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Countywide Bluetooth System: Use Cases & Performance Measures

Shaun Quayle
Washington County

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Bluetooth Travel Time & O/D System

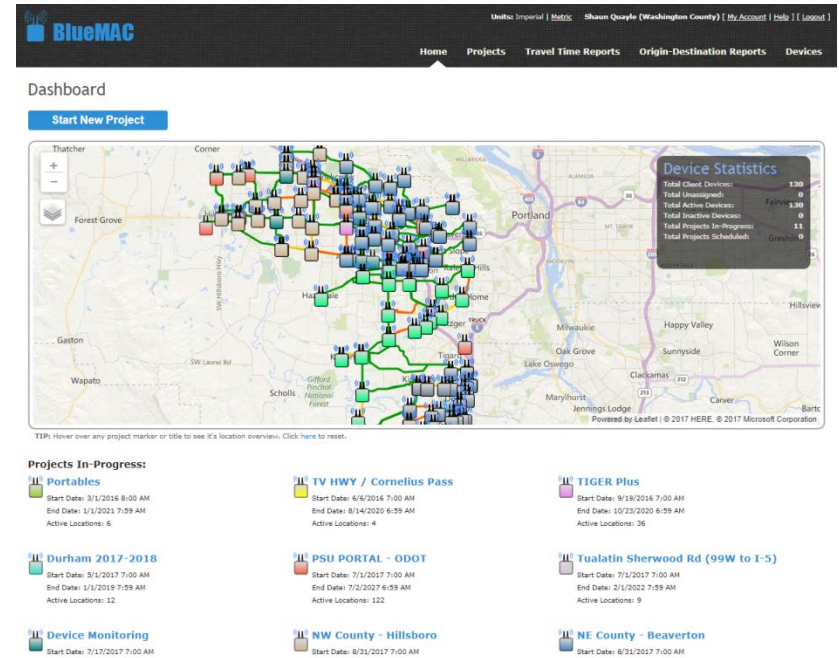
Shaun Quayle, P.E.
Washington Co. Traffic Eng.

TREC – Friday Transportation Seminar

November 3, 2017

Agenda

- Bluetooth Background
- County System
- Use Cases
 - Operations
 - Planning
- Perf Meas.



Need “Statement”

- Realistic existing condition models → “Pass the straight face test”
- Discern problem locations, days & times operationally
- Proactive knowledge of issues
 - Alert of significant travel time change
 - Track travel time “rankings” over time

Bluetooth Background

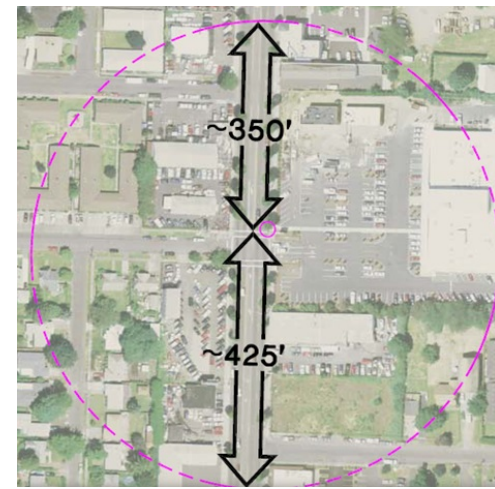
Bluetooth™ = robust, short-range *wireless* radio comm. protocol between electronic devices

- Unlicensed, low-power 2.4 GHz band
- Media Access Control (MAC) Address
 - **Anonymous** Unique Identifier (48 bit, >28 trillion)
- Class 1 ~ 300', Class 2 ~ 30', Class 3 ~ 3'

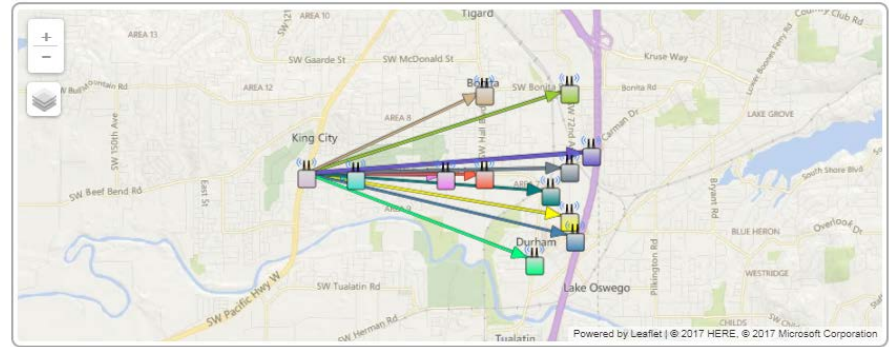
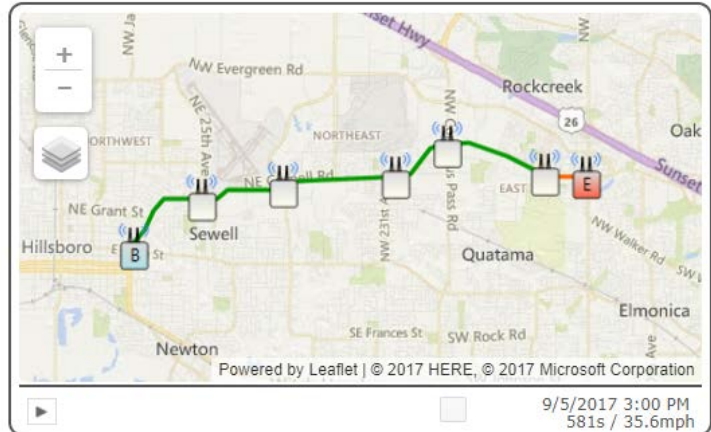
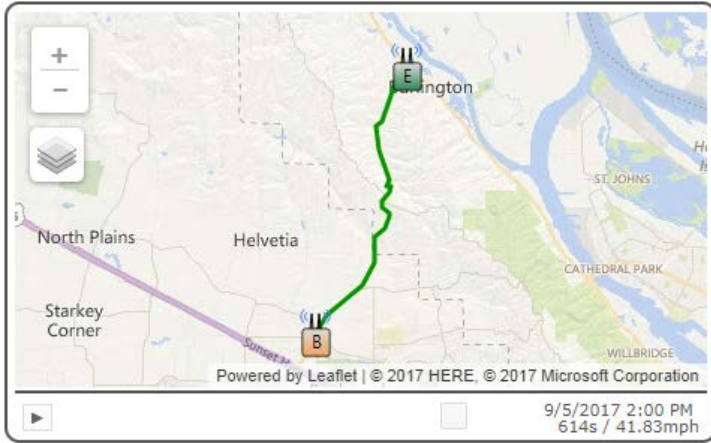


Bluetooth Background

MAC Reader Station	Time Period		Tube Counts	MAC Address Matches between On-Ramp and Pairing Station	Vehicle Capture Rate
Brookwood Parkway Eastbound On-Ramp	AM	7 am - 9 am	727	113	16%
	Midday	12 noon - 2 pm	1,108	96	9%
	PM	4 pm - 6 pm	806	153	19%
	All Day		8,697	969	11%
185 th Avenue Northbound to Eastbound On-Ramp	AM	7 am - 9 am	895	79	9%
	Midday	12 noon - 2 pm	1,775	163	9%
	PM	4 pm - 6 pm	1,508	114	8%
	All Day		12,299	1,036	8%
185 th Avenue Southbound to Eastbound On-Ramp	AM	7 am - 9 am	956	103	11%
	Midday	12 noon - 2 pm	578	80	14%
	PM	4 pm - 6 pm	339	66	19%
	All Day		4,796	595	12%

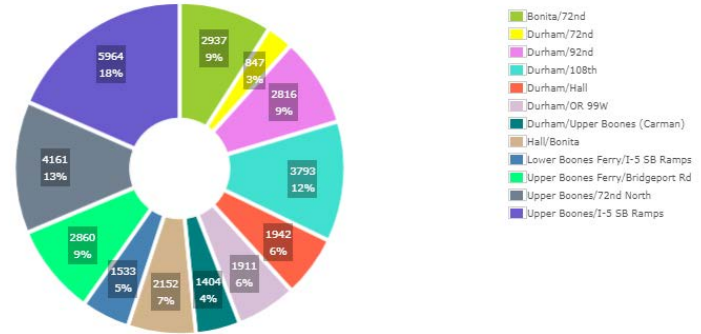


Sampling Relative to Devices



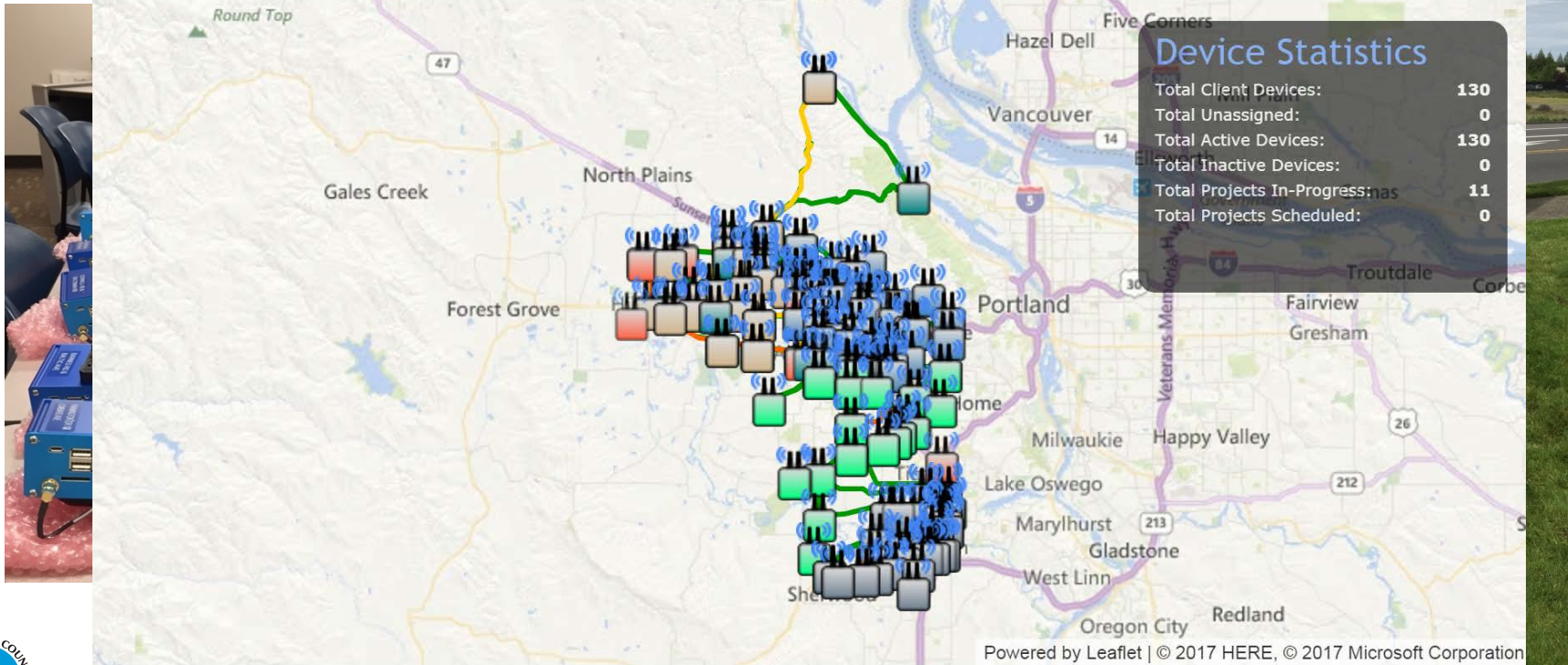
Observed Trips (s) from Durham/OR 99W

View: [As Origin](#) [As Destination](#)



Loc	Destination	Number of Trips	Percentage
	Bonita/72nd	2937	9.1%
	Durham/72nd	847	2.6%
	Durham/92nd	2816	8.7%
	Durham/108th	3793	11.7%

Washington Co. System



Use Case #1 – Snow Day!

***How does snow impact
AM peak commute
(7am to 9am)?***

*Rainy Tues. Jan 10th vs.
Snowy Wed., Jan 11th*

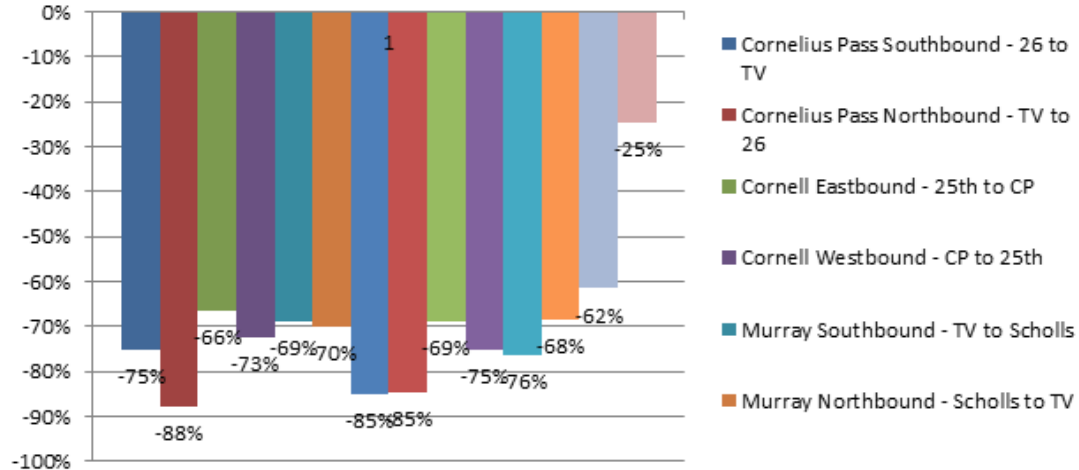
- *Cornelius Pass Road*
- *185th Avenue*
- *Murray Blvd*
- *Durham Road*
- *72nd Avenue*



Snow Day = Less Trips

Trips Reduced by 75%
(range = 25% to 88%)
(Jan 11th snow vs. Jan 10th rain)

**% Change in Number of Trips During Snowy AM
Peak Commute - 1/11/2017**



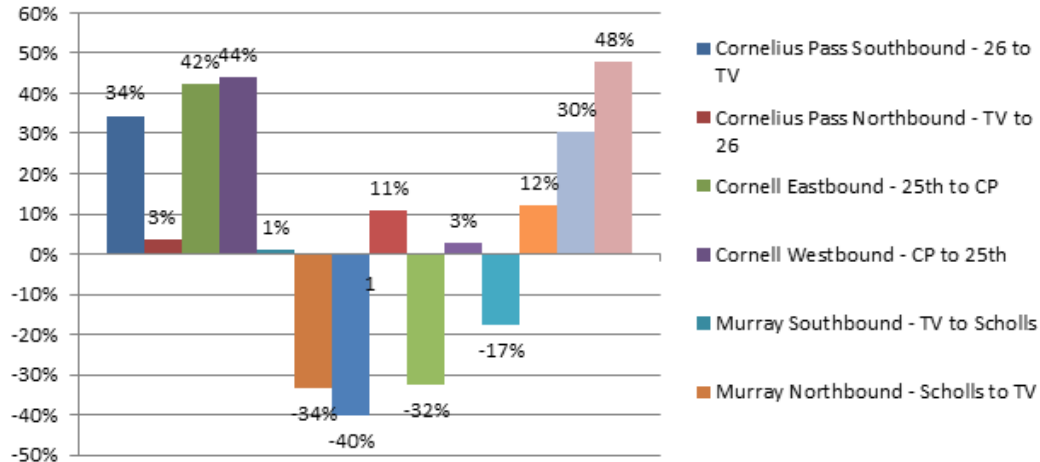
Snow Day = Faster & Slower Travel Times

Average No Change

(range = -40% to +48%)

(Jan 11th snow vs. Jan 10th rain)

**% Change in Travel Time During Snowy AM Peak
Commute - 1/11/2017**



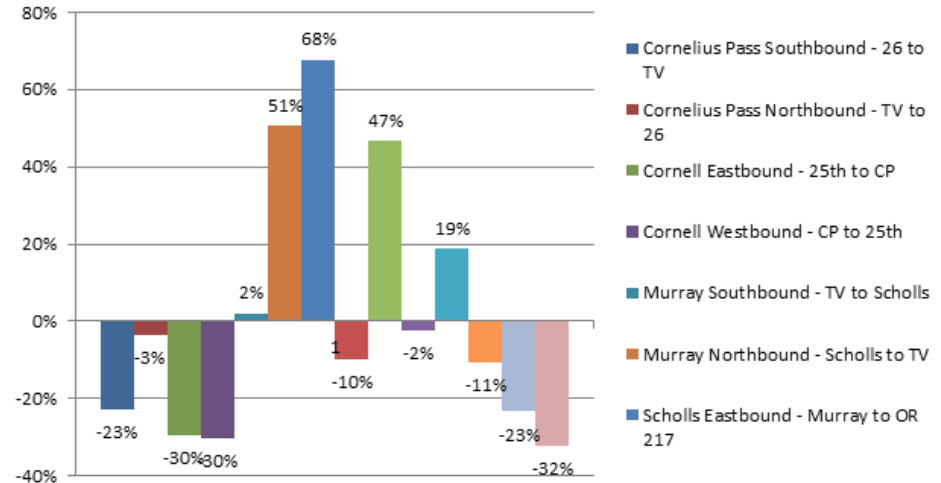
Snow Day = Faster & Slower Running Speeds

Average -5% speed reduction

(range = -32% to +68%)

(Jan 11th snow vs. Jan 10th rain)

% Change in Speed During Snowy AM Peak Commute - 1/11/2017



Use Case #2 –Signal Timing

***Citizen complaint(s)
along Scholls Ferry
Road in AM peak.***

Impact of signal timing
adjustment, setting
Nimbus/Scholls “free”

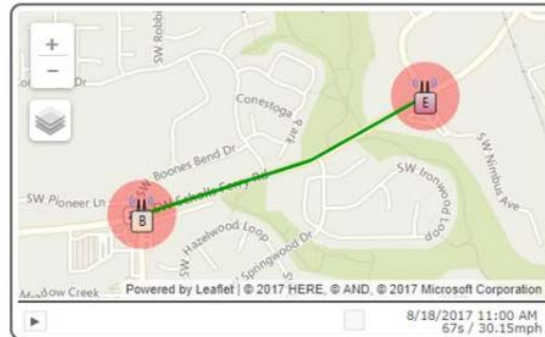
*Scholls Ferry Road Corridor – Bluetooth
readers between 121st and Nimbus during
critical AM peak.*



Scholls Ferry at 121st Ave to Scholls Ferry at Nimbus Ave

Trip Distance(mi):	0.56
Expected Travel Time(s):	63 (1:03)
Number of Trips:	104527
Mean/Median Speed(mph):	19.7 / 23.2
Mean/Median Travel Time(s):	102.3 (1:42) / 87 (1:27)
Standard Deviation:	60.5
15th Percentile Travel Time(s):	52
85th Percentile Travel Time(s):	148 (2:28)
95th Percentile Travel Time(s):	228 (3:48)

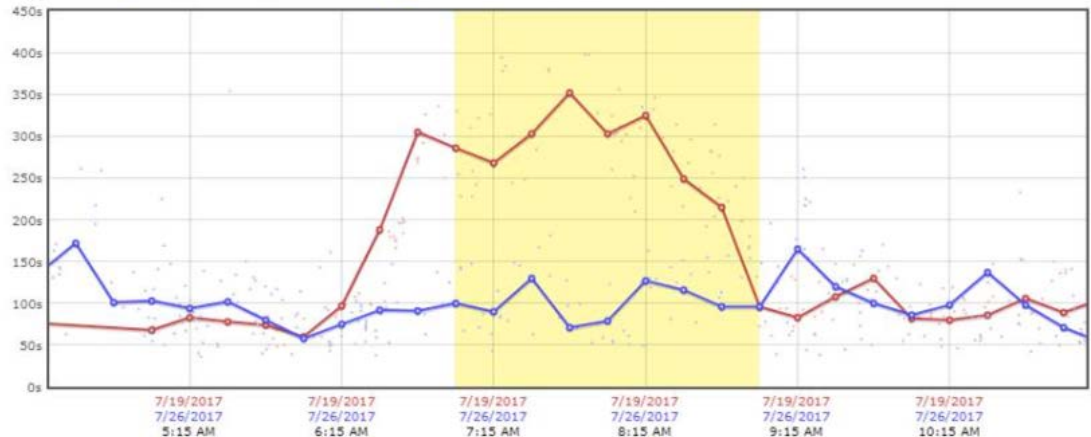
Note: You may adjust the location of the devices by clicking and dragging the markers on the map to the right. This will update the route and distance/time taken calculated.



EMAIL

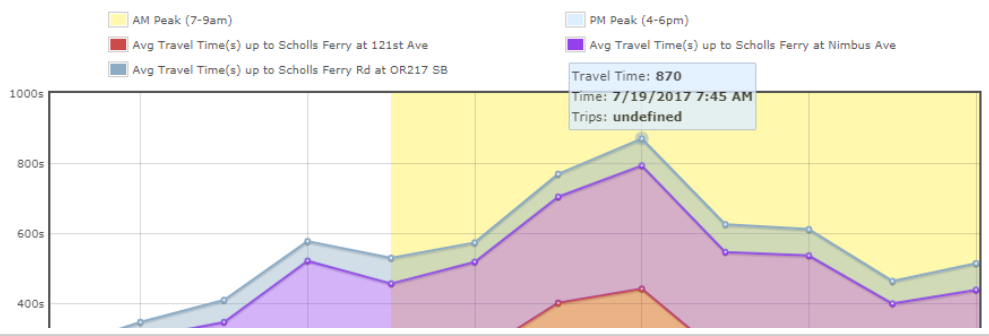
Observed Travel Times (s) from Scholls Ferry at 121st Ave to Scholls Ferry at Nimbus Ave

	Total Trips	Mean	Median	Std. Deviation	15th Percentile	85th Percentile	95th Percentile
Baseline:	4930	139.6 (2:19)	114.5 (1:54)	85.8	63 (1:03)	233 (3:53)	331 (5:31)
Overlay:	5234	93.4 (1:33)	85 (1:25)	44.3	53	132 (2:12)	165 (2:45)
Delta:	-304	46.2 (0:46)	29.5 (0:30)	41.5	10.0 (0:10)	101.0 (1:41)	166.0 (2:46)



FORE

Total Trips	Mean	Median	Std. Deviation	15th Percentile	85th Percentile	95th Percentile
2590	548.8 (9:08)	537 (8:57)	173	343 (5:43)	770 (12:50)	865.5 (14:25)



Weekday 6am to 9am



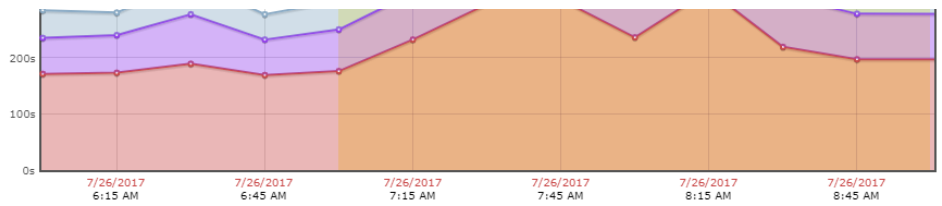
Median Std. Deviation 15th Percentile 85th Percentile

537 (8:57) 173 343 (5:43) 770 (12:50)

Median Std. Deviation 15th Percentile 85th Percentile

328 (5:28) 64.2 281.5 (4:41) 426 (7:06)

AF

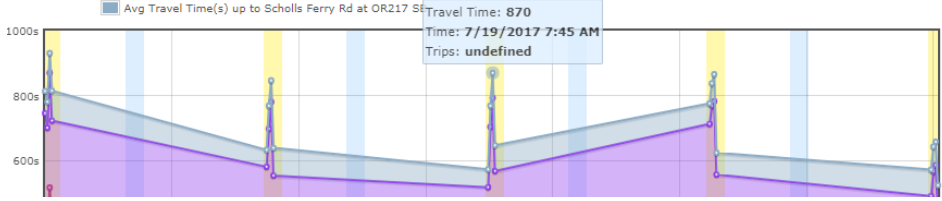


FORE

Total Trips	Mean	Median	Std. Deviation	15th Percentile	85th Percentile	95th Percentile
859	729.1 (12:09)	768.3 (12:48)	118.4	624 (10:24)	865.5 (14:25)	N/A

- AM Peak (7-9am)
- PM Peak (4-6pm)
- Avg Travel Time(s) up to Scholls Ferry at 121st Ave
- Avg Travel Time(s) up to Scholls Ferry Rd at OR217 St
- Avg Travel Time(s) up to Scholls Ferry at Nimbus Ave

Weekday 7:15am to 8:15am



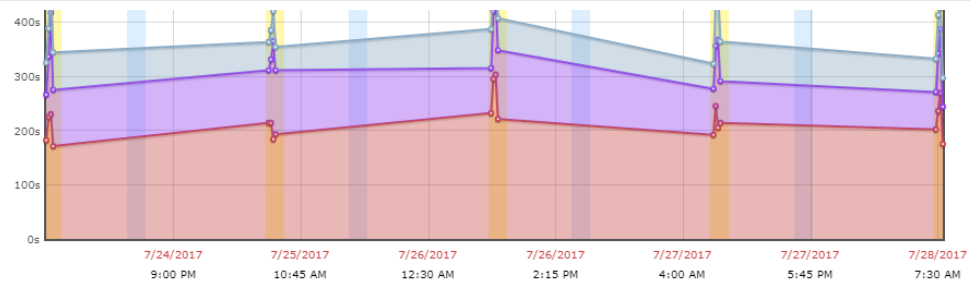
Median Std. Deviation 15th Percentile 85th Percentile

768.3 (12:48) 118.4 624 (10:24) 865.5 (14:25)

Median Std. Deviation 15th Percentile 85th Percentile

387.3 (6:27) 60.9 331.5 (5:31) 470.5 (7:50)

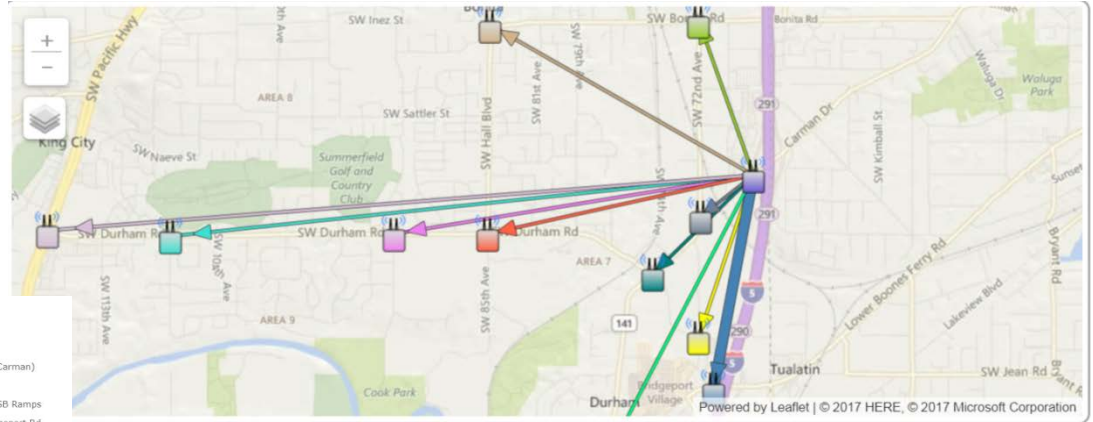
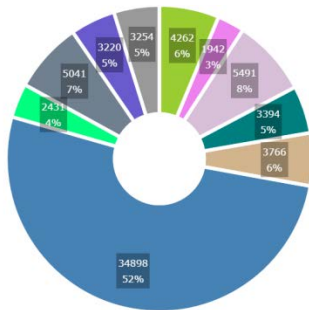
AFT



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Use Case #3 – Model Calibration

Need to validate existing routing.



Observed Trips (s) from Upper Boones/I-5 SB Ramps

Loc	Destination	Number of Trips	Percentage
	Bonita/72nd	4262	6.3%
	Durham/72nd	992	1.5%
	Durham/92nd	1942	2.9%
	Durham/108th	1034	1.5%
	Durham/Hall	1228	1.8%
	Durham/OR 99W	5491	8.1%
	Durham/Upper Boones (Carman)	3394	5.0%

OD Bluetooth v. Regional Model

Table 4 Weekday Peak Period Origin-Destination Data Comparison

Origin Station	Last Destination Station Detected	MAC Trip Percentage		Regional Travel Model Percentage	
		AM	PM	AM	PM
Brookwood Parkway / Eastbound On-ramp (Based on Four-Day Data)	US 26 East of Brookwood	11%	18%	2%	2%
	US 26 East of 185 th	21%	32%	15%	19%
	US 26 adjacent to Vista Ridge Tunnel	49%	28%	61%	52%
	OR 217 between US 26 and Walker	4%	6%	5%	9%
	OR 217 between Allen and Denny ¹	2%	4%	2%	3%
	OR 217 between Scholls Ferry and Greenberg	13%	12%	14%	15%
Northbound 185 th Avenue / Eastbound On-ramp (Based on Four-Day Data)	US 26 East of 185 th	21%	33%	11%	15%
	US 26 adjacent to Vista Ridge Tunnel	60%	46%	71%	52%
	OR 217 between US 26 and Walker	5%	6%	2%	9%
	OR 217 between Allen and Denny ¹	3%	4%	3%	5%
	OR 217 between Scholls Ferry and Greenberg	11%	11%	13%	20%
Southbound 185 th Avenue / Eastbound On-ramp (Based on Two-Day Data)	US 26 East of 185 th	22%	46% ²	15%	32%
	US 26 adjacent to Vista Ridge Tunnel	36%	35% ²	36%	25%
	OR 217 between US 26 and Walker	11%	1% ²	13%	16%
	OR 217 between Allen and Denny ¹	7%	1% ²	10%	7%
	OR 217 between Scholls Ferry and Greenberg	24%	17% ²	26%	21%

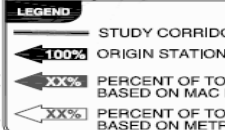
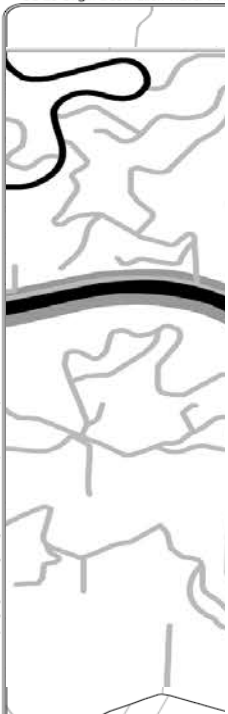
¹ Results based on extrapolation of August 3rd data, due to technical difficulties at this station during other time periods.

² Data has limited number of matches and the results should be used with caution.

Colored text denoted a lower/higher trip distribution percentage measured by this study as compared to Metro's regional model:

- Red text MAC much lower (more than 10% lower)
- Orange text MAC slightly lower (between 10% lower and 5% lower)
- Grey text MAC similar (between 5% lower and 5% higher)
- Green text MAC slightly higher (between 5% higher and 10% higher)
- Blue text MAC significantly higher (more than 10% higher)

US 26 Origin-Destination Travel Tim



KITTELSON & ASSO
TRANSPORTATION ENGINEERS

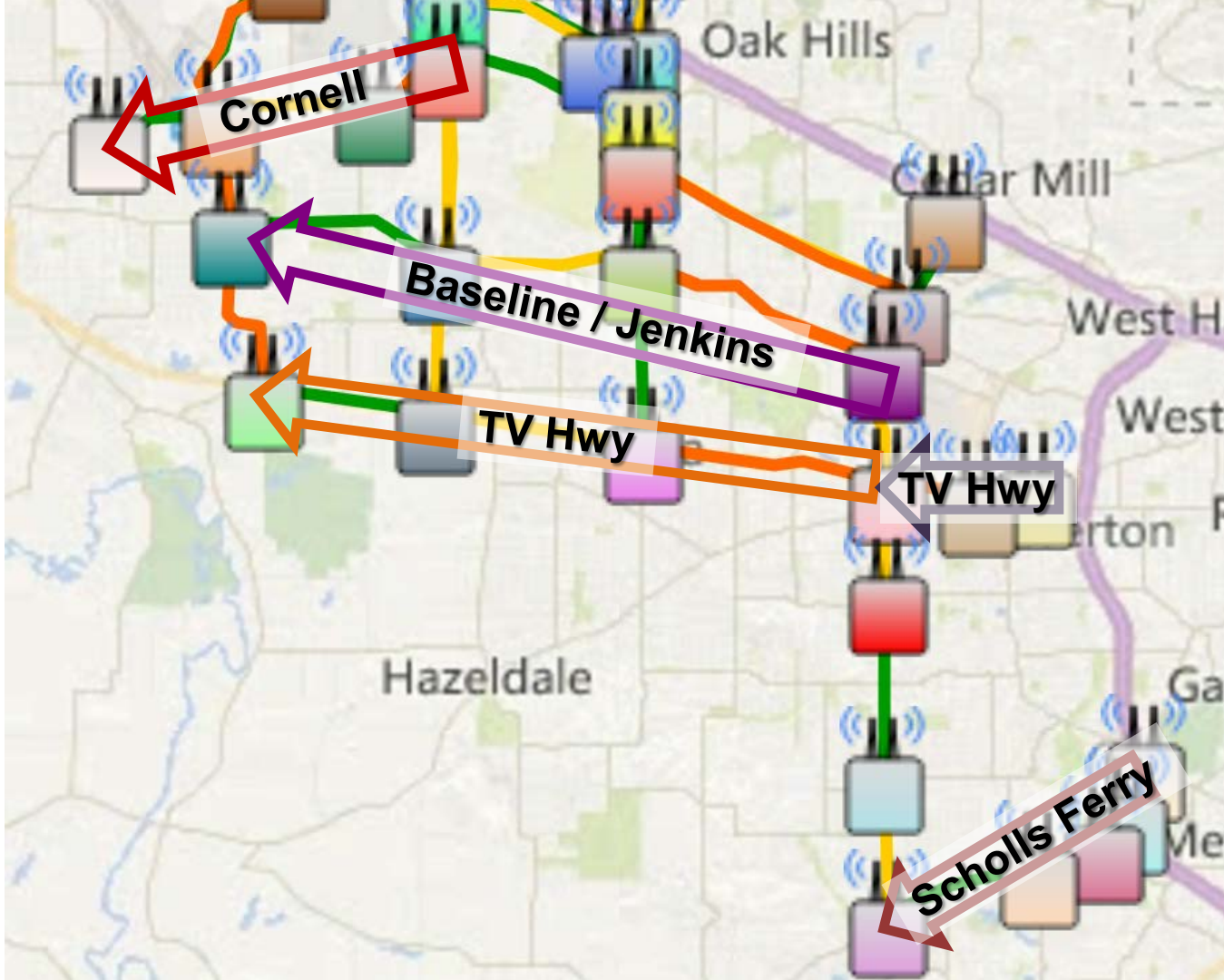
January 2011



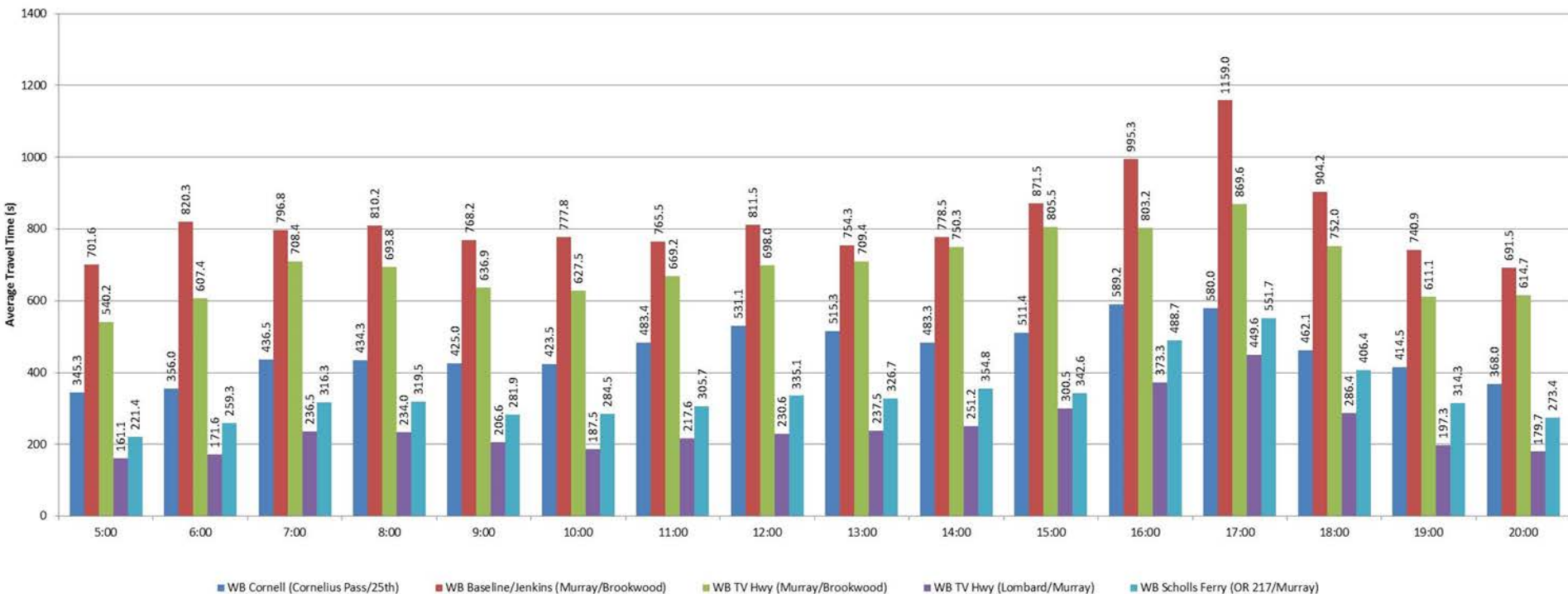
FIGURE 3

Bluetooth Performance Measures

- **Travel Time & Planning Time Index**
 - Compare 1 corridor over time
 - $PTI = 95\% TT / \text{Free Flow TT}$ (Reliability)
- **% Longer than Free Flow**
 - Normalized, multiple corridors over time
- **Avg. Running Speed**
 - Normalized, but not relatable to lay audiences



Westbound Arterial Weekday Travel Time - Oct 17 to Nov 17, 2016



WB Cornell (Cornelius Pass/25th)

WB Baseline/Jenkins (Murray/Brookwood)

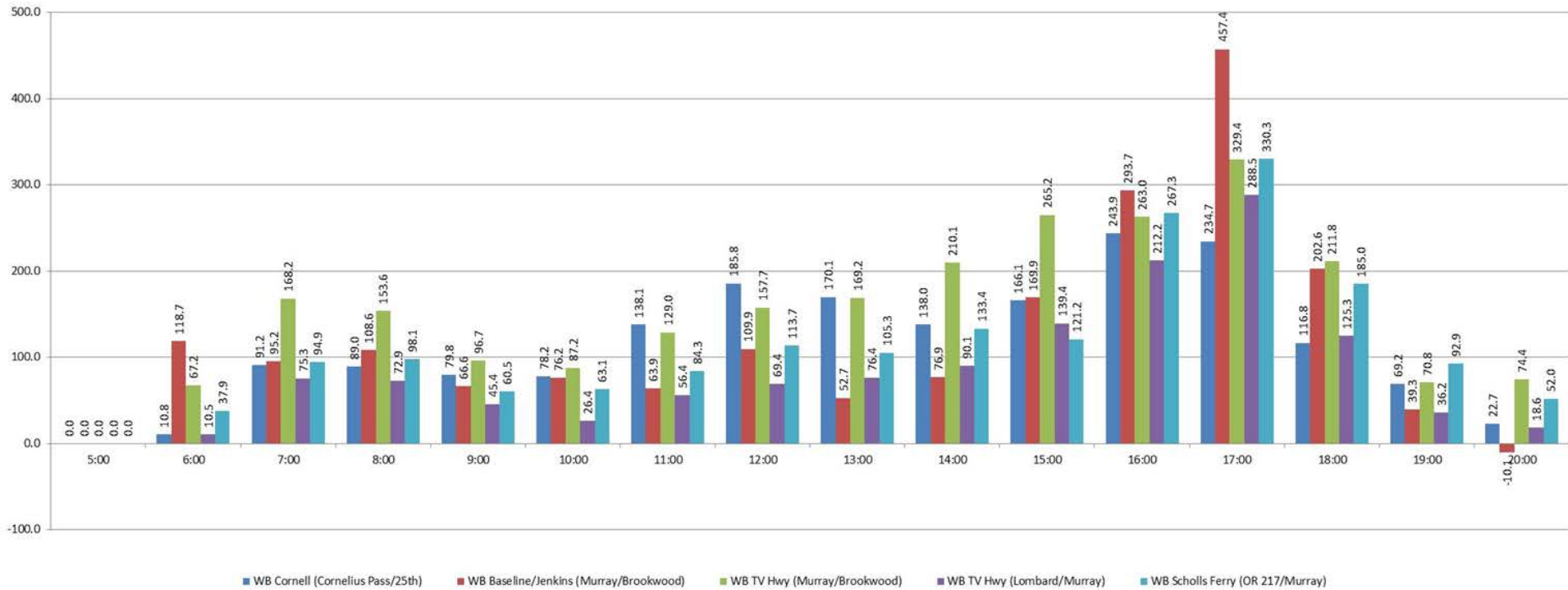
WB TV Hwy (Murray/Brookwood)

WB TV Hwy (Lombard/Murray)

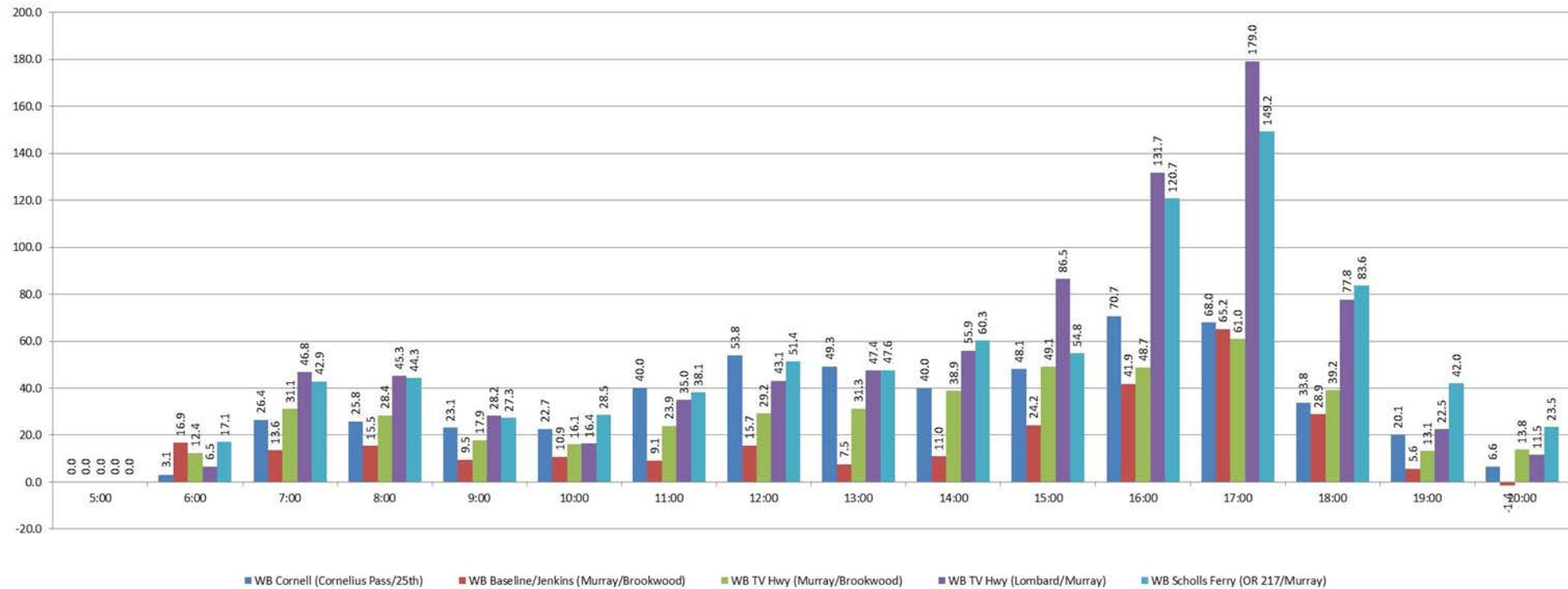
WB Scholls Ferry (OR 217/Murray)



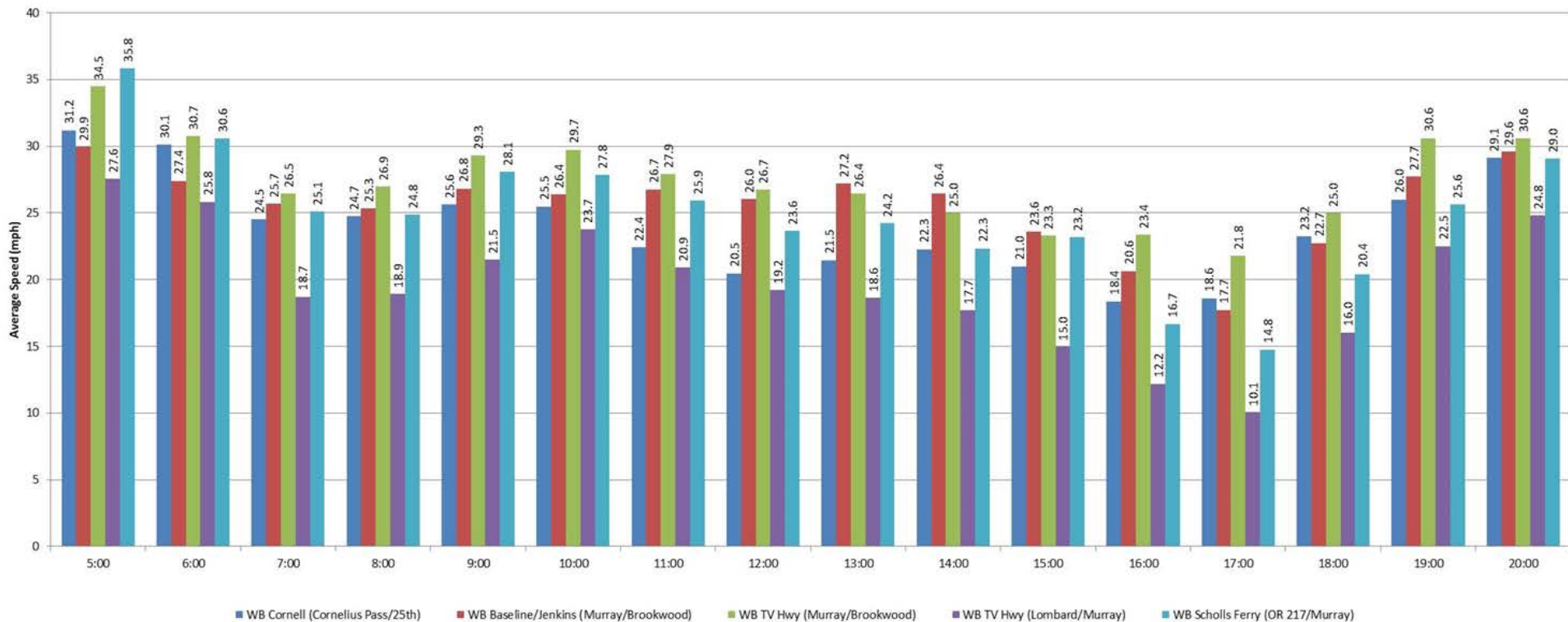
Westbound Arterial Weekday TT Longer Than 5am-6am "Free-Flow" - Oct 17 to Nov 17, 2016



Westbound Arterial Weekday Percent Difference TT Longer Than 5am-6am "Free-Flow" - Oct 17 to Nov 17, 2016



Westbound Arterial Weekday Avg Speed - Oct 17 to Nov 17, 2016






Absolute Percent Over "Free Flow" (5-6am)
Fall 2016 Weekdays - October 17 to November 17, 2016

	WB Cornell (Cornelius Pass/25th)	WB Baseline/Jenkins (Murray/Brookwood)	WB TV Hwy (Murray/Brkwd)	WB TV Hwy (Lombard/Murray)	WB Scholls Ferry (OR 217/Murray)	EB Cornell (25th/Cornelius Pass)	EB Baseline/Jenkins (Brookwood/Murray)
Start Location	Cornell/Cornelius Pass	Jenkins/Murray	TV Hwy/Murray	TV Hwy/Lombard	Scholls Ferry/OR 217	Cornell/25th	Baseline/Brookwood
End Location	Cornell/25th	Baseline/Brookwood	TV Hwy/Brookwood	TV Hwy/Murray	Scholls Ferry/Murray	Cornell/Cornelius Pass	Jenkins/Murray
Number of Signals	12	20	13	6	10	12	20
Trip Distance (miles)	2.96	5.67	5.17	1.23	2.19	2.96	5.67
Expected Travel Time	330 (5:30)	641 (10:41)	538 (8:58)	167 (2:47)	256 (4:16)	330 (5:30)	641 (10:41)
5:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6:00	3.1	16.9	12.4	6.5	17.1	14.5	23.8
7:00	26.4	13.6	31.1	46.8	42.9	39.3	68.1
8:00	25.8	15.5	28.4	45.3	44.3	43.6	40.0
9:00	23.1	9.5	17.9	28.2	27.3	44.1	27.2
10:00	22.7	10.9	16.1	16.4	28.5	48.0	27.9
11:00	40.0	9.1	23.9	35.0	38.1	81.7	42.2
12:00	53.8	15.7	29.2	43.1	51.4	100.8	44.9
13:00	49.3	7.5	31.3	47.4	47.6	82.1	43.2
14:00	40.0	11.0	38.9	55.9	60.3	65.9	47.1
15:00	48.1	24.2	49.1	86.5	54.8	72.5	37.6
16:00	70.7	41.9	48.7	131.7	120.7	88.2	56.0
17:00	68.0	65.2	61.0	179.0	149.2	113.2	76.9
18:00	33.8	28.9	39.2	77.8	83.6	66.1	39.7
19:00	20.1	5.6	13.1	22.5	42.0	43.9	19.2
20:00	6.6	-1.4	13.8	11.5	23.5	30.1	9.2
Aggregate (5am-9pm)	531.3	273.9	454.1	833.5	831.1	933.8	603.0

TIGER



Congested Locations (Pk Hr)

Rank (1 = most congested)	 Fall 2016 - Oct 17 to Nov 17, 2016		Absolute Percent Over "Free Flow" (5-6am)
	1	WB TV Hwy - Lombard to Murray	
2	WB Scholls Ferry - OR 217 to Murray	17:00 to 18:00	149%
3	EB Scholls Ferry - Murray to OR 217	7:00 to 8:00	147%
4	WB TV Hwy - Lombard to Murray	16:00 to 17:00	132%
5	WB Scholls Ferry - OR 217 to Murray	16:00 to 17:00	120%
6	EB Cornell - 25th to Cornelius Pass	17:00 to 18:00	113%
7	EB TV Hwy - Murray to Lombard	17:00 to 18:00	112%
8	NB Murray - TV to US 26	17:00 to 18:00	110%
9	EB TV Hwy - Brookwood to Murray	7:00 to 8:00	109%
10	NB Murray - Scholls to TV	7:00 to 8:00	107%

TIGER




Congested Locations (Pk Hr)

Rank (1 = most congested)	 Winter 2017 - Feb 20 to Mar 24, 2017		Absolute Percent Over "Free Flow" (5-6am)	Congestion change from previous season	Top 10 Fall & Winter?
	Location	Time			
1	WB TV Hwy - Lombard to Murray	17:00 to 18:00	178%	-1%	Yes
2	WB TV Hwy - Lombard to Murray	16:00 to 17:00	146%	14%	Yes
3	EB Scholls Ferry - Murray to OR 217	7:00 to 8:00	131%	-16%	Yes
4	WB Scholls Ferry - OR 217 to Murray	17:00 to 18:00	125%	5%	Yes
5	NB Murray - TV to US 26	17:00 to 18:00	119%	9%	Yes
6	EB Scholls Ferry - Murray to OR 217	8:00 to 9:00	117%	18%	No
7	WB TV Hwy - Lombard to Murray	15:00 to 16:00	109%	23%	No
8	WB TV Hwy - Lombard to Murray	18:00 to 19:00	98%	20%	No
9	EB TV Hwy - Brookwood to Murray	17:00 to 18:00	86%	-9%	No
10	EB Baseline-Jenkins - Brookwood to Murray	17:00 to 18:00	84%	7%	No

TIGER



Congested Locations (Pk Hr)


Rank (1 = most congested)	 Spring 2017 - April 3 to May 5, 2017		Absolute Percent Over "Free Flow" (5-6am)	Congestion change from previous season	Top 10 Fall, Winter & Spring?
1	WB TV Hwy - Lombard to Murray	17:00 to 18:00	160%	-18%	Yes
2	WB Scholls Ferry - OR 217 to Murray	17:00 to 18:00	140%	15%	Yes
3	EB Scholls Ferry - Murray to OR 217	7:00 to 8:00	134%	3%	Yes
4	EB Scholls Ferry - Murray to OR 217	8:00 to 9:00	133%	16%	No
5	WB TV Hwy - Lombard to Murray	16:00 to 17:00	120%	-26%	Yes
6	NB Murray - TV to US 26	17:00 to 18:00	117%	-2%	Yes
7	WB TV Hwy - Murray to Brookwood	13:00 to 14:00	102%	53%	No
8	WB Scholls Ferry - OR 217 to Murray	16:00 to 17:00	98%	-27%	No
9	EB Scholls Ferry - Murray to OR 217	12:00 to 13:00	92%	18%	No
10	EB TV Hwy - Murray to Lombard	17:00 to 18:00	89%	-13%	No



TIGER



Duration of Congestion "Score"

Rank (1 = most congested)	 Winter 2017 - Feb 20 to Mar 24, 2017	Aggregated Sum of Hourly Percentages Over "Free Flow" (5-6am)	Congestion change from previous season	Top 10 Fall & Winter?
1	WB TV Hwy - Lombard to Murray	977.5	144	Yes
2	EB Scholls Ferry - Murray to OR 217	945.1	128	Yes
3	EB TV Hwy - Murray to Lombard	829.1	-19	Yes
4	EB TV Hwy - Brookwood to Murray	703.4	-97.7	Yes
5	WB Scholls Ferry - OR 217 to Murray	682.1	-149	Yes
6	WB TV Hwy - Murray to Brookwood	653.7	199.6	No
7	NB 185th - TV to US 26	621.2	-42.5	Yes
8	EB Cornell - 25th to Cornelius Pass	619.2	-314.6	Yes
9	NB Murray - TV to US 26	601.9	-12.7	Yes
10	EB Baseline/Jenkins - Brkwd to Murray	601	-2	Yes

Summary



- County has 124 roadside permanent Bluetooth readers to support
 - Travel time & Reliability
 - Running speed, and
 - Origin-Destination assessments.
- Access to System for Agency Partners

Thanks to agency partners!



Question & Answer



Shaun_quayle@co.washington.or.us ; 503-846-7938

Live Demo of Site

[Add Manual Segment?](#)

[Add a Custom Route?](#)

System detected Automatic Travel Time segments

Overview

ROUTE From Boones
Ferry Rd/Ibach St
 To Boones Ferry
 Road/Tualatin Road

[Delete](#)

ROUTE From Boones
Ferry Road/Martinazzi
 Ave
 To Durham/Upper
 Boones (Carman)

[Delete](#)

ROUTE From Boones
Ferry Road/Martinazzi
 Ave
 To Lower Boones
 Ferry/I-5 SB Ramps

[Delete](#)

ROUTE From Boones
Ferry Road/Tualatin
 Road
 To Boones Ferry
 Rd/Ibach St

[Delete](#)

ROUTE From Boones
Ferry Road/Tualatin
 Road
 To Herman Rd/124th
 Ave

[Delete](#)

ROUTE From
Durham/108th
 To Upper Boones/I-5 SB
 Ramps

[Delete](#)

ROUTE From
Durham/Hall
 To Lower Boones
 Ferry/I-5 SB Ramps

[Delete](#)

The following filter settings have been applied to this project.

Date Range: 8/31/2017 - 1/2/2028

Time Range: 5:00 AM - 9:00 PM

Day(s) Selection: Monday, Tuesday, Wednesday, Thursday, Friday

Matches that are less than 1mph or greater than 200mph are not included in the segment details.

[Period Filter Options](#) [Download CSV](#)

Overview

TIP: Jump quickly to a pair by clicking on a marker to see the corresponding destinations pairs.



Status	Location Pairs	Total Matches	Last Match	Last Match Travel Time (s)	Last Match Speed (mph)
	ROUTE Boones Ferry Rd/Ibach St To Boones Ferry Road/Tualatin Road	-	-	-	-
	ROUTE Boones Ferry Road/Martinazzi Ave To Durham/Upper Boones (Carman)	-	-	-	-
	ROUTE Boones Ferry Road/Martinazzi Ave To Lower Boones Ferry/I-5 SB Ramps	-	-	-	-
	ROUTE Boones Ferry Road/Tualatin Road To	-	-	-	-

