Intelligent Transportation
Traffic Data Management

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Intelligent Transportation

PROBLEM

- Traffic congestion is a **$87.2 billion annual drain** on the U.S. economy[1]:
  - 4.2 billion lost hours (one work week for every traveler)[1]
  - 2.8 billion gallons of wasted fuel (three weeks worth of gas for every traveler)[1]   [1] Texas Transportation Institute Urban Mobility Report, 2007 data

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GOAL

- To improve the performance of the surface transportation network through:
  - Capturing real-time data from infrastructure and vehicles
  - Developing data-driven solutions to improve mobility by leveraging optimization opportunities (e.g., path planning for commuter groups)

Intelligent Transportation
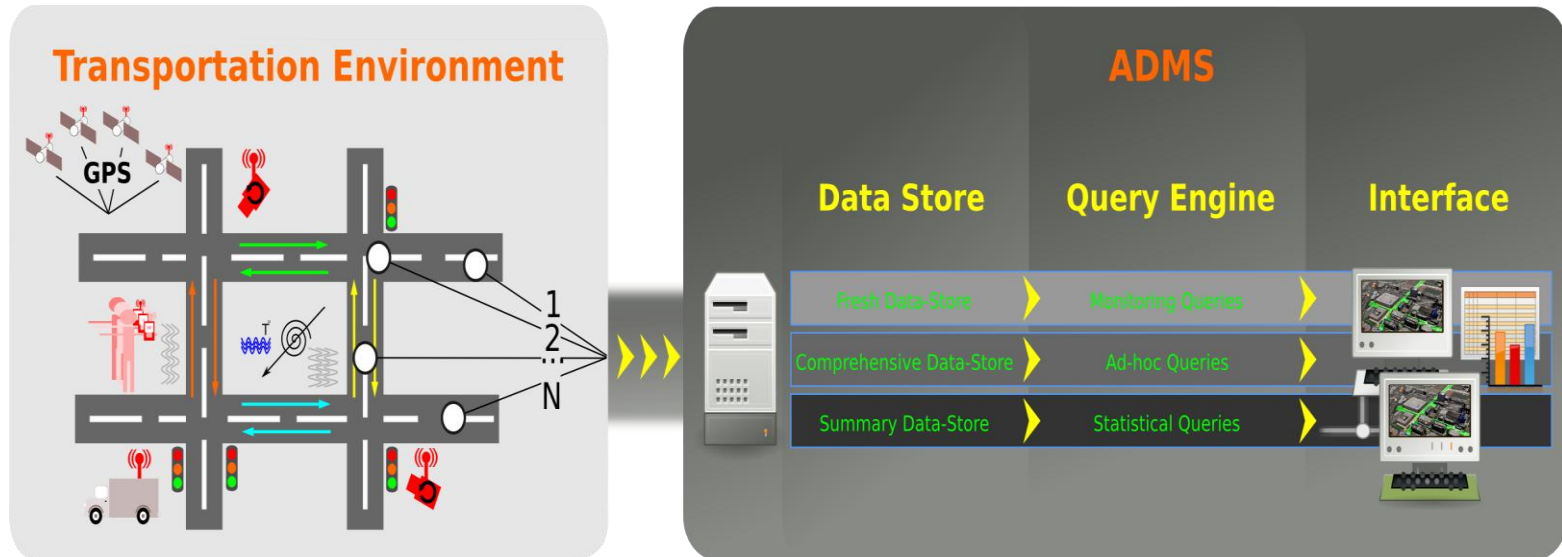
Facilitating an infrastructure for acquiring, processing, storing and querying real-time and historical transportation datasets

TransDec: Data-Driven Decision Making in Transportation Systems

Outline

- TransDec

- Accomplishments

- Projects

  - Stream Data Processing

  - Time-dependent Route Planning

  - Inferring Traffic from Video Feeds

- Future Plans

TransDec Team

- **Government**

  - LA-MTA: Los Angeles County Metropolitan Transportation Authority

  - RIITS: Regional Integrated Intelligent Transportation System

- **USC**

  - Annenberg Innovation Lab

  - Price School of Public Policy

  - Integrated Media Systems Center

- **Industry**

  -

  -

TransDec

| Input Traffic Data | Data Processing | Storage | Query Retrieval &Visualization |

46 MB/min   16 TB/Year / 26 MB/min
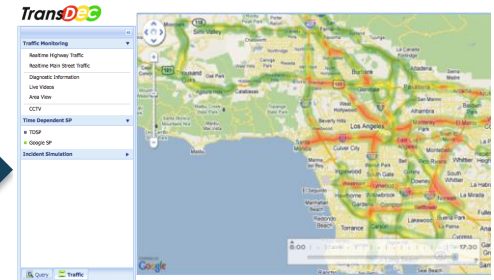
Highway

Traffic Monitoring Videos

Real-time Flow Data Extraction
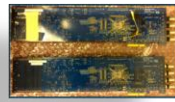
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BIG DATA!

Microsoft SQL Azure

ORACLE DATABASE 11g

Ramp Meter

Event

CMS

CalTrans

intel

Viewmont

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Accomplishments

- **Unrivaled research**
  - $1.8+ million funding in last 2 years

- **Advanced development**
  - Largest repository of SC traffic data (15+TB)
  - End-to-End system

- **Intellectual property**
  - Algorithms & Papers (**Best paper award**)
  - Filed and provisional two patents

- **Technology Transfer**
  - Incubator, Amplify.la

Outline
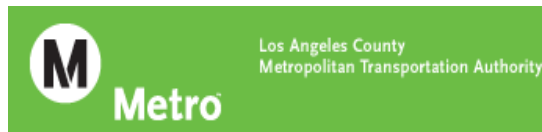
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Stream Data Processing

- **Traffic Data Lifecycle: Loop Detectors**

  - Loop Detector: most commonly used traffic sensors
  - The data is collected in Detector Cabinet and relayed to the service provider.
  - Provide two data fields: volume (count) and occupancy (% time a vehicle is over the sensor)

Loop Detector

Detector Cabinet

Stream Data Processing

Data Type	Sample XML	Cycle		Hourly (in KB)	Daily (in KB)	Annual (in KB)	3 Years (in KB)
bus_mta_inv2.xml				0.96	23.00	8,395.00	25,185.00
bus_mta_rt2.xml				31,950.00	766,800.00	279,882,000.00	839,646,000.00
cctv_inv.xml	57	86400	0.04	2.38	57.00	20,805.00	62,415.00
cms_inv.xml	52	86400	0.04	2.17	52.00	18,980.00	56,940.00
cms_rt.xml	48	75	38.40	2,304.00	55,296.00	20,183,040.00	60,549,120.00
event_d7.xml	11	75	8.80	528.00	12,672.00	4,625,280.00	13,875,840.00
rail_mta_inv.xml	1	86400	0.00	0.04	1.00	365.00	1,095.00
rail_rt.xml	8	60	8.00	480.00	11,520.00	4,204,800.00	12,614,400.00
rms_inv.xml	865	86400	0.60	36.04	865.00	315,725.00	947,175.00
rms_rt.xml	1236	75	988.80	59,328.00	1,423,872.00	519,713,280.00	1,559,139,840.00
signal_inv.xml	2095	86400	1.45	87.29	2,095.00	764,675.00	2,294,025.00
signal_rt.xml	2636	45	3,514.67	210,880.00	5,061,120.00	1,847,308,800.00	5,541,926,400.00
tt_d7_inv.xml	746	86400	0.52	31.08	746.00	272,290.00	816,870.00
tt_d7_rt.xml	152	60	152.00	9,120.00	218,880.00	79,891,200.00	239,673,600.00
vds_art_d7_inv.xml	115	86400	0.08	4.79	115.00	41,975	
vds_art_d7_rt.xml	45	60	45.00	2,700.00	64,800.00	23,652,000	
vds_art_ladot_inv.xml	2538	86400	1.76	105.75	2,538.00	926,370.00	2,779,110.00
vds_art_ladot_rt.xml	969	60	969.00	58,140.00	1,395,360.00	509,306,400.00	1,527,919,200.00
vds_fr_d7_inv.xml	957	86400	0.66	39.88	957.00	349,305.00	1,047,915.00
vds_fr_d7_rt.xml	361	30	722.00	43,320.00	1,039,680.00	379,483,200.00	1,138,449,600.00
Total KB from XML data	13980	864660	6,985.28	41		88,885.00	11,012,906,655.00

Heterogeneous (loop detector, gps, events)

Continuous

Large

Stream Data Processing

- **Microsoft StreamInsight**
  - Efficient retrieval of high-rate streaming data
  - On the fly processing and analysis
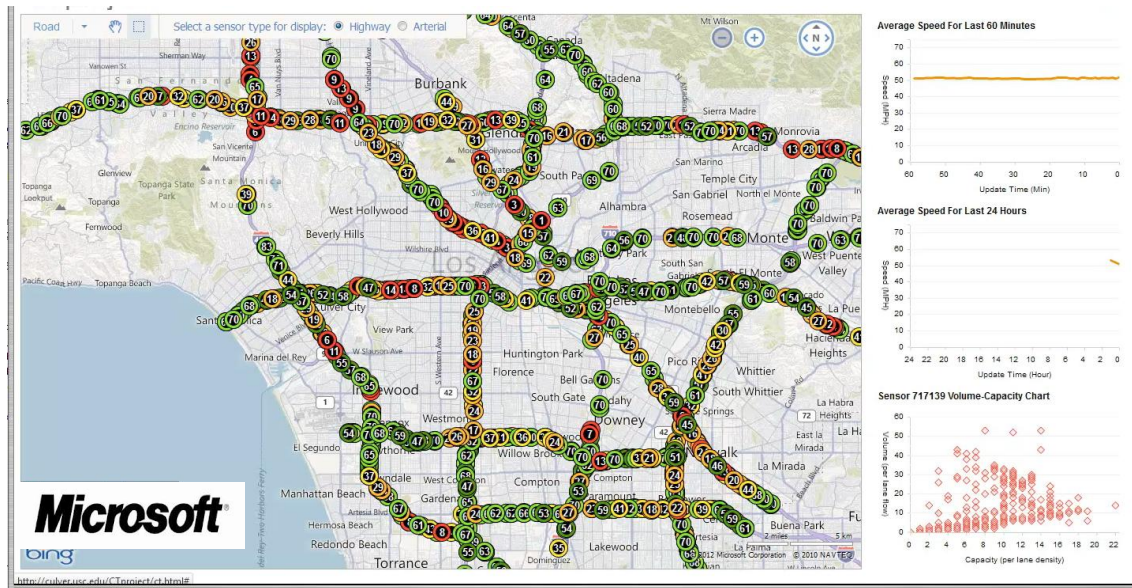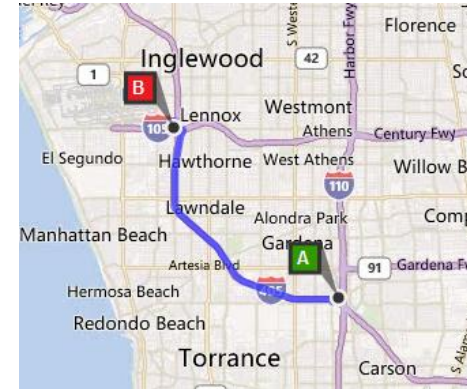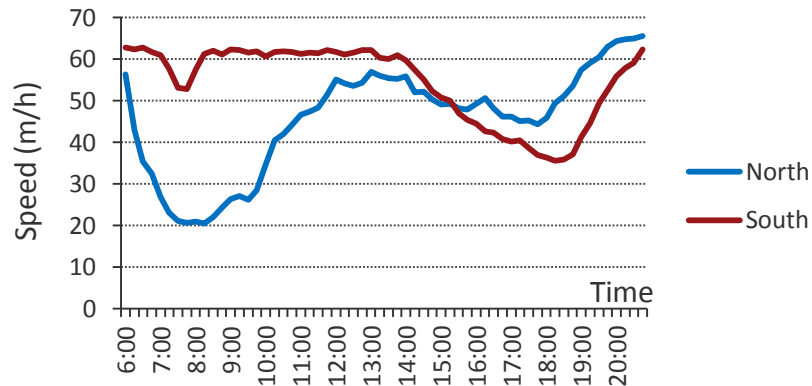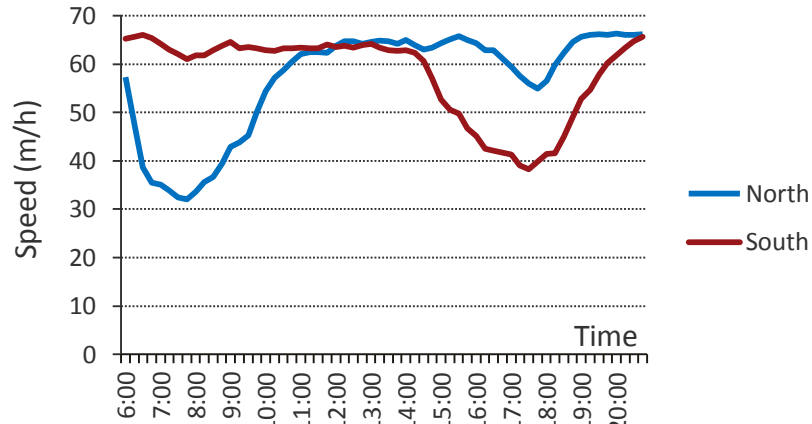
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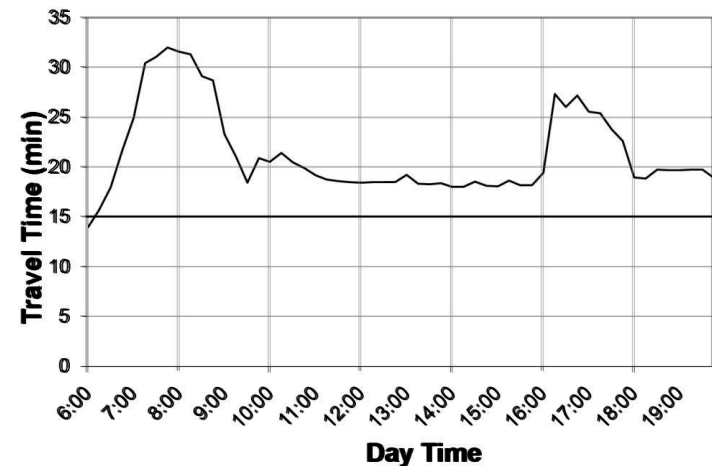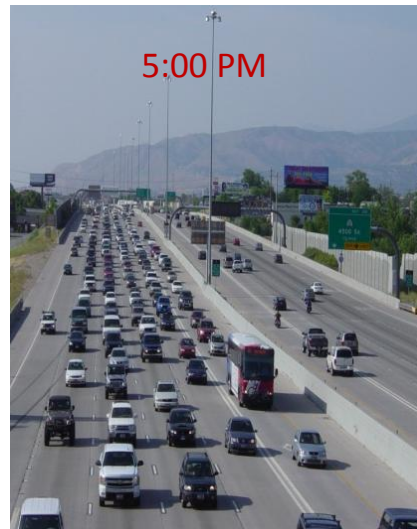
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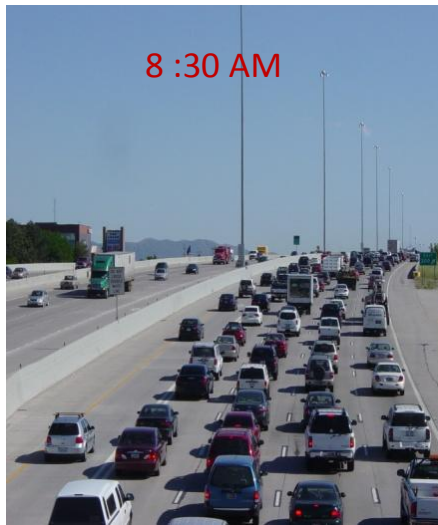# Time-dependent Route Planning

- Traffic patterns varies based on the time of the day, day of the week and season

Time-dependent Route Planning

- Existing FP Techniques
  - Based on the constant edge weights for each edge
- In Real-world
  - The weight of an edge is a function of time, i.e., time-dependent
  - Arrival-time to an edge determines the travel-time on that edge
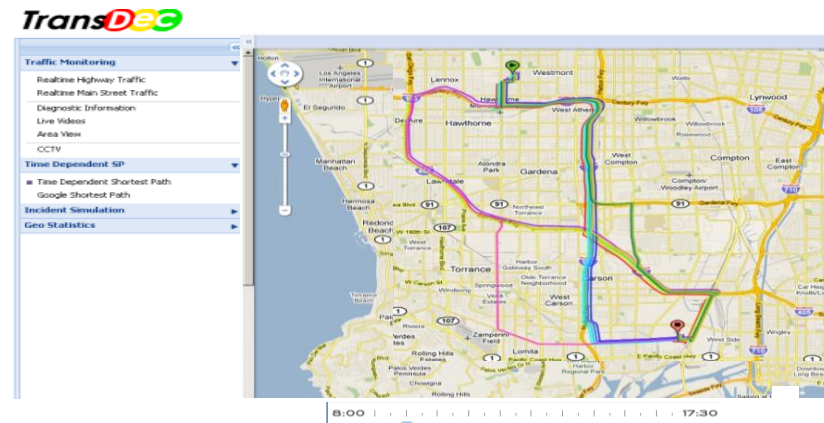

8 :30 AM

5:00 PM

Time-dependent Route Planning
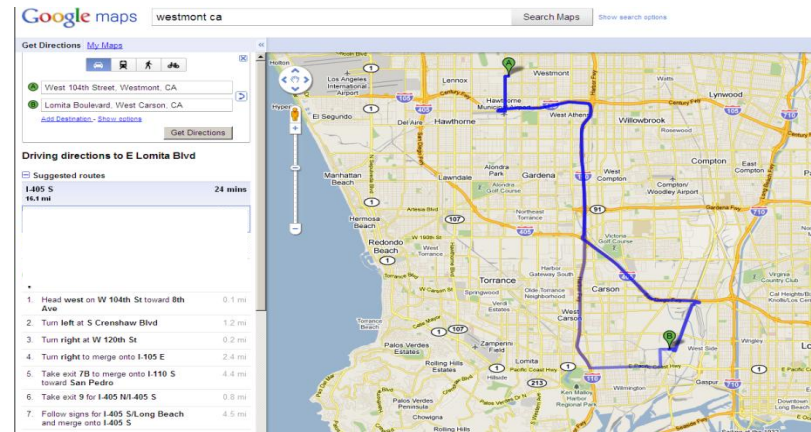
Baseline Offerings

- Constant travel-time
- Current traffic conditions

Unused Variables

- Historical traffic averages
- Time of day
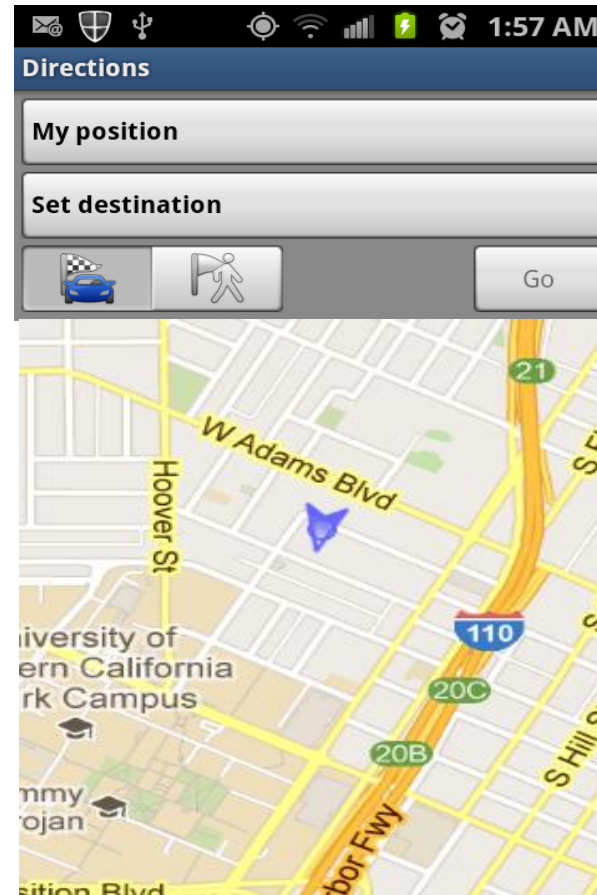- Day of week
- Season of year
- Holidays or events

Time-dependent Route Planning

ClearPath

USC Stevens
Institute for Innovation

- **Technology Transfer** for commercialization

- **Moving Forward**
Collaboration with courier companies

Time-dependent Route Planning

FILED UNDER *Cellphones, Mobile Software*

Apple confirms it's working on a traffic service, moving away from Google Maps?

Apple is now collecting anonymous traffic data to build a crowd-sourced traffic database with the goal of providing iPhone users an improved traffic service in the next couple of years.

Ford Motor Company Expands Collaboration with INRIX on Traffic and Routing

Global Partnership Enhances Ford SYNC and Powers Next-Generation Navigation Systems on All Ford, Lincoln and Mercury Vehicles

NAVTEQ Launches Enhanced Traffic Patterns™

TomTom Provides Historical Traffic Data to City of Zürich

BusinessWire   Press Release: TomTom – Mon, Oct 17, 2011 8:00 AM EDT

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Inferring Traffic from Video Feeds

- Today technology: Inductive loop detectors

- Major drawbacks
  - Expensive to install and maintain
  - Traffic must be interrupted for installation and repair
  - Can not detect slow or stationary vehicle

Inferring Traffic from Video Feeds

- Infer traffic flow using Intel Viewmont co-processor and its SDK
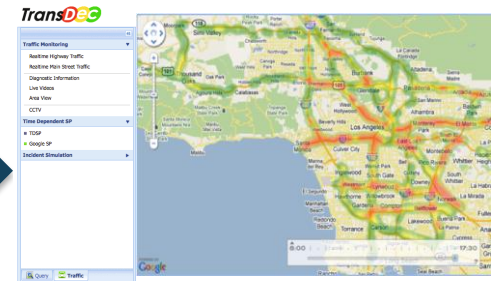
- Compare traffic flow with loop detector data

TransDec

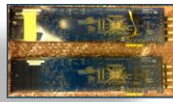| Input Traffic Data	Data Processing	Storage	Query Retrieval &Visualization

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Traffic Monitoring Videos

CalTrans

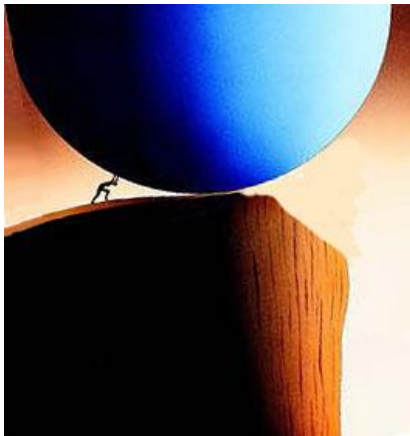Real-time Flow Data Extraction

Viewmont

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Future Plans

- Develop spatio-temporal analytical and data mining techniques to discover

Tipping-points   Butterfly Effects   Black Swans

Questions ?

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