Organic vs. Purchased Data for Travel Time Predictions

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2019 North West Passage Technician's Forum

Glossary

- ATMS – Advanced Traffic Management System.
- BTR – Bluetooth Reader.
- HERE – HERE Technologies. 3rd Party TT Provider.
- MAC – Media Access Control (“MAC address”).
- SLT – South Lake Tahoe.
- TT – Travel Time.
- Waze – 3rd Party TT & Alerts Provider.

Overview

Organic Data

- ~~Single Loops~~
- ~~Double Loops~~
- Bluetooth
- ~~WiFi~~
- ~~Microwave~~

Purchased Data

- Waze
- HERE

Bluetooth/Waze/HERE

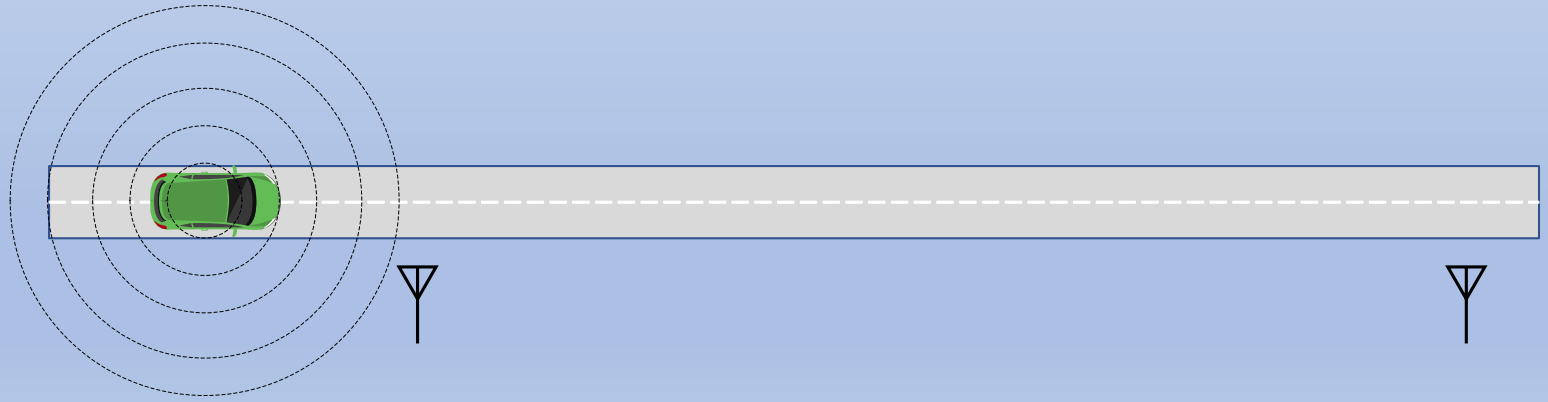
- I-80 – Sacramento Case Study
- US-50 - South Lake Tahoe Case Study

Bluetooth Pros (vs Loops)

- ✓ Easy install - Less than 30 minutes per site.
- ✓ Relatively inexpensive - $2400/site.
  - ✓ BTR - $2200
  - ✓ Antenna - $160
  - ✓ Bracket - $40
- ✓ Off pavement – Any cabinet with power suffices.
- ✓ Quick repair – Less than 30 minutes per site.
- ✓ No Lane Closure – Outside Clear Recovery Zone or guarded by rail.
- ✓ Non Intrusive – Does not interfere with Travelers' Phones/Cars.
- ✓ High Deployment – Anyone over 10 years has smart phone.
- ✓ Anonymous – Can encrypt MAC address.
- ✓ Single Detector detects both directions at most locations.

Bluetooth/WiFi Basics

1. Detector Captures MAC Addresses (48 unique bits).
2. Forwards to Server.
3. Downstream Detector Captures MAC Address.
4. Forwards to Server.
5. Server Calculates Travel Time.
6. Server Exports Travel Time.



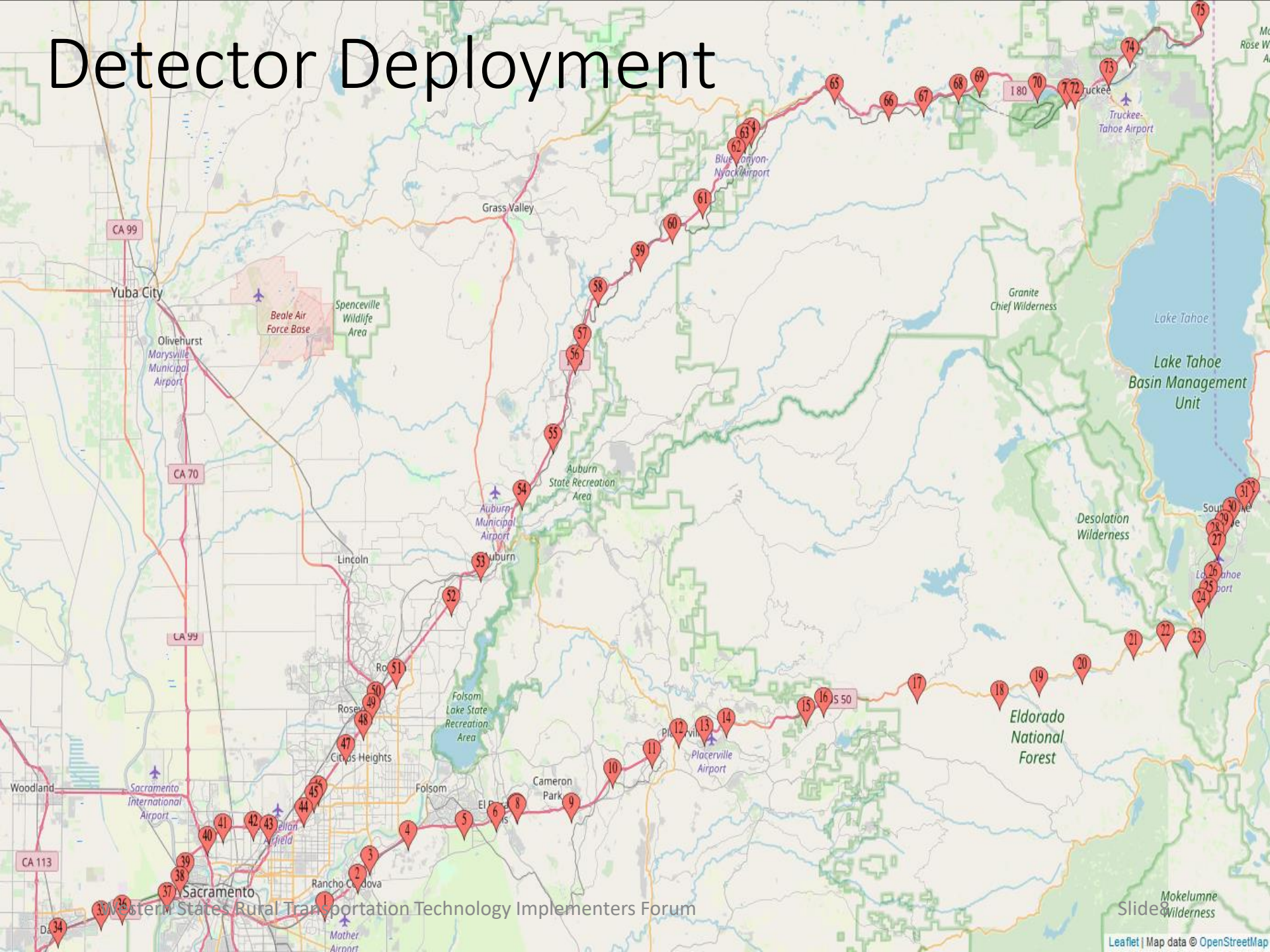
Iteris Solution

Choice of Vendors. Only Iteris' Velocity had non-cloud option.

- Caltrans owned and operated in-house VM server.
- Readers inside Caltrans metal cabinets.
- Low Bandwidth Requirement.
- Bluetooth or WiFi Detectors.
- Data is Pushed to Server.
- Linux OS.

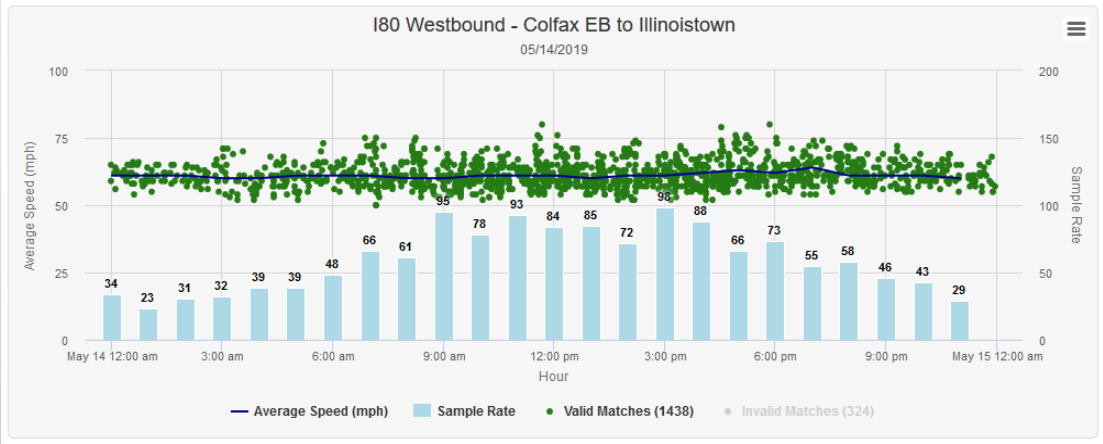
Iteris Solution

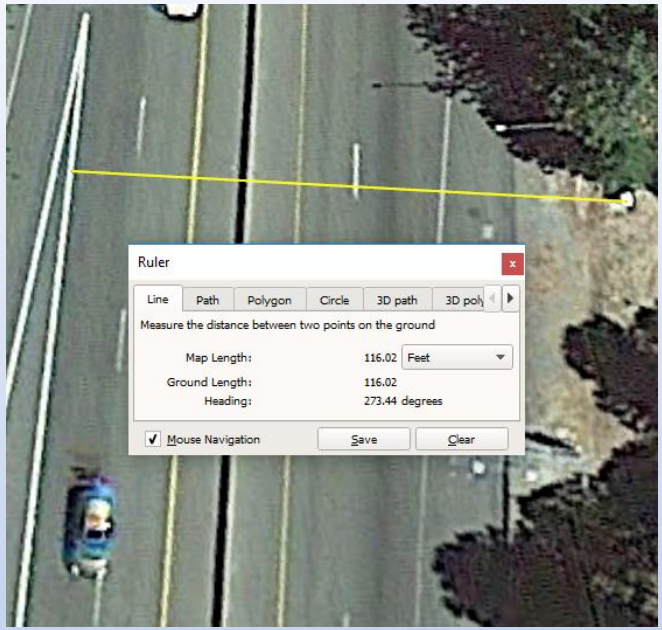
Detector Deployment



Location Selection

- Bidirectional Detection (Mostly).
- < 150’, Bidirectional Ok





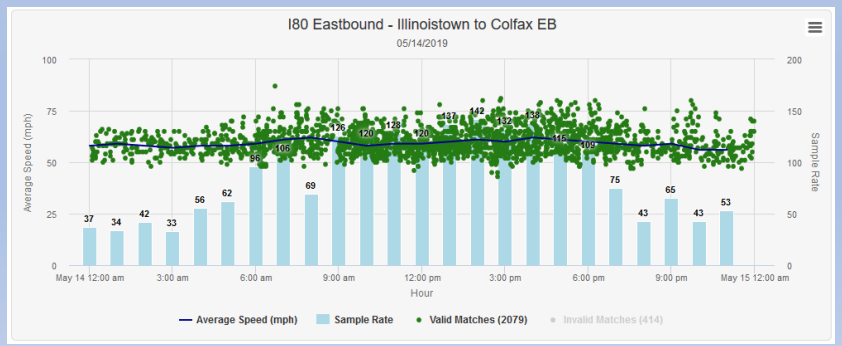
Bidirectional
Colfax WB

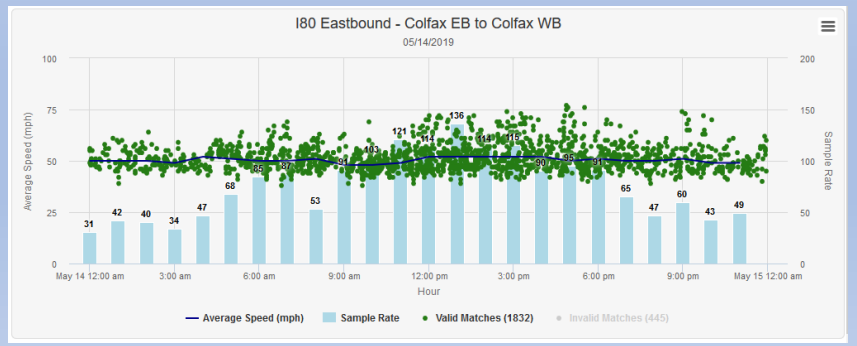
1.4 miles

3.4 miles

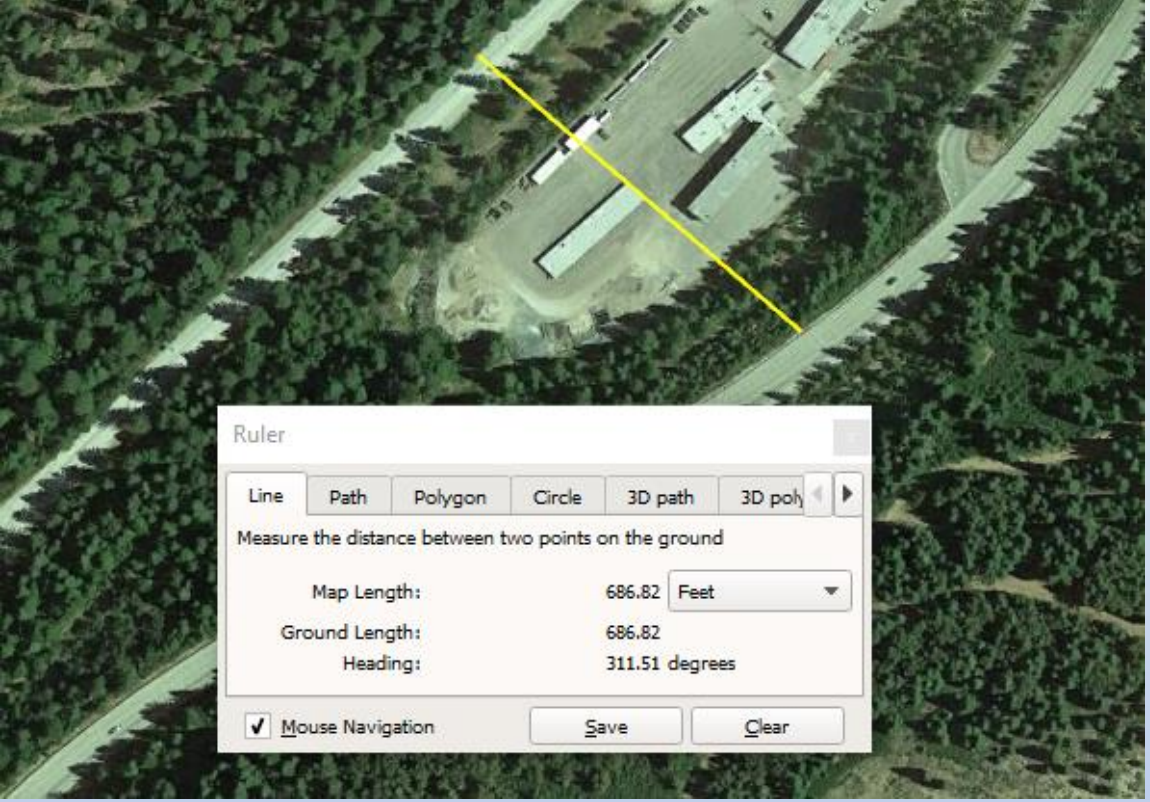
Bidirectional
Illionois Town

Bidirectional
Colfax EB





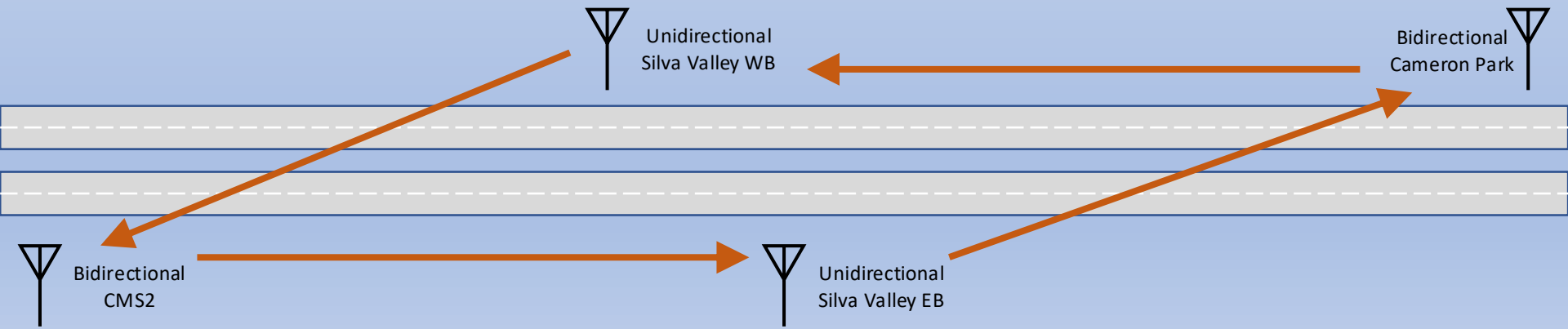
Location Selection



Kingvale Caltrans Yard

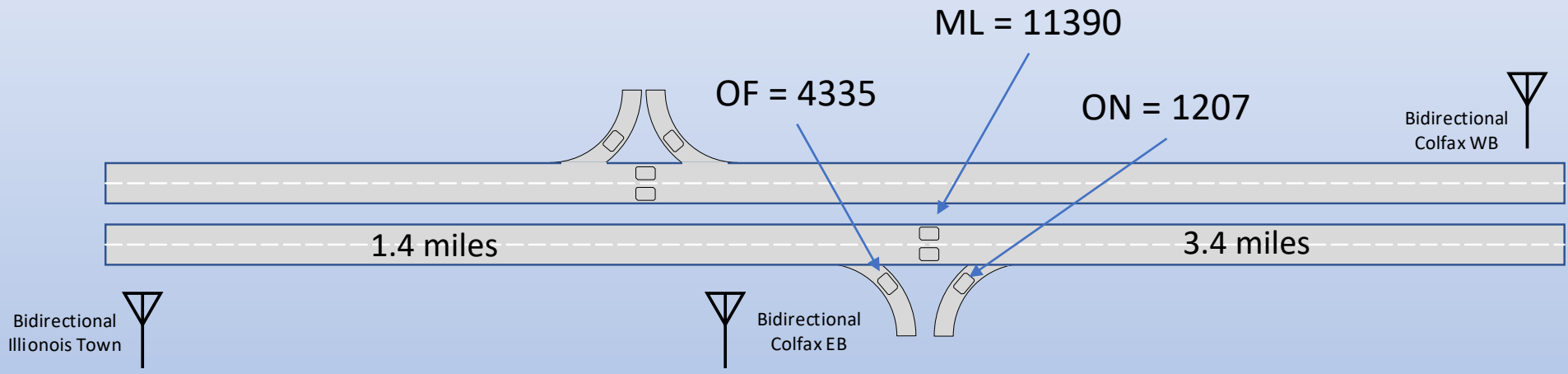
Directional Detection

- > 150’.
- Elevation Obstruction.
- Trees.
- Buildings.



BTR Detector Penetration

(Same Side and Both Sides)



Loop Counted Vehicles = 11,390 (ML) + 4,335 (OF) = 15,725
BTR Matches = 2079 Valid (+ 414 Outliers) = 2,493
Percent Penetration = 13.2% (+ 2.63%) = **15.9%**

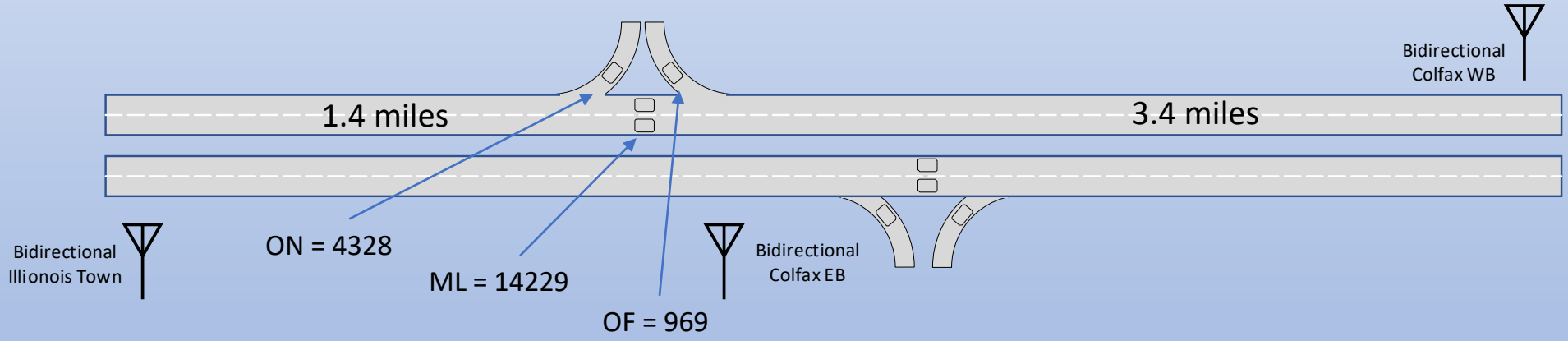
Loop Counted Vehicles = 11,390 (ML) +1,207 (ON) = 12,597
BTR Matches = 1832 Valid (+ 445 Outliers) =2,277
Percent Penetration = 14.5% (+ 3.53%) = **18.5%**

BTR Detector Penetration

(Opposite Side and Both Sides)

Loop Counted Vehicles = 14,229 + 4,328 = 18,557
BTR Matches = 1,438 (+ 324) = 1,762
Percent Penetration = 7.75% (+ 1.75%) = **9.50%**

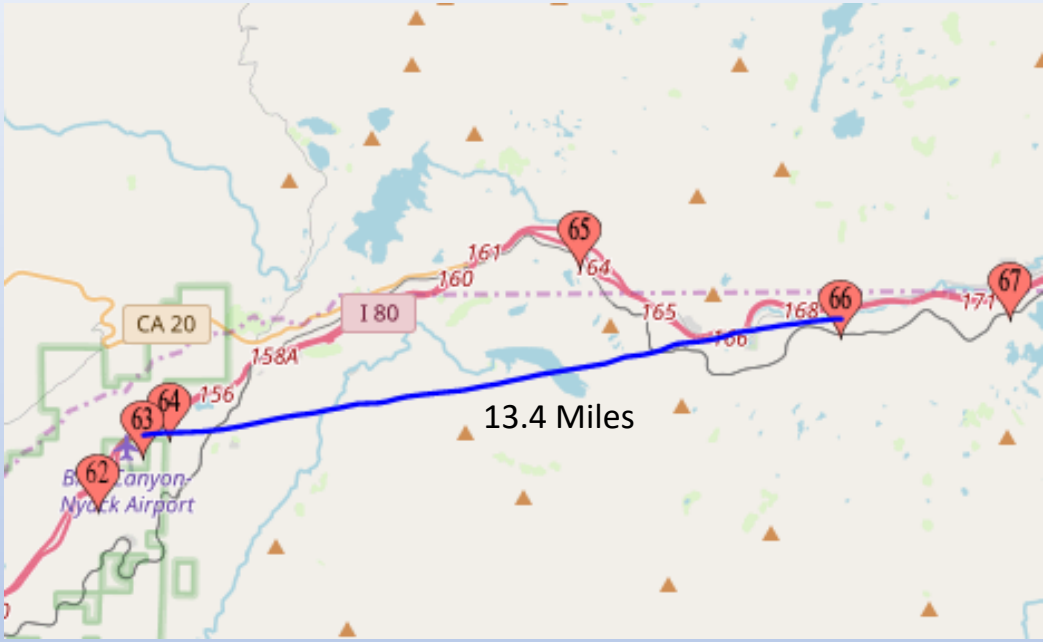
Loop Counted Vehicles = 14,229 + 969 = 15,198
BTR Matches = 1482 (+ 341) = 1,823
Percent Penetration = 9.75% (+ 2.24%) = **12.0%**

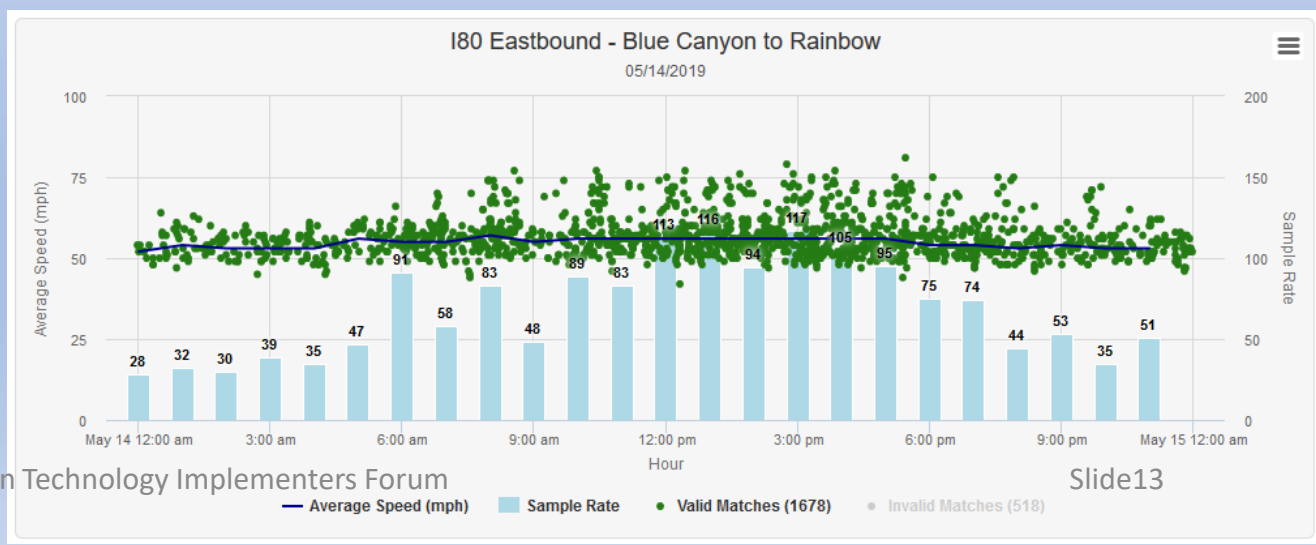


Location Selection

BTR Location Considerations:

- On/off points
- Distance Between BTR's
- Frontage Road
- Traffic Lights
- 2.4Ghz Noise
- Power (Wired vs Solar).
  - If Solar, Snow Implications.
- Communication
  - Low Bandwidth
  - 93 Byte Frame/Hit

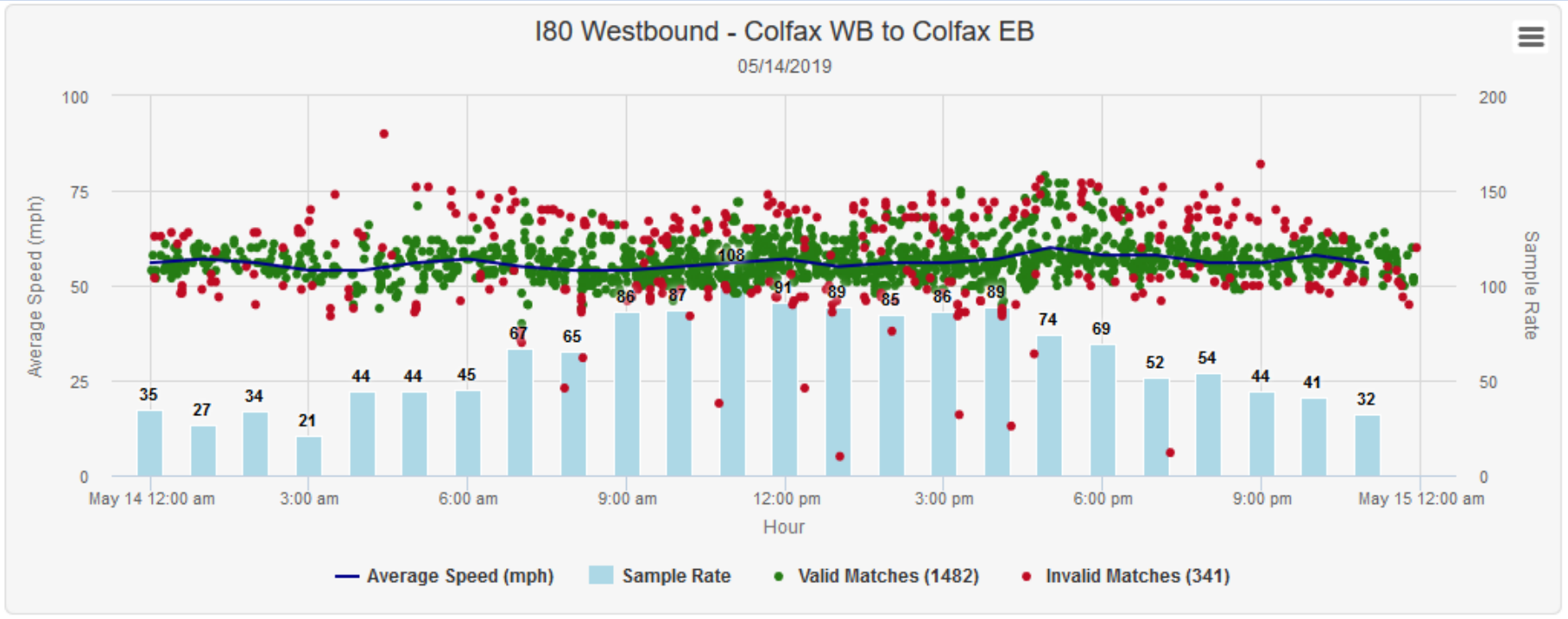




BTR Detector Filters

Data Filters

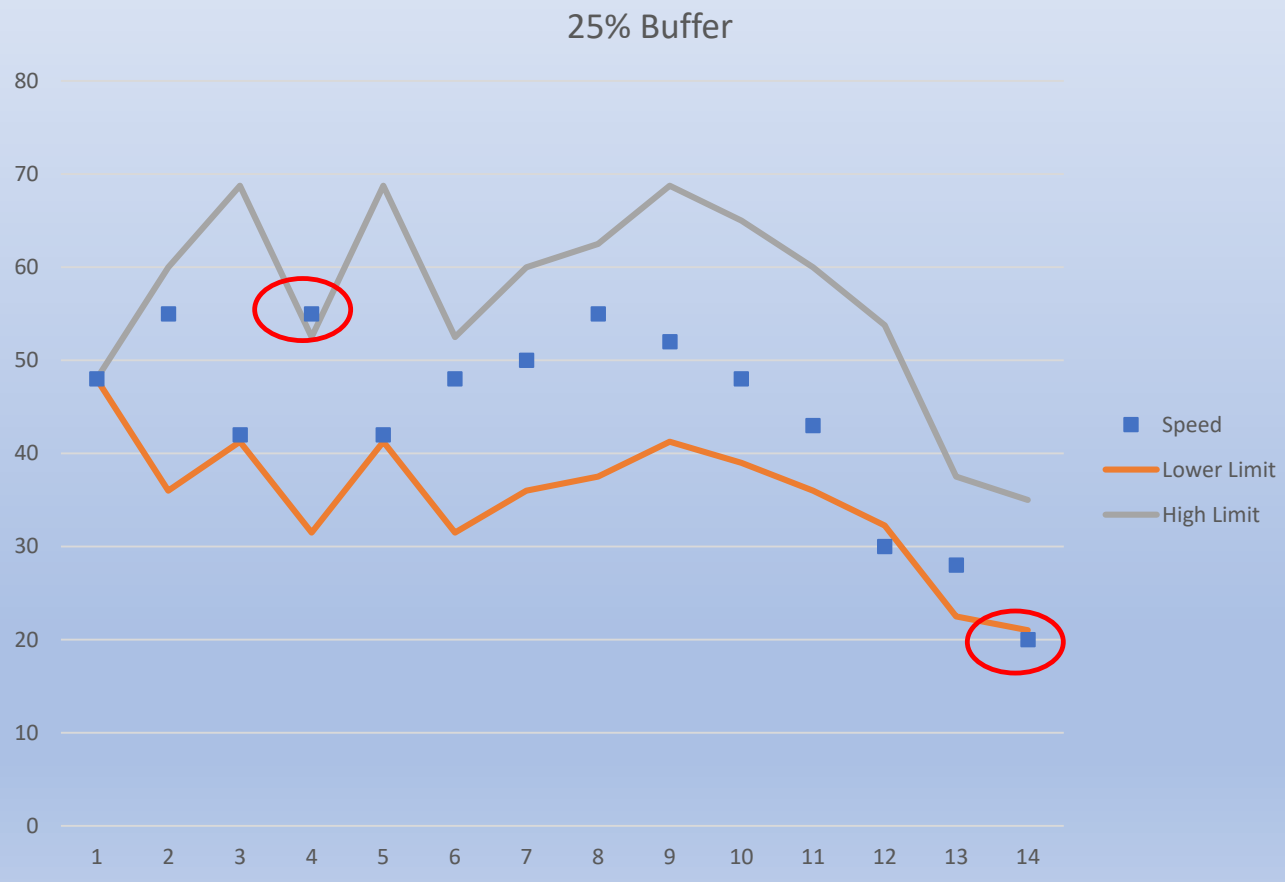
- ❑25% Buffer
- ❑45% Buffer
- ❑Interquartile Range
- ❑None



Percent Filter Example

Speed	Lower Limit	High Limit
48	n/a	n/a
55	36	60
42	41.25	68.75
55	31.5	52.5
42	41.25	68.75
48	31.5	52.5
50	36	60
55	37.5	62.5
52	41.25	68.75
48	39	65
43	36	60
30	32.25	53.75
28	22.5	37.5
20	21	35

Is data point within 25% of previous sample? i.e.. Less than 125% or greater than 75%? If outside range, it is an outlier.

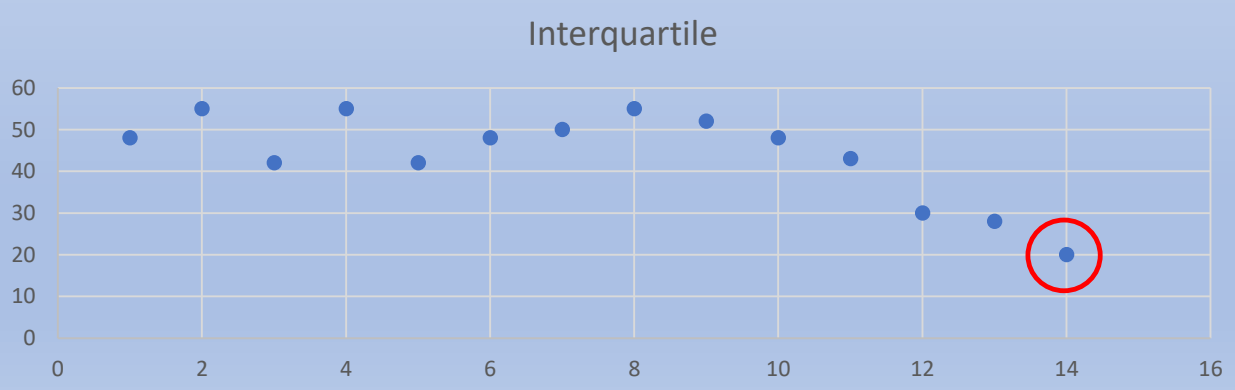


Interquartile Filter Sample

Sample	Speed
1	48
2	55
3	42
4	55
5	42
6	48
7	50
8	55
9	52
10	48
11	43
12	30
13	28
14	20

Is data point more than 1.5 interquartile ranges (IQR) below the first quartile or above the third quartile? If so, it's an outlier.

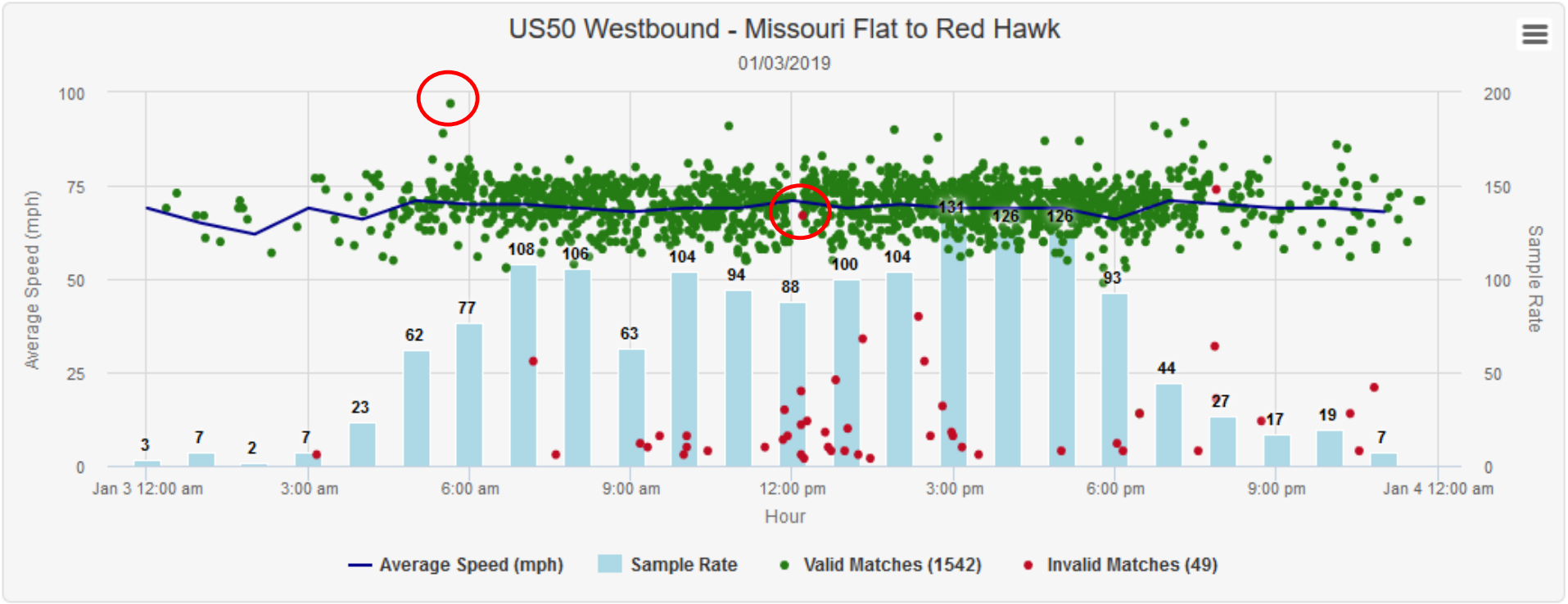
Variable	Value
1st Quartile (Median of lower half of samples)	42
3rd Quartile (Median of higher half of samples)	51.5
IQR (3rd – 1st)	9.5
Low Threshold (Q1 - 1.5*IQR)	27.75
High Threshold (Q3 + 1.5*IQR)	65.75



Bluetooth Issues

Filtering Algorithm Issues

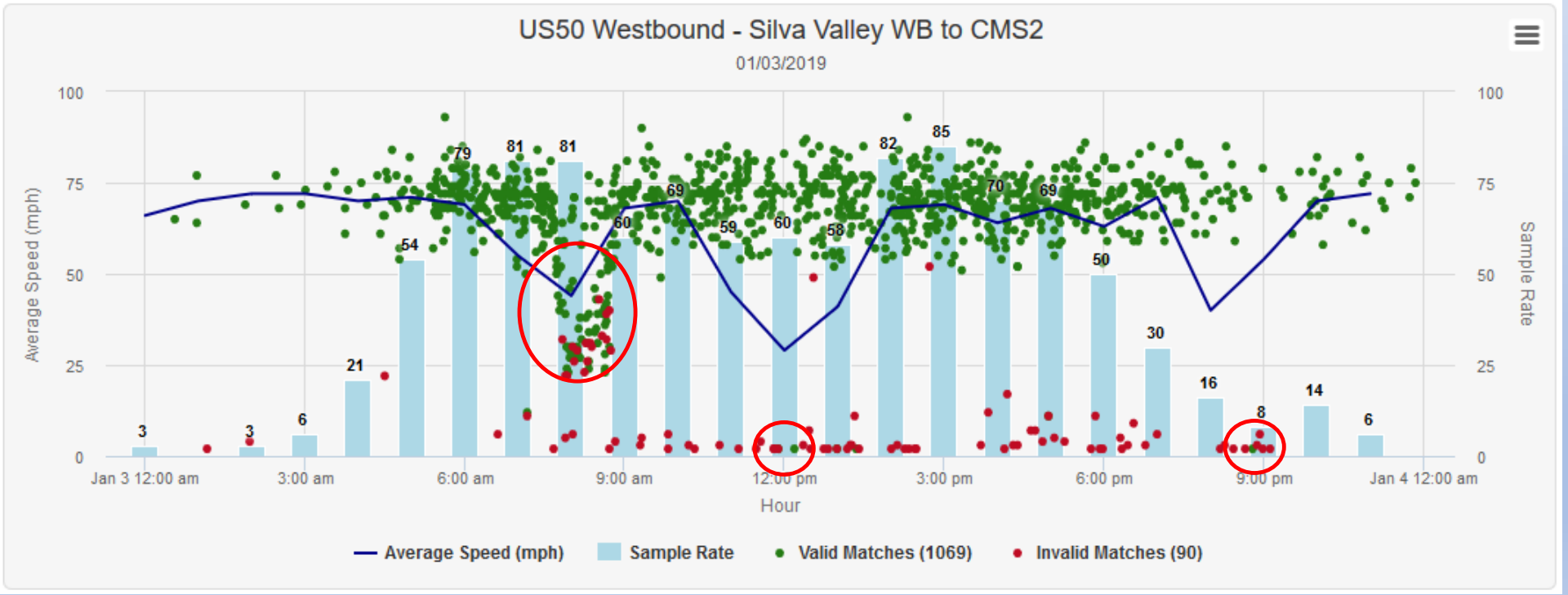
- Excessive Speeds Reported (Outliers?).

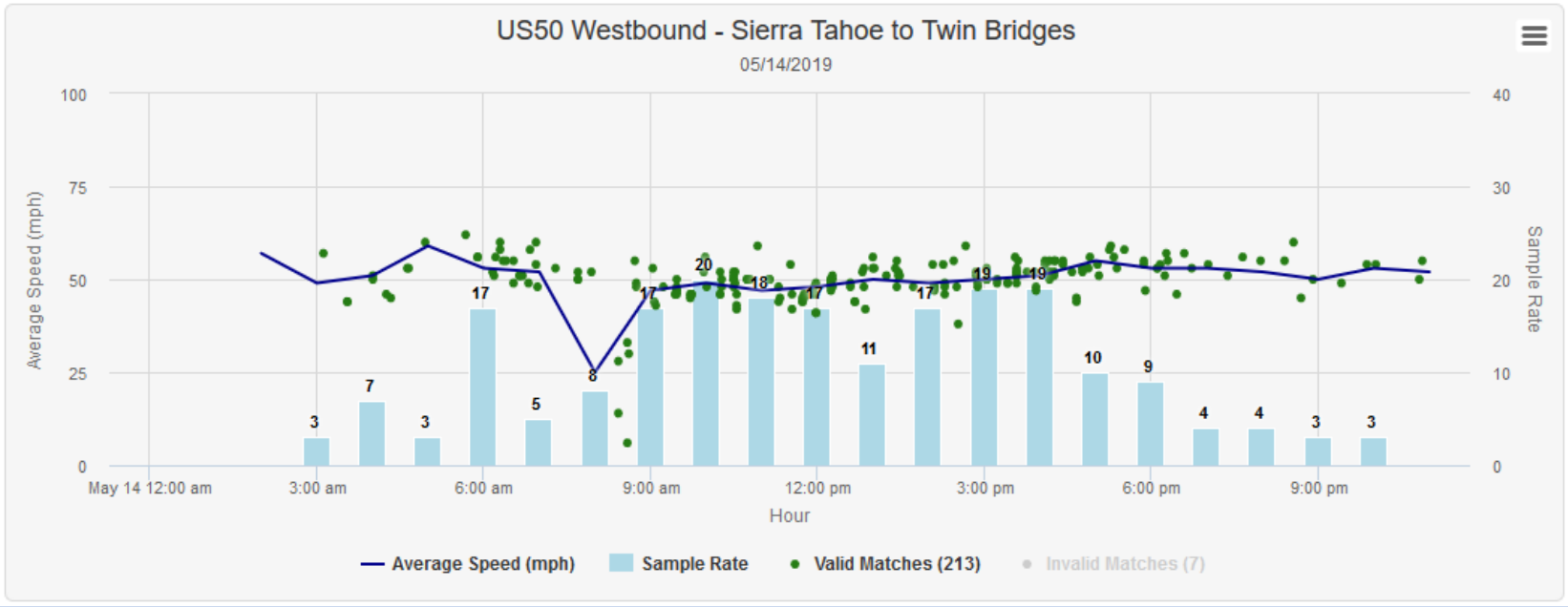


Bluetooth Issues

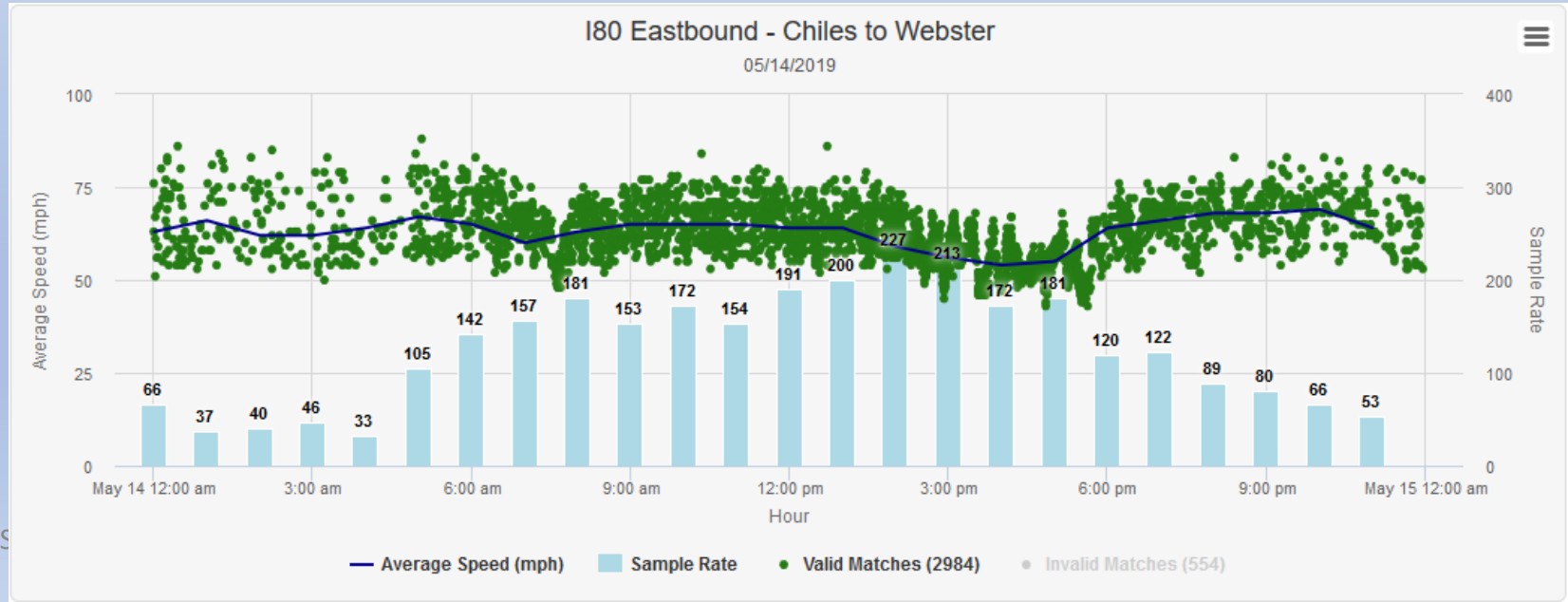
Speeds graphs were not smooth

- Average affected by single outlier.
- Average changed significantly minute over minute.
- Frontage Road Interference.





Rural vs. Urban – May 14th, 2019



BTR HW Issues

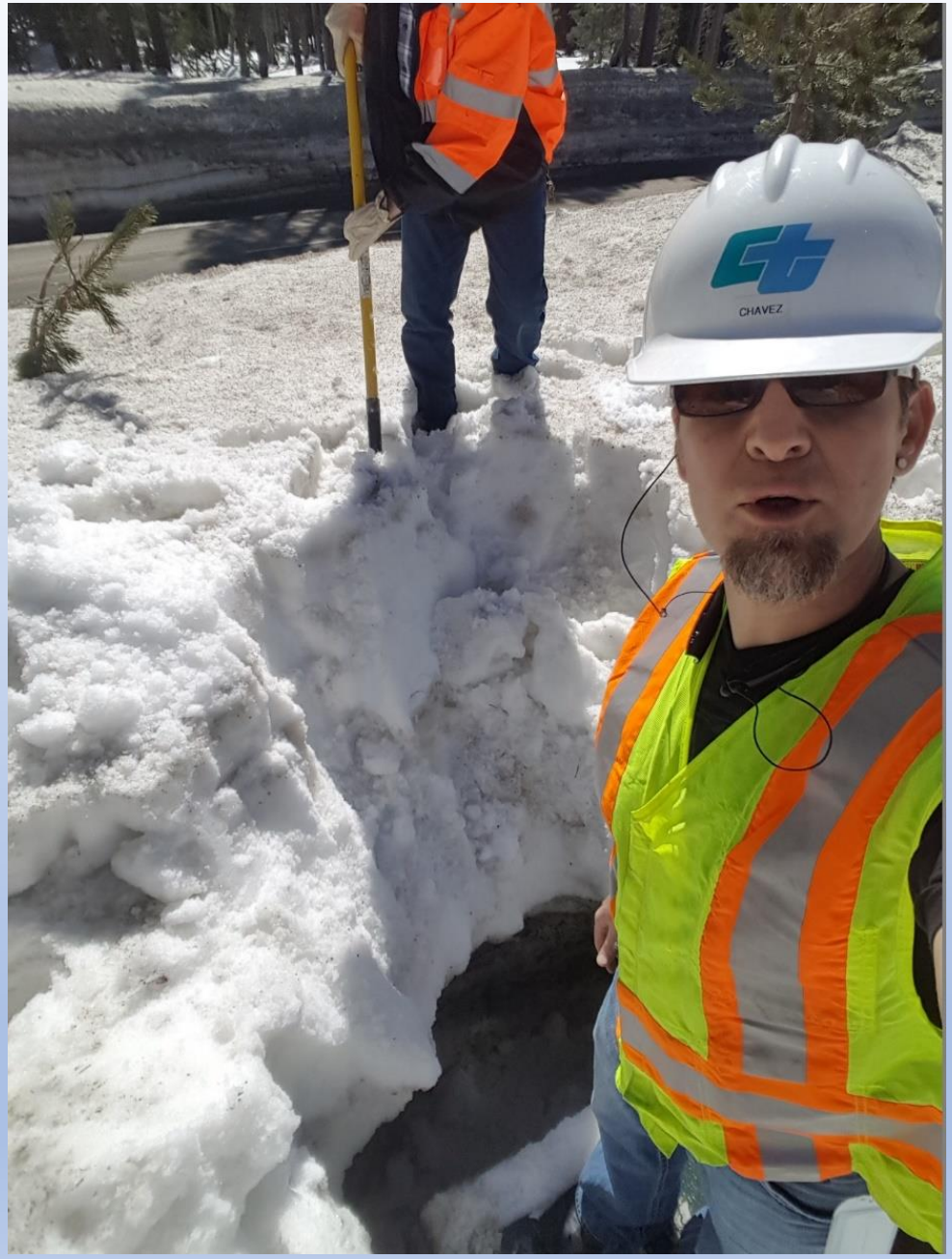
- HW Failures.
  - Motherboard (Close to 20%/Year)
  - Power Supply (Wall Wart)
  - WiFi/USB Dong (Consumer Grade)
- No Reset Button
  - Serial Interface Discouraged

Environmental Issues

- Snow
- Knock Downs
- 2.4 GHz Noise?

Bradshaw Rd:

BTR would fail every 2 to 3 weeks. Swapped out all supporting hardware. Root cause was never isolated. At least 8 units bricked.



SW Issues

- IP Address Maintained in Two Files.
- Lack of Reset Button.
- Cleartext Password.
- 2x Reboots (by Design).
- Can Bypass Login via Links.
- OS Randomly Corrupted.
- Duplicate MAC Addresses on Road.
- GUI Displays Last Captured MAC (Stale Data).

Bluetooth Cons Summary

- Erratic Travel Times.
- Low Rural Penetration.
- 2.4GHz Interference.
- HW Failure.
- Weather Impact.
- Rural Power.
- Few Cabinets in Rural Areas.
- Duplicate MAC Addresses.

Let's try something to eliminate these cons, enter crowd source data in the form of HERE.

What is HERE?

HERE captures location content such as road networks, buildings, parks and traffic patterns. It then **sells** or licenses that mapping content, along with navigation services and location solutions.

PROS

- Rurally Available
- No HW
- No Comm
- No Power
- No interference
- Unaffected by weather conditions
- Paid Support – ($30k/yr. for District 3)
- XML Feed!
- Supported in ATMS 5.3
- Supported in ActiveITS
- Confidence Factor included
- Historical Data available

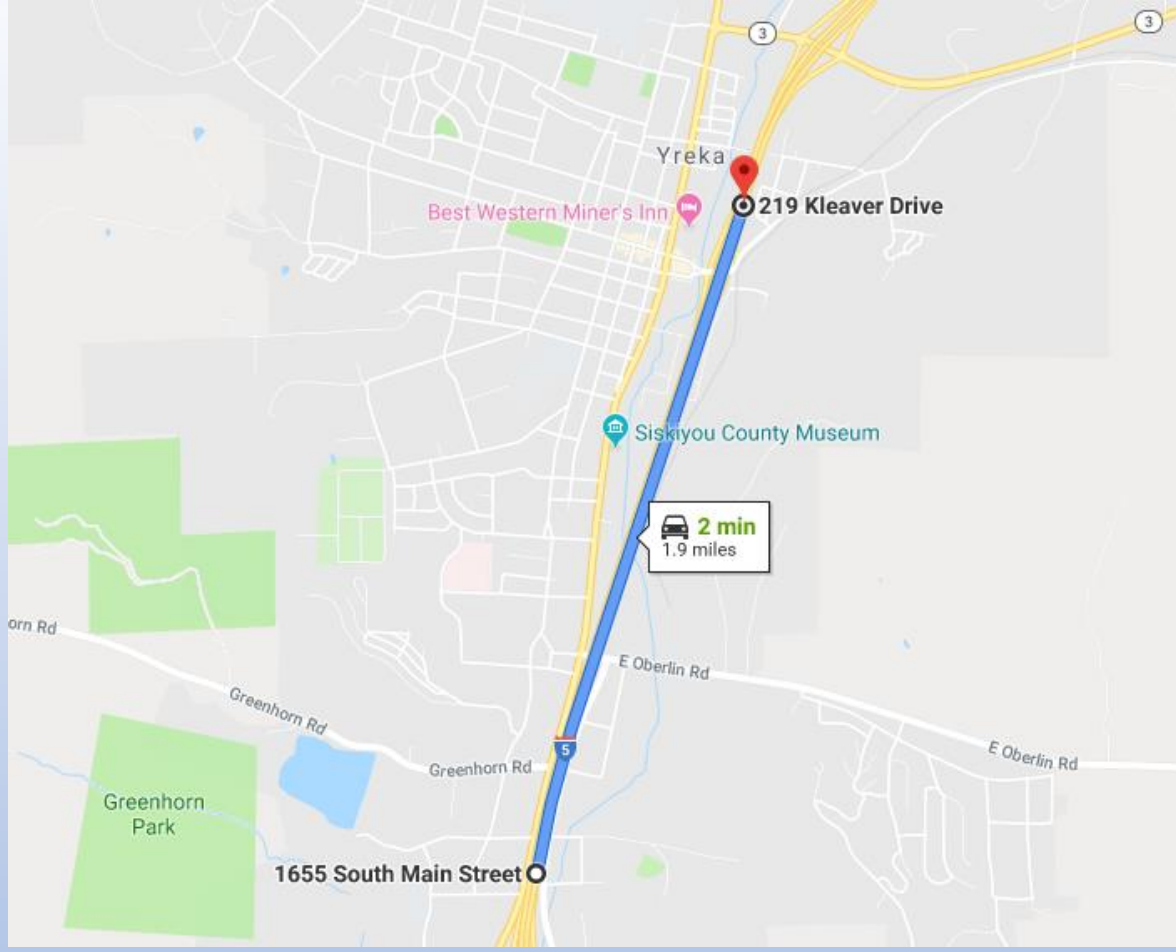
HERE TMC's

TMC: Traffic Message Channel.

- ✓ TMC codes are a reference system designed to give a unique alpha-numeric code to road segment for the purposes of assigning traffic information to that segment.
- ✓ Assigned and certified by TISA (Traveler Information Services Association).

Country Code	Table ID	Direction	Location
1 (Numeric or Alpha)	05 (Numeric)	N(-) or P(+)	012345
Country Code. The United States uses Country Code 1.	Table ID within the country.	Direction of travel. P(+) = North or East N(-) = South or West	Specific location.

TMC Example



105P05430

1 = US
05 = Northern California
P = Northbound
05430 = Unique identifier within US, CA, NB.

HERE TMC's Defined

	A	B	C	D	E	F	G
1	ADMIN1	ADMIN2	ADMIN3	ADMIN4	ADMIN5	TMC	TMC_LENGTH
489475	United States	California	Siskiyou	Uninc Siskiyou County		105P05435	2.621803
489476	United States	California	Siskiyou	Yreka		105P05430	1.852229
489477	United States	California	Siskiyou	Yreka		105P05431	0.743655

H	I	J	K	L	M	N
LINEAR	PARENT_LIN	TMC_ORDER	ROAD_NAME	ROAD_NUM	ROAD_DIR	POINT_DESC
105P00139	105P03009	182		I-5	Northbound	Bailey Hill Rd/Exit 793
105P00139	105P03009	177		I-5	Northbound	Foothill Dr/Exit 775
105P00139	105P03009	178		I-5	Northbound	CA-3/Montague Rd/Exit 776

O	P	Q	R	S	T	U
TMC_TYPE	POS_OFF	NEG_OFF	START_LAT	START_LON	END_LAT	END_LON
1	105P05436	105P05434	41.92239	-122.57598	41.95772	-122.59409
1	105P05431	105P05429	41.70787	-122.64236	41.73348	-122.63174
1	105P05432	105P05430	41.73348	-122.63174	41.74239	-122.62407

TMC Definitions
Released Quarterly

TMC's Travel Time

Travel Time File: RealtimeFlowA0105.xml

```
<RW LI="105+03009" DE="I-5" PBT="2019-05-21T02:22:17Z" mid="0bd861ff-1567-421a-942d-6419ffe0bbb4">
    <FIS>
        <FI>
            <TMC PC="5430" DE="Foothill Dr/Exit 775" QD="-" LE="1.85222"/>
            <CF TY="TR" SP="64.54" SU="64.54" FF="65.12" JF="0.12952" CN="0.74" TS="0"/>
        </FI>
        <FI>
            <TMC PC="5431" DE="CA-3/Montague Rd/Exit 776" QD="-" LE="0.74365"/>
            <CF TY="TR" SP="62.26" SU="62.26" FF="64.81" JF="0.57629" CN="0.73" TS="0"/>
        </FI>
        <FI>
            <TMC PC="5432" DE="CA-96/Klamath River Hwy/Exit 786" QD="-" LE="10.17161"/>
            <CF TY="TR" SP="60.31" SU="60.31" FF="62.45" JF="0.50320" CN="0.77" TS="0"/>
        </FI>
```

RW: Roadway

- **LI**: Unique String Identifier. **Note Embedded +/- Sign**.
- **DE**: Text Description of the Road.
- PBT: Base Timestamp.
- mid: NAVTEQ identifier. DO NOT USE.

TMC's Travel Time

Travel Time File: RealtimeFlowA0105.xml

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            <CF TY="TR" SP="60.31" SU="60.31" FF="62.45" JF="0.50320" CN="0.77" TS="0"/>
        </FI>
```

FIS: List of Flow Items.

- FI: Flow Item.
  - **TMC: Traffic Message Center.**
  - **CF: Current Flow.**

TMC's Travel Time

Travel Time File: RealtimeFlowA0105.xml

```
<RW LI="105+03009" DE="I-5" PBT="2019-05-21T02:22:17Z" mid="0bd861ff-1567-421a-942d-6419ffe0bbb4">
    <FIS>
        <FI>
            <TMC PC="5430" DE="Foothill Dr/Exit 775" QD="-" LE="1.85222"/>
            <CF TY="TR" SP="64.54" SU="64.54" FF="65.12" JF="0.12952" CN="0.74" TS="0"/>
        </FI>
        <FI>
            <TMC PC="5431" DE="CA-3/Montague Rd/Exit 776" QD="-" LE="0.74365"/>
            <CF TY="TR" SP="62.26" SU="62.26" FF="64.81" JF="0.57629" CN="0.73" TS="0"/>
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            <CF TY="TR" SP="60.31" SU="60.31" FF="62.45" JF="0.50320" CN="0.77" TS="0"/>
        </FI>
```

TMC: Traffic Message Channel.

- **PC:** Point Location Code = TMC ID (stripped).
- DE: Description.
- QD: Queuing direction. (Opposite of traffic flow).
- LE: Length. Units defined above.

TMC's Travel Time

Travel Time File: RealtimeFlowA0105.xml

```
<RW LI="105+03009" DE="I-5" PBT="2019-05-21T02:22:17Z" mid="0bd861ff-1567-421a-942d-6419ffe0bbb4">
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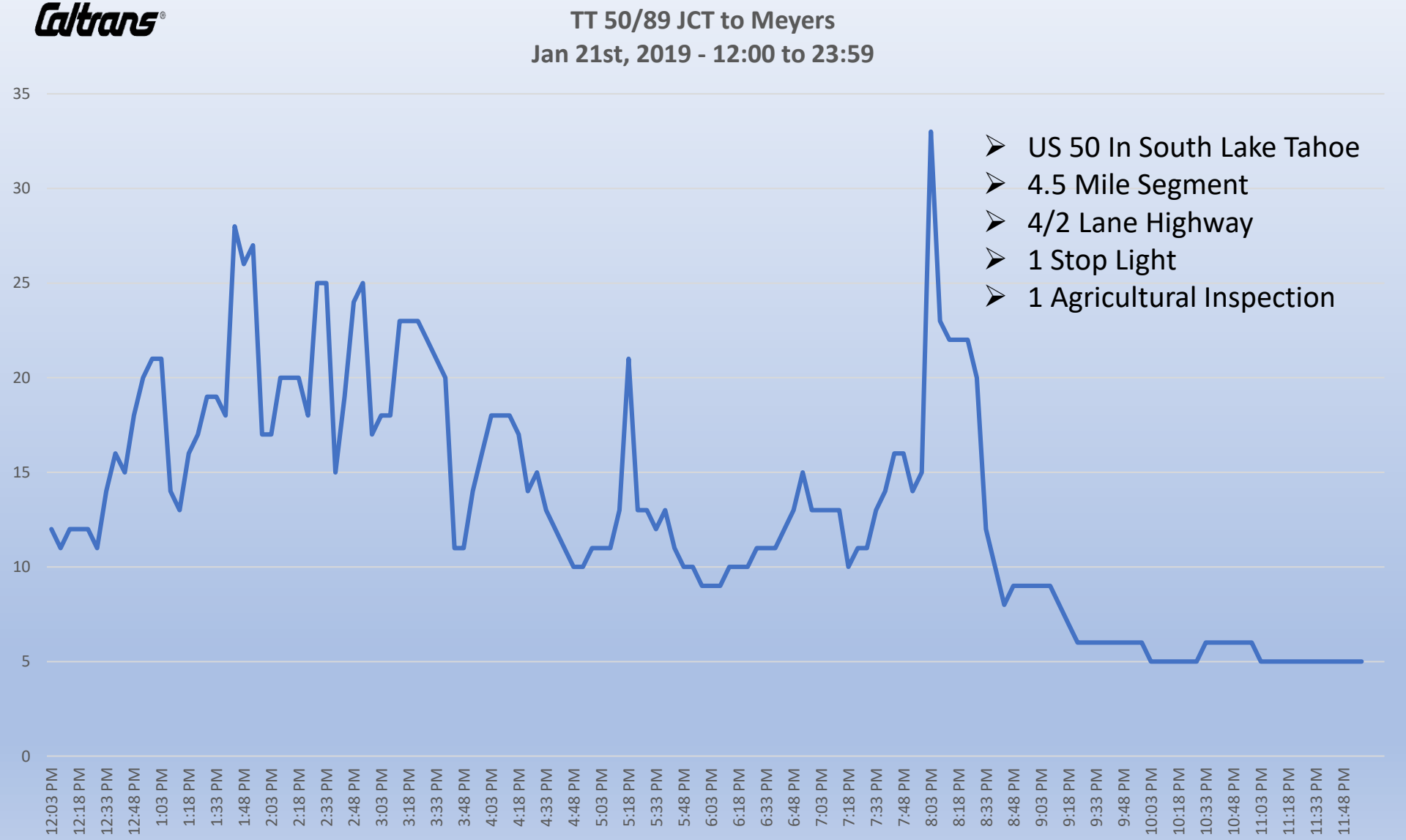
            <CF TY="TR" SP="60.31" SU="60.31" FF="62.45" JF="0.50320" CN="0.77" TS="0"/>
        </FI>
```

CF: Current Flow

- TY: Always "TR" for normal lanes. (RM, EX, Etc.)
- **SP:** Capped Average Speed.
- **SU:** Uncapped Average Speed.
- FF: Free Flow Speed.
- JF: Jam Factor. -1 to 10.
- **CN:** Confidence Factor. 0.1 to 1.0 (DO NOT IGNORE)
- TS: Travers ability Status. "O"pen or "C"losed.

HERE in the Office – Actual CMS TT



From: Paula Peterson <tahoepaula@[redacted]

Sent: Monday, January 21, 2019 8:15 PM

To: Nelson, Steve@DOT <steve.nelson@[redacted]

Subject: Message boards in South Lake Tahoe

Hello...hope you had a nice holiday!

There is something off with the message board times posted in SLT. It took people between 2.5 hours and 3 hours to get from the Y to Meyers for most of the day but the sign said 11 minutes, or sometimes 14 minutes. its great if the signs are accurate so people know...many are turning back tonight as they've been on US50 for hours and not getting far. Of course that is a bigger issue, I'm just curious about the timing.

SouthTahoeNOW.com
Your One Stop for Lake Tahoe News & Information

Standstill on South Lake Tahoe area highway and streets; Groups looking into solution

Submitted by paula on Tue, 01/22/2019 - 8:44pm

Paula Peterson

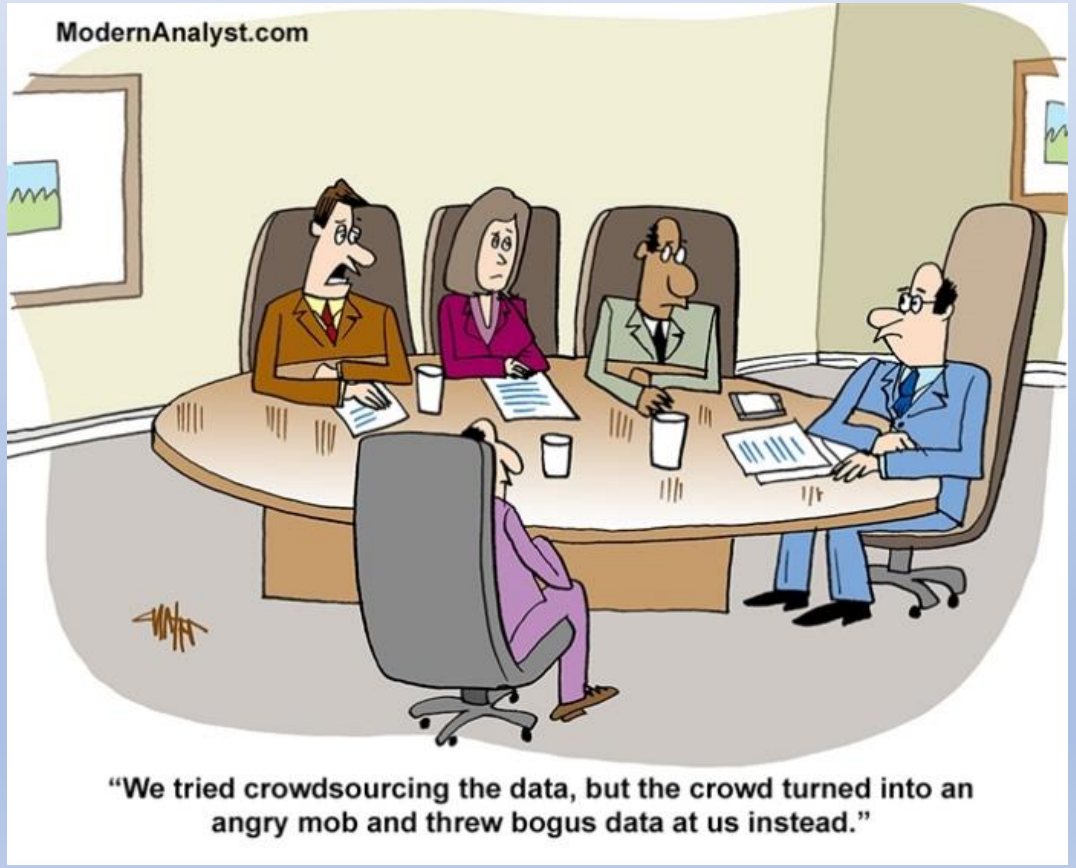
SOUTH LAKE TAHOE, Calif. - It's almost a perfect storm for traffic in Lake Tahoe: extra visitors in town for the holiday weekend and epic ski conditions with snow and chain requirements over US50 and Echo Summit.

On Monday, locals and visitors alike were part of that storm, leaving motorists stranded along US 50, Lake Tahoe Blvd., and all surface streets in Meyers that have a link to the highway over Echo Summit.

This isn't a new problem, but one that rears its ugly head on many Sundays and holidays throughout the year. And it's not just a South Lake Tahoe problem but one seen in Truckee and other towns across the west as populations grow.

What is Waze?

- ✓Crowd Source
- ✓Alerts
- ✓Traffic Conditions

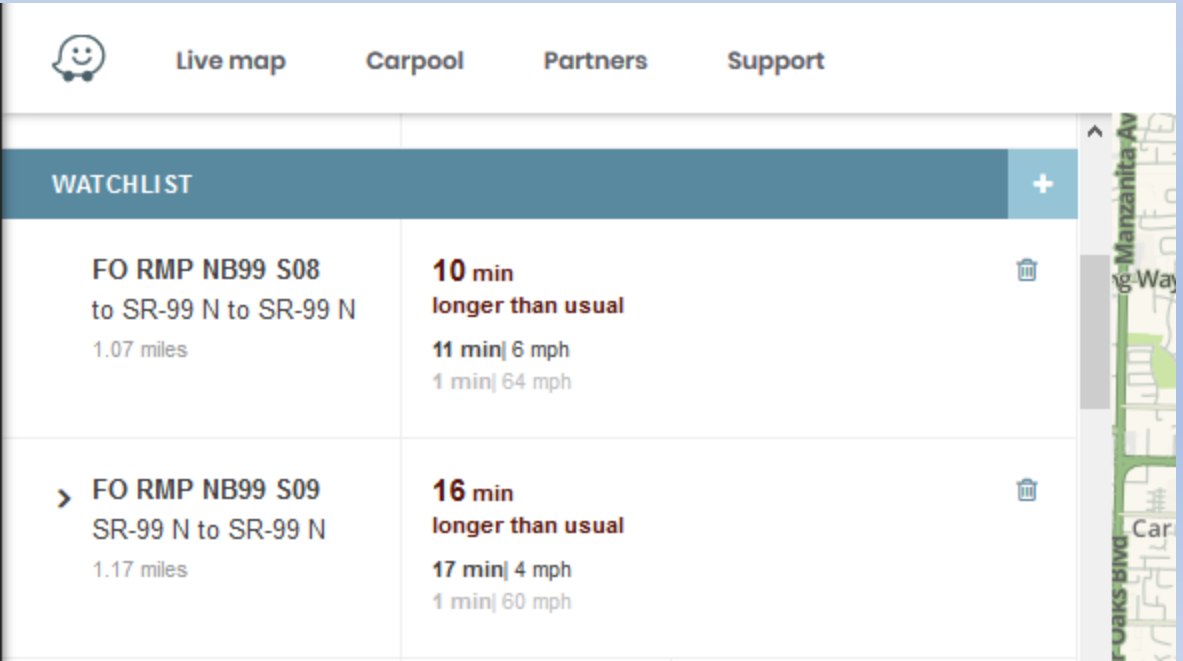


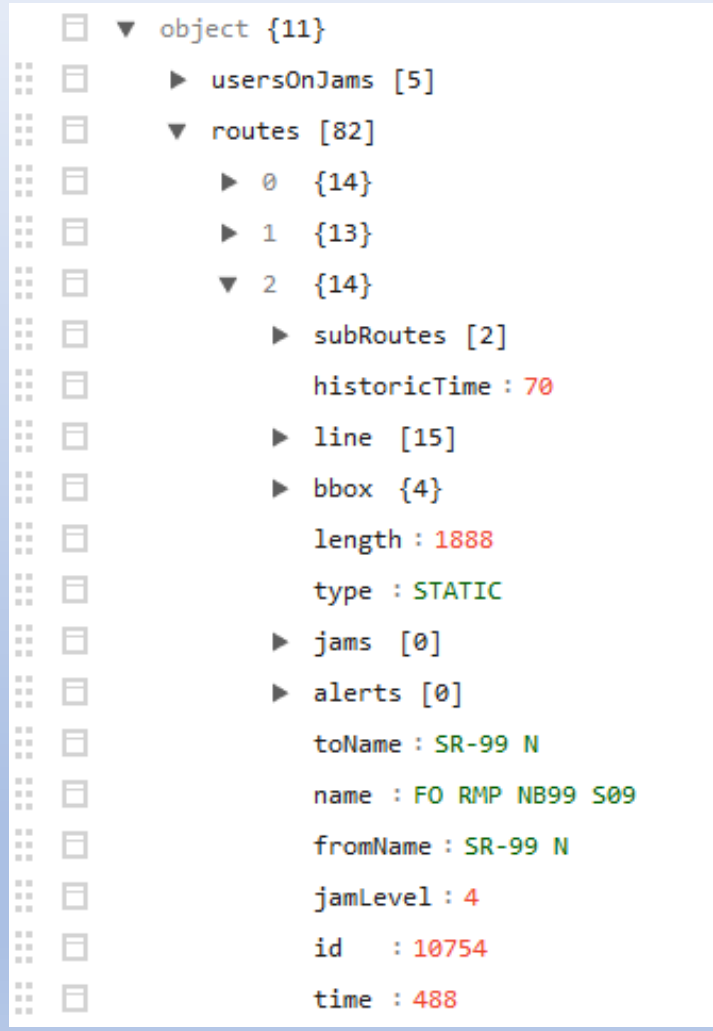
Pros Over Bluetooth

- ➢ Rurally Available
- ➢ No HW
- ➢ No Comm
- ➢ No Power
- ➢ No interference
- ➢ Immune to weather
- ➢ Non Fixed Endpoints

Waze Pros

- JSON Feed
- Segment Accuracy Feedback
- TT Granularity In Seconds
- Not Limited by TMC End Points
  - ¿Interpolated by Waze?





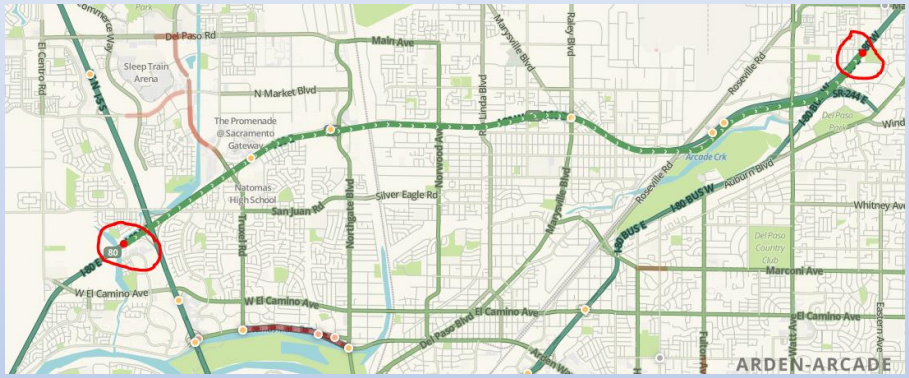
Waze Cons

Not Resolved

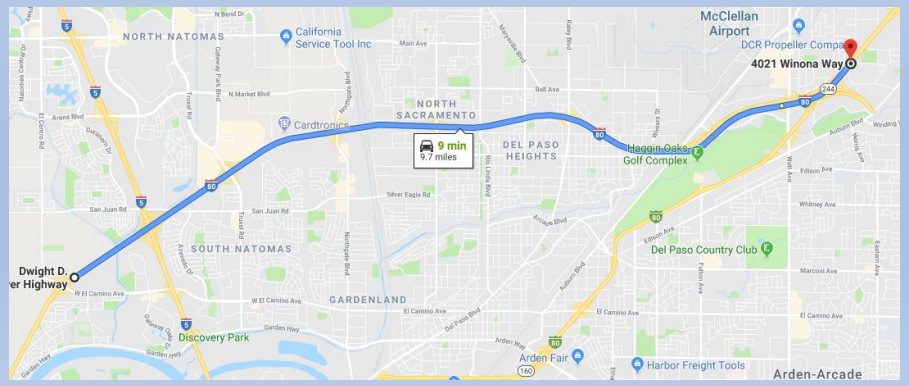
- Lack of Confidence Factor
- No Legacy ATMS Integration
- No Support for ActiveITS

I80 Comparison (High Volume)

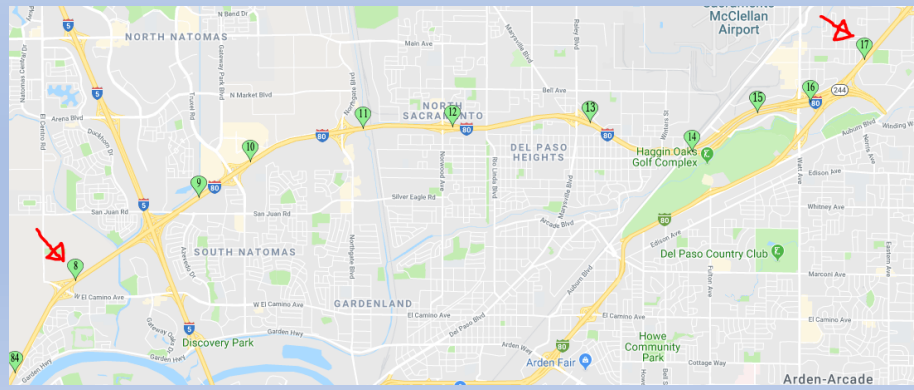
WAZE - 1 Segments, 9.14 Miles.



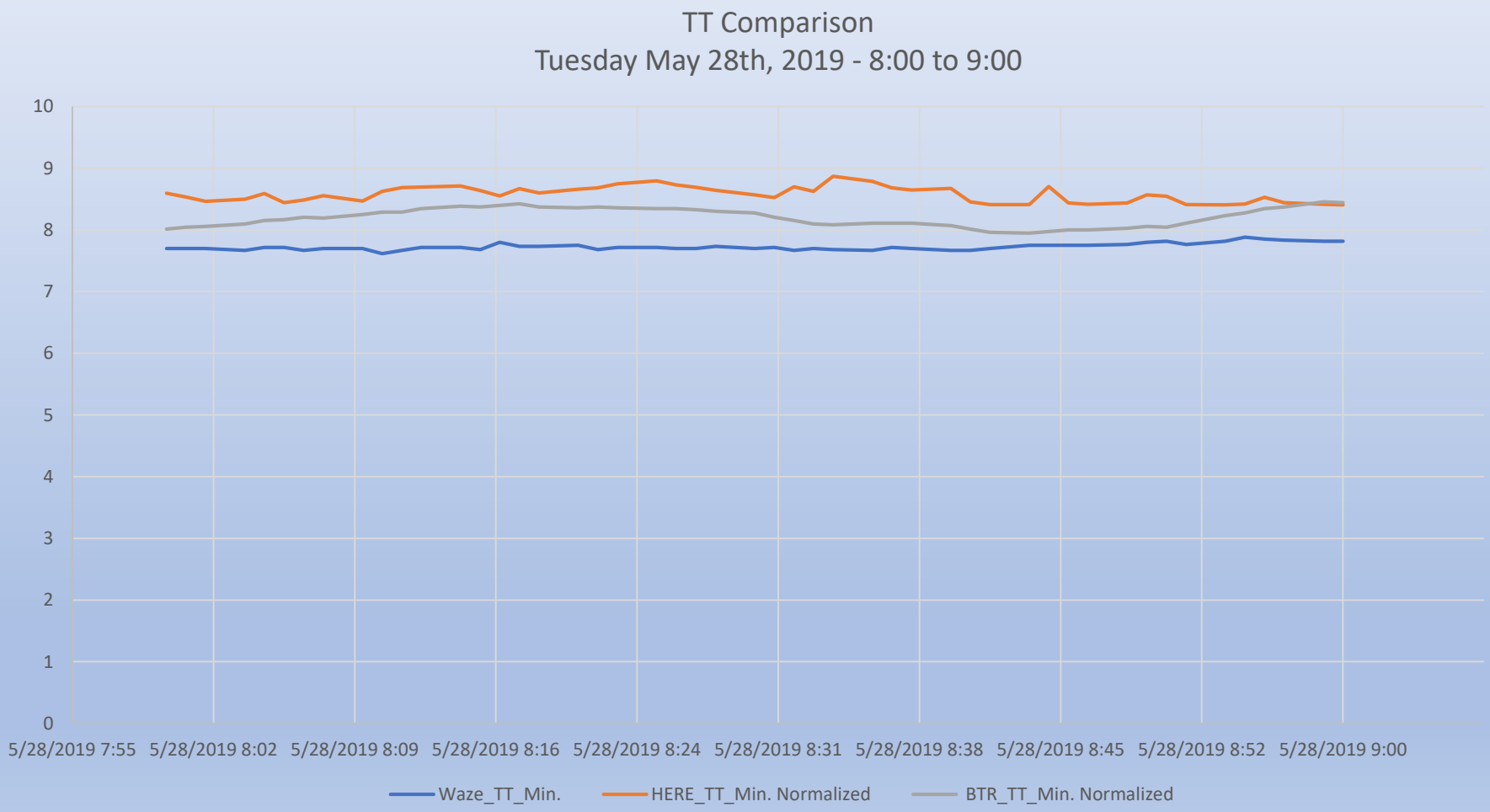
HERE 9 – Segments, 9.71 Miles



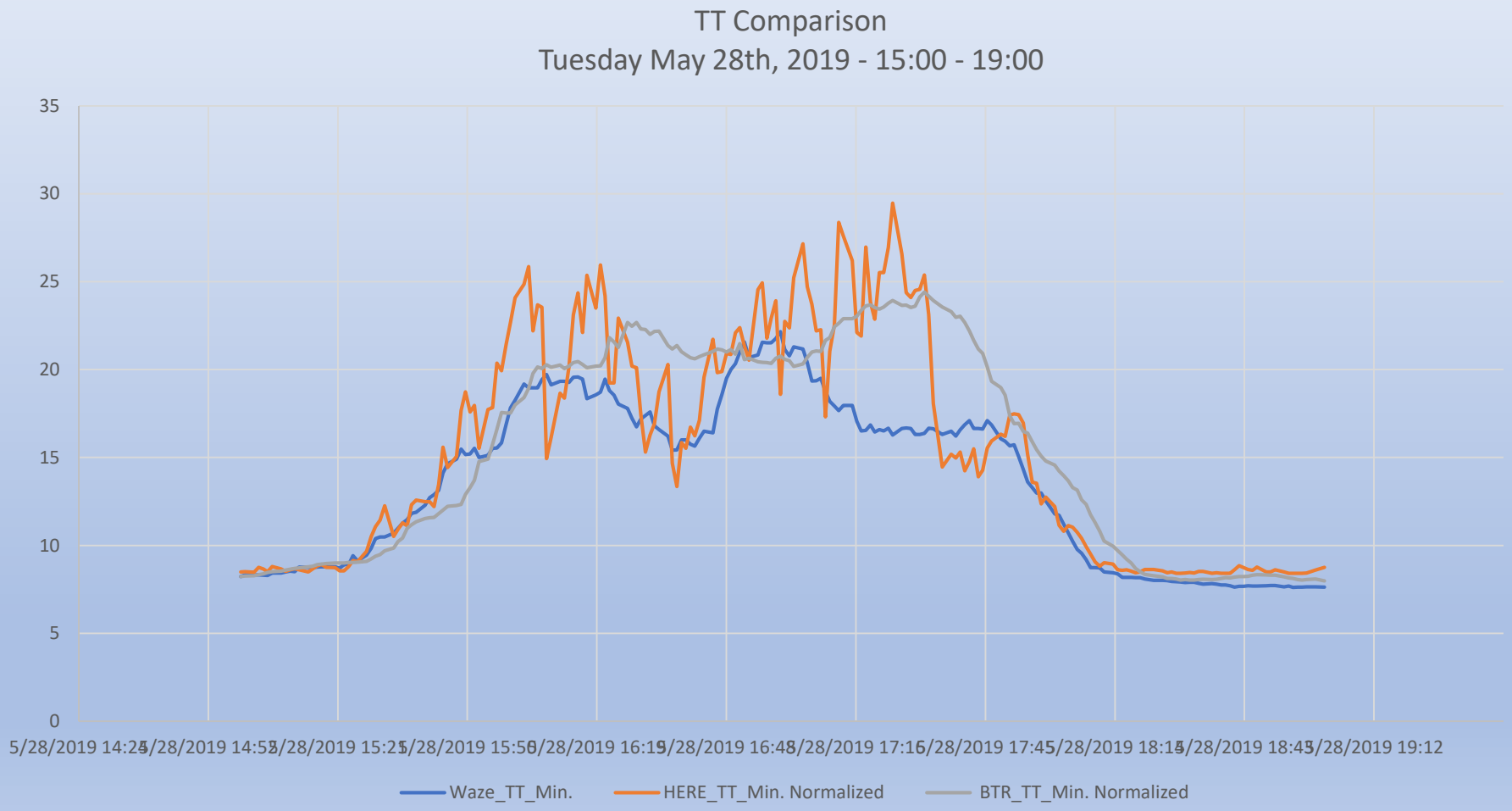
10 BTR Readers – 9 BTR Segments, 11.1 Miles



I80 Comparison – Free Flow

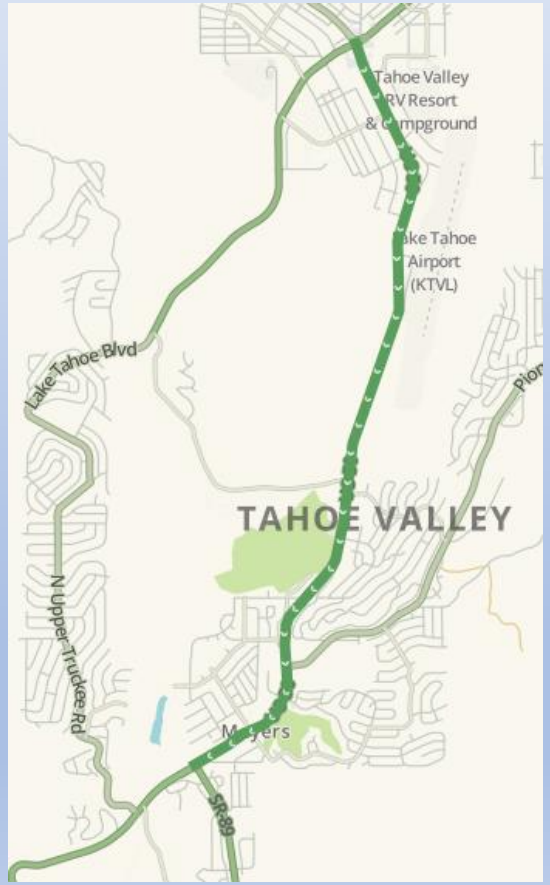


I80 Comparison – Heavy Flow

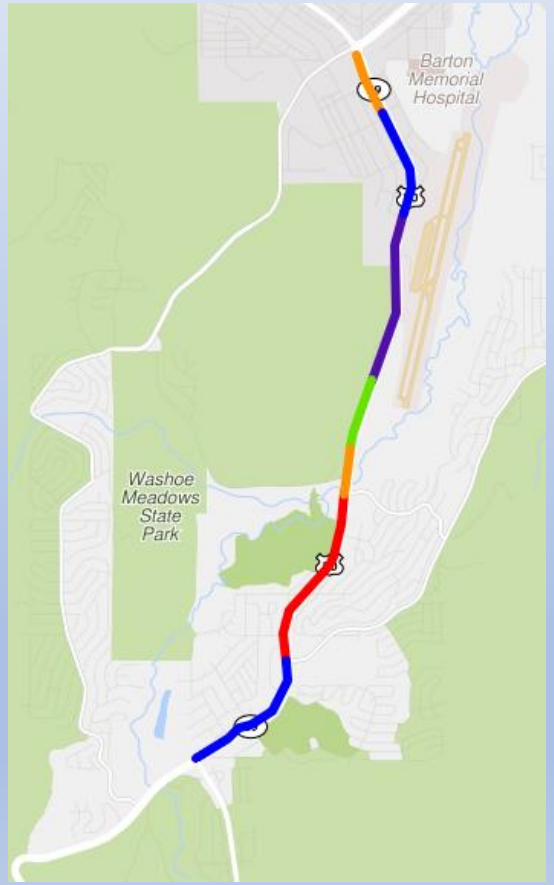


SLT Revisited (Low Volume)

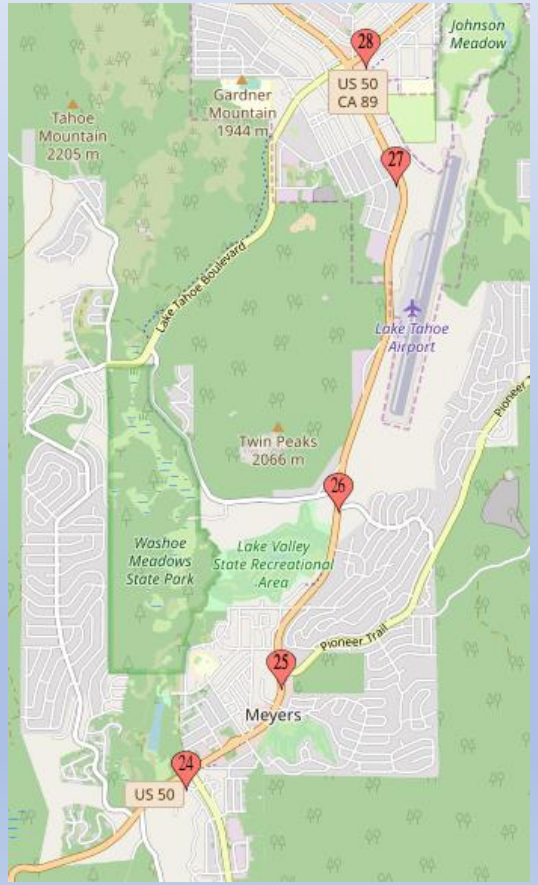
Waze
1 Easy Segment
4.83 Miles



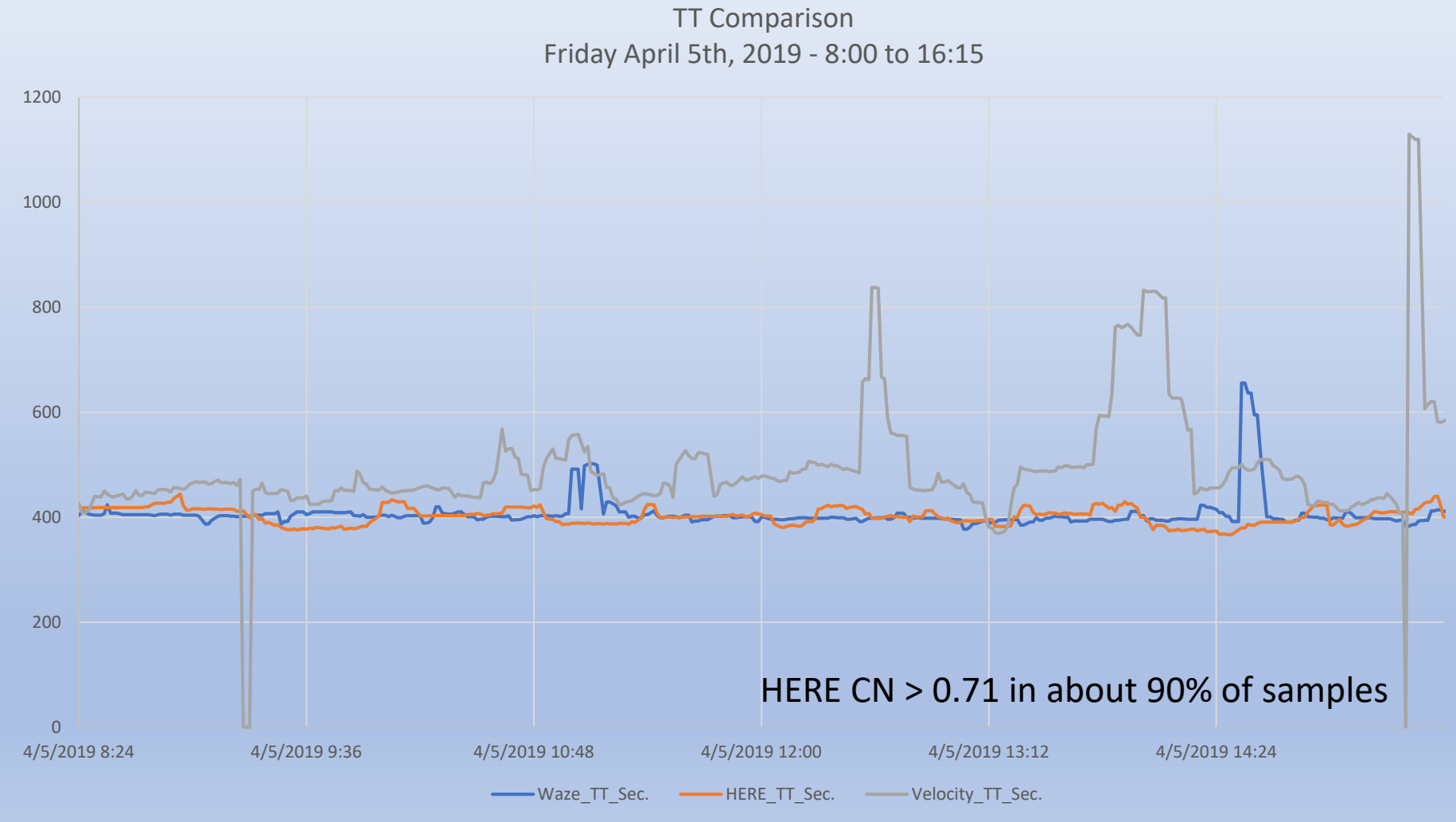
HERE
7 Fixed Segments
4.81



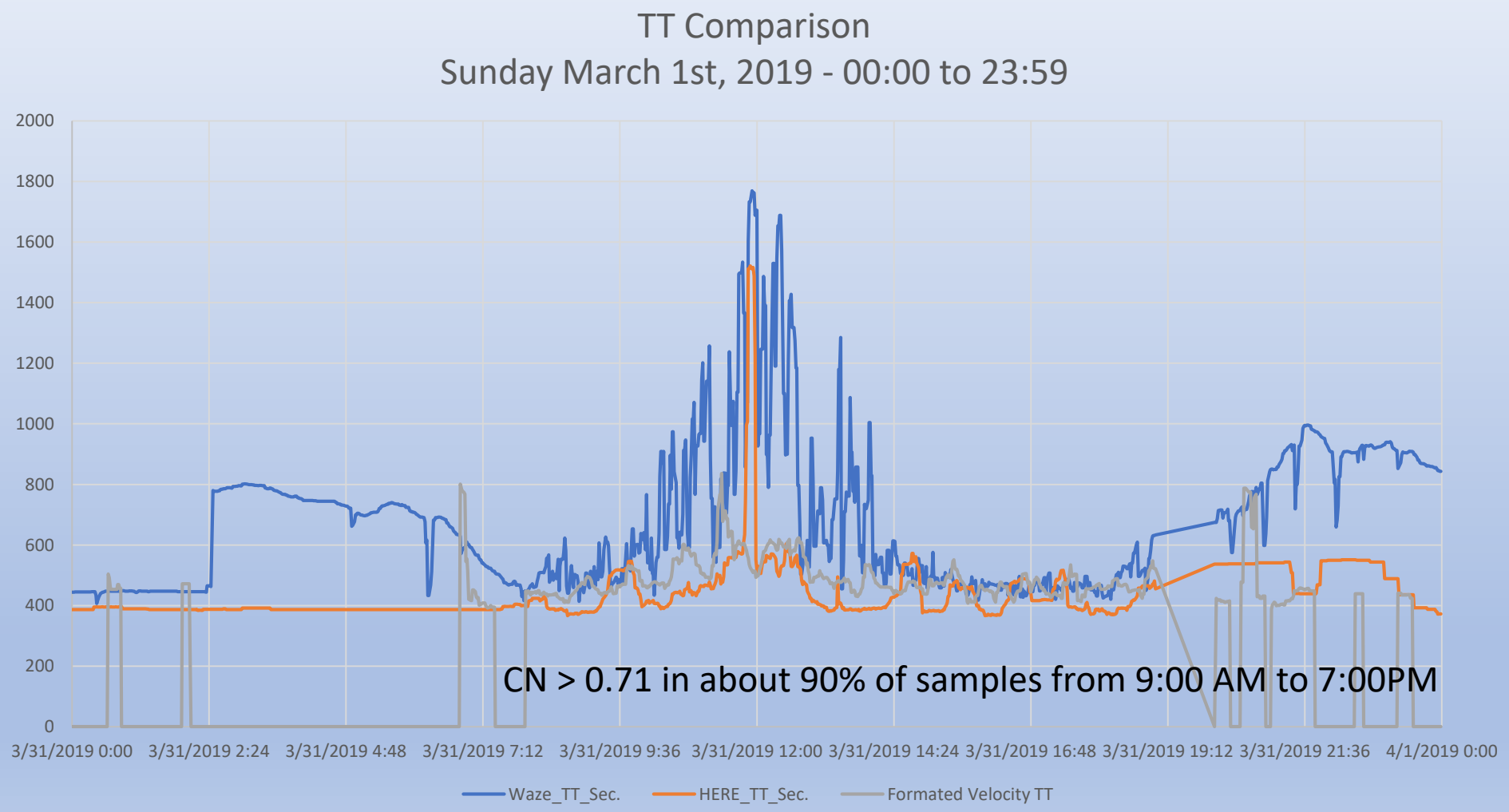
Bluetooth - Velocity
5 Readers, 4 Segments
5.01 Miles



SLT Revisited – Free Flow



SLT Revisited – Heavy Flow



Conclusion & Next Steps

- BTR's are out.
- Phasing out Loops.
- Jury is out on Waze vs. HERE.
- Tach Runs
  - Free flow with Traffic.
  - Free flow without Traffic.
  - Bad Weather.
  - Holiday Weekend (July 4th).

Q & A