THE EASTERN TRANSPORTATION COALITION

CONNECTING FOR SOLUTIONS

Web Meeting: Hurricane Traffic Volumes Pilot Results: States' Experience with Real-time Connected Vehicle Data

January 28, 2021

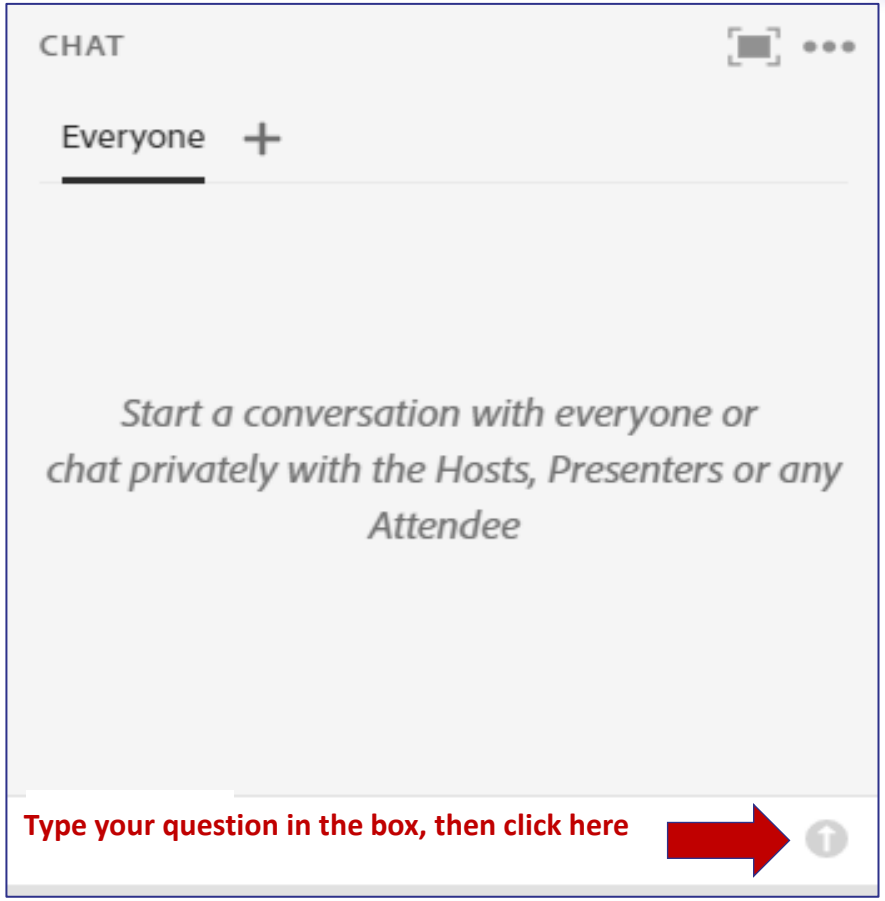
Audio Instructions

- Participants will be in “Listen Only” mode throughout the web meeting
- Please press *0 to speak to an operator for questions regarding audio
- Please call Justin for difficulties with the web or audio application
- **This web meeting will be recorded**
- Presentations will be posted to the Eastern Transportation Coalition website. Participants will receive a link to the presentations after they are posted.

Make Comments & Ask Questions

IN THE CHAT BOX

- Please pose your questions using the **chat box**
- Questions will be monitored then answered by the speakers either at the end of their presentation or at the end of the web meeting



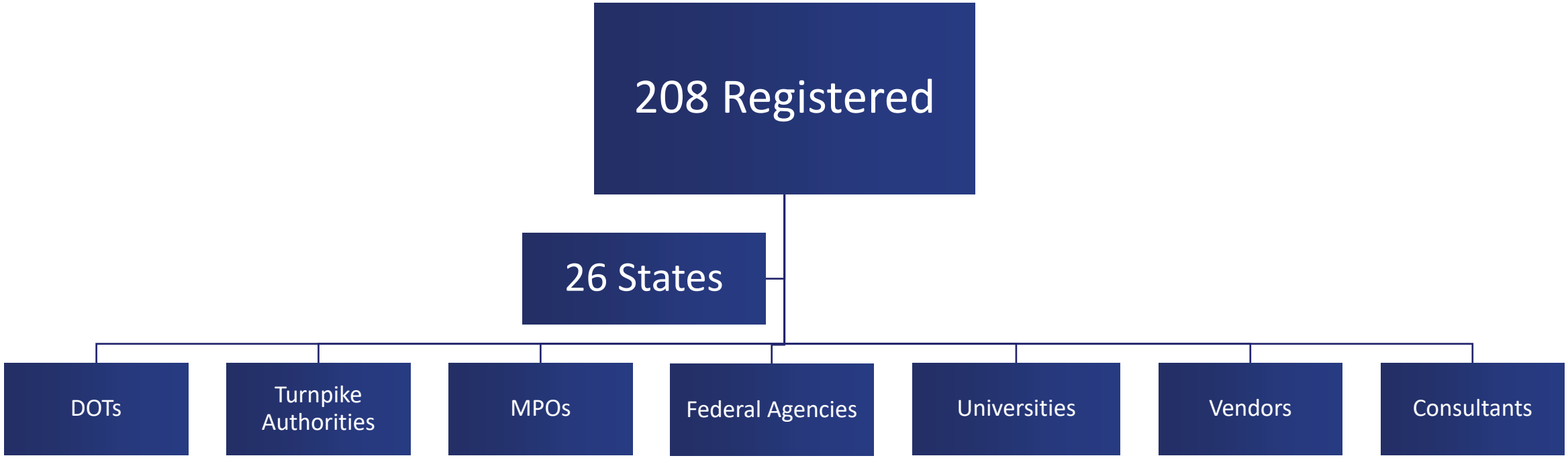
Welcome

Denise Markow, TSMO Program Director
The Eastern Transportation Coalition

Agenda

Topic	Speaker
Welcome & Introductions	Denise Markow, TSMO Program Director, The Eastern Transportation Coalition
Background	Stan Young, Advanced Transportation & Urban Scientist, National Reliable Energy Laboratory
Goals and Objectives	Stan Young
Overview of Connected Vehicle Data	Jaap van den Hoek, Director of Solutions Engineering, Wejo
Accuracy of Real Time Volume Data	Kaveh Farokhi Sadabadi, Senior Faculty Specialist, University of Maryland CATT
More Goals and Objectives	Stan Young
State Feedback	Denise Markow Simona Babiceanu, Data Scientist, Traffic Engineering Division, Virginia DOT
Lessons Learned and Summary Findings	Stan Young
Wrap Up	Denise Markow

The Eastern Transportation Coalition Sponsored Event



Coalition Update

RECENT

- ✓ **Traveler Information Web Roundtable –** Nov 19, 2020
- ✓ **Traffic Data Marketplace (previously VPPIII) RFI Meetings** – Dec 2020
- ✓ **The Changing World of Optimal Traffic Monitoring Web Meeting** – Dec 10, 2020

UPCOMING

- ✓ **RITIS-PDA Suite User Group Web Meeting** – Feb 11, 2021
- ✓ **WAZE Technical Working Group Data Workshops** – Feb 24 & March 3, 2021
- ✓ **Traveler Info Services Virtual Summit –** April 1, 2021
  - Innovative Capture and Dissemination of Traveler Information

Introductions & Project Team

Stan Young
Advanced Transportation & Urban Scientist
National Reliable Energy Laboratory

Jaap Van Den Hoek
Director of Solutions Engineering
Wejo

Kaveh Farokhi Sadabadi
Senior Faculty Specialist
University of Maryland CATT

Wander Boesjes
"Agency Support"
Moonshadow Mobile, Inc.

Zach Vander Laan
Faculty Research Assistant
University of Maryland CATT

Peter Carnes
CEO
Traffax

Eimar Boesjes
CEO
Moonshadow Mobile, Inc.

Background, Goals & Objectives

Stan Young, Advanced Transportation and Urban Scientist, National Renewable Energy Laboratory (NREL)

Background

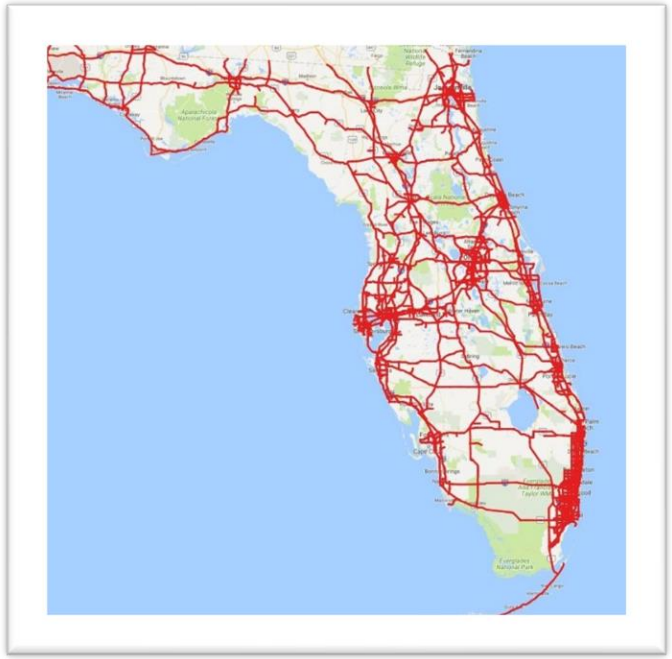
An existing partnership has been researching the viability of accurate traffic volumes derived from probe data

- Past studies include:
  - Florida
  - Maryland
  - Colorado
  - New Hampshire
  - Pennsylvania
  - Massachusetts
  - Tennessee
  - USDOT Pooled Fund Study for non-traditional sources for AADT

Background

HISTORIC volumes are viable.

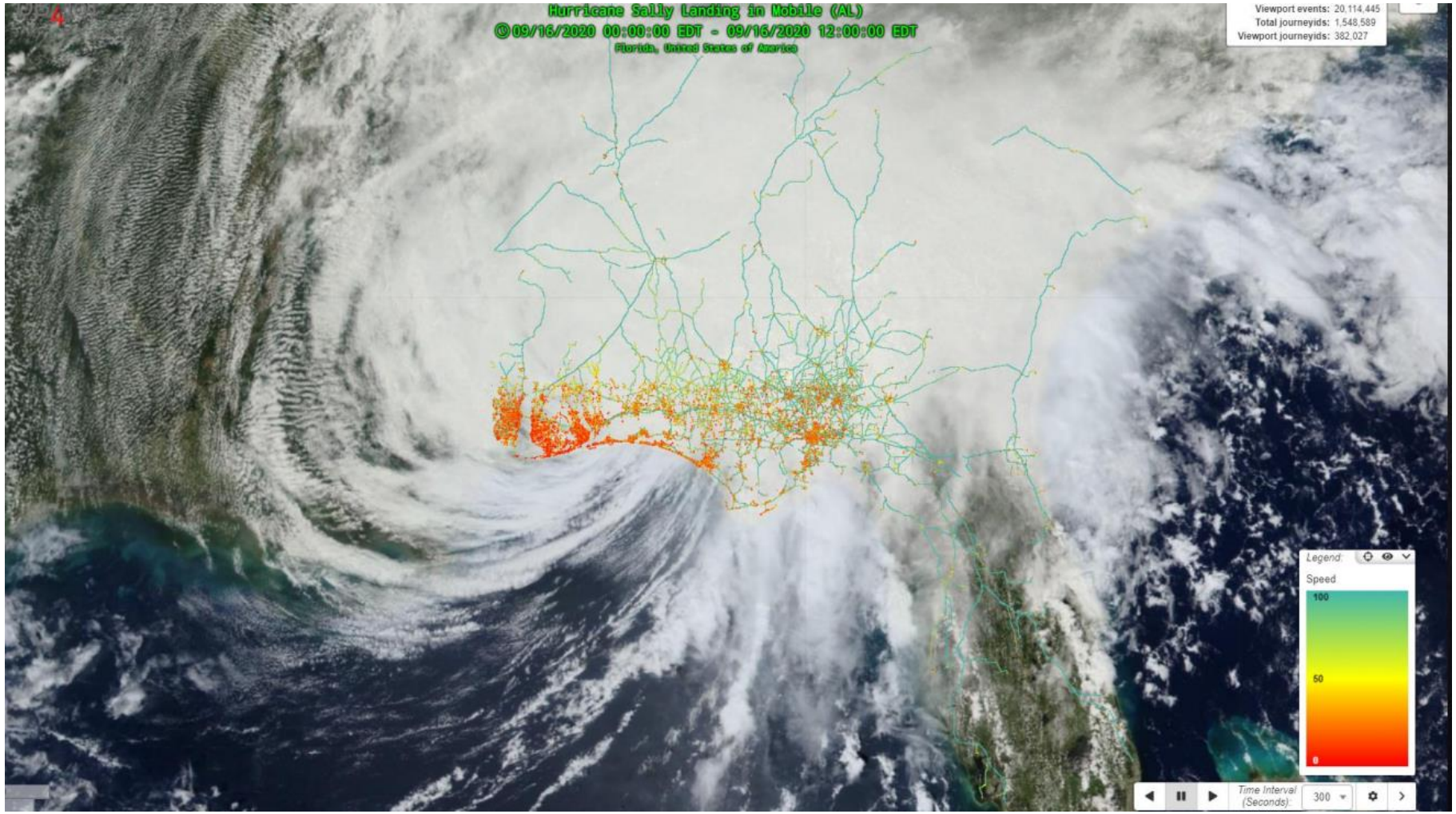
But what about REAL TIME volume!



Real-time volumes are the second dimension
(along side travel time & speed)
for full operational awareness.

TETC Pilot Proof of Concept

Could we use connected vehicle data to generate volume estimates in near real-time so that this data could be used to monitor hurricane evacuations?



The Players and Framework

PLAYERS	FRAMEWORK
Eastern Transportation Coalition	Coordination and Funding
Traffax	Validation Data Collection Partner
State DOT TETC Members	Florida, Alabama, Georgia, Tennessee, North Carolina, Virginia
Wejo	CV Data Provider Moonshadow – Wejo Partner – Display and processing platform
National Renewable Energy Lab	Collaborator & Technical Partner for ongoing research

Testing a Solution: Real-Time Vehicle Movements

What?

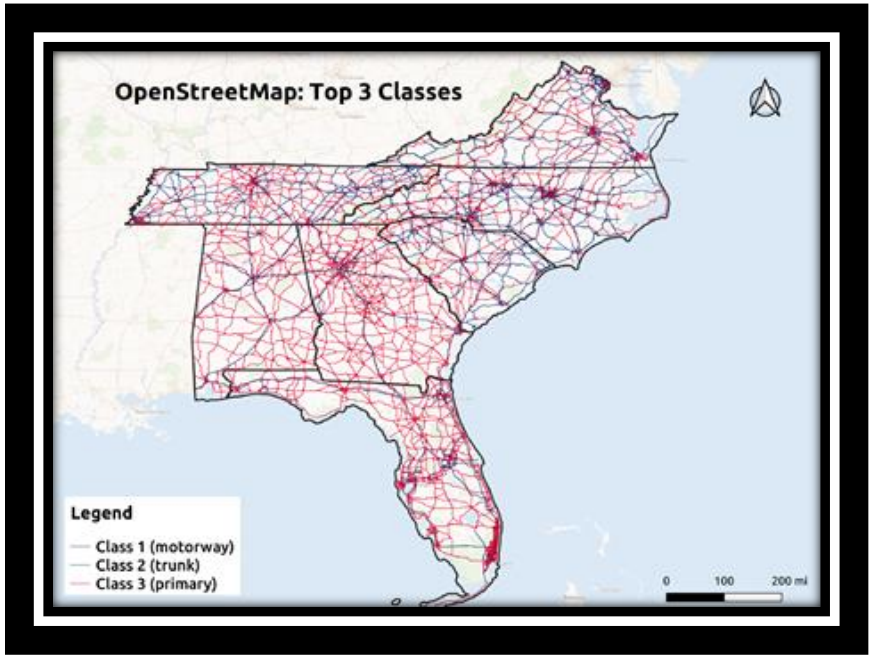
- Connected Vehicle Data – available real-time
  - 3 second pings, >3% penetration
- 21 licenses to view live stream vehicle movement
- Estimate volumes based on scaling factors

Where?

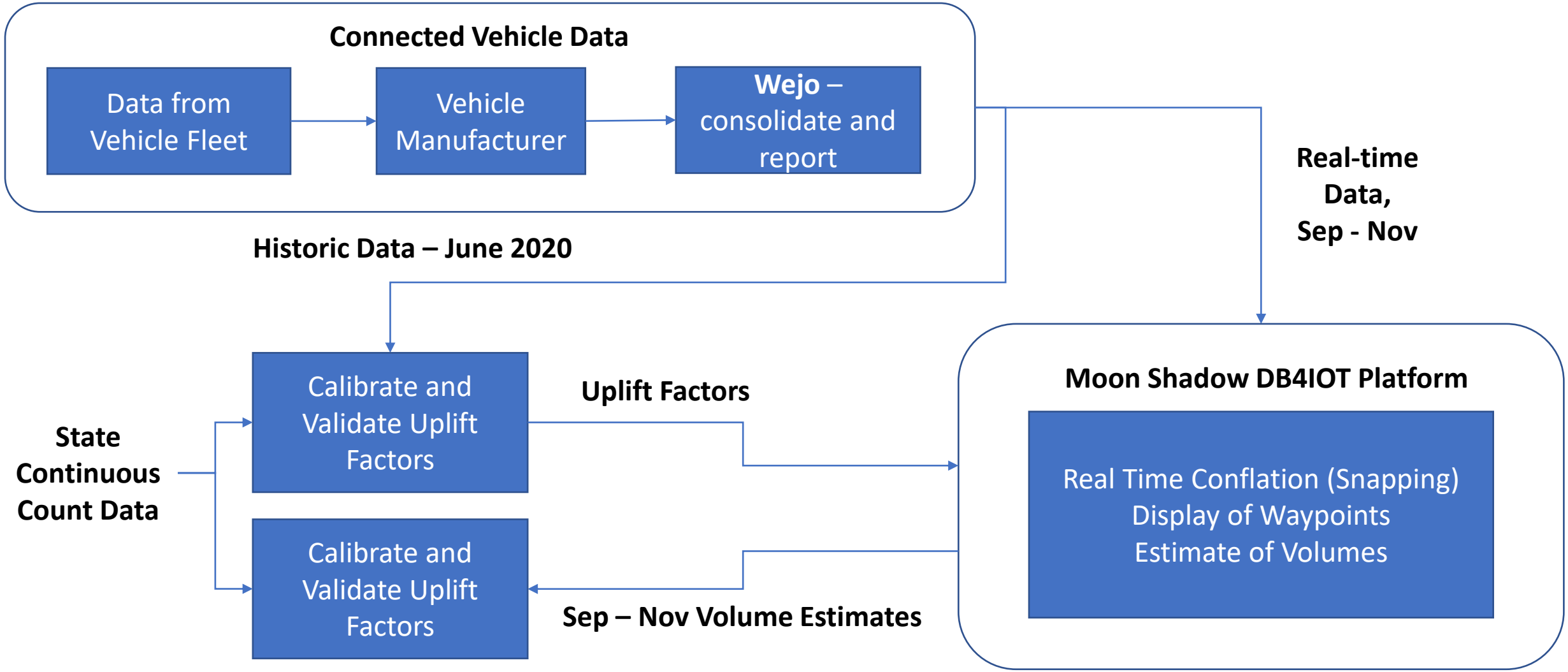
- Alabama, Florida, Georgia, North Carolina, Tennessee, Virginia
- Interstates, Turnpike and the NHS system (FRC 1,2,&3)

Why?

- Take volume research to real-time



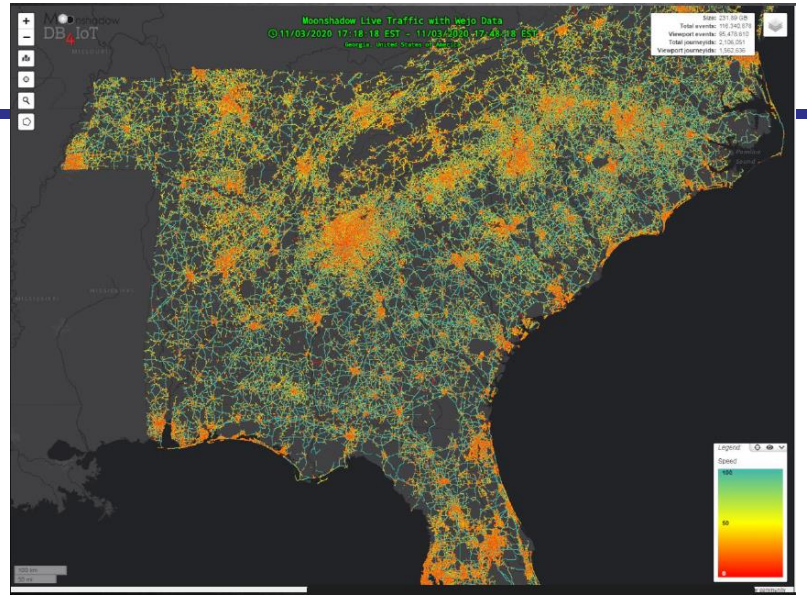
Data Flow Framework

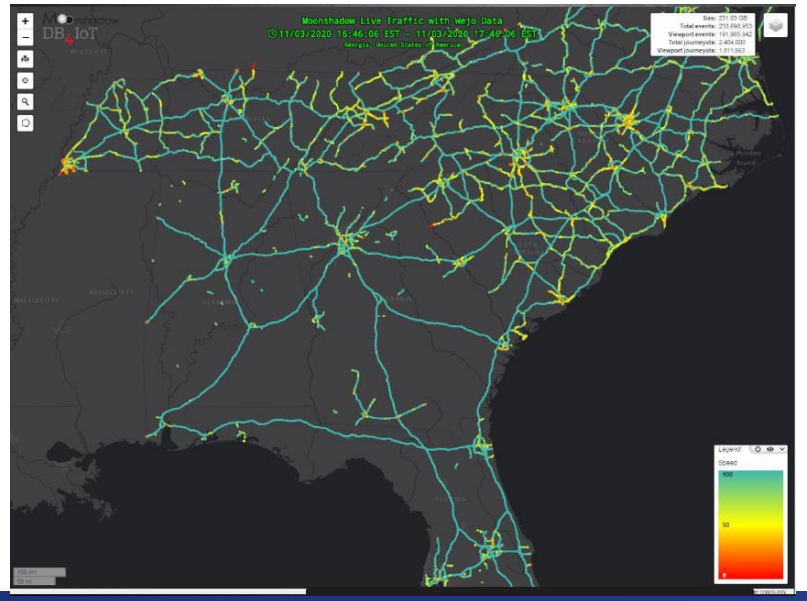


Goals & Objectives

1. Demonstrate that **real-time connected vehicle data** representative of about 3% of all vehicular traffic across all seven states **can be delivered and visualized in real-time.**

2. **Process observed CV trips in real time**, assigning them to appropriate roadway segments, and obtained counts of probe vehicles from which to estimate traffic volume.

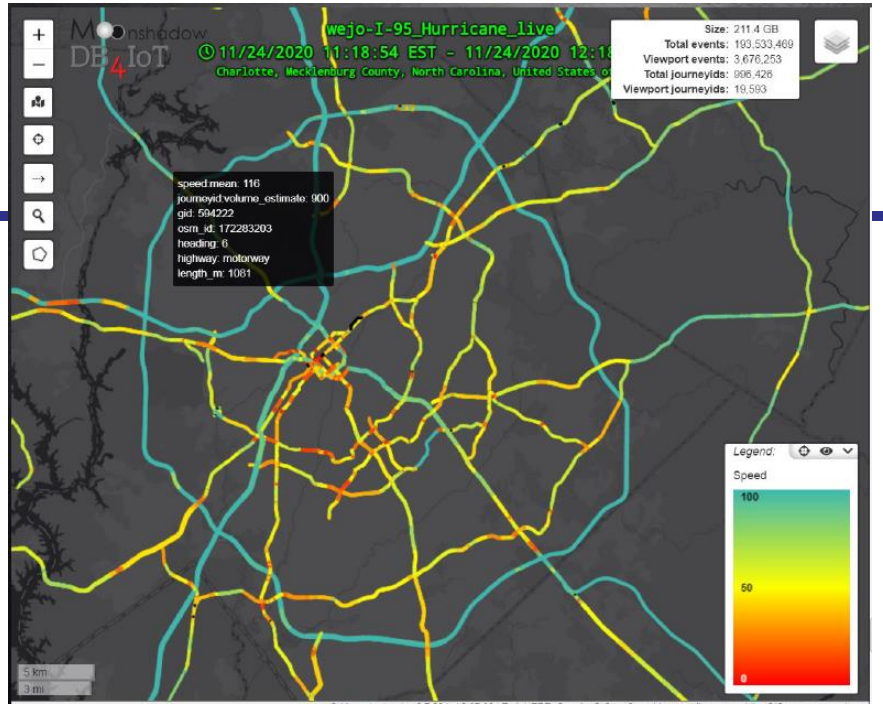


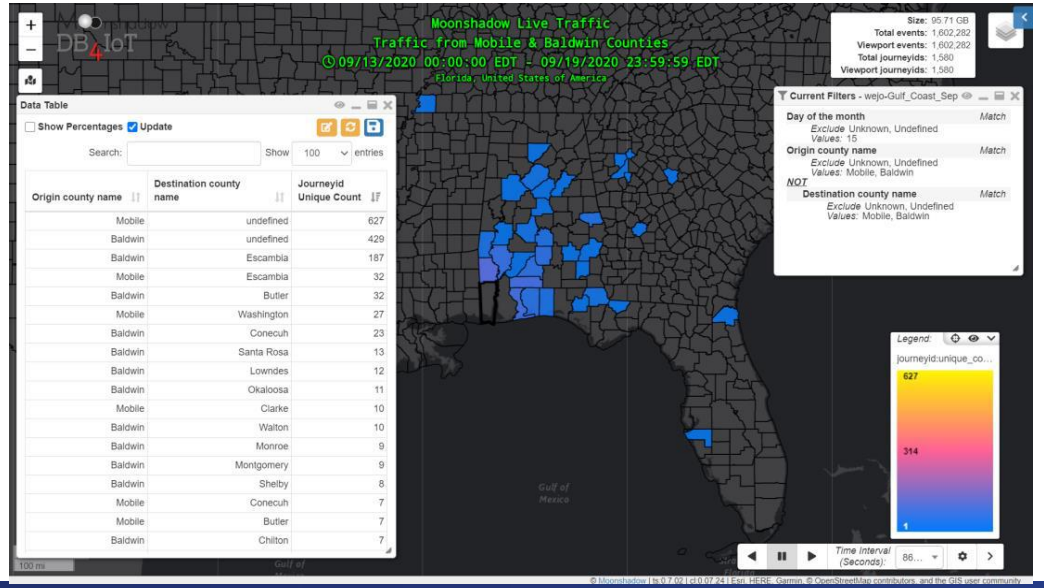


Goals & Objectives

3. **Assess meaningful Volume Measures** from the live data streams by calibrating to known journey penetrations rates, and relative to nominal traffic volume conditions.

4. **Show that the mobility patterns of people,** where they go and when, change significantly in the event of a major storm.

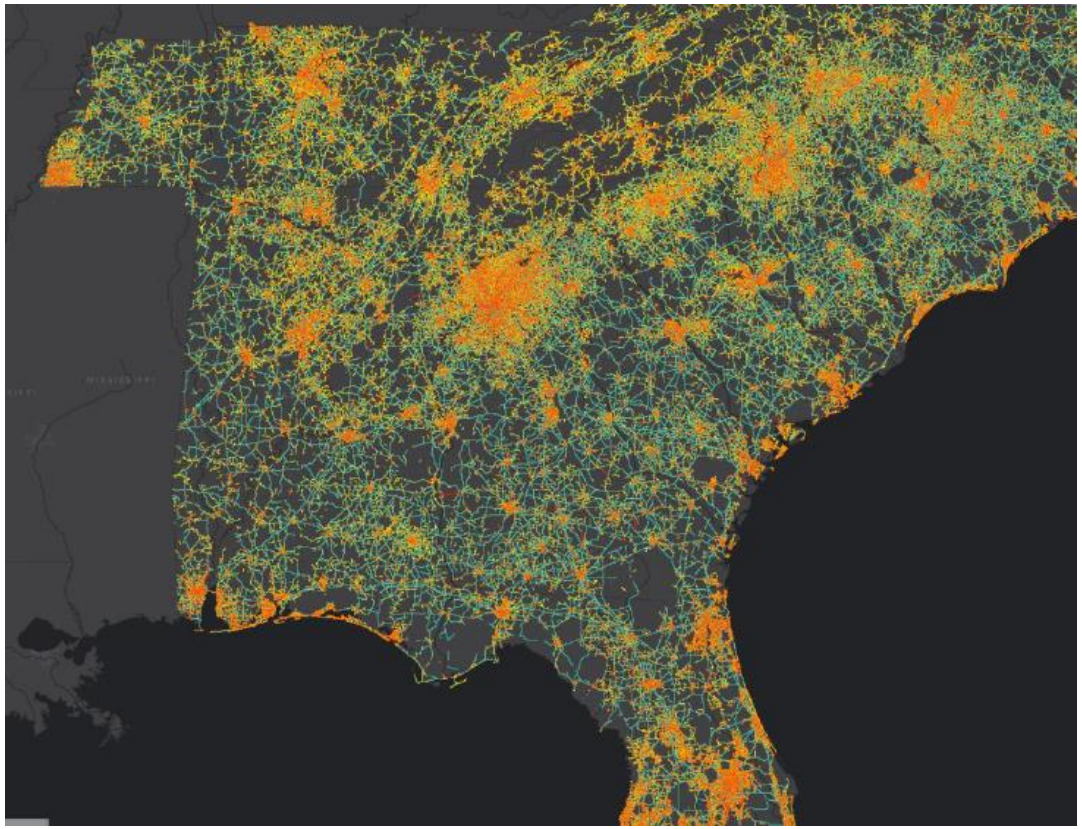




Proof of Concept Goal #1

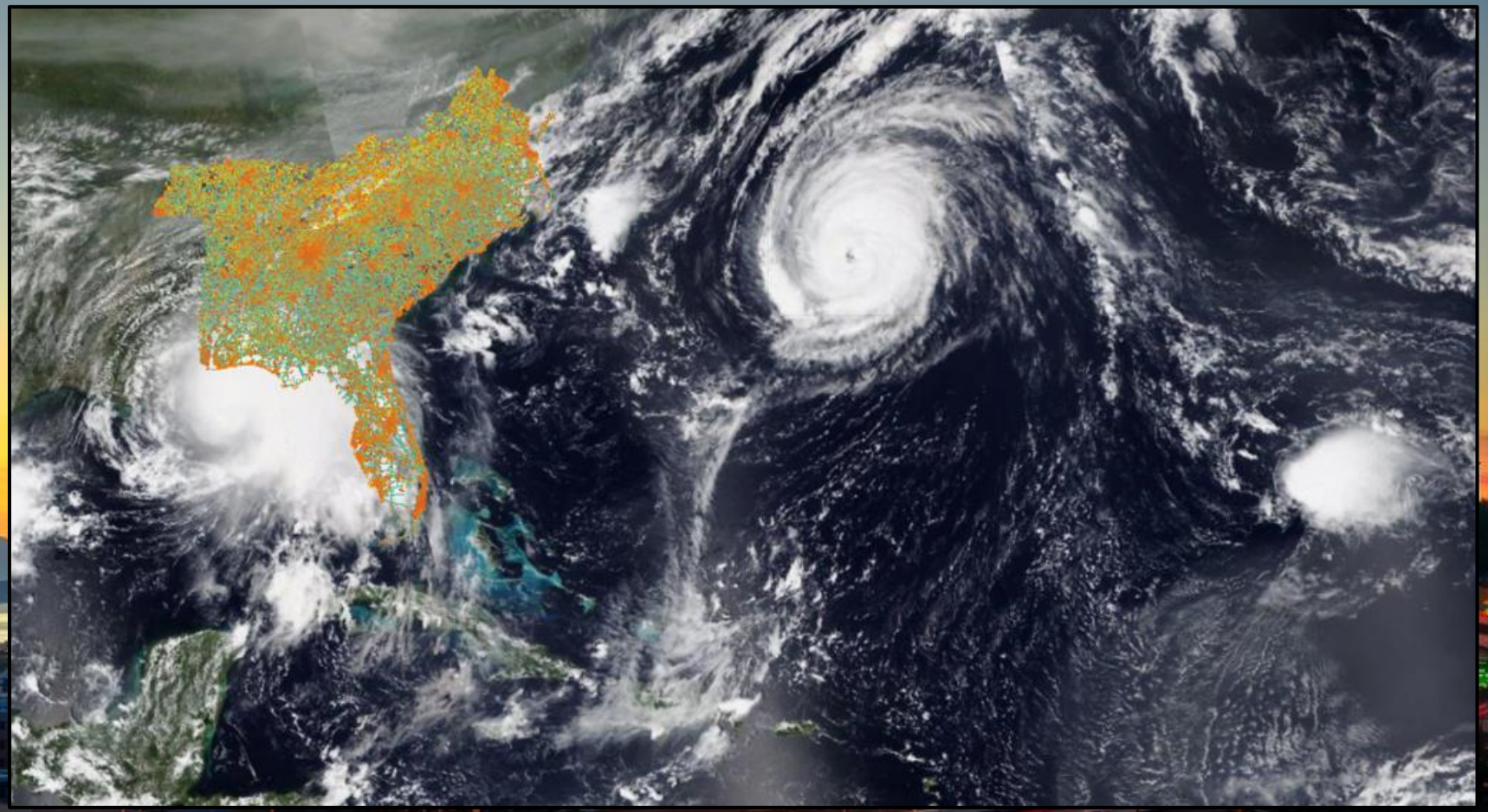
Real-time CVD across all states is delivered and visualized in real-time

Source CV Data: Wejo



Overview of Connected Vehicle Data

Jaap van den Hoek, Director of Solutions Engineering, Wejo



WEJO & The Eastern Transportation Coalition

January 28, 2021

Take A Look: Mobile Data vs. Connected Vehicle Data (CVD)

Two very different ways to see road vehicle density

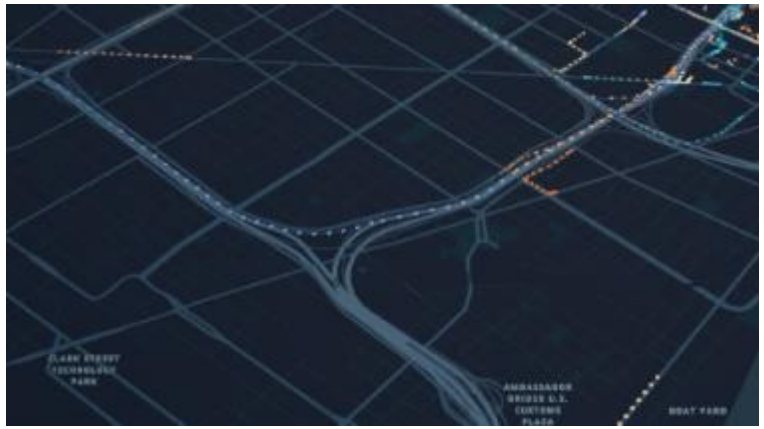
Location: Los Angeles
Time period: December 4–11

Source (click to play):
Connected vehicle data stream

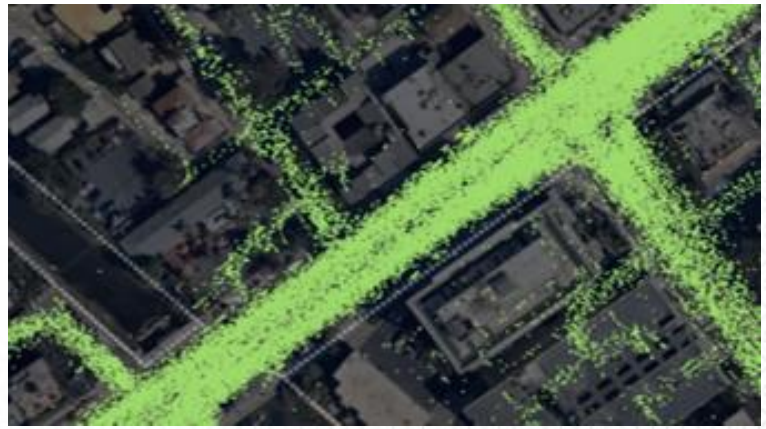
The Power of CVD: Unlocking Real Value

It’s faster, more in-depth and offers new levels of information

3 second capture rate with 30 second latency



High volume of journeys tracked: 1.3 billion per month



Accurate to 3 meters, which helps identify highway lanes and parking spots

Data from historical events gives insights about incident hotspots, harsh breaking or acceleration, speeding and more

wejo

Hurricane Proof of Concept for The Eastern Transportation Coalition
September – November 2020

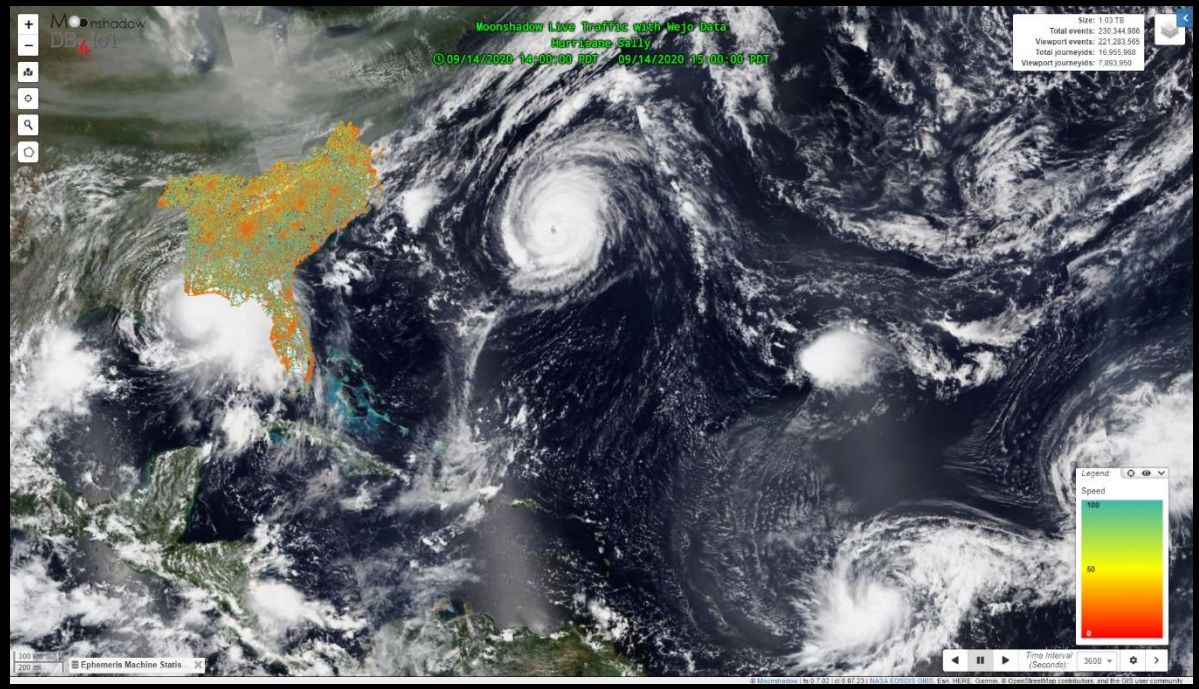
Problem Statement:
Can connected vehicle data help monitor hurricane evacuation traffic and generate volume estimates in near real-time?

Six States:
Alabama, Florida, Georgia, North Carolina, Tennessee, Virginia

Three Months: September 1 – November 30, 2020

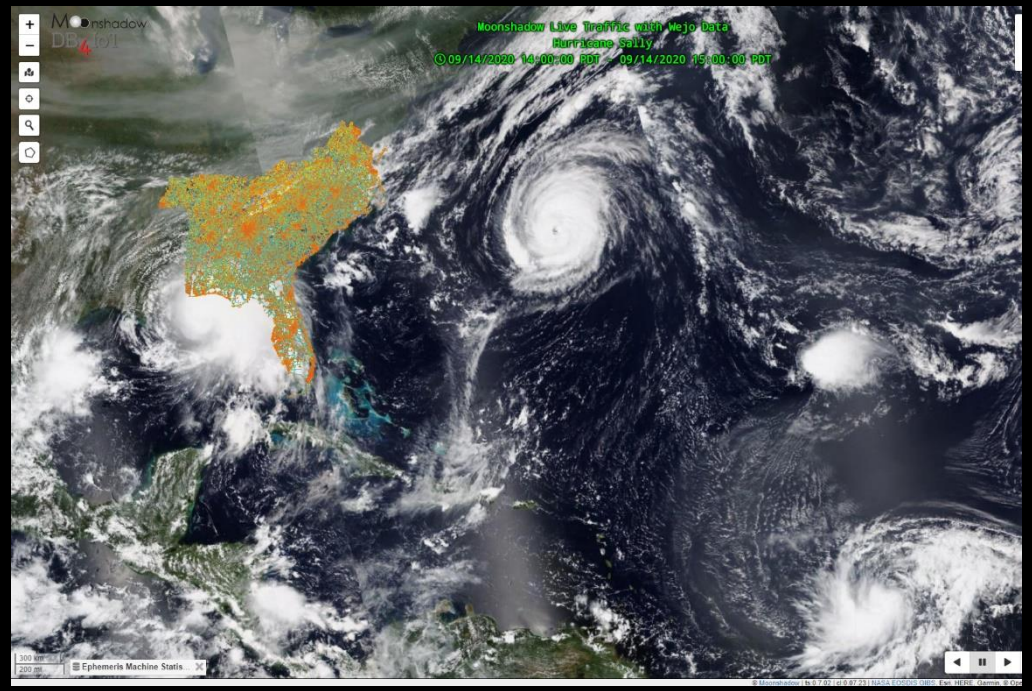
Technology:

Moonshadow **Live** Traffic with Wejo Data



Hurricane Proof of Concept for The Eastern Transportation Coalition
September – November 2020

Waypoints/Day	2,500,000,000
Trips/Day	7,500,000
Vehicles/Day	2,500,000
Peak Hour Vehicle Updates per Second	100,000
Files per Hour	40,000
Gigabytes/Day	50
Average Vehicle to User Map Latency (seconds)	45
Average User Map Update Frequency (seconds)	30
Vehicle Update Frequency (seconds)	3



Understanding and monitoring dwell time around POIs to determine length of stay and purpose of visit

What We Learned

- Wejo data is a true Big Data (>TB) Real-Time data source
- Over 2 Million vehicles per day over six states
- Over 75B data points per month, >200B during POC
- Segment volume uplift factors applied in 15 minute intervals
- Real-time monitoring site (DB4IOT) and sample data for ETC
- Base data provided in geodetic (lat-lon), is map agnostic
- Objective 1 & 2 accomplished

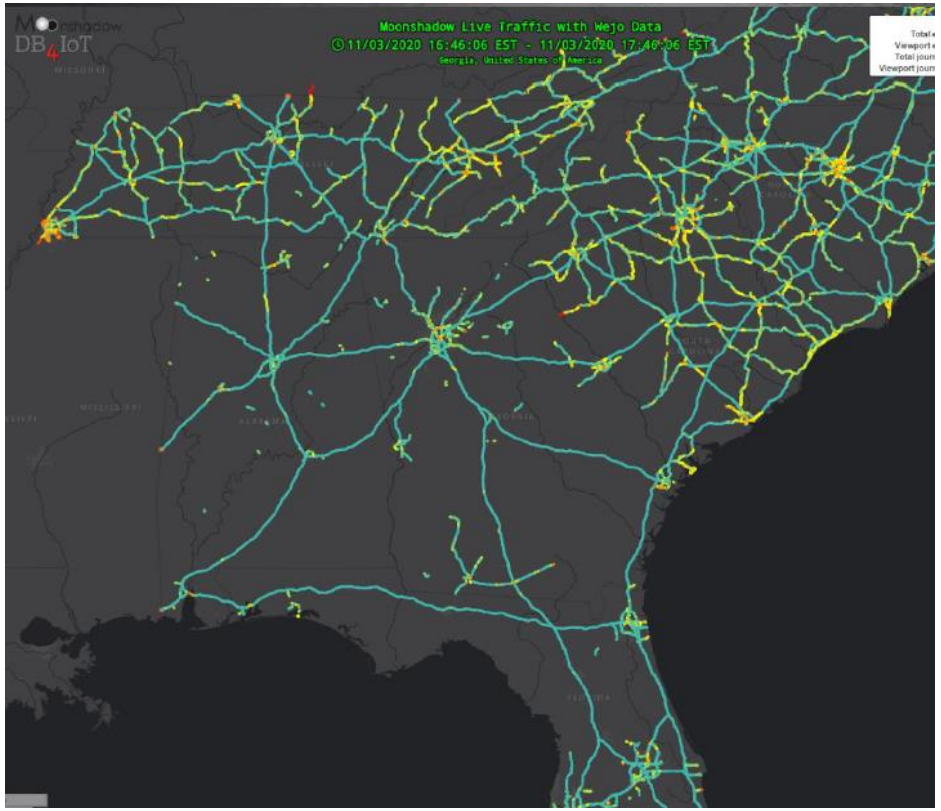

wejo
Thank you!
wejo.com

Goal #1 – Lessons Learned

CV data is viable in real-time

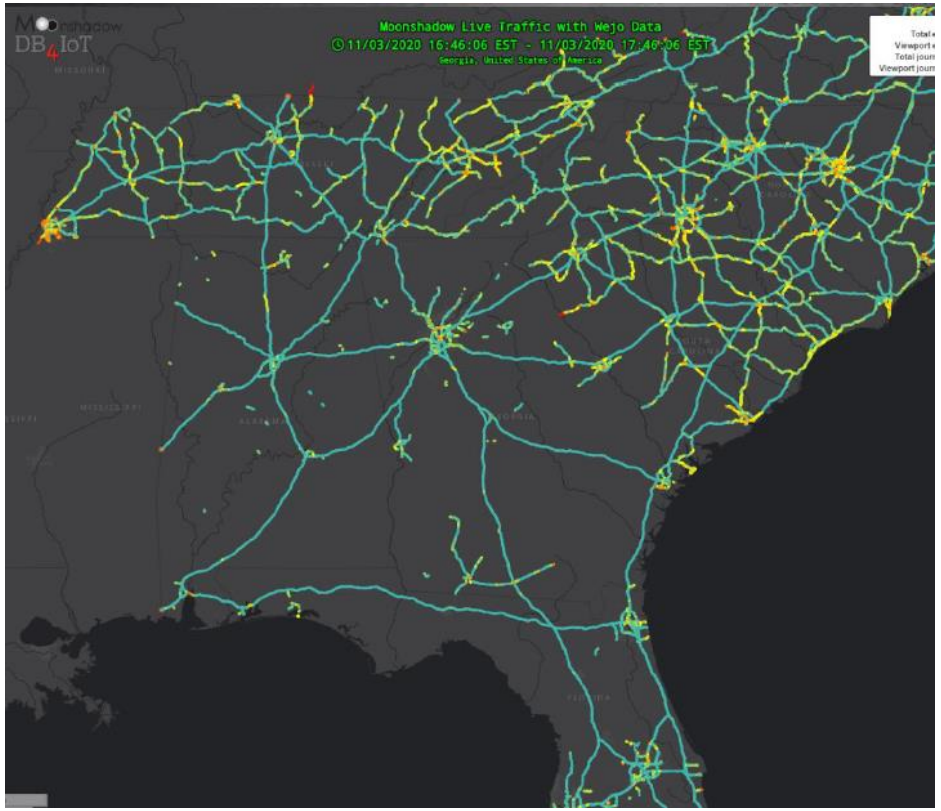
Ingesting, processing, and displaying real-time CV data is ‘no small feat’

Map agnostic format has advantages and disadvantages



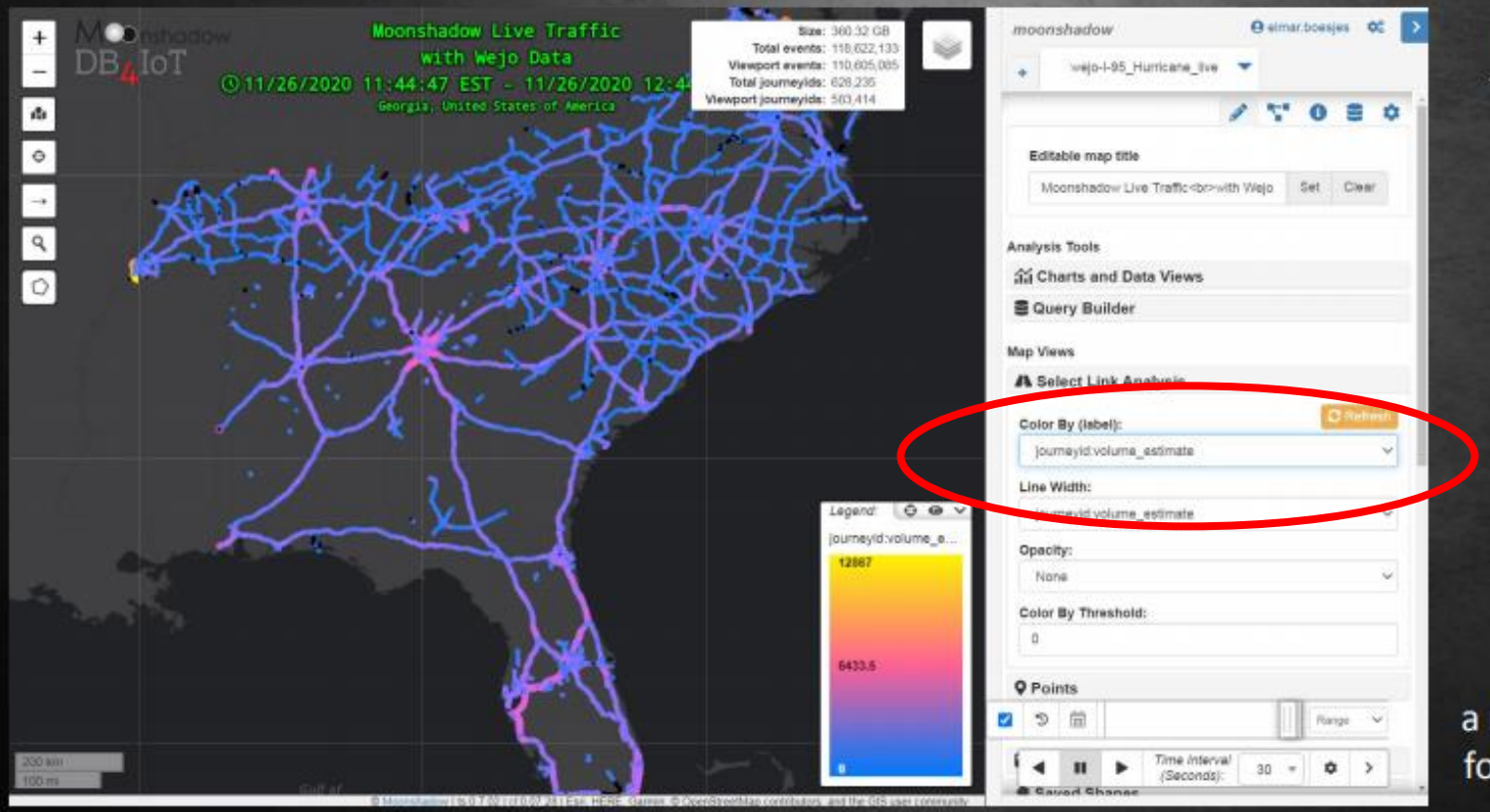
Proof of Concept Goal #2

Process observed CV trips in real time, assigning them to appropriate roadway segments, and obtained counts of probe vehicles from which to estimate traffic volume.



Moonshadow

wejo | DATA INSIGHT partner



Moonshadow Live Traffic takes in Wejo data at scale

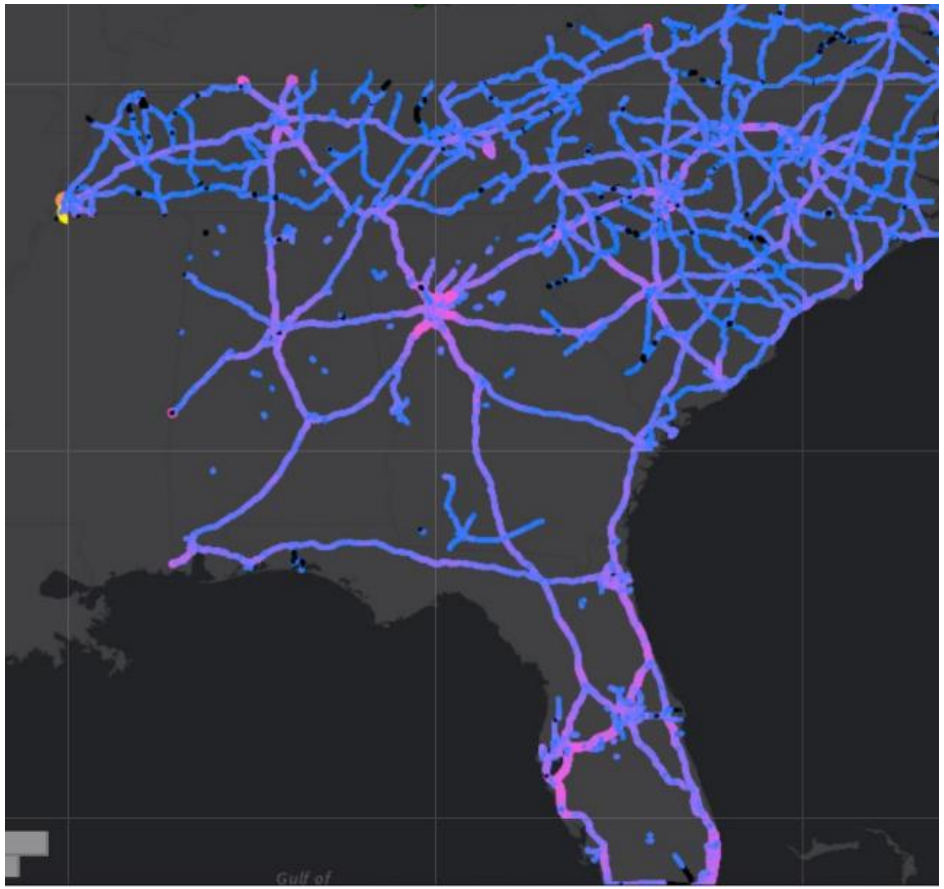
to provide
a mobility analytics platform
for transportation engineers

Goal #2 – Lessons Learned

- Real-time CV data is intuitive, but volume estimates requires aggregation to segment levels
- Conflating data to map segments (OSM) in real-time is challenging, but doable
- DB4IOT, though robust, required data science skill
  - need to work toward ‘Easy Buttons’
- Need to bridge language between traffic engineering with data science / IT
- Approximately 30 seconds measured latency

Proof of Concept Goal #3

Assess meaningful Volume Measures from the live data streams by calibrating to known journey penetrations rates, and relative to nominal traffic volume conditions.



Accuracy of Real Time Volume Data

Kaveh Farokhi Sadabadi, Senior Faculty Specialist,
University of Maryland CATT

The Uplift Process

INPUT DATA

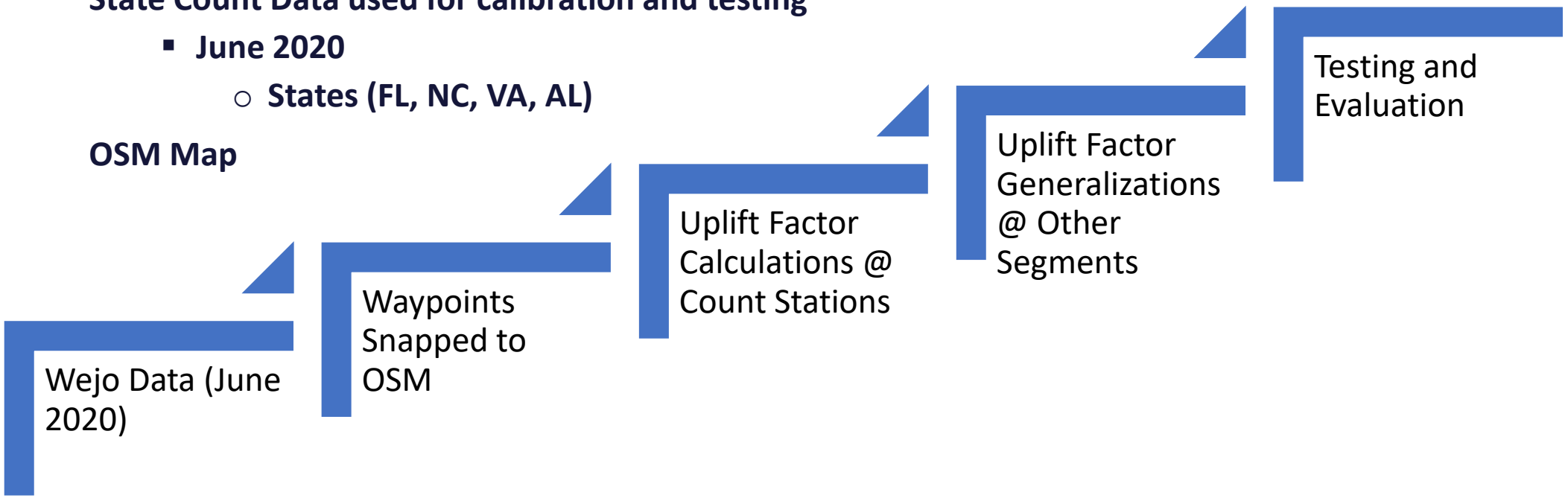
Wejo Data

- **June 2020 (one month/6 states for uplift factor calculation)**
- **Sep-Nov 2020 (three months for real-time platform and evaluation)**

State Count Data used for calibration and testing

- **June 2020**
  - **States (FL, NC, VA, AL)**

OSM Map



The Uplift Factors

- **States**
  - **Florida, North Carolina, Virginia**
- **Functional Road Class (FRC) 1-3**
  1. Motorway
  2. Trunk
  3. Primary
- **Time of Day (TOD)**
  - 15-minute time intervals
  - 96 time intervals per day (0-95)

Day of Week (DOW)

0. Sunday
1. Monday
2. Tuesday
3. Wednesday
4. Thursday
5. Friday
6. Saturday

Input Data – Some Notes and Challenges

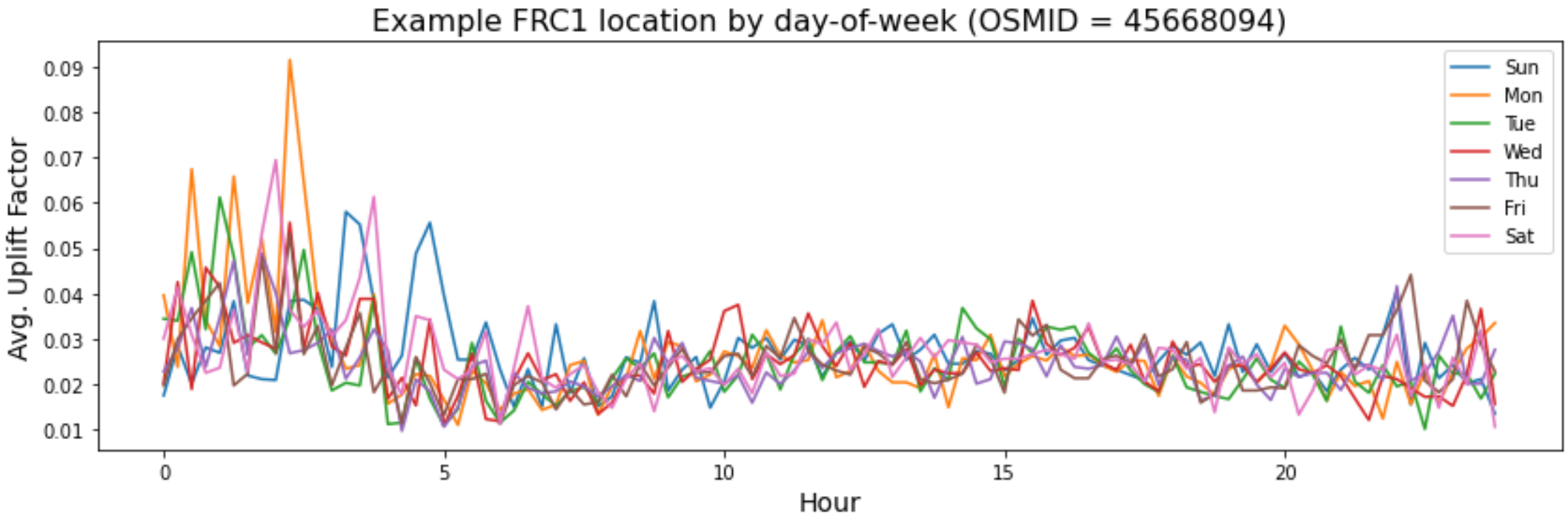
- **Real-Time counts based on 15 minutes rolling window –**
  - Historical data all in one-hour formats
- **Real-time Volume desired in Directional Format**
  - Some CCS counts are non-directional
- **Reference count data conflated to Open Street Maps –**
  - Some error was noted in the pilot – nothing significant.
  - Conflation process needs streamlining for implementation
- **Count data and real-time waypoints time reference**
  - May be reported in different time zones (UTC vs. local)

- **Overall – challenges, not show-stoppers**

Descriptive Stats

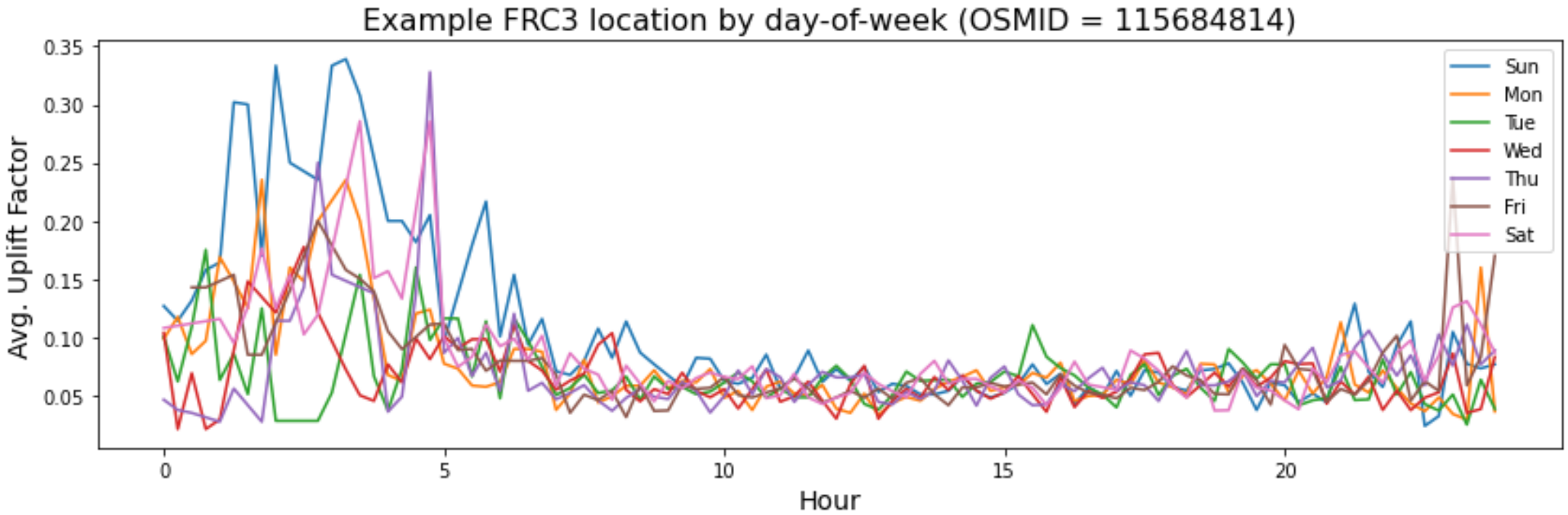
State	Road Class	All Locations		Count Locations		
		# OSM Segments	Total Miles	# of CCS	Total Miles	# Hours of Data
Florida	FRC 1	9,426	4,754	87	547	52,723
	FRC 2	1,432	478	6	7	2,429
	FRC 3	37,606	12,818	208	525	84,356
North Carolina	FRC 1	7,095	4,648	47	267	49,361
	FRC 2	7,517	3,825	17	69	12,472
	FRC 3	12,041	5,582	10	22	3,796
Virginia	FRC 1	5,874	3,339	548	1,090	388,665
	FRC 2	5,588	3,726	69	326	81,472
	FRC 3	10,039	4,704	48	393	51,330

Results – Florida – Functional Road Class 1 OSM / DOW / TOD



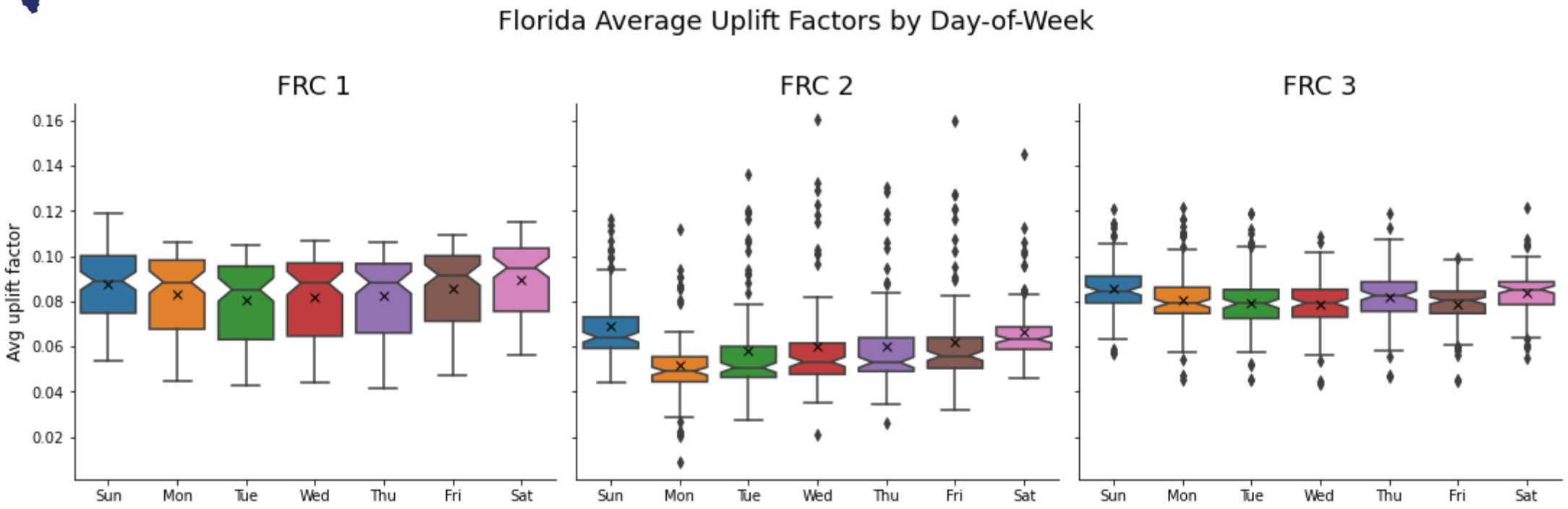
- On a tech level, this slide summarizes results. CV is consistent enough to provide meaningful volume in real-time

Results – Florida – Functional Road Class 3 OSM / DOW / TOD



- Off-peak hours have larger variability can have difference uplift factors –
  However, core hours (6am to 10pm) are typically quite consistent based on road class, DOW, and TOD

Uplift Factors – Florida FRC / DOW



- There is some fluctuation by DOW, and the box plot provide indication of variance (in turn expected accuracy)
- The Inter-Quartile Range is typically 1% - 4%, providing for reasonable accuracy

Summary – Lessons Learned

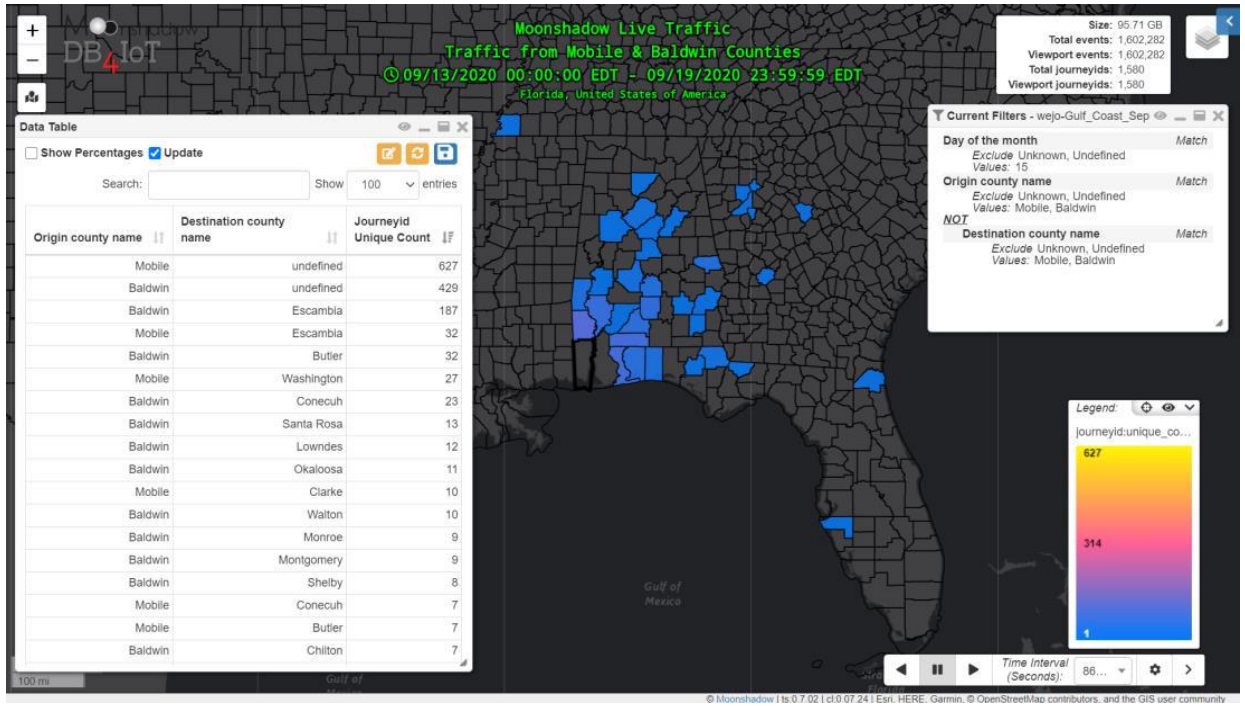
- Florida, North Carolina, Virginia uplink factors calculated
  - Size of data proved challenging – three states completed within resources
- Uplink factors variation
  - Most variation is with road class, DOW, and TOD
  - Some variation from State to State
- Initial assumption of 3% uplift is conservative – closer to 5% in lower road classes
- Overnight hours had higher variance (as expected)
  - Move to hourly (rather than 15 min) during low volume periods
- Conflation and snapping will require more attention in implementation – some errors noticed in POC

Summary – Was the POC Successful?

- Despite the data processing challenges, analysis to date indicates that …
  - Volumes of reasonable accuracy for operations are feasible in real-time through connected vehicle data
  - Simple factoring (DOW, TOD, State) provides a workable solution – more advanced ML/AI techniques may only improve
  - Sheer size and velocity of data will require efficient calibration, calculation, and conflation techniques –
- **OVERALL – the POC indicated that real-time CV data is sufficient to provide workable real-time Volume Estimates!**

Proof of Concept Goal #4

Show that the mobility patterns of people, where they go and when, change significantly in the event of a major storm.



Goal #4 – Lessons Learned

- Trip Origins and Destination (O&D) typically repeatable every day
- During Hurricane, O&D patterns should reveal people getting out of the way (evacuation) or sheltering in place
- Real-Time is not second-to-second, but rather daily di-urnal patterns
- Goals #1 through #3 consumed most resources …. But …..
- Case studies conducted in collaboration with Moon Shadow revealed
  - Observable changes in roadway use during onset of Sept tropical storm
  - Visitations to home improvement stores (Lowe's / Home Depot) escalate during hurricane onset
- Real-Time OD behavior is a new – uncharted field – great opportunity

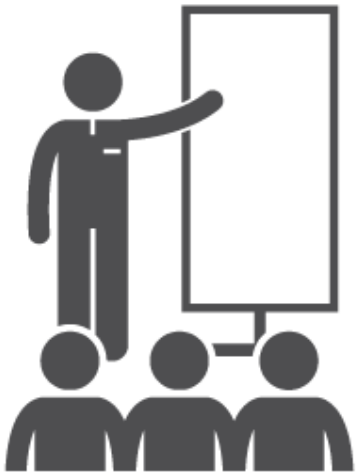
State Feedback

Denise Markow, TSMO Program Director,
The Eastern Transportation Coalition

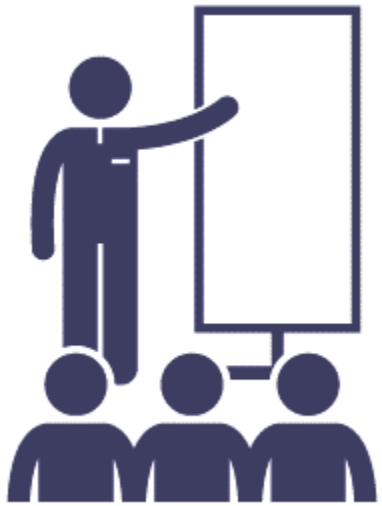
Simona Babiceanu, Data Scientist, Traffic Engineering Division
Virginia DOT

State Participation

- Identified power users/subject matter experts from participating states
- Asked them to interface with the visualization platform DB4IoT and provide feedback
- Original 21 licenses were provided to a set of pre-determined people.
- Training sessions were held
- After training, other users were identified to better fit the request
- Licenses were transferred to other users who attended training



State Participation



THANK YOU!

State	Licensees
Alabama	**Alex Hainen**
	Brett Sellers
Florida	**Raj Ponnaluri**
	Omar Faruk
	Michelle Arnold
Georgia	**Brad Mann**
	Tom McQueen
	Robert Binns
North Carolina	Dominic Ciaramitaro
	Kelly Wells
Tennessee	Brad Freeze
	David Lee
Virginia	**Simona Babiceanu**
	Chien-Lun Lan
Researchers	**Alex Hainen**
	Srinivas Pulugurtha
	Dr. Han Lee
	Dr. Lei Zhu UNC
	Scott Benedict

Useful Data Features from a DOT Perspective

Impressive data amount and freshness

- Data set rich in timestamp/location/route detail

Emerging type of data, can provide new insights and meet current needs (ubiquitous volumes, O-D matrices, vehicle trajectories)

- Totally different scale from currently available volume info
- Complements currently available data

Real-time aspect – valuable for TOC and weather event operations

- Capability of understanding more/less frequently used roads
- Compliance with designated evacuation routes

Availability of data from border regions with other states

VDOT Virginia Department of Transportation

Challenges

Volumes are a big DOT need – Scaling up journeys to volumes

Building trust in data at the DOT level – Validation & Local Customization

Probe Vehicles – Bias towards newer vehicles equipped with CV tech.

Privacy Issues – O-D lat/longs often sufficient to identify one's house.

Other

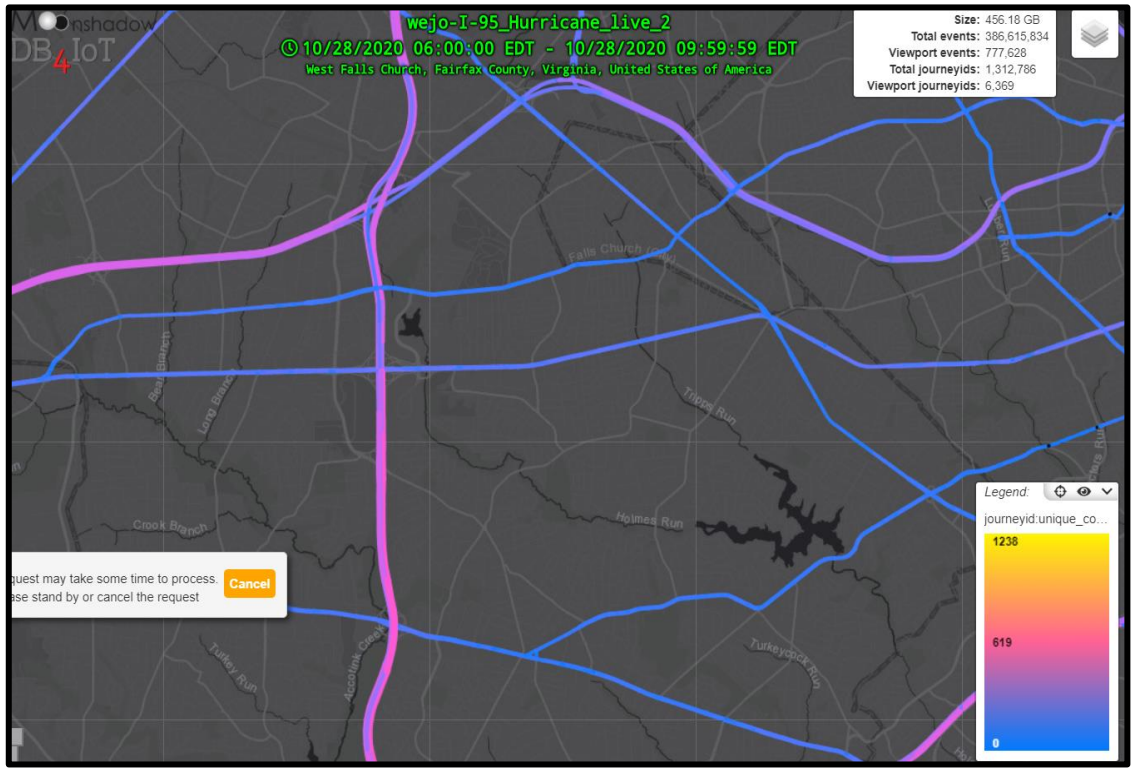
- Speeds – Some speeds are very high, may need some cleaning up.
- Frequency of Data Updates – Can vary, some updates may be missing (quite often)
- Map matching – Lat/longs not always sufficient to determine direction of travel, so heading data element is very useful

VDOT Virginia Department of Transportation

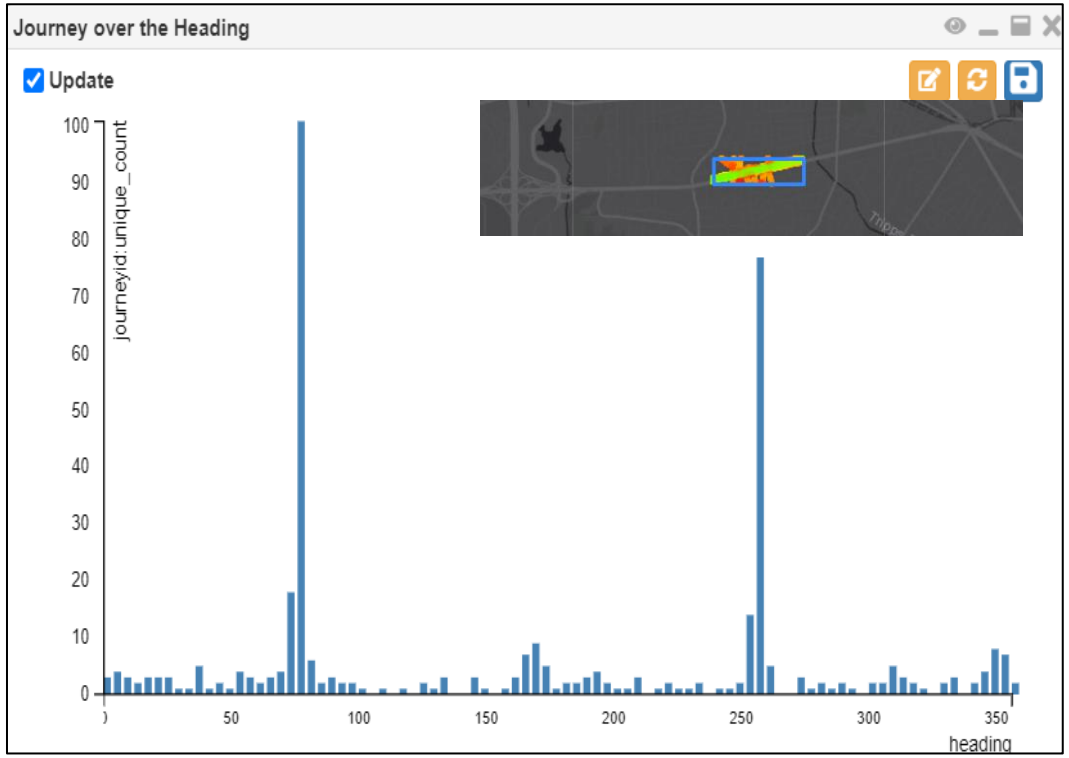
Unique Journey ID O-D Matrix by District Virginia, Sept 13 – 19, 2020

Destination District	Origin District: Bristol	Culpeper	Fredericksburg	Lynchburg	Hampton Roads	Northern Virginia	Richmond	Salem	Staunton	Out of State	UKN
Bristol	49,844	128	15	56	157	26	104	2,735	391	1,848	8,666
Culpeper	133	187,676	4,908	1,370	331	8,912	3,187	343	3,781	137	6,948
Fredericksburg	10	4,894	265,795	165	4,365	9,579	9,324	47	382	596	11,694
Lynchburg	63	1,387	179	144,236	988	110	2,894	6,791	1,240	2,163	4,222
Hampton Roads	298	362	4,644	897	921,233	593	7,646	3,557	521	8,517	22,972
Northern Virginia	11	9,006	9,460	102	449	705,610	1,069	82	3,314	255	70,570
Richmond	133	3,010	9,602	2,910	7,587	1,143	582,944	480	1,070	2,591	13,324
Salem	2,495	314	43	6,784	3,381	109	482	251,139	2,594	1,794	9,494
Staunton	313	3,885	400	1,186	450	3,315	1,151	2,258	246,676	779	19,352
Out of State	2,517	171	803	2,326	9,341	370	2,777	2,167	987	9,489	3,397
UKN	14,751	13,310	20,680	8,670	39,711	121,291	24,340	17,608	33,524	8,970	446,266

User Images – Virginia DOT

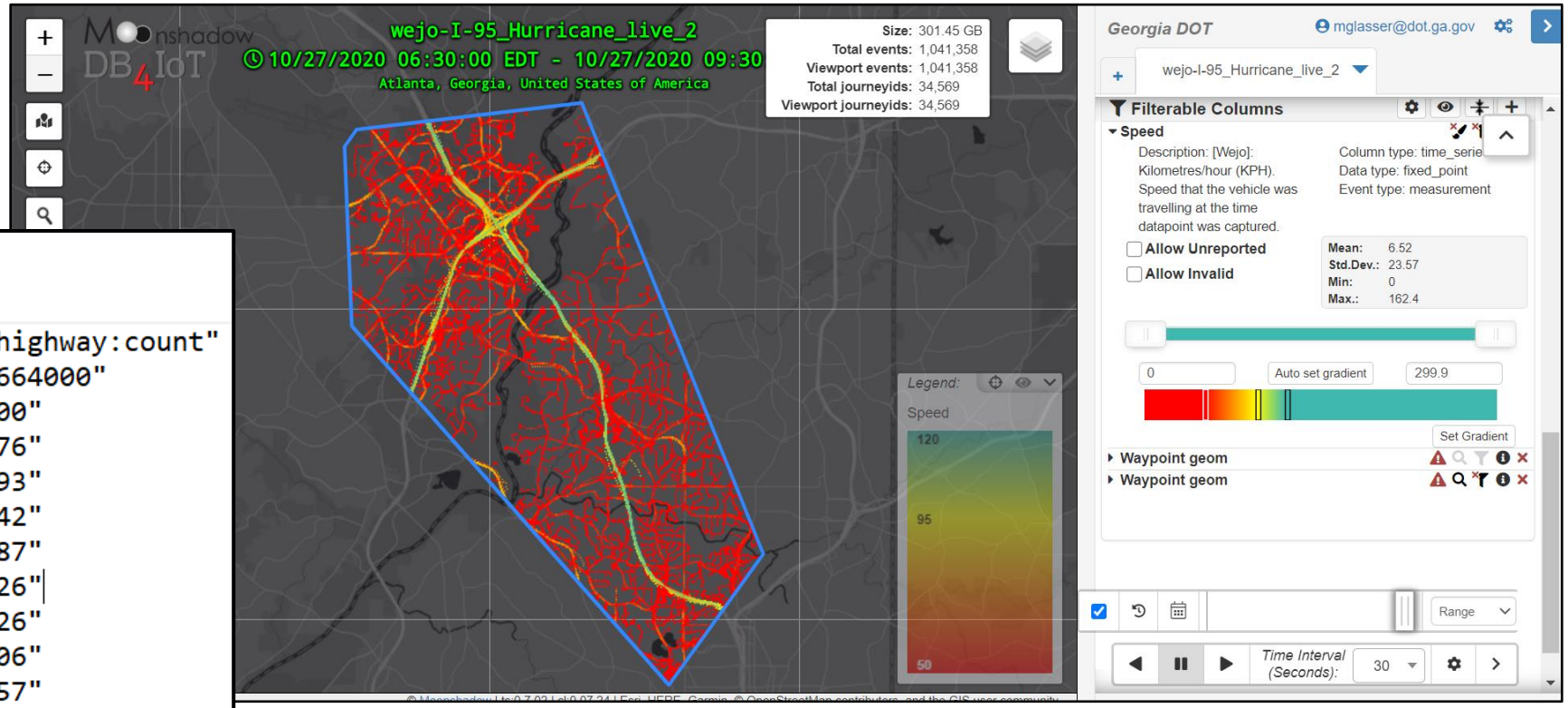


At a high level of zoom, unique journey ID counts for both directions are visible (good!). Even three colors visible for 495 work (has 4 directions)



Nice bar charts plotting unique journey ID counts against the heading. This was done on only one small stretch of US-50 and adjacent roads and clearly shows the two peaks at about 180 (degrees) difference on the X-axis, corresponding to the bearings the vehicles from the two directions would have. Beautiful!

User Images – Georgia DOT



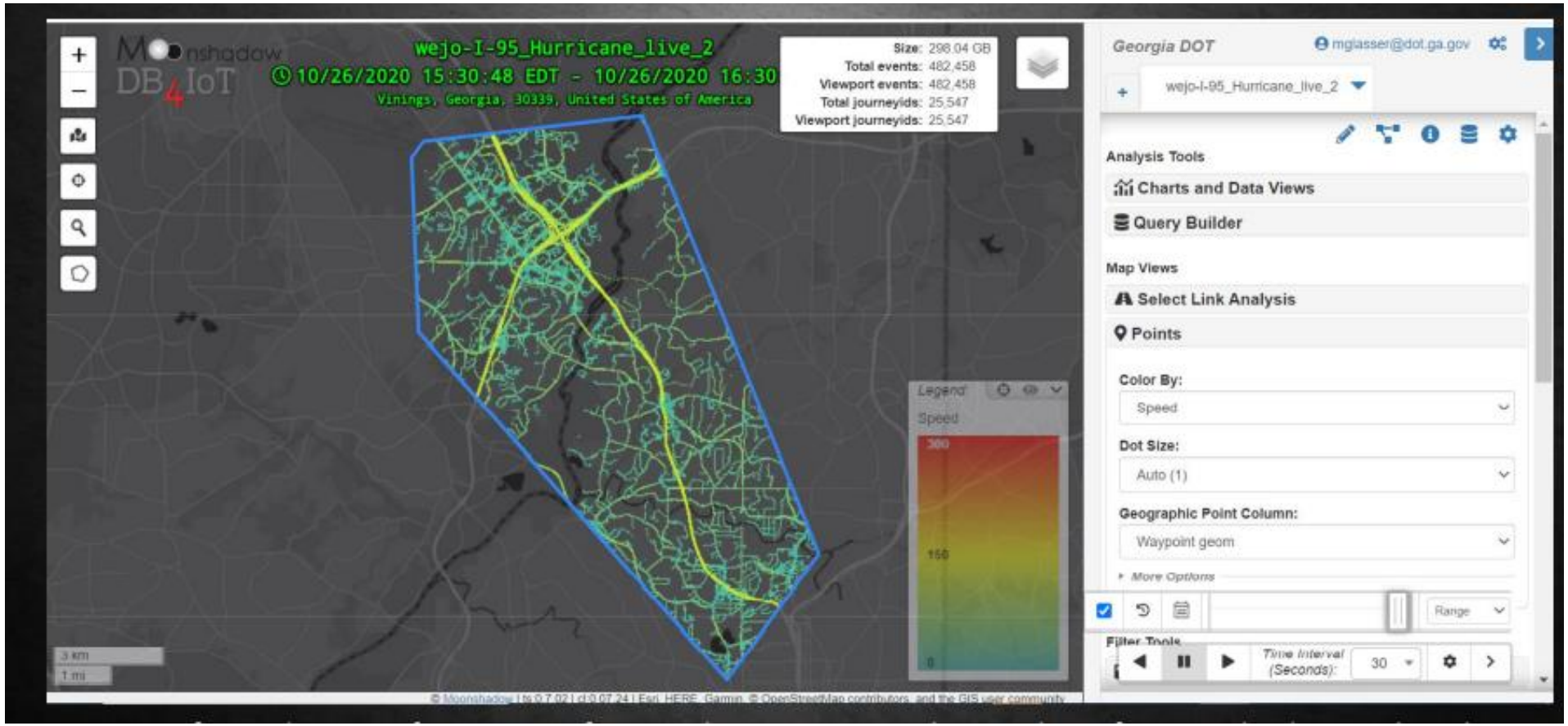
ec24c69c-2d1f-473c-9080-89f0d1ff9419 - Notepad

File Edit Format View Help

```
"day_of_the_week","time_of_the_day","highway:count"
"undefined","02:15 AM - 02:30 AM","11664000"
"Tuesday","06:00 AM - 06:15 AM","140400"
"Tuesday","06:15 AM - 06:30 AM","183676"
"Tuesday","06:30 AM - 06:45 AM","168093"
"Tuesday","06:45 AM - 07:00 AM","128542"
"Tuesday","07:00 AM - 07:15 AM","136787"
"Tuesday","07:15 AM - 07:30 AM","173926"
"Tuesday","07:30 AM - 07:45 AM","248126"
"Tuesday","07:45 AM - 08:00 AM","131406"
"Tuesday","08:00 AM - 08:15 AM","108157"
"Tuesday","08:15 AM - 08:30 AM","98899"
"Tuesday","08:30 AM - 08:45 AM","120160"
"Tuesday","08:45 AM - 09:00 AM","91517"
"Tuesday","09:00 AM - 09:15 AM","76219"
"Tuesday","09:15 AM - 09:30 AM","60794"
```

This query shows how color gradient can be changed for roadways (during AM rush)

User Images – Georgia DOT



A query of speeds set up for NW 1-75 from midtown to I-285, the number of events displays in the white box at upper right

State Feedback – Follow Up Calls

- Virginia DOT is interested in increased coverage for volume estimates **VA-**
- Recommendation for potential performance enhancement is to create smaller regions with small buffers across state lines **VA-**
- Ability to capture O-D patterns caught my attention; wonderful source in tracking O-D patterns or potential changes in traffic volumes **NC-**
- The visualization tool is not intuitive for transportation **FL-**
- Benefits of this data is that it gives us a different lens to look at data other than O-D data **GA-**

Sample Table from North Carolina, the Holy Grail

			Counted	Historical	Get from NCDOT	Calculated
Day of Week	Hours	Route	Today's Wejo Volume	Normal Wejo DOW HOD Vol	Normal NCDOT DOW HOW Vol	Estimated Total Volume
Monday	12 noon to 4 pm	I-40	3000	1000	30,000	90,000

State Feedback – Summary

Real-time display of CVD (moving vehicles) incredibly intuitive

- Confirms contraflow, incidents, etc.
- Platform initially glitchy, but stabilized

Volume display

- Only provided probe count (till Nov) – required specialized query
- Visually the density of vehicle re-enforced ability to provide volumes
- Demo provided ample evidence that real-time probe volumes is within reach

- Raw CVD data requires specialized resources to consume

Lessons Learned and Summary Findings

Stan Young, Advanced Transportation and Urban Scientist, National Renewable Energy Laboratory (NREL)

Proof of Concept Overall Take-Aways

- ❑ CV data is viable now and will only grow in size and velocity
- ❑ Managing CV data at scale is challenging for industry, but doable
- ❑ Visualization of CVD (individual vehicles) brings intuitive value
- ❑ **Real-time volume estimates from CV data appears viable for implementation**
- ❑ Proof of Concept provided valuable insight to …
  - Specifications for operational systems in terms of use and functionality
  - Bridge the language between Traffic and Information Technology
  - Blaze new ground to visualize real-time volume and O&D

Next Steps

- ❑ Base CV data is being procured through the TETC Traffic Data Marketplace
- ❑ The POC will result in draft Framework, Specifications, and Approach for implementation within the Coalition
- ❑ Forming Coalition committee for guidance, oversight, and vision of the ETC Traffic Volume Project
- ❑ Expect additional information in Q2/3 of 2021

Additional Questions?

Remaining Questions from the CHAT Box

Wrap Up

Meeting information & presentations will be posted to
The Eastern Transportation Coalition website.
Participants will receive a link to the presentations after they are posted.

THE EASTERN TRANSPORTATION COALITION

CONNECTING FOR SOLUTIONS

Thank You!

For additional information, please contact:

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