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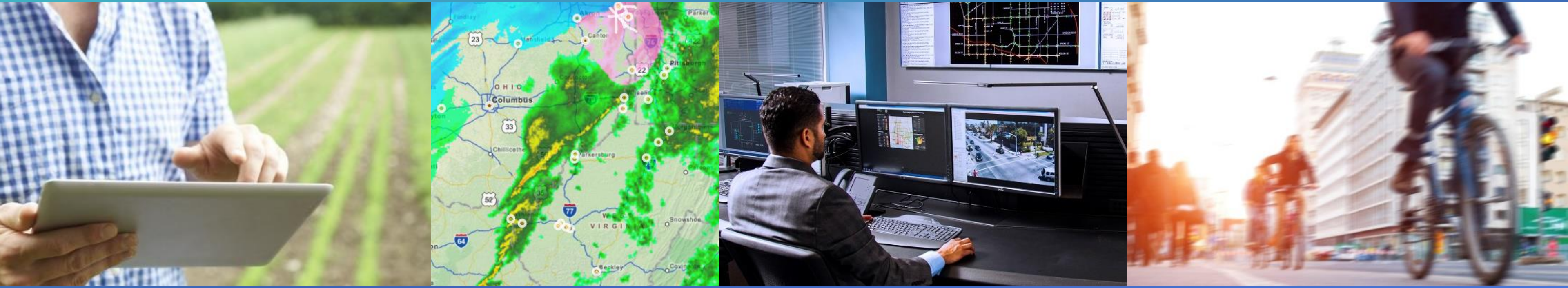

Using Big Data for Performance Measurement and Congestion Monitoring for Local Agencies

Kavin Mehta

April 27, 2017

Agenda

- What is Big Data ?
- Big Data in Transportation
- Current Big Data Usage in Transportation

What is Big Data ?

- There is no standard definition, but generally Big Data is data characterized by three attributes: volume, variety and velocity

Volume (Data Quantity)	**Variety** (Type of Data)	**Velocity** (Speed of Data)

- It is data whose scale, diversity, and complexity require new architectures, technologies, algorithms, and tools to manage, store and extract value from it.
- Due to the size and complexity of data, it has become increasingly important to have advanced analytics tools that can **create business value** from all the data

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Big Data in Transportation

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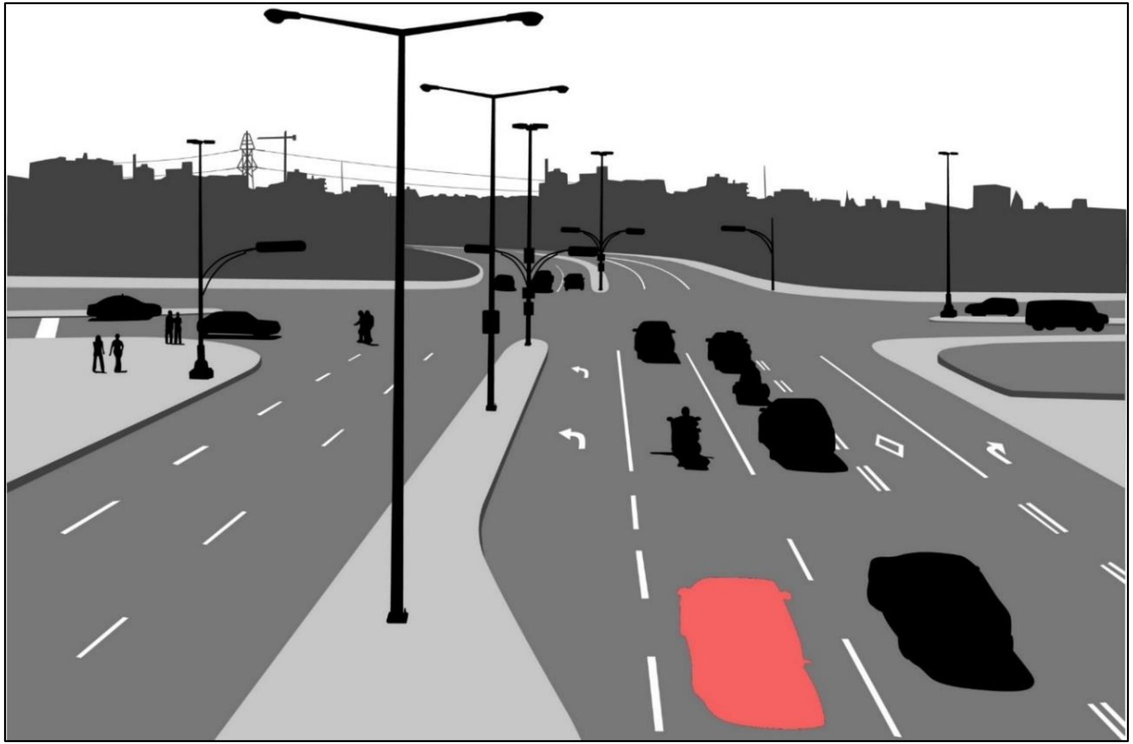
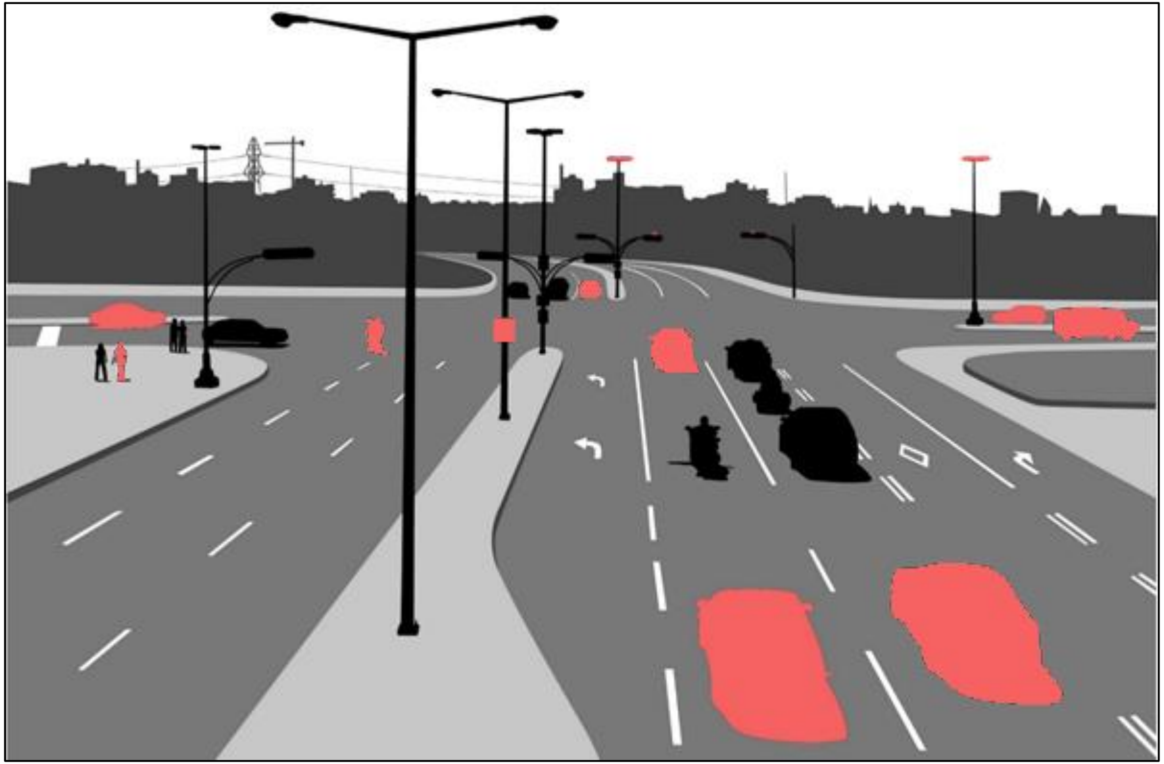
Manual Data Collection



Big Data Collection

- Probe Data
- Sensor Data
- Historical Data
- Social Data
- Weather Data
- Camera Data
- Transit Data



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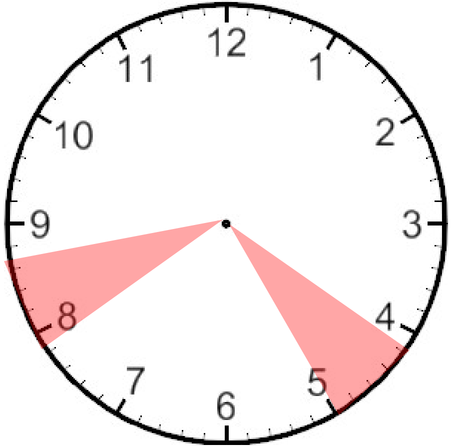
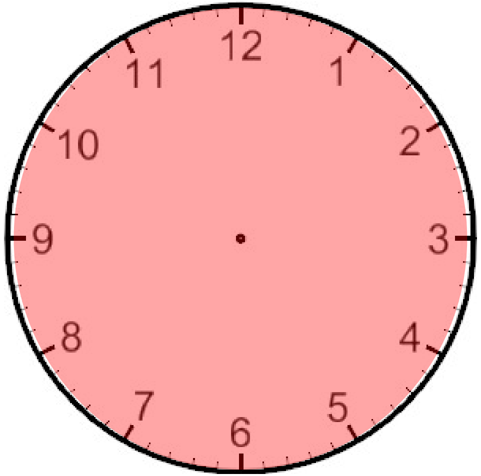
Greater Accuracy – More Times

Manual Data Collection



Big Data



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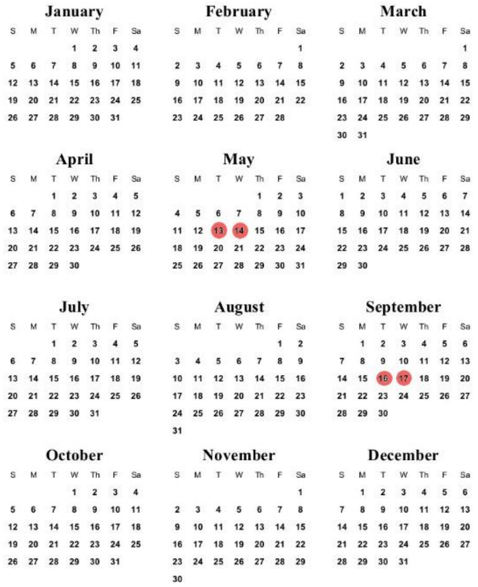
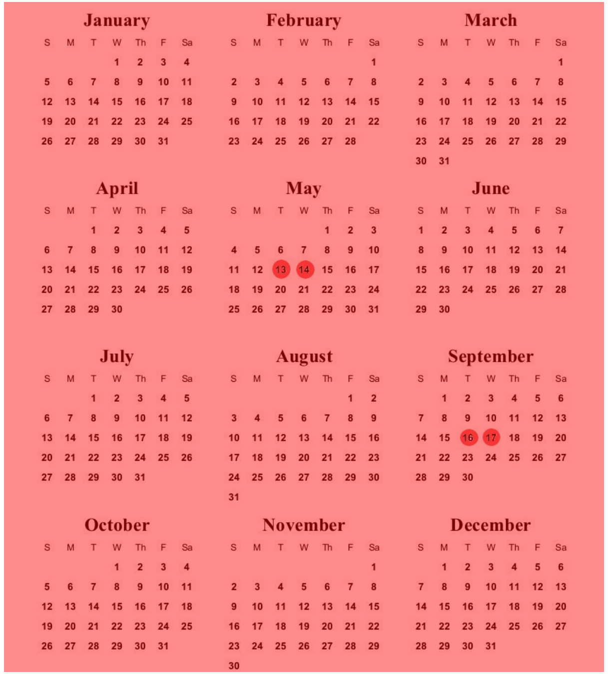
Greater Accuracy – More Days

Manual Data Collection



Big Data



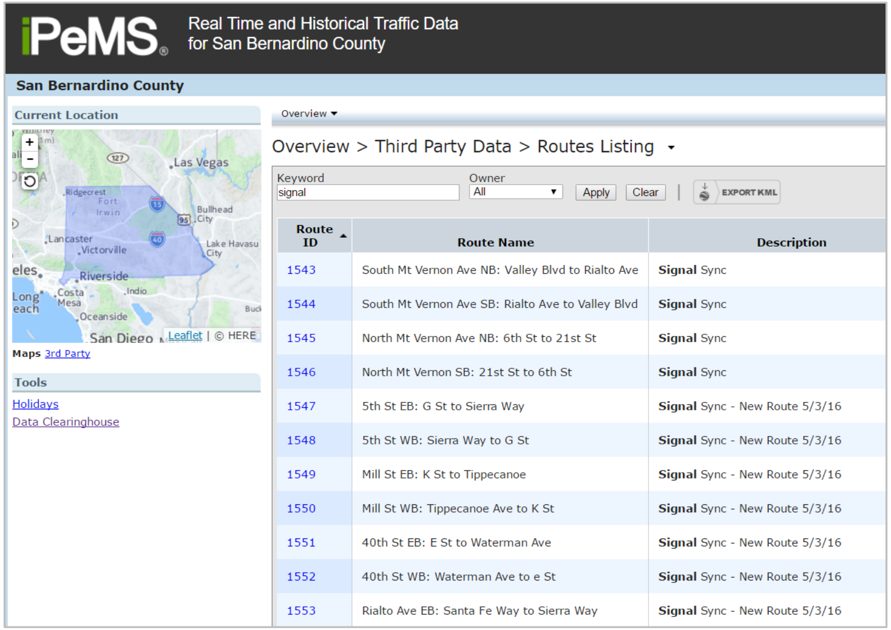
Benefits of Big Data in Transportation

- Greater accuracy
- Reduced costs
- Continuous data availability
- Better prediction
- Better planning
- Better and more real time operations

Current Big Data Usage in Transportation

Use Case #1:
Signal Synchronization

SANBAG uses customized routes to review and to rank the need for resynchronization



Route ID	Route Name	Description
1543	South Mt Vernon Ave NB: Valley Blvd to Rialto Ave	Signal Sync
1544	South Mt Vernon Ave SB: Rialto Ave to Valley Blvd	Signal Sync
1545	North Mt Vernon Ave NB: 6th St to 21st St	Signal Sync
1546	North Mt Vernon SB: 21st St to 6th St	Signal Sync
1547	5th St EB: G St to Sierra Way	Signal Sync - New Route 5/3/16
1548	5th St WB: Sierra Way to G St	Signal Sync - New Route 5/3/16
1549	Mill St EB: K St to Tippecanoe	Signal Sync - New Route 5/3/16
1550	Mill St WB: Tippecanoe Ave to K St	Signal Sync - New Route 5/3/16
1551	40th St EB: E St to Waterman Ave	Signal Sync - New Route 5/3/16
1552	40th St WB: Waterman Ave to e St	Signal Sync - New Route 5/3/16
1553	Rialto Ave EB: Santa Fe Way to Sierra Way	Signal Sync - New Route 5/3/16

Method

1. Define signal synchronization corridors in iPeMS Third Party
2. Extract the performance for each route in the AM, Midday, PM and Midnight time periods
3. Fuse with model volumes to calculate the vehicle-hours of delay
4. Review and rank the delay

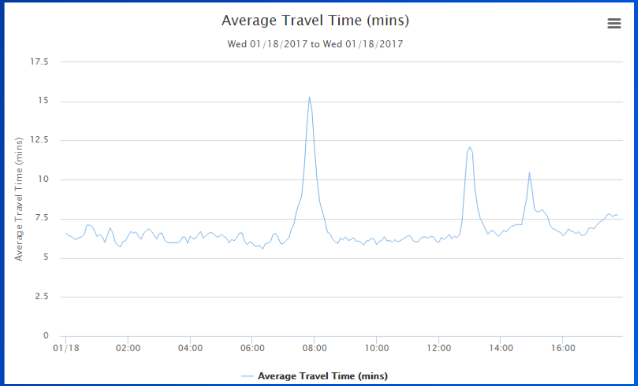
Use Case #2:
Route Performance Reports

City of Pasadena Department of Transportation used to manually maintain the performance across several routes using “floating car” travel time study.

With the help of iPeMS they can now automatically generate performance reports across user defined corridors.

					Average Travel Time (mins)		
Route ID	Route Name	Direction	Description	Length (mi)	August 2016	October 2016	Difference
244	Orange Grove Corridor	NE		6.50	15.47	15.56	0.09

Time Comparison report showing changes in travel time



Graph showing changes in average travel time across a corridor

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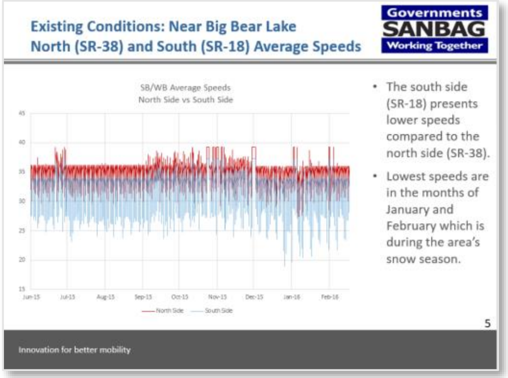
Use Case #3:
Planning Studies

The Mountain Area Transportation Planning Study – The Big Bear/Lake Arrowhead area is characterized with strong weekend / holiday traffic as holiday makers arrive on Fri / Sat & return to the LA region on Sun.

- The model was not set up to deal with these non-commute traffic patterns
- The team reviewed 1 years' worth of data between May 2015 & April 2016



The Team Used iPeMS to:

- Review 24/7 data to identify the peak periods on typical weekends, summer weekends & holiday weekends
- Understand seasonal trends
- Review the impact of inclement weather i.e. snow
- Write an existing conditions report

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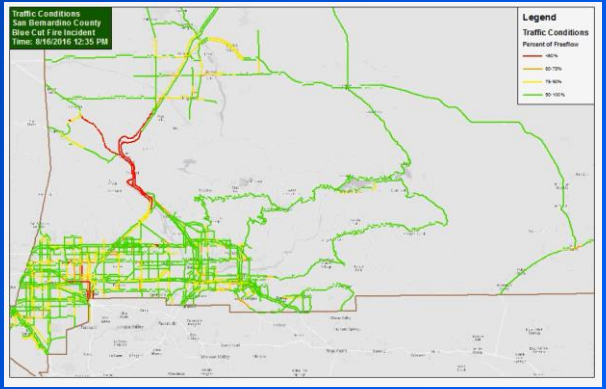
Use Case #4:
Operational Analysis

On 8/16/2016, the Blue Cut Fire was reported just west of I-15 in Cajon Pass. Later that day, the I-15 and other roads were closed. The I-15 reopened two days later. 89% of the fire was contained by 8/22.

SANBAG monitored conditions region-wide including the performance of the detour routes.



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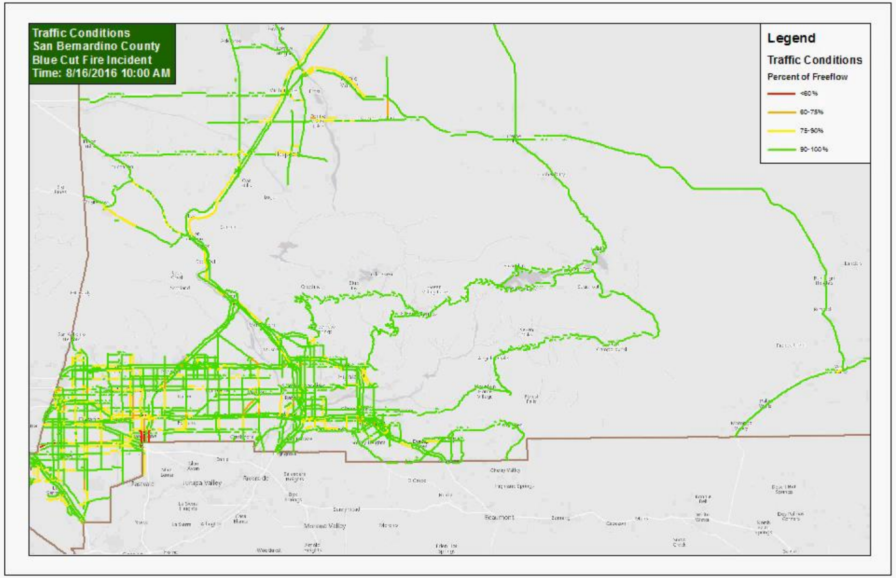
Use Case #4:
Operational Analysis Continued



Use Case #5:
AM, MD, PM Peak Measurements

Fresno-COG monitors their AM, Mid-Day, and PM peaks across their CMP Network in real time

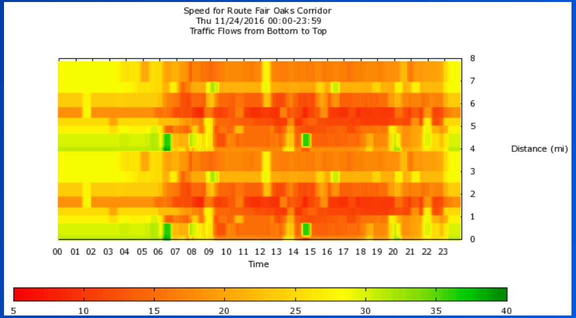
Route ID	Route Name	Direction	Length (mi)	Travel Time AM (min)	Travel Time MD (min)	Travel Time PM (min)	Average Speed AM (mph)	Average Speed MD (mph)	Average Speed PM (mph)
181	SR 41:Jensen-SR 180-NB	N	2.90	2.75	2.73	2.74	62.77	63.17	63.03
182	SR 41:Jensen-SR 180-SB	S	2.30	2.13	2.11	2.14	64.57	64.97	64.19
183	SR 41:SR 180-Shields-NB	N	1.80	1.89	1.76	1.97	59.7	62.73	58.31
184	SR 41:SR 180-Shields-SB	S	2.10	1.95	1.96	2.05	63.64	63.21	61.04
185	SR 41:Shields-Shaw-NB	N	2.00	2.00	1.86	1.93	60.51	63.99	62.08
186	SR 41:Shields-Shaw-SB	S	1.80	1.77	1.70	1.93	62.03	63.37	58.26
187	SR 41:Shaw-Herndon-NB	N	2.00	1.95	1.87	1.87	62.71	65.16	65.15
188	SR 41:Shaw-Herndon-SB	S	1.90	2.07	1.79	1.90	60.72	64.21	61.24
189	SR 41:Herndon-Madera-NB	N	3.00	2.74	2.70	2.70	65.27	66.28	66.2
190	SR 41:Herndon-Madera-SB	S	3.00	2.87	2.84	2.79	63.61	64.08	64.58
191	SR 99:Jensen-SR 180-NB	NW	3.00	2.84	2.88	3.02	63.56	62.76	60.23
192	SR 99:Jensen-SR 180-SB	SE	3.10	2.88	2.96	3.03	64.31	62.46	61.12
193	SR 99:SR 180-Shaw-NB	NW	6.40	6.09	6.22	6.43	63.53	62.3	60.34
194	SR 99:SR 180-Shaw-SB	SE	6.40	6.96	6.41	6.34	58.38	60.86	61.11
195	SR 99:Shaw-Herndon-NB	NW	2.10	1.95	1.99	2.02	64.71	63.22	62.42
196	SR 99:Shaw-Herndon-SB	SE	2.10	1.95	2.02	2.02	64.38	62.37	62.11
197	SR 99:Herndon-Madera-NB	NW	1.40	1.27	1.30	1.33	65.01	63.47	62.34
198	SR 99:Herndon-Madera-SB	SE	1.40	1.31	1.36	1.37	64.65	62.46	62.08
199	SR 168:SR 180-Shaw-EB	N	3.70	3.51	3.39	3.38	63.64	65.84	66.08
200	SR 168:SR 180-Shaw-WB	S	3.70	3.75	3.45	3.44	61.64	64.99	65.17
201	SR 168:Shaw-Herndon-EB	NE	2.60	2.41	2.34	2.26	64.18	66.11	68.4
202	SR 168:Shaw-Herndon-WB	SW	2.80	2.45	2.53	2.54	67.71	65.46	65.14
203	SR 180:SR 99-SR 41-EB	NE	2.00	1.83	1.81	1.82	65.39	66.31	65.96
204	SR 180:SR 99-SR 41-WB	SW	2.50	2.40	2.50	2.56	63.33	62.25	60.47
205	SR 180:SR 41-SR 168-EB	E	1.60	1.48	1.47	1.50	64.99	65.56	64.6
206	SR 180:SR 41-SR 168-WB	W	1.70	1.53	1.51	1.53	65.01	66.02	65.3

Use Case #6:
Monthly and Daily Contours

The City of Pasadena uses Monthly Contours to study traffic trends around holidays across their busy corridor

November Month Contour

Daily Contour



- Daily and Monthly Contours help users see monthly and seasonal trends
- Contours are auto generated across a user defined corridor

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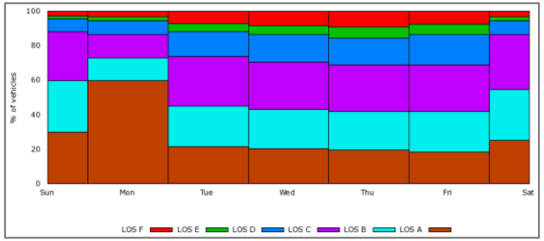
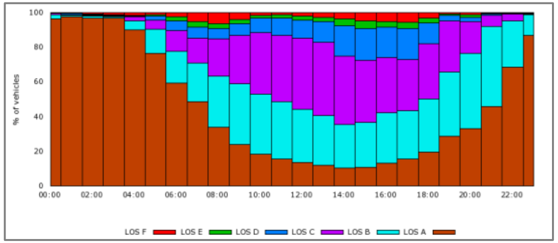
Use Case # 7: LOS Monitoring

Route ID	Route Name	Average Speed (mph)	Travel Time (min)	Travel Time Index	Length (mi)	Road Type	LOS
21	I-205 NB (Complete)	49.10	30.49	1.22	23.90	Freeway	C
24	I-405 NB (Complete)	43.40	3.86	1.21	2.60	Freeway	D
25	US-97 SB (TRIP97)	49.50	89.82	1	73.90	Highway - Class I	C
26	US-97 NB (TRIP97)	50.70	87.57	1	73.90	Highway - Class I	B
27	I-205 SB (Complete)	49.30	31.17	1.24	23.90	Freeway	C
28	I-405 SB (Complete)	39.70	6.59	1.32	4.00	Freeway	E
42	US-97 SB (Biggs-US197)	51.00	80.20	1.01	67.80	Highway - Class I	B
43	US-97 NB (Biggs-US197)	51.10	80.00	1.01	67.90	Highway - Class I	B
44	US-97 SB (US197-Madras)	54.60	27.28	1.01	24.80	Highway - Class I	B
45	US-97 NB (US197-Madras)	55.30	26.98	1.01	24.80	Highway - Class I	A
54	US-97 SB (OR31-OR58)	56.00	27.27	1	25.40	Highway - Class I	A
55	US-97 NB (OR31-OR58)	57.50	26.59	1	25.40	Highway - Class I	A
56	US-97 SB (OR58-OR39)	54.70	86.20	1.05	77.70	Highway - Class I	B
57	US-97 NB (OR58-OR39)	55.80	84.16	1.04	77.40	Highway - Class I	A
58	US-97 SB (OR39-CAL)	57.80	19.42	1	18.70	Highway - Class I	A
59	US-97 NB (OR39-CAL)	57.70	19.04	1	18.30	Highway - Class I	A
61	US-97 NB (Complete)	53.30	325.79	1.01	288.70	Highway - Class I	B
84	US-97 SB (S Century Dr to USFS)	54.30	10.93	1.02	9.80	Highway - Class I	B



LOS for Day of Week



LOS for Time of Day

- Users can easily create routes across any corridor
- Based on the road type the system calculates the LOS for the route
- LOS calculations use standards as described in Highway Capacity Manual 2010 (HCM Ver. 2010)

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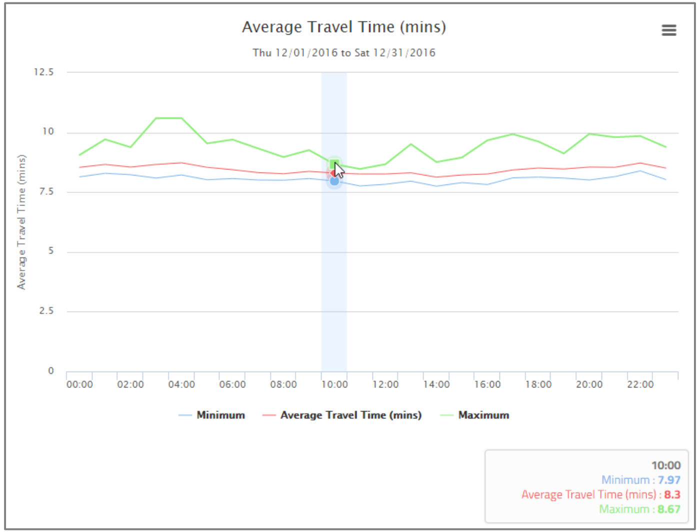
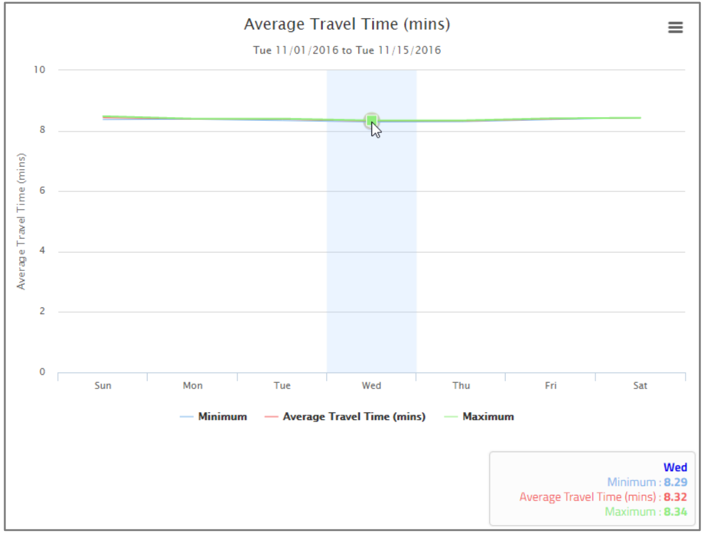
Use Case #8: Corridor Analysis

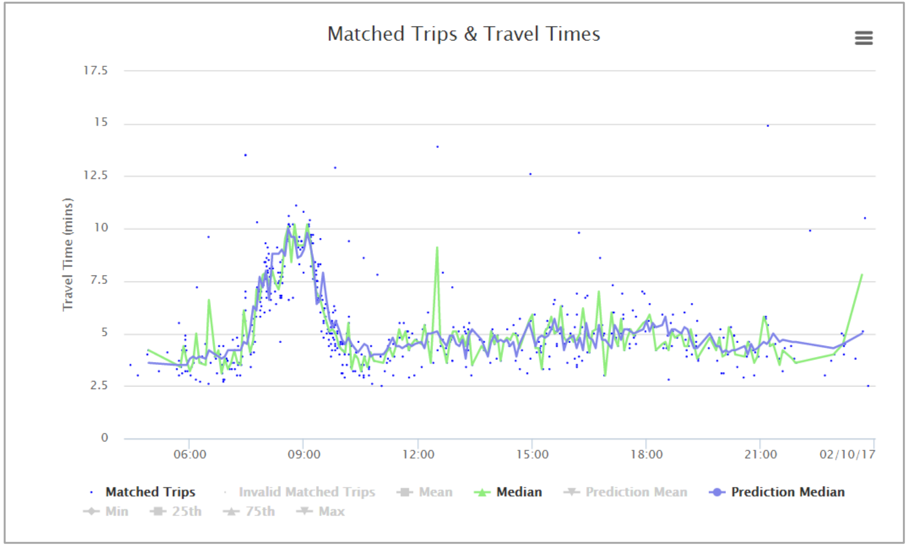


Avg. Travel Time for Time of Day



Avg. Travel Time per Day of Week

Use Case #9:
Automate Traffic State Predictions



Graph shows the Bluetooth matched trips between an origin and a destination on an expressway in Santa Clara County. The blue line represents the predicted travel time values and the green line shows the actual travel time.

Santa Clara County uses machine learning algorithms with real time data to automate flow and travel time predictions

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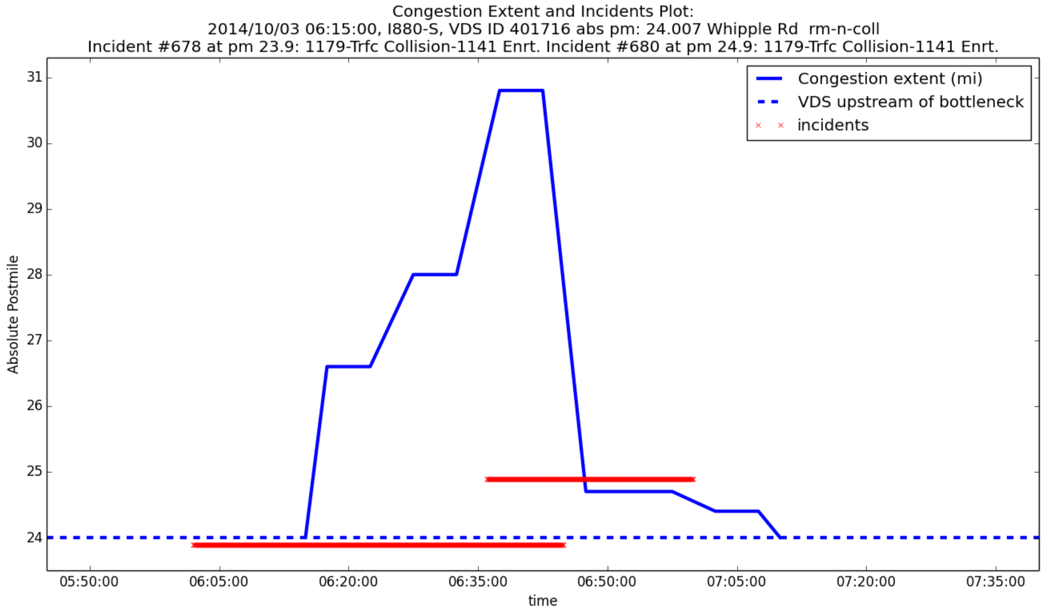
Use Case #10:
Incident Analysis

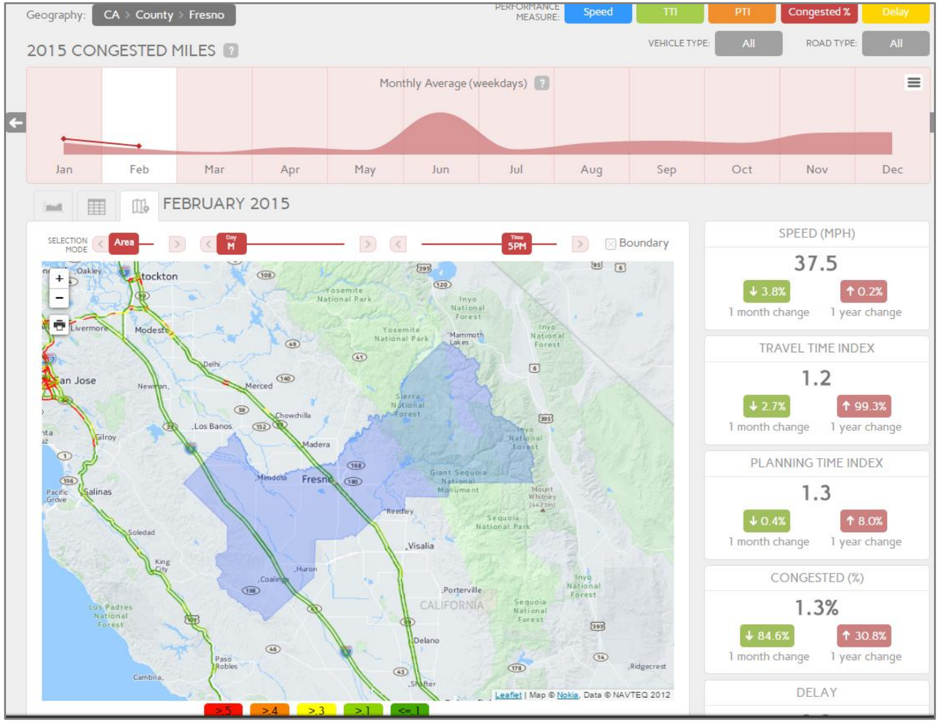


Above graph uses bottleneck information, incident data from CHP incident feed, post mile information from PeMS to create a report that helps in Secondary Crash Identification

As Shown in the Graph:

- At ~ 6pm a primary incident began. This is the bottom red line.
- At ~ 6:15pm the bottleneck algorithm detected a queue at a nearby detector station and the queue began to build from there. This is the solid blue line.
- At 6:35pm, a secondary incident occurred somewhere within the queue caused by the primary incident.
- Shortly after the primary incident was resolved, and the queue dissipated.
- Lastly the secondary incident was resolved.

Use Case #11:
Congestion Monitoring Dashboard



- Links to historical HERE and Iteris processed 5-minute summaries
- Geo-tagged to produce summary stats & reports
- Monthly and Annual comparisons
- Map animates to show TOD and DOW data
- Volume data is used to calculate delay

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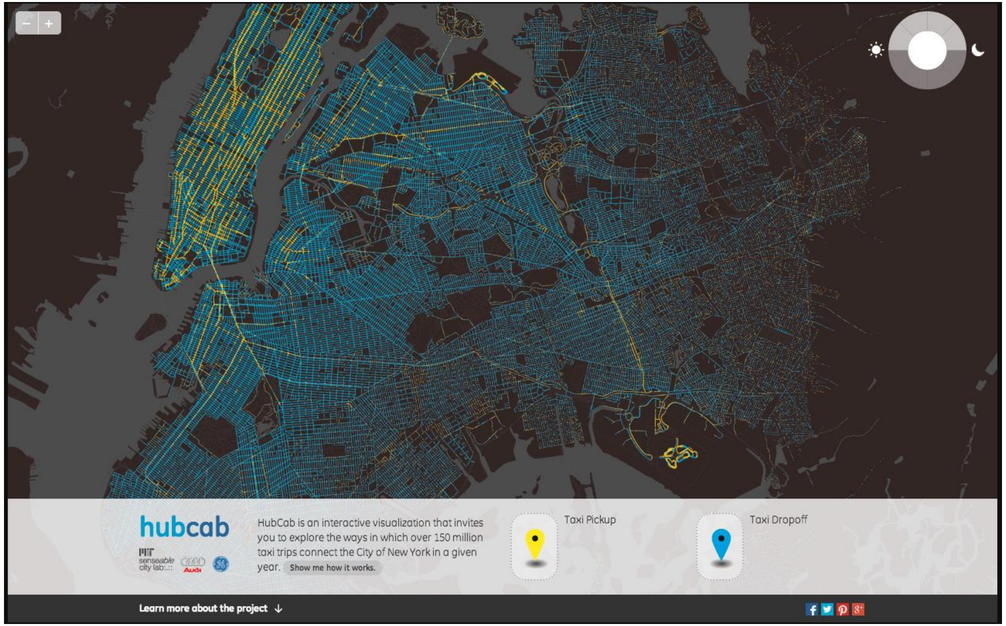
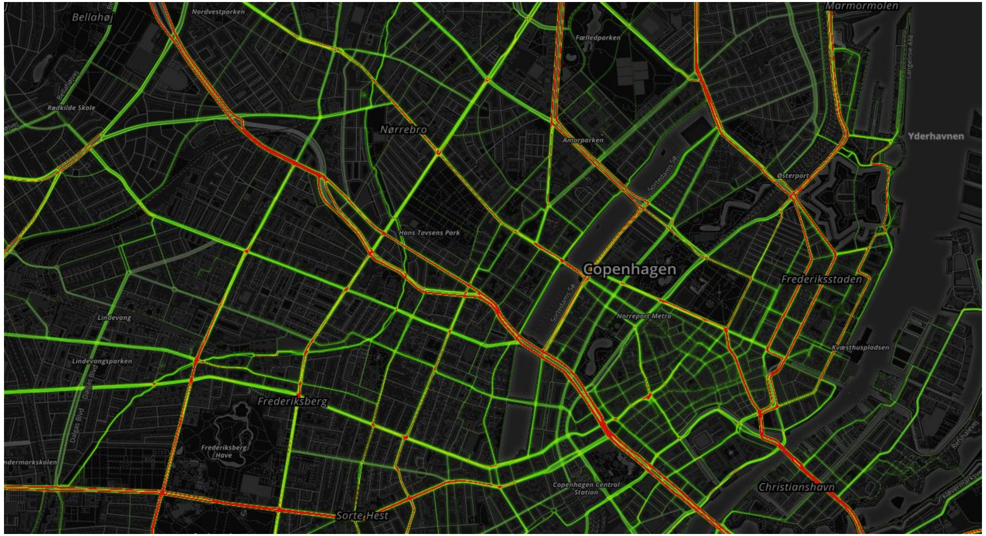
Use Case #12:
Pickup and Drop offs



Source: http://hubcab.org

- The HubCab project tracks more than 150 million taxi rides in New York City
- The tool provides interactive way to analyze taxi pickups and drop-offs across different areas and at different times

Use Case #13:
Data Driven Bicycle + Mobility Planning



Heatmap showing bicycle congestion across Copenhagen using Strava®

Source: http://labs.strava.com

- Copenhagen is often considered the most bike friendly city in the world
- ~50% of the Copenhagen's residents commute by bikes
- Their traffic lights recognize and favor cyclists

Other Use Cases

- Project Prioritization
- Construction Monitoring
- Impact from Incidents
- Evaluation / Calibration of operations projects e.g. ramp metering
- Identification of locations of excessive speeding (Vision Zero)
- Community and Sporting Events Analysis
- Use as input to simulation models to better predict how incidents affect network performance

Thank You!

Questions?

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