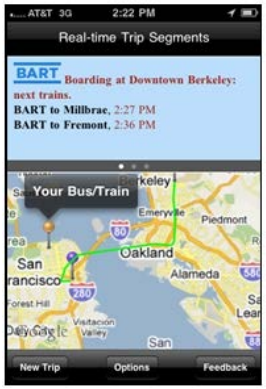
Intersection control

CC of the future: collaborative commuting

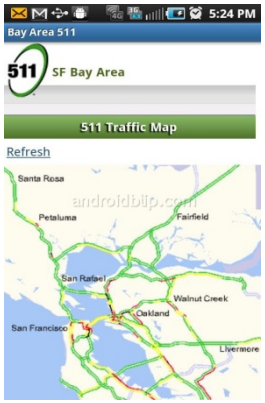
The difference between previous approaches and the future includes

- **Massive use of connected devices for traffic / demand management**
- **Apps will be built on existing services (Google maps. etc.)**
- **Apps will contain specific functionality**
  - **Travel info, advisories, parking etc.**
  - **Reroutes and incentivization**
  - **Diary system,…**

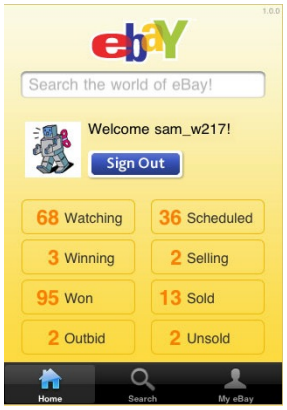
Routing



Transit info



Traffic info



Incentive cashing

Personal tracker

Social interactions

CC of the future: cloud based backend system

Corridor specific hardware interface

- **Data wearhouse, databases**
- **Simulation, estimation, forecast, control engines**
- **Platform support (hardware, phone and web apps)**
- **Process monitoring**
- **Feeds, outputs, visualization**

Closing remarks

Connected corridors is more than just "regulating traffic":

- It relies on interagency collaboration
- It relies on private sector / public sector partnerships
- Its basis relies on classical approaches:
  - Metering, CMS, HOV/HOT, special use operations
  - Arterial / highway coordination
- It also will be the battleground for new approaches to emerge
  - CMS based reroutes, incentivization, tolling
  - Modeshift, integration of transit in management schemes
- It will also rely on new technologies
  - Social networks
  - Mobile / connected devices / connected cars

Connected corridors is new engagement of commuters

- Collaborative commuting, empowerment of the commuters
  - Comuto, rideshare programs, taxi share programs
  - Last mile problems, traffic Air B&B, etc.
- Moving management from TMC centric to decentralized
- Travel collaboration: a new paradigm to emerge

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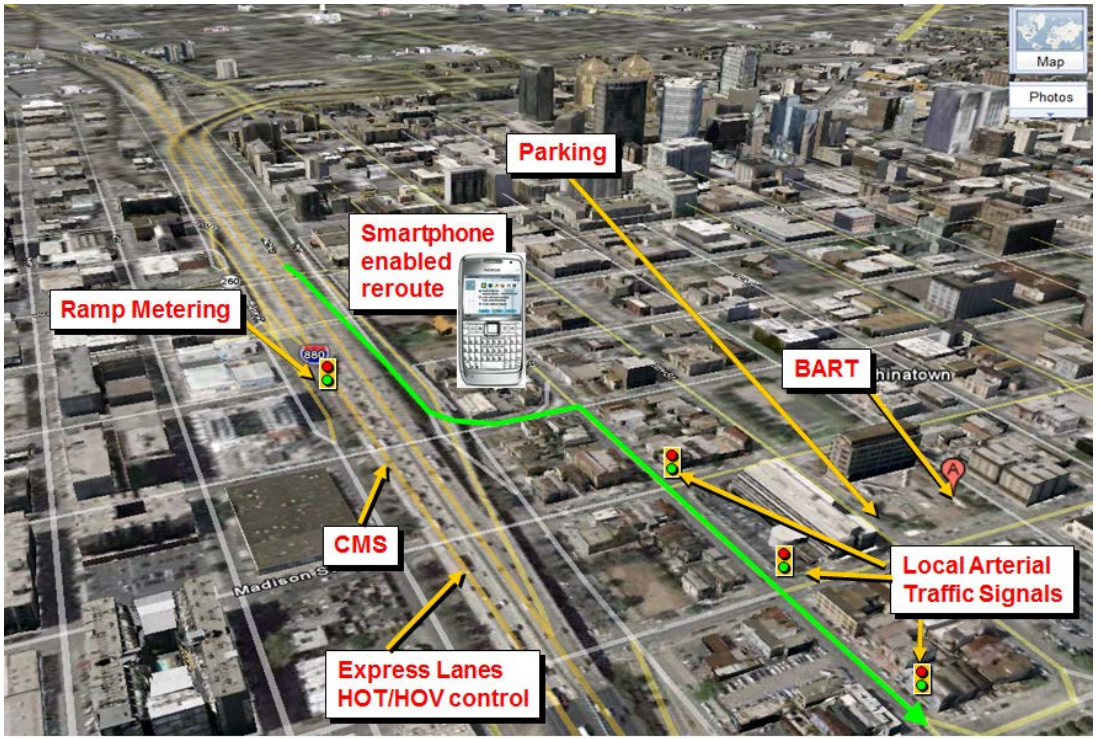

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