

GPS Probe Data Collection and Applications





Scott Lee, PE
scott.lee@idaxdata.com
425-614-6231

Presentation Overview

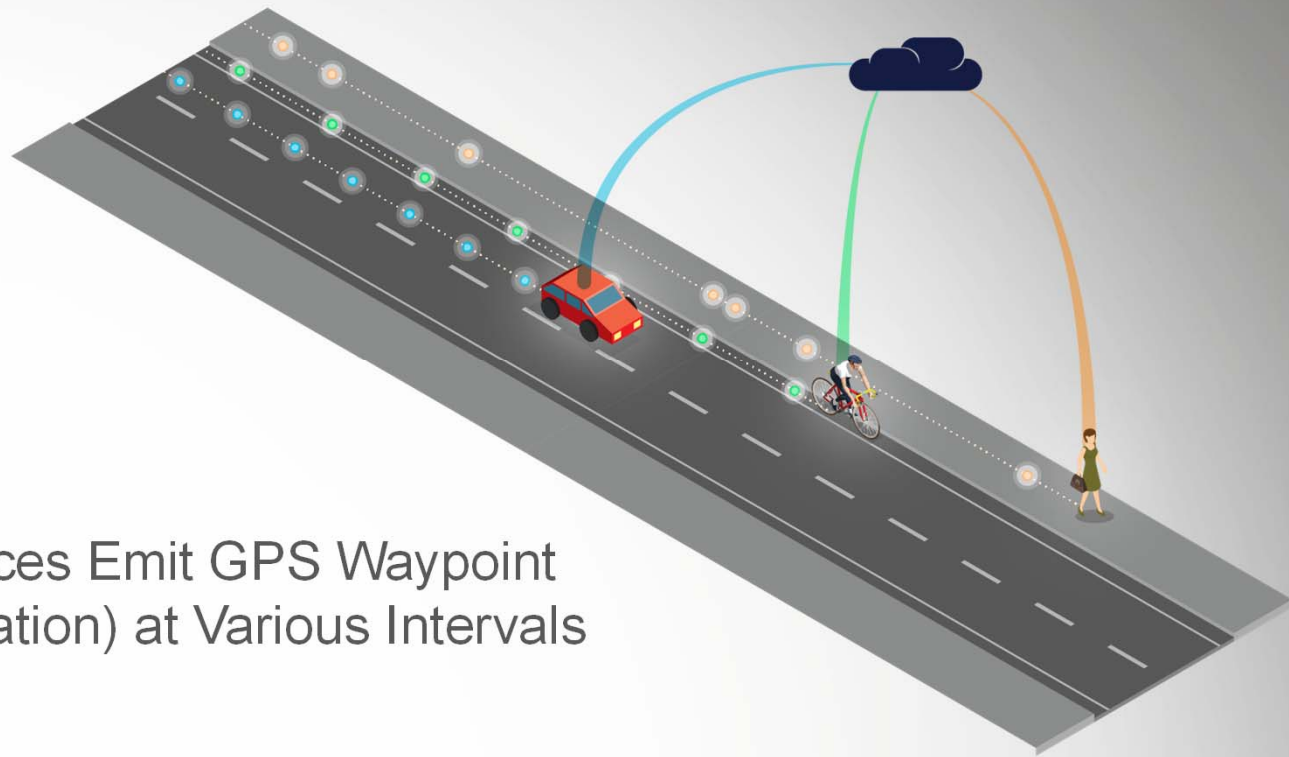
- Introduction to GPS Probe Data Collection
- Available Applications Through Dataset Providers
- Application Examples and Research

What is GPS Probe Data Collection



- GPS Probe Data is a Non-Intrusive Collection From Vehicles and Consumer Smartphones.
- Other Non-Intrusive Collection Techniques Include Cellular Data and Location-Based Services Data

How It Works



Devices Emit GPS Waypoint
(Location) at Various Intervals

Probe Data Vs. Wi-Fi and Bluetooth



	Probe Data	VS	Bluetooth/Wi-Fi
Collection	“Active”		“Passive”
Typical Capture Rates	1-5%		10-40%
Typical Uses	High-Volume		High and Low Volume

Probe Data Providers and Products

Example Providers: TomTom, HERE, INRIX

Provider Products: INRIX Example



**Real Time
Data**



**Speed and Travel Time
“Roadway Analytics”**



**Raw Data
“Trips Data”**

Probe Data Applications

- Speed
- Travel Time
- Performance Metrics
- Origin-Destination
- Route Utilization
- Others

INRIX Dataset

Largest Global Network of GPS Probe Data

- 400 Distinct Sources of Probe Data From 275+ Million Real-Time Vehicles and Devices

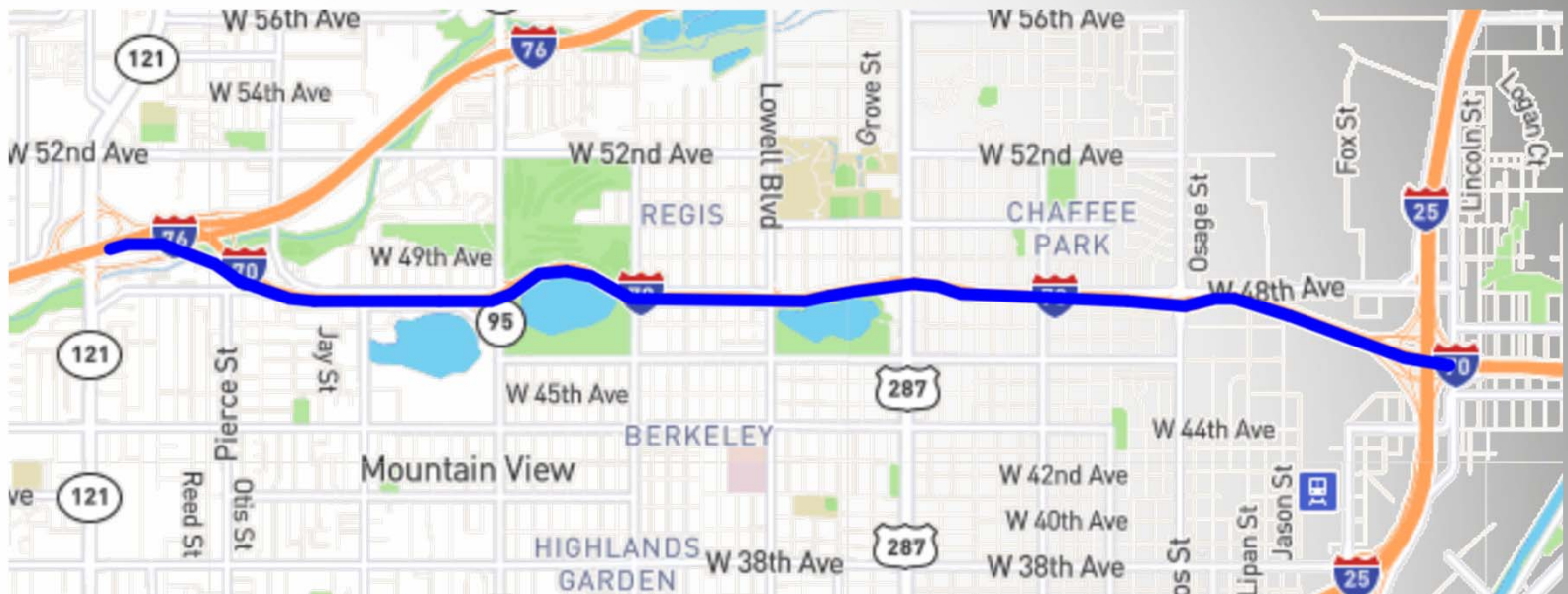
Anonymous GPS-Based Data From:

- Vehicles – Commercial Fleet, Delivery and Taxi, and Passenger
- Consumer Smart Phones
- Others Including Road Sensors and Toll Tags

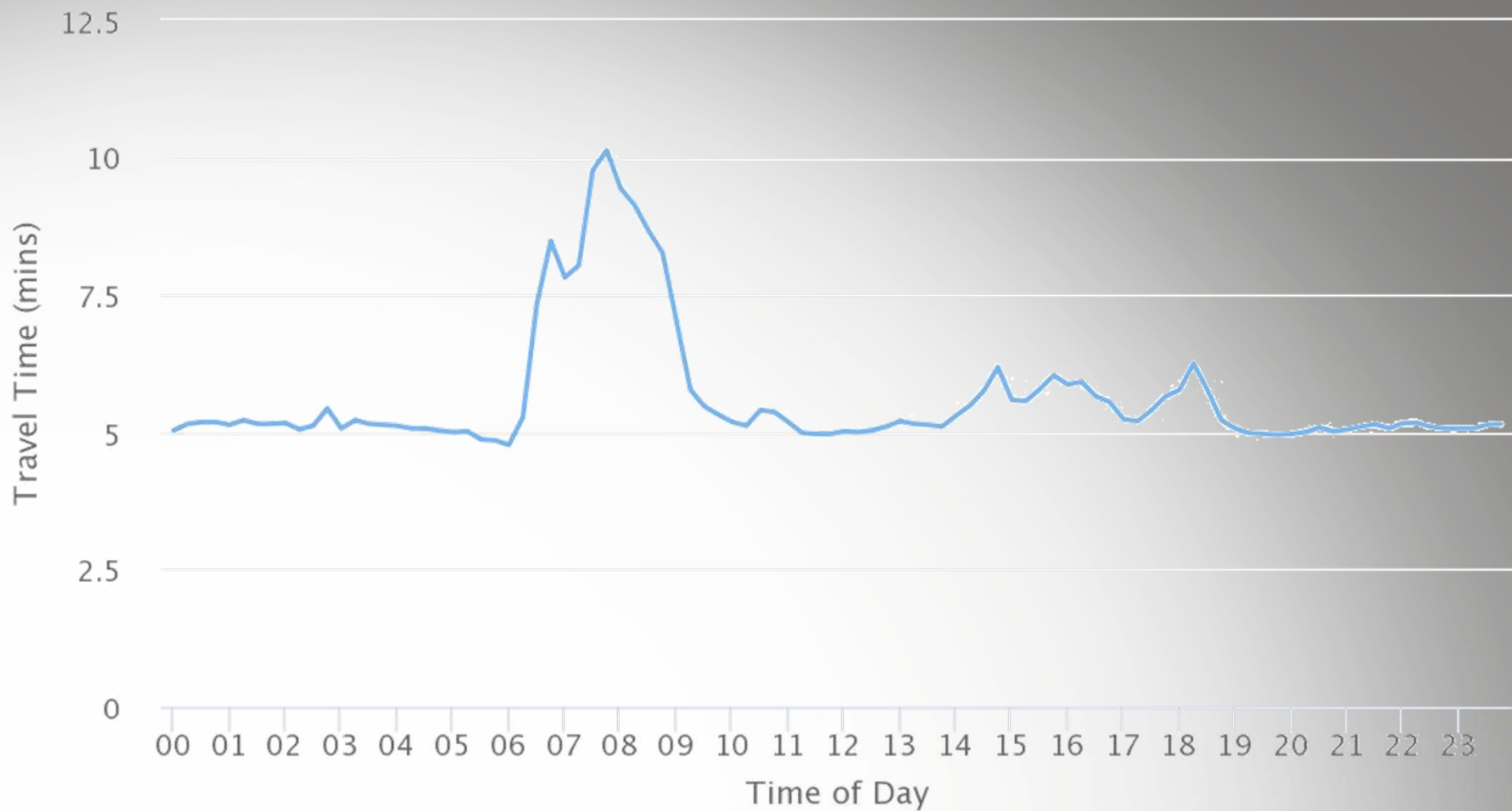
Roadway Analytics: Speed and Travel Time Study

Study Area: I-70 Between I-76 and I-25

Objective: To Understand Speed and Travel Time Relationships
During Typical Weekday in May 2017

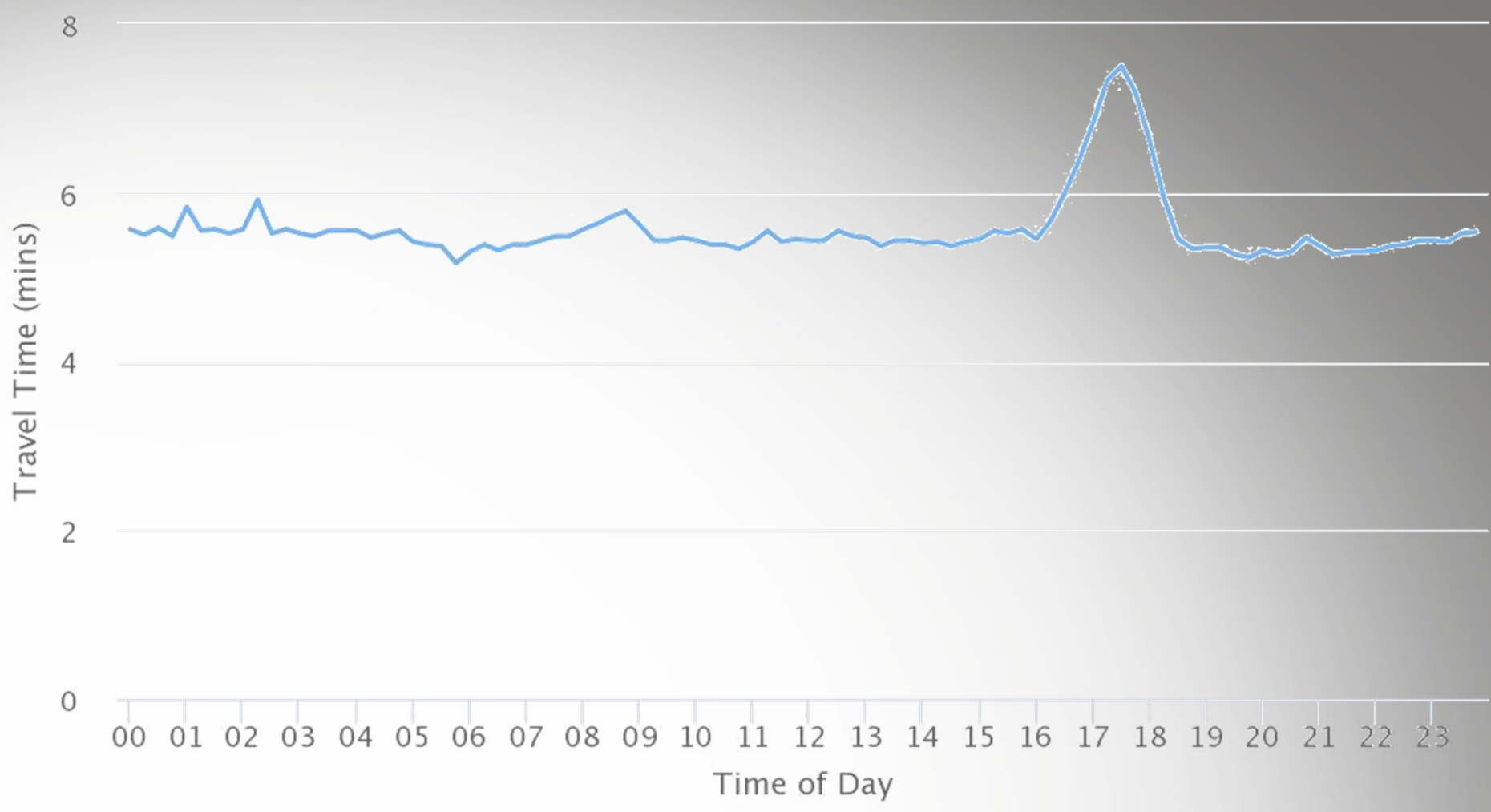


I-70 EB



● 05/01/2017 - 05/31/2017 (Tu,We,Th)

I-70 WB



● 05/01/2017 - 05/31/2017 (Tu,We,Th)

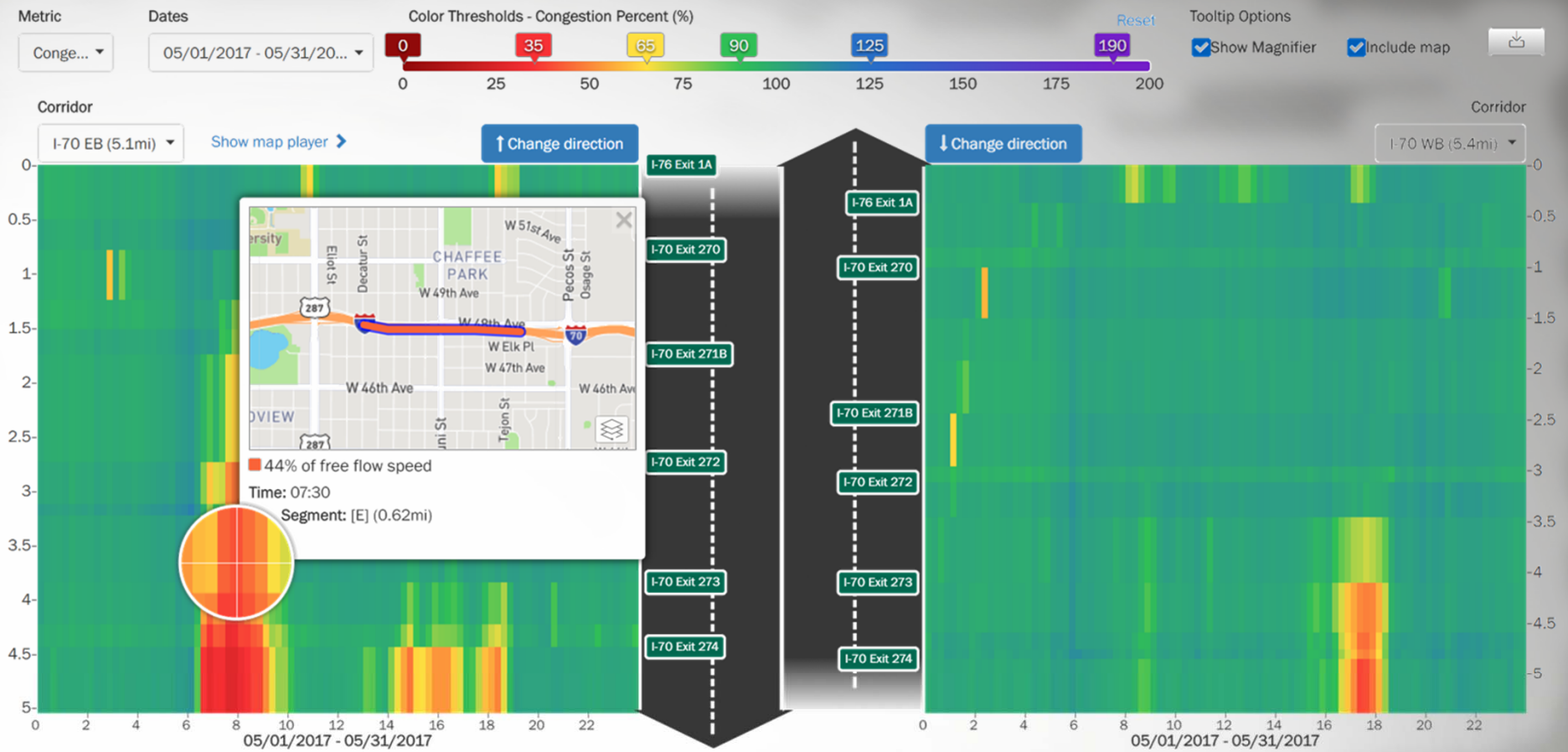
Summarized Performance Metrics

Corridor Name	Metrics	6:00 AM	6:15 AM	6:30 AM	6:45 AM	7:00 AM	7:15 AM	7:30 AM	7:45 AM	8:00 AM	8:15 AM	8:30 AM	8:45 AM	9:00 AM
I-70 EB	speeds	63.39	57.4	41.25	35.68	38.7	37.71	31.03	29.9	32.1	33.16	34.96	36.65	43.11
I-70 EB	speedPercent5	59.43	46.87	29.43	26.39	28.06	26.55	21.62	14.32	12.4	15.18	18.88	16.05	17.67
I-70 EB	speedPercent25	61.44	54.61	37.5	30.82	32.13	33.18	25.72	25.98	29	31.79	31.85	34.64	44.79
I-70 EB	speedPercent75	65.65	62.28	49.15	44.68	48.49	45.46	40.41	40.41	46.99	46.27	47.98	49.55	57.73
I-70 EB	speedPercent95	67.86	64.49	55.61	50.1	53.64	50.24	45.12	45.35	51.52	56.13	55.27	54.12	60.22
I-70 EB	travelTimeSecs	286	316	440	509	469	482	586	608	566	548	520	496	421
I-70 EB	travelTime5	268	282	327	363	339	362	403	401	353	324	329	336	302
I-70 EB	travelTime25	277	292	370	407	375	400	450	450	387	393	379	367	315
I-70 EB	travelTime75	296	333	485	590	566	548	707	700	627	572	571	525	406
I-70 EB	travelTime95	306	388	618	689	648	685	841	1270	1466	1198	963	1133	1029
I-70 EB	comparativeSpeed	120.15	123.74	103.51	103.42	127.73	136.72	116.74	110.12	110.36	100.52	91.94	83.44	87.29
I-70 EB	comparativeSpeed5	112.65	101.05	73.84	76.5	92.63	96.25	81.36	52.73	42.64	46.01	49.67	36.55	35.78
I-70 EB	comparativeSpeed25	116.46	117.74	94.09	89.33	106.04	120.31	96.78	95.67	99.7	96.37	83.76	78.87	90.69
I-70 EB	comparativeSpeed75	124.45	134.27	123.34	129.5	160.06	164.82	152.05	148.83	161.54	140.26	126.2	112.83	116.89
I-70 EB	comparativeSpeed95	128.62	139.03	139.56	145.2	177.05	182.12	169.78	167.01	177.09	170.13	145.38	123.24	121.93
I-70 EB	congestionPcts	107.08	96.96	69.68	60.28	65.38	63.71	52.41	50.51	54.23	56.03	59.06	61.91	72.83
I-70 EB	congestionPcts5	100.4	79.18	49.71	44.59	47.41	44.85	36.53	24.19	20.96	25.64	31.9	27.12	29.86
I-70 EB	congestionPcts25	103.79	92.26	63.34	52.07	54.28	56.06	43.45	43.89	49	53.71	53.8	58.52	75.67
I-70 EB	congestionPcts75	110.91	105.21	83.03	75.48	81.92	76.8	68.27	68.27	79.38	78.17	81.06	83.71	97.53
I-70 EB	congestionPcts95	114.63	108.94	93.95	84.63	90.62	84.87	76.23	76.61	87.03	94.82	93.38	91.43	101.73
I-70 EB	historicAvgSpeeds	52.75	46.38	39.85	34.5	30.3	27.58	26.58	27.15	29.09	32.99	38.02	43.92	49.39
I-70 EB	historicAvgCongestionPcts	89.12	78.36	67.32	58.29	51.18	46.6	44.9	45.87	49.14	55.73	64.23	74.19	83.43
I-70 EB	travelTimeIndexes	0.93	1.03	1.43	1.66	1.53	1.57	1.91	1.98	1.84	1.78	1.69	1.61	1.37
I-70 EB	travelTimeIndexes5	0.87	0.92	1.06	1.18	1.1	1.18	1.31	1.31	1.15	1.05	1.07	1.09	0.98
I-70 EB	travelTimeIndexes25	0.9	0.95	1.2	1.32	1.22	1.3	1.46	1.46	1.26	1.28	1.23	1.19	1.03
I-70 EB	travelTimeIndexes75	0.96	1.08	1.58	1.92	1.84	1.78	2.3	2.28	2.04	1.86	1.86	1.71	1.32
I-70 EB	travelTimeIndexes95	1	1.26	2.01	2.24	2.11	2.23	2.74	4.13	4.77	3.9	3.13	3.69	3.35
I-70 EB	planningTimeSecs	306	388	618	689	648	685	841	1270	1466	1198	963	1133	1029
I-70 EB	planningTimeIndexes	1	1.26	2.01	2.24	2.11	2.23	2.74	4.13	4.77	3.9	3.13	3.69	3.35
I-70 EB	bufferTimeSecs	20	72	178	180	179	203	255	662	900	650	443	637	608
I-70 EB	bufferTimeIndexes	0.07	0.23	0.4	0.35	0.38	0.42	0.44	1.09	1.59	1.19	0.85	1.28	1.44

Detailed Data Output

Segment ID	Road	Direction	Start Latitude	End Latitude	Start Longitude	End Longitude	State/Region	District	Postal Code	Segment Length(Miles)	Ref Speed(miles/hour)	Intersection
1187636873	70 / I-70 W	W	39.7840092	39.7841174	-105.021863	-105.0282988	Colorado	Denver	80221	0.345893	57	I-70 Exit 272 / US-287 Federal Blvd
1187596552	70 / I-70 E	E	39.7834632	39.782536	-105.002756	-104.998993	Colorado	Denver	80211	0.210791	57	
1187392644	70 / I-70 W	W	39.78359237	39.7850212	-105.0407722	-105.0499998	Colorado	Denver	80212	0.515724	59	
1187578445	70 / I-70 W	W	39.784428	39.787118	-105.07011	-105.077012	Colorado	Jefferson	80033	0.438562	61	I-76 Exit 1A / I-70 Exits 269A,269B
1187428867	70 / I-70 E	E	39.7861596	39.784455	-105.0800242	-105.071148	Colorado	Jefferson	80033	0.505063	62	I-76 Exit 1A / I-70 Exits 269A,269B
Date Time	Segment ID	UTC Date Time	Speed(miles/hour)	Hist Av Speed(miles/hour)	Ref Speed(miles/hour)	Travel Time(Minutes)	CValue	Pct Score30	Pct Score20	Pct Score10		
2017-05-09T05:15:00-07:00	1187636873	2017-05-09T12:15:00Z	57	58	57	0.37	100	100	0	0		
2017-05-09T05:30:00-07:00	1187636873	2017-05-09T12:30:00Z	58	58	57	0.35	100	100	0	0		
2017-05-09T05:45:00-07:00	1187636873	2017-05-09T12:45:00Z	60	58	57	0.35	93.13	100	0	0		
2017-05-09T06:00:00-07:00	1187636873	2017-05-09T13:00:00Z	60	57	57	0.35	98.73	100	0	0		
2017-05-09T06:15:00-07:00	1187636873	2017-05-09T13:15:00Z	58	57	57	0.37	100	100	0	0		
2017-05-09T06:30:00-07:00	1187636873	2017-05-09T13:30:00Z	58	57	57	0.37	94.93	100	0	0		
2017-05-09T06:45:00-07:00	1187636873	2017-05-09T13:45:00Z	65	57	57	0.32	46.67	100	0	0		
2017-05-09T07:00:00-07:00	1187636873	2017-05-09T14:00:00Z	58	57	57	0.35	100	100	0	0		
2017-05-09T07:15:00-07:00	1187636873	2017-05-09T14:15:00Z	65	57	57	0.32	68.47	100	0	0		
2017-05-09T07:30:00-07:00	1187636873	2017-05-09T14:30:00Z	58	58	57	0.35	97.93	100	0	0		
2017-05-09T07:45:00-07:00	1187636873	2017-05-09T14:45:00Z	59	58	57	0.35	90.87	100	0	0		
2017-05-09T08:00:00-07:00	1187636873	2017-05-09T15:00:00Z	60	58	57	0.35	99.27	100	0	0		
2017-05-09T08:15:00-07:00	1187636873	2017-05-09T15:15:00Z	58	58	57	0.35	100	100	0	0		
2017-05-09T08:30:00-07:00	1187636873	2017-05-09T15:30:00Z	59	58	57	0.35	100	100	0	0		
2017-05-09T08:45:00-07:00	1187636873	2017-05-09T15:45:00Z	59	58	57	0.35	96.47	100	0	0		
2017-05-09T09:00:00-07:00	1187636873	2017-05-09T16:00:00Z	58	58	57	0.35	100	100	0	0		
2017-05-09T09:15:00-07:00	1187636873	2017-05-09T16:15:00Z	63	58	57	0.33	75.6	100	0	0		
2017-05-09T09:30:00-07:00	1187636873	2017-05-09T16:30:00Z	59	58	57	0.35	97.47	100	0	0		
2017-05-09T09:45:00-07:00	1187636873	2017-05-09T16:45:00Z	61	58	57	0.33	78	100	0	0		
2017-05-09T10:00:00-07:00	1187636873	2017-05-09T17:00:00Z	59	58	57	0.35	41.2	100	0	0		
2017-05-09T10:15:00-07:00	1187636873	2017-05-09T17:15:00Z	56	58	57	0.37	86.2	100	0	0		
2017-05-09T10:30:00-07:00	1187636873	2017-05-09T17:30:00Z	60	58	57	0.35	89.73	100	0	0		
2017-05-09T10:45:00-07:00	1187636873	2017-05-09T17:45:00Z	55	58	57	0.37	100	100	0	0		
2017-05-09T11:00:00-07:00	1187636873	2017-05-09T18:00:00Z	61	58	57	0.33	77.13	100	0	0		
2017-05-09T11:15:00-07:00	1187636873	2017-05-09T18:15:00Z	59	57	57	0.35	87.07	100	0	0		
2017-05-09T11:30:00-07:00	1187636873	2017-05-09T18:30:00Z	62	57	57	0.33	88.33	100	0	0		
2017-05-09T11:45:00-07:00	1187636873	2017-05-09T18:45:00Z	61	57	57	0.33	99.73	100	0	0		
2017-05-09T12:00:00-07:00	1187636873	2017-05-09T19:00:00Z	61	57	57	0.33	95.27	100	0	0		
2017-05-09T12:15:00-07:00	1187636873	2017-05-09T19:15:00Z	60	57	57	0.35	98.87	100	0	0		
2017-05-09T12:30:00-07:00	1187636873	2017-05-09T19:30:00Z	58	57	57	0.35	100	100	0	0		
2017-05-09T12:45:00-07:00	1187636873	2017-05-09T19:45:00Z	57	57	57	0.37	100	100	0	0		
2017-05-09T13:00:00-07:00	1187636873	2017-05-09T20:00:00Z	58	57	57	0.35	100	100	0	0		
2017-05-09T13:15:00-07:00	1187636873	2017-05-09T20:15:00Z	58	58	57	0.35	100	100	0	0		

Congestion Scan



Bottleneck Review

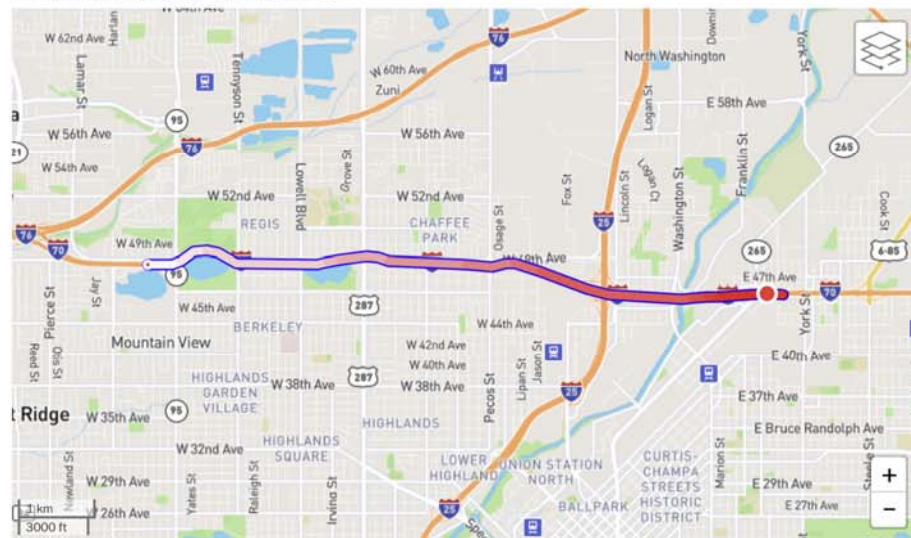
Summary Table

Corridor	Road Name	Intersection	Direction	Impact Factor	Occurrences	Avg Max Duration (min)	Average Max Length (miles)
I-70 EB	I-70 E / US-6 E / US-50 E / US-24 E / US-40 E	I-70 Exit 281 / Peoria St	E	14635	6	202	7.50
I-70 EB	I-70 E / US-6 E / US-50 E / US-24 E / US-40 E	I-70 Exits 282,283,284 / Chambers Rd	E	11793	4	196	9.35
I-70 EB	I-70 E / US-6 E / US-50 E / US-24 E / US-40 E	I-70 Exit 275B / CO-265 Brighton Blvd / Brighton Blvd	E	10182	31	72	2.83
I-70 WB	I-70 W / US-6 W / US-50 W / US-24 W / US-40 W	I-70 Exit 275C / York St / 45th Ave	W	8576	1	723	7.37
I-70 WB	I-70 W / US-6 W / US-50 W / US-24 W / US-40 W	I-70 Exit 272 / US-287 Federal Blvd	W	7547	36	26	5.01

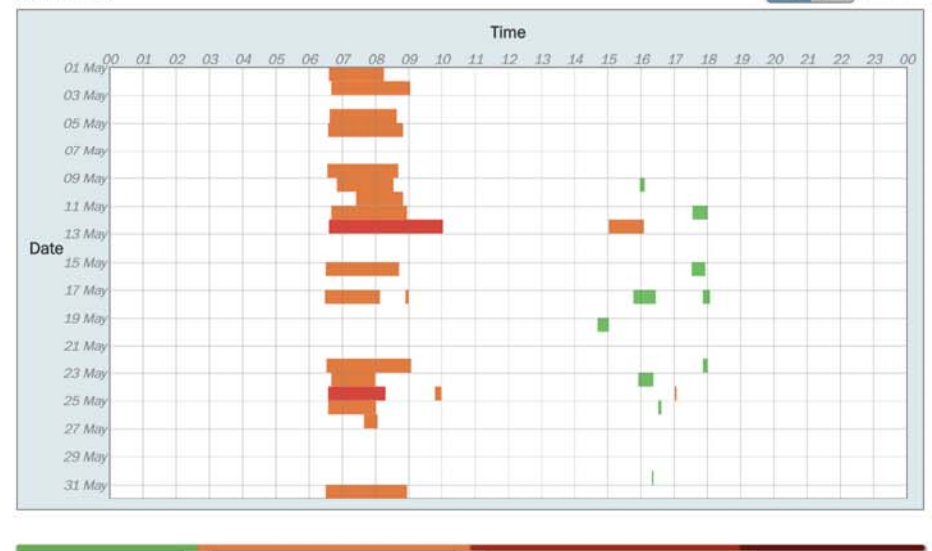
1 to 5 of 37 Entries

Show items 5 ▾ 1 2 3 4 5 ...

I-70 E / US-6 E / US-50 E / US-24 E / US-40 E



Occurrences



Raw Trips Data: Origin-Destination Study on E11 through Dubai, UAE

Objective: Determine OD Relationships Throughout The Corridor During Various Peak and Non-Peak Hours.

- Over 1 Million Trips Represented By Over 80 Million Waypoints
- Two Months of Data (February and March)
- 53 Zones Represented at Each On/Off Ramp Accessing Freeway
- Build Customized Tool in an Online Web App With SQL Server



OD MATRIX

Zones:

All selected (51)

From:

02/06/2017 12:00 AM

To: / Hrs: 96

02/10/2017 12:00 AM

Week Days:

S M T W TH F S

Peak Hrs:

All selected (24)

Non Stop

Compute Matrix

Export To CSV

Matrix Values: TRIPS DURATION

pages 1 | 2

From / To	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27
1		169	1	18	138	564	54	24	40	46	20	53	38	57	21	7	86	32	46	18	36	83	20	1	13	180
2	53		1	13	29	52	10	3	10	17	9	17	6	9	1	1	10	5	9	2	3	8	1	1	3	11
3	10	0		31	7	29	1	4	7	7	1	0	0	1	0	5	3	1	2	4	0	3	0	0	0	7
4	9	32	22		59	65	6	3	6	5	1	1	1	2	1	1	7	3	1	1	4	13	2	0	6	7
5	319	145	3	89		197	50	10	21	36	20	34	15	34	7	3	37	11	24	7	11	23	3	4	13	164
6	417	23	1	40	162		55	16	16	43	19	31	13	21	1	4	33	14	15	9	5	32	4	4	24	25
7	42	8	4	12	33	64		57	55	47	17	34	14	25	13	4	25	5	14	4	12	31	2	1	8	26
8	14	1	0	8	13	19	158		119	34	9	16	5	8	3	1	19	4	1	2	9	17	2	2	4	16
9	40	17	4	18	39	57	126	182		167	58	93	29	39	12	3	41	4	33	10	7	25	3	2	8	49
10	57	5	0	15	28	55	50	31	154		309	346	63	72	22	14	37	8	33	15	17	43	10	1	12	57
11	19	1	0	3	9	28	16	11	47	347		358	91	110	22	12	46	14	26	17	13	49	11	2	9	69
12	29	5	0	2	10	36	21	18	50	339	922		123	127	22	14	69	23	32	20	29	71	14	1	16	99
13	24	2	0	0	6	8	13	12	24	41	38	61		238	24	34	47	17	9	16	23	44	11	2	13	110
14	164	14	4	14	43	119	50	31	168	148	147	230	484		117	55	99	19	43	34	41	81	8	6	43	88



16	1	12	00:20:40	show
1	13	38	00:21:20	show
13	1	24	00:25:23	show

Key Takeaways

- Understand Types of Users
Trips Data is Representing
- Must be Set Up in Web
Environment to Handle Queries
on Database
- Methodology for Trip
Recognition Through Zones



Raw Trips Data:

Arterial Roadway Floating Car Study Research

Route	Compass Direction	Route Distance	Run Distance	Avg Speed	Travel Time	# Stops	Start Time	Stopped Time	Congested Time	Street Class	LOS	TTI Index
EB SFD - 8E	E	0.4	0.4	25.56	0.95	0	11/17/2016 7:34	0	0	III	B	1.369327074
EB SFD - 8E	E	0.4	0.4	31.18	0.77	0	11/17/2016 7:49	0	0	III	A	1.122514432
EB SFD - 8E	E	0.4	0.42	18.07	1.38	1	11/17/2016 8:03	0.43	0.52	III	C	1.936912009
EB SFD - 8E	E	0.4	0.41	19.94	1.23	1	11/17/2016 8:24	0.25	0.38	III	C	1.755265797
EB SFD - 8E	E	0.4	0.41	19.92	1.23	1	11/17/2016 8:40	0.33	0.42	III	C	1.757028112
EB SFD - 8E	E	0.4	0.4	27.61	0.88	0	11/17/2016 8:53	0	0	III	B	1.267656646
EB SFD - 8E	E	0.4	0.44	2.22	11.95	18	11/17/2016 15:59	8.7	11.67	III	F	15.76576577
EB SFD - 8E	E	0.4	0.42	2.27	11.23	15	11/17/2016 16:19	7.87	11.18	III	F	15.4185022
EB SFD - 8E	E	0.4	0.45	1.64	16.32	26	11/17/2016 16:44	13.47	16.12	III	F	21.34146341
EB SFD - 8E	E	0.4	0.43	2.16	11.82	27	11/17/2016 17:45	8.6	11.57	III	F	16.2037037
WB SFD - 8E	W	0.4	0.42	5.31	4.7	5	11/17/2016 7:39	2.78	3.7	III	F	6.5913371
WB SFD - 8E	W	0.4	0.42	5.04	4.97	5	11/17/2016 7:53	2.9	4.07	III	F	6.944444444
WB SFD - 8E	W	0.4	0.42	2.8	8.92	8	11/17/2016 8:11	6.67	8.28	III	F	12.5
WB SFD - 8E	W	0.4	0.42	2.61	9.72	9	11/17/2016 8:29	7.35	9.08	III	F	13.40996169
WB SFD - 8E	W	0.4	0.42	5.11	4.9	4	11/17/2016 8:46	3.27	3.93	III	F	6.849315068
WB SFD - 8E	W	0.4	0.42	5.73	4.4	5	11/17/2016 8:57	2.65	3.52	III	F	6.108202443
WB SFD - 8E	W	0.4	0.42	19.64	1.27	1	11/17/2016 16:14	0.18	0.32	III	C	1.782077393
WB SFD - 8E	W	0.4	0.42	18.44	1.37	1	11/17/2016 16:33	0.32	0.4	III	C	1.898047722
WB SFD - 8E	W	0.4	0.42	19.26	1.3	2	11/17/2016 17:03	0.1	0.4	III	C	1.817237799
WB SFD - 8E	W	0.4	0.42	9.28	2.72	2	11/17/2016 17:59	1.08	1.73	III	F	3.771551724

Arterial Roadway Floating Car Study Research



FLOATING CAR

RAW PROBE TRIPS DATA

LIMITATIONS/ CHALLENGES

- Manual
- Limited Runs During Peak Periods
- \$\$\$

- Number of Trips
- Waypoint Time Spacing
- Defining Corridor Extents

BENEFITS

- Waypoint Frequency
- Pick Exact Time to Collect Data

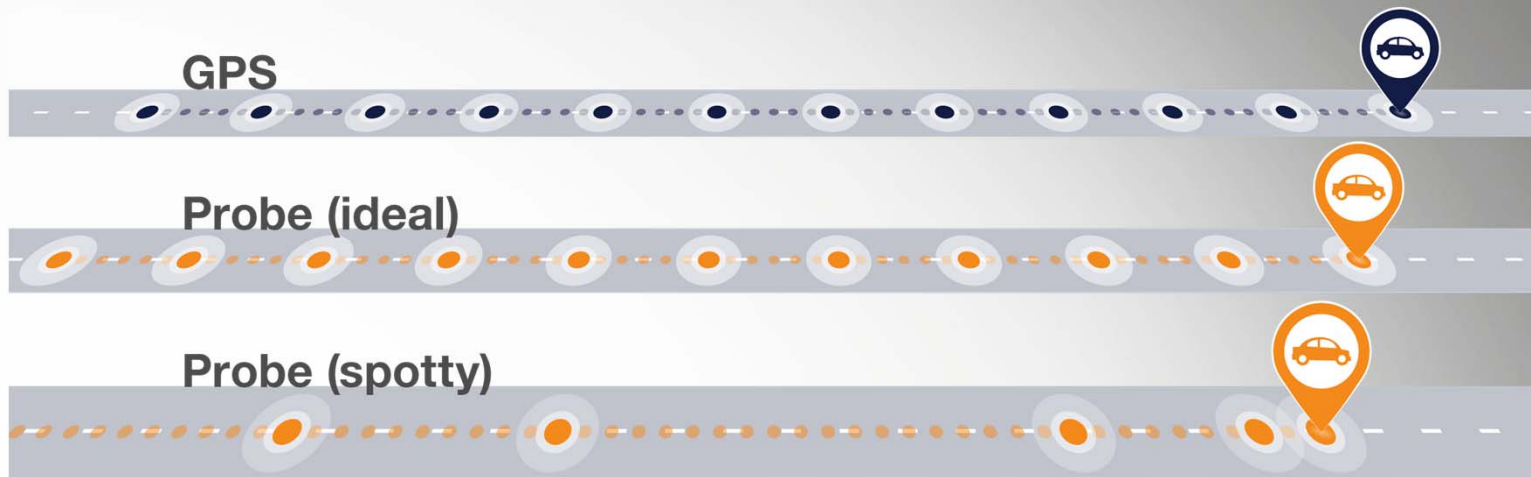
- No Manual Driving of Corridor
- Can Pull Data Historically From Multiple Days and Time Periods
- Reduced Costs

Arterial Roadway Floating Car Study Research

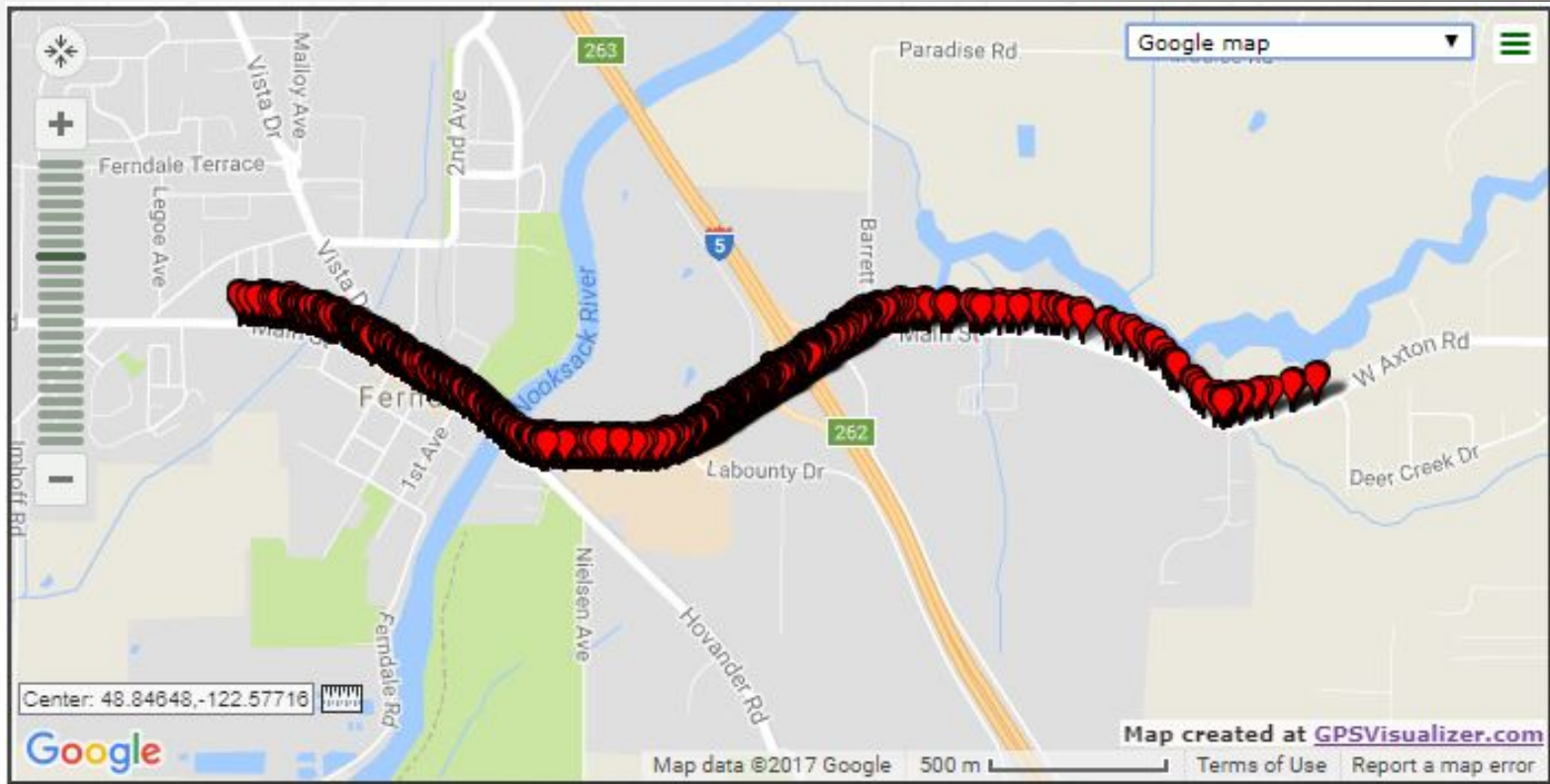
Two Approaches to Review Probe Data

1. Review of Individual Trips Through The Corridor
2. Review of “Trip Parts” Through The Corridor

GPS Location Recorder vs GPS Probe Data From Devices



Representation of Trips/Waypoints During PM Peak Hour

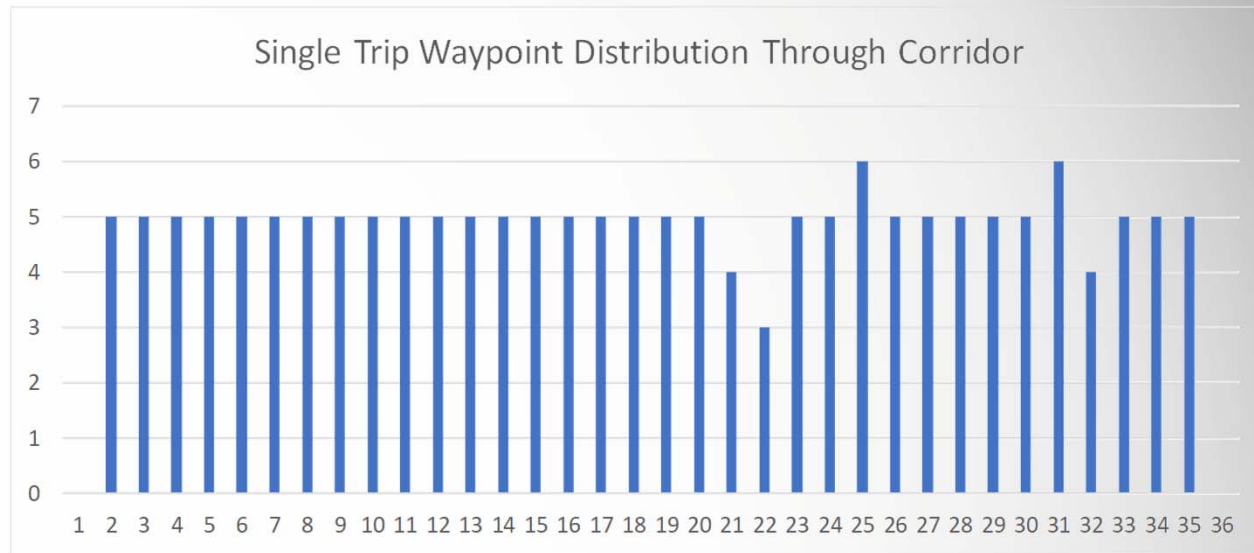


Good Trip Through Corridor

Avg. Waypoint Spacing ~5 sec

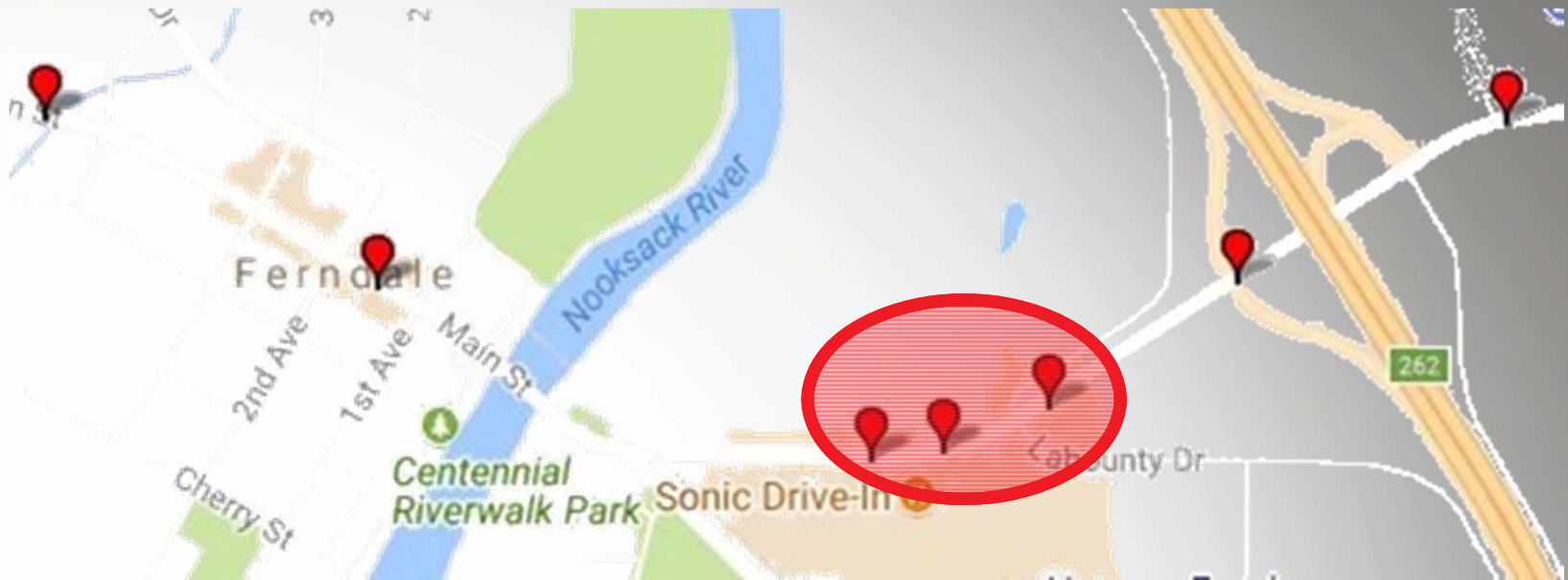


Single Trip Waypoint Distribution Through Corridor



Spotty Trip Through Corridor

Waypoint Spacing Not Consistent



Arterial Roadway Floating Car Study Research

Next Steps:

- Determine Number of Consistent Waypoint Trips and Duration of Data Pull to Obtain Statistically Significant Sample
- Compile Trip Parts to Put Together Entire Corridor Congestion Metrics



Q & A