



Intelligent Transportation Traffic Data Management

Ugur Demiryurek
Associate Director, IMSC
Viterbi School of Engineering
University of Southern California
Los Angeles, CA 900890781
[*demiryur@usc.edu*](mailto:demiryur@usc.edu)



Intelligent Transportation

PROBLEM

- Traffic congestion is a **\$87.2 billion annual drain** on the U.S. economy¹:
 - 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

HOME TIME MAGAZINE | PHOTOS | VIDEOS | SPECIALS | TOPICS | SUBSCRIBE Mobile A

NewsFeed | U.S. | Politics | World | Business | Money | Tech | Health

TIME Magazine U.S.

Current Issue | Archive | Covers | Subscribe

The High Cost of Congestion
By STEPHEN GANDEL Monday, Oct. 17, 2011

Newsfeed

- Time Begins to Crawl Backwards: The 7 Harshest Critics' Jobs at Breaking Down
- WATCH: Online Puror After Police Pepper-Spray Demonstrators at UC Davis
- Purity In Pakistan: Government Bans Text Messages With Obscenity - Or the Word 'Jesus'

PRINT | EMAIL | REPRINTS | SHARE

Like 1 0

Transportation expert Alan Pisarski used to say the only solution for the U.S.'s traffic problems would be a 10% unemployment rate. Not quite. Downturns do ease slowdowns, but there's a slight curve to the relationship. A recent study from the Texas Transportation Institute found that Americans still spend an extra 34 hours a year in their cars because of traffic. The reason: although fewer people are working, more Americans are taking jobs farther from their homes. The TTI expects tie-ups to climb as the economy improves. Coincidentally, President Obama a recently proposed spending \$50 billion to upgrade our infrastructure, which might ease some of that congestion. Many Republicans say we can't afford it. But the TTI estimates that congestion already costs us \$101 billion a year, or \$743 per urban commuter, in extra fuel and wasted time. That's about what we spend each year to service our overused cars.

HOME PAGE | TODAY'S PAPER | VIDEO | MOST POPULAR | TIMES TOPICS

The New York Times Business Day **Technology**

WORLD | U.S. | N.Y. | REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

Search Technology

Inside Technology

Internet | Start-ups | Business Computing | Companies

EXTRA! EXTRA! NOOK Simple Touch™ is now FI

New Ways to Exploit Raw Data May Bring Surge of Innovation, a Study Says
By STEVE LOHR Published: May 13, 2011

Math majors, rejoice. Businesses are going to need tens of thousands of you in the coming years as companies grapple with a growing mountain of data.

Data is a vital raw material of the information economy, much as coal and iron ore were in the Industrial Revolution. But the business world is just beginning to learn how to process it all.

The current data surge is coming from sophisticated computer tracking of shipments, sales, suppliers and customers, as well as e-mail, Web traffic and social network comments. The quantity of business data doubles every 1.2 years, by one estimate.

Mining and analyzing these big new data sets can open the door to a new wave of innovation, accelerating productivity and economic growth. Some economists, academics and business executives see an opportunity to move beyond the payoff of the first stage of the Internet, which combined computing and low-cost communications to automate all kinds of commercial transactions.

RECOMMEND

Twitter

LinkedIn

Print

Reprints

Share

SOUND OR MY VOICE REPRODUCED BY PERMISSION OF THE COPYRIGHT OWNER.



Intelligent Transportation

PROBLEM

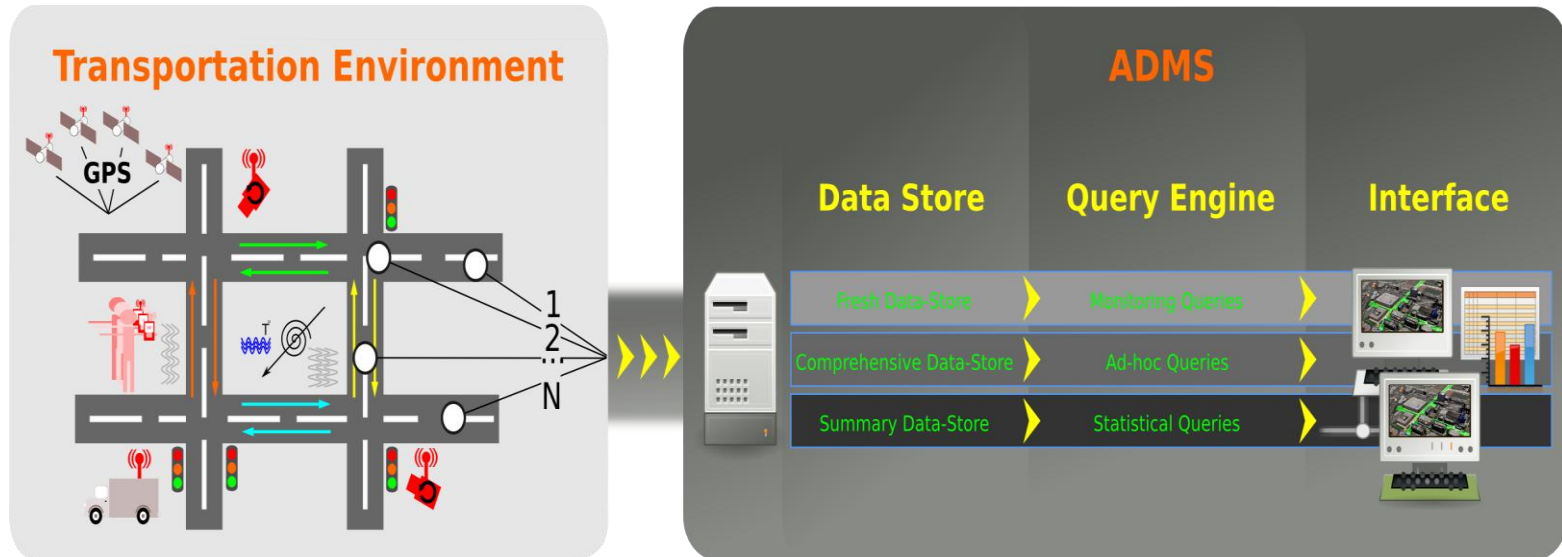
- Traffic congestion is a **\$87.2 billion annual drain** on the U.S. economy¹:
 - 4.2 billion lost hours (one work week for every traveler)¹
 - 2.8 billion gallons of wasted fuel (three weeks worth of gas for every traveler)¹ ¹ Texas Transportation Institute Urban Mobility Report, 2007 data

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

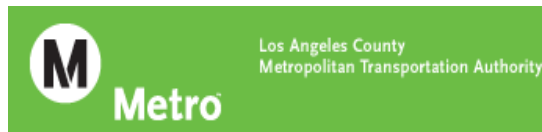
- TransDec
- Accomplishments
- Projects
 - Stream Data Processing
 - Time-dependent Route Planning
 - Inferring Traffic from Video Feeds
- Future Plans



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**

- **Microsoft**
- **intel**



TransDec

Input Traffic Data

Data Processing

Storage

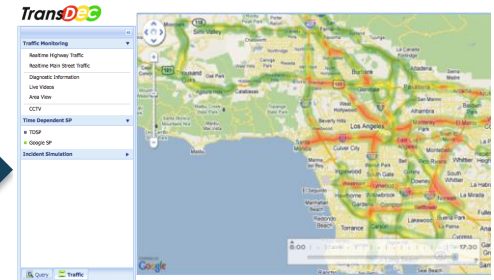
Query Retrieval & Visualization



46 MB/min



26 TB/year



Highway

Traffic Monitoring Videos

Real-time Flow Data Extraction

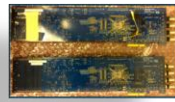
Light

BIG DATA!

Ra...ter

Event

CalTrans CMS



Viewmont



Outline

- TransDec
- **Accomplishments**
- Projects
 - Stream Data Processing
 - Time-dependent Route Planning
 - Inferring Traffic from Video Feeds
- Future Plans



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

- TransDec
- Accomplishments
- **Projects**
 - Stream Data Processing
 - Time-dependent Route Planning
 - Inferring Traffic from Video Feeds
- Future Plans



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



A Data Management Problem

Heterogeneous (loop detector, gps, events)

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		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	41,975.00	125,925.00
vds_art_d7_rt.xml	45	60	45.00	2,700.00	64,800.00	23,652,000.00	70,956,000.00
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	41,000.00	1,000,885.00	3,600,000.00	11,012,906,655.00

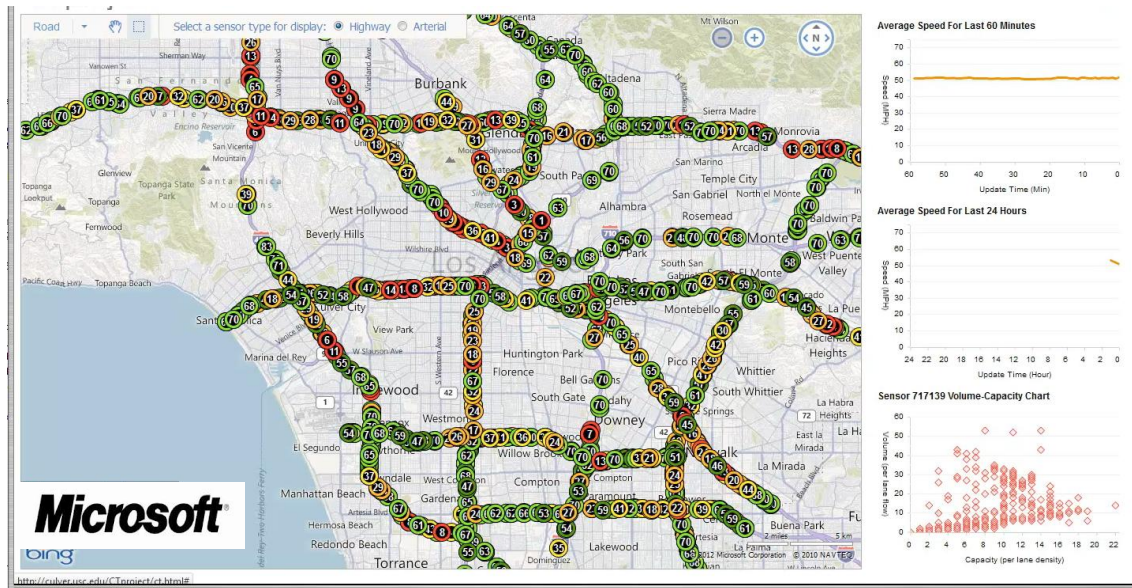
Continuous

Large



Stream Data Processing

- **Microsoft StreamInsight**
 - Efficient retrieval of high-rate streaming data
 - On the fly processing and analysis





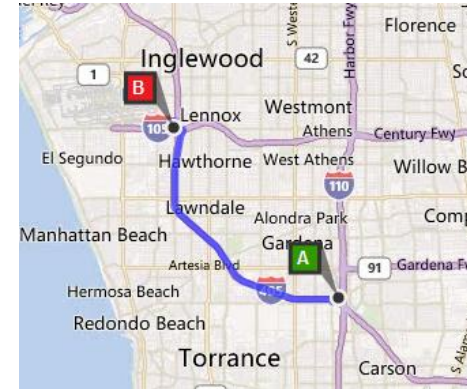
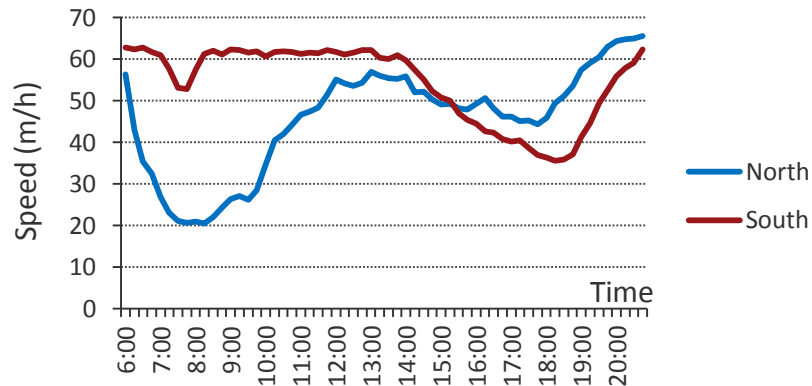
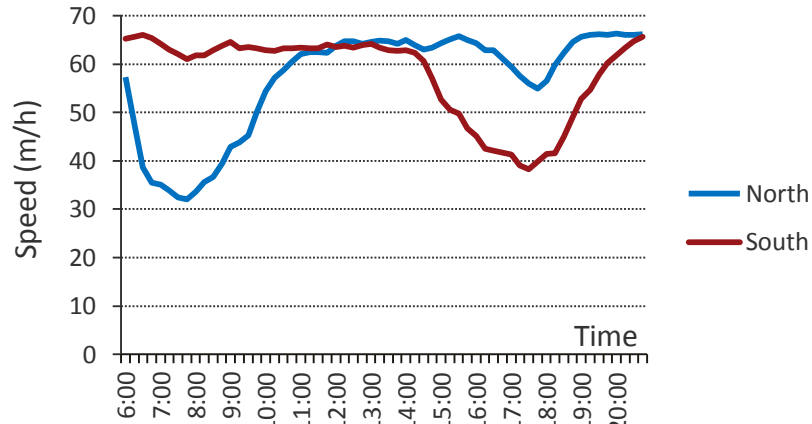
Outline

- TransDec
- Accomplishments
- **Projects**
 - Stream Data Processing
 - **Time-dependent Route Planning**
 - Inferring Traffic from Video Feeds
- Future Plans



Time-dependent Route Planning

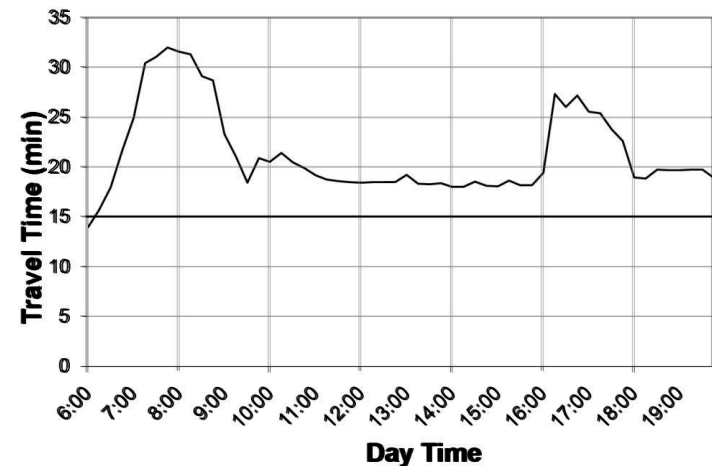
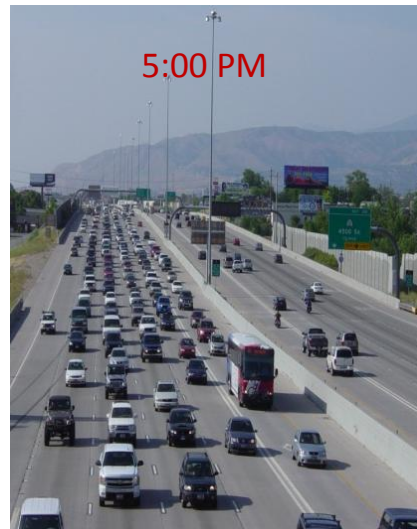
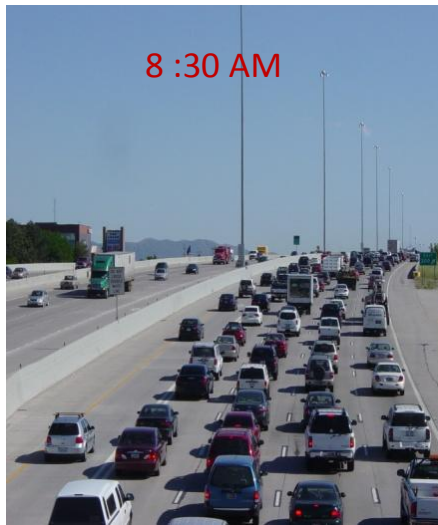
- Traffic patterns varies based on the time of the day, day of the week and season





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





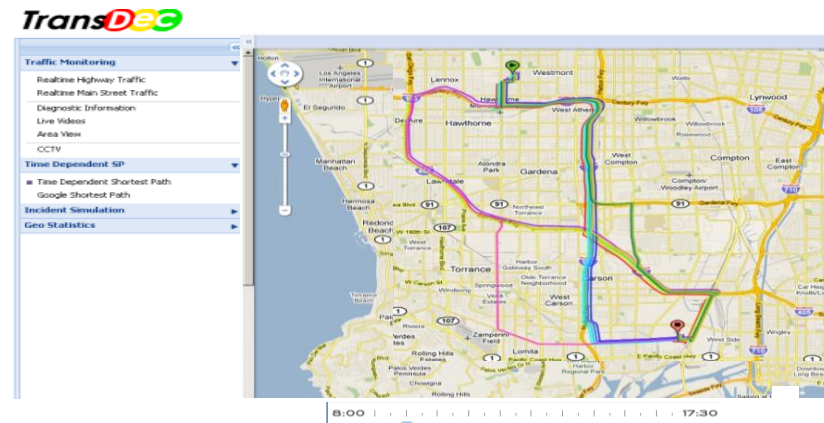
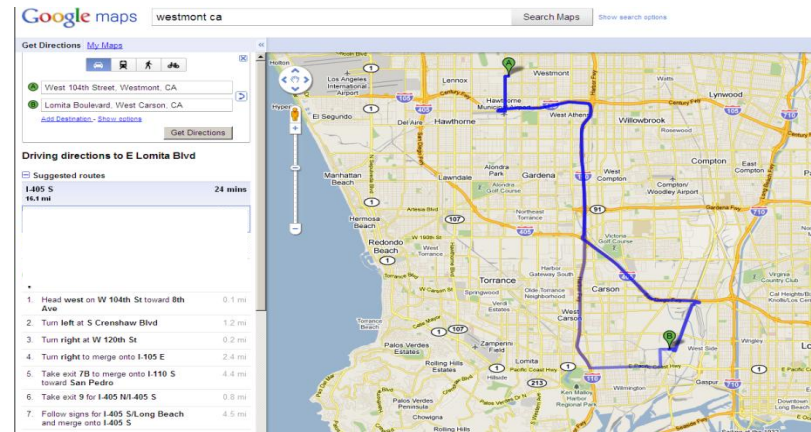
Time-dependent Route Planning

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

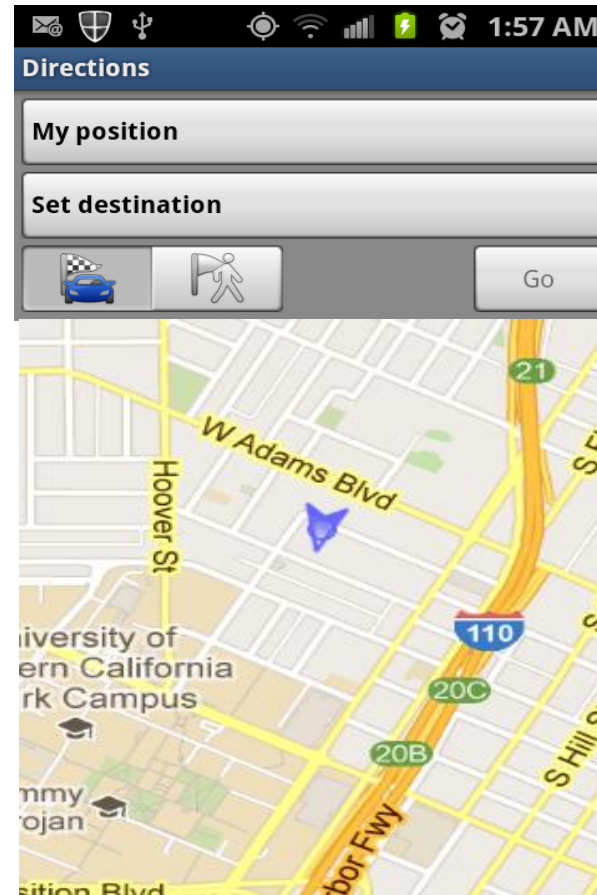




Time-dependent Route Planning



- **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



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



Outline

- TransDec
- Accomplishments
- **Projects**
 - Stream Data Processing
 - Time-dependent Route Planning
 - **Inferring Traffic from Video Feeds**
- Future Plans



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 Flow from Video Feeds

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





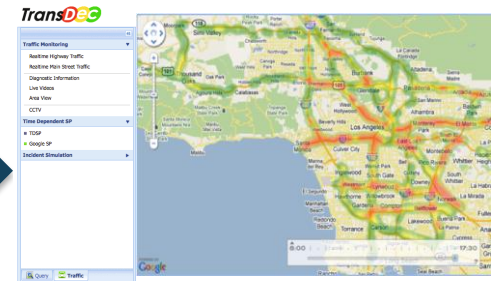
TransDec



46 MB/min



15 TB/Year

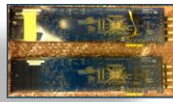


Traffic Monitoring Videos



CalTrans

Real-time Flow Data Extraction



Viewmont



OUTLINE

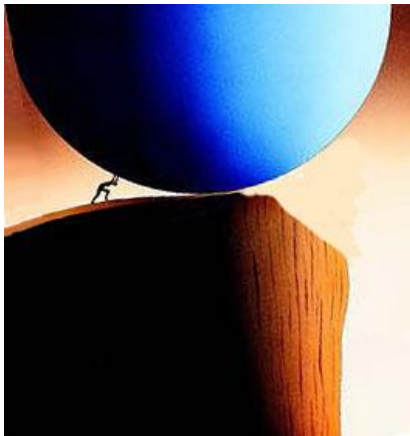
- TransDec
- Accomplishments
- Projects
 - Stream Data Processing
 - Time-dependent Route Planning
 - Inferring Traffic from Video Feeds
- **Future Plans**



Future Plans

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

Tipping-points



Butterfly Effects



Black Swans





Questions ?

Ugur Demiryurek
demiryur@usc.edu