ITS AMERICA CONFERENCE & EXPO

Connected-Car data: Unpacking different approaches to generating meaningful safety metrics

Thursday, April 27, 2023, 3:00 PM – 4:30 PM

IMPLEMENTING INNOVATION FOR ALL | #ITSA2023

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Our Panel

Amir Gholds, SMATS Traffic Solutions

Raman Jafroudi, Kapsch TrafficCom

Erika Kemp, Texas Department of Transportation

Michael Martin
Texas A&M Transportation Institute

Carl Novelli, Wejo

Lucy Lai, SMATS Traffic Solutions

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Agenda

1. An overview data sources for safety projects
2. Approaches to generating meaningful safety analytics from connected vehicle data
3. V2X and video data and analytics for safety studies
4. A user perspective: TxDOT
5. Use cases: Connected vehicle data for safety
6. Panel discussion
7. Audience Q&A

An Overview:
Data sources for safety projects

Michael Martin

Associate Research Scientist

Texas A&M Transportation Institute

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UrbanOS Delivered by accenture
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STRAVA
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mobileye An Intel Company
waze
unacast.
blyncsy MOVEMENT DATA INTELLIGENCE
Spireon
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SMATS
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gm
GroundTruth
SOLERA
RITIS
remix by Via
LOCUS
REKOR
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ROUTE REPORTS
RoadBotics by Michelin
cubic telecom
MobilityData
TELENAV
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verizon connect
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ECONOLITE
SKYHOOK
idax DATA SOLUTIONS
iteris
remix by Via
INRIX
IMS Insurance & Mobility Solutions
LexisNexis RISK SOLUTIONS
KORE
HiveSafety
GEOTAB
Teletrac Navman

An Overview:
Data sources for safety projects

The Data Fundamentals:

- Crashes
- Exposure
- Driver behaviors
- Roadway characteristics
- Environmental conditions

https://highways.dot.gov/safety

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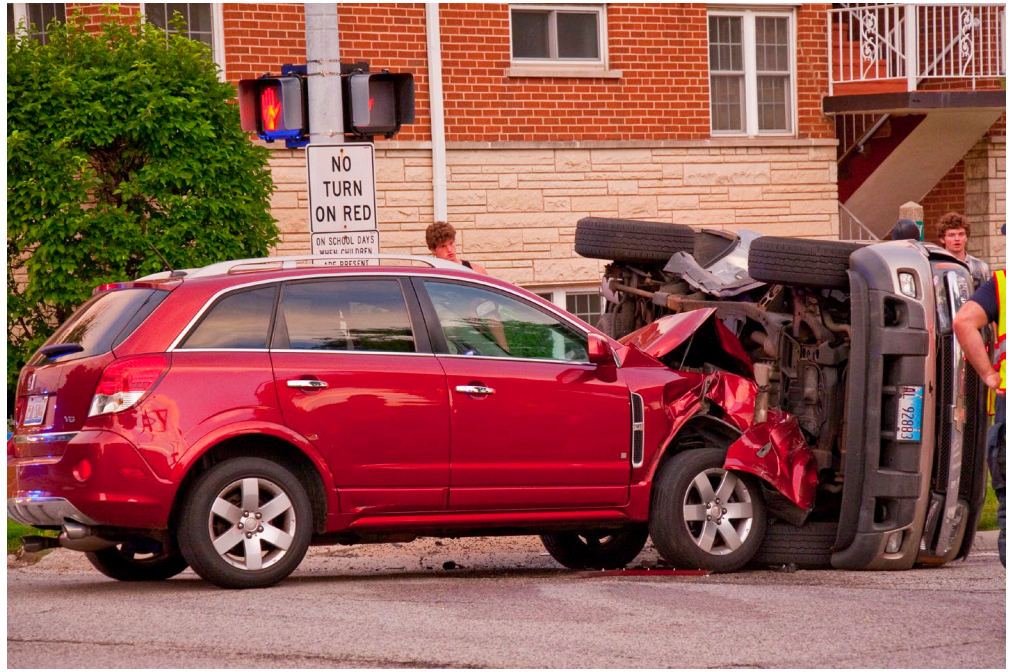
An Overview:
Data sources for safety projects

Crashes

- Location
- Time
- Severity
- Vehicle types
- Contributing factors
- Conditions
- Collision type



An Overview:
Data sources for safety projects

Exposure

- Traffic volume (AADT)
- Trips
  - Counts
  - Length
  - Duration
- Turning movements

An Overview:
Data sources for safety projects

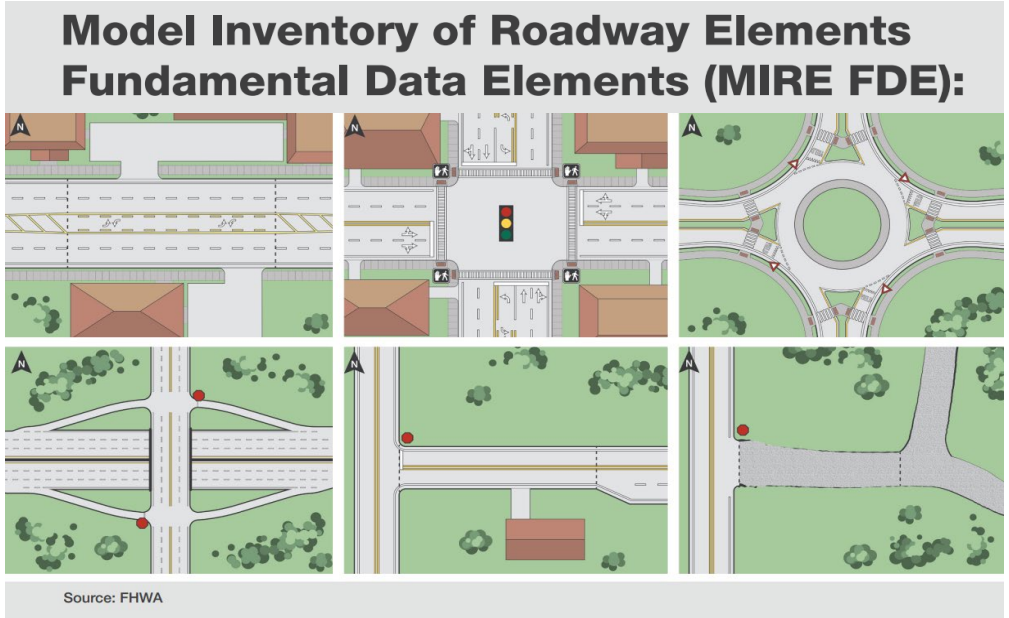
Driver Behaviors

- Operating speeds
- Hard braking
- Hard acceleration
- Distractions
- Turning movements
- Lane departures
- Emergency braking
- Seat belt (un)latching
- Passengers

An Overview:
Data sources for safety projects

Roadway Characteristics

- Posted speed limit
- Segment
- Intersection / driveways
- Curves
- Functional class
- Number of lanes
- Shoulder width
- Median type
- Pavement type / condition



An Overview:
Data sources for safety projects

Environmental Conditions

- Lighting conditions
- Precipitation
- Temperature
- Event intensity

An Overview:
Data sources for safety projects

Take Aways:

- Paint a more complete picture by filling in data gaps
- Don’t think you have to collect it all yourself!
- Quality matters, but don’t let perfect be the enemy of good

How to generate meaningful safety analytics from connected vehicle data

Carl Novelli

Wejo

Michael Martin

Texas A&M
Transportation Institute

Amir Ghods

SMATS Traffic Solutions

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How to generate meaningful safety analytics from connected vehicle data

Connected car data for safety analytics

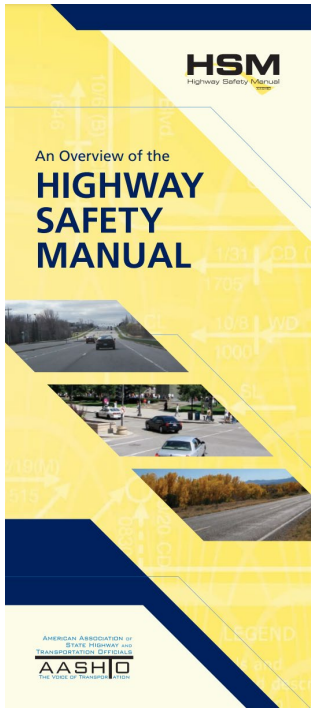
- High-resolution in-vehicle data
- High accuracy
- Network-wide coverage
- Accurate and cost-effective data collection:
  - Speed
  - AADT
  - Turning Movements
  - Weather Conditions
- Capturing unique driver behavioral attributes

How to generate meaningful safety analytics from connected vehicle data

Goals

- Reduce crash frequency
- Reduce crash severity

How do you get started?



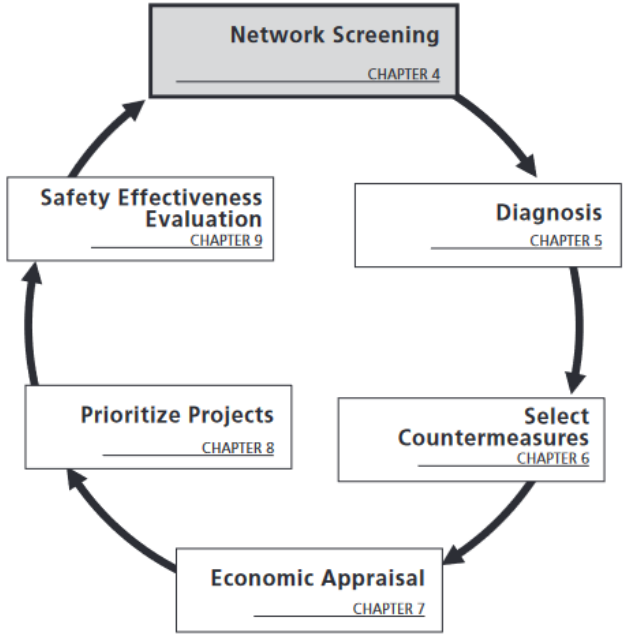
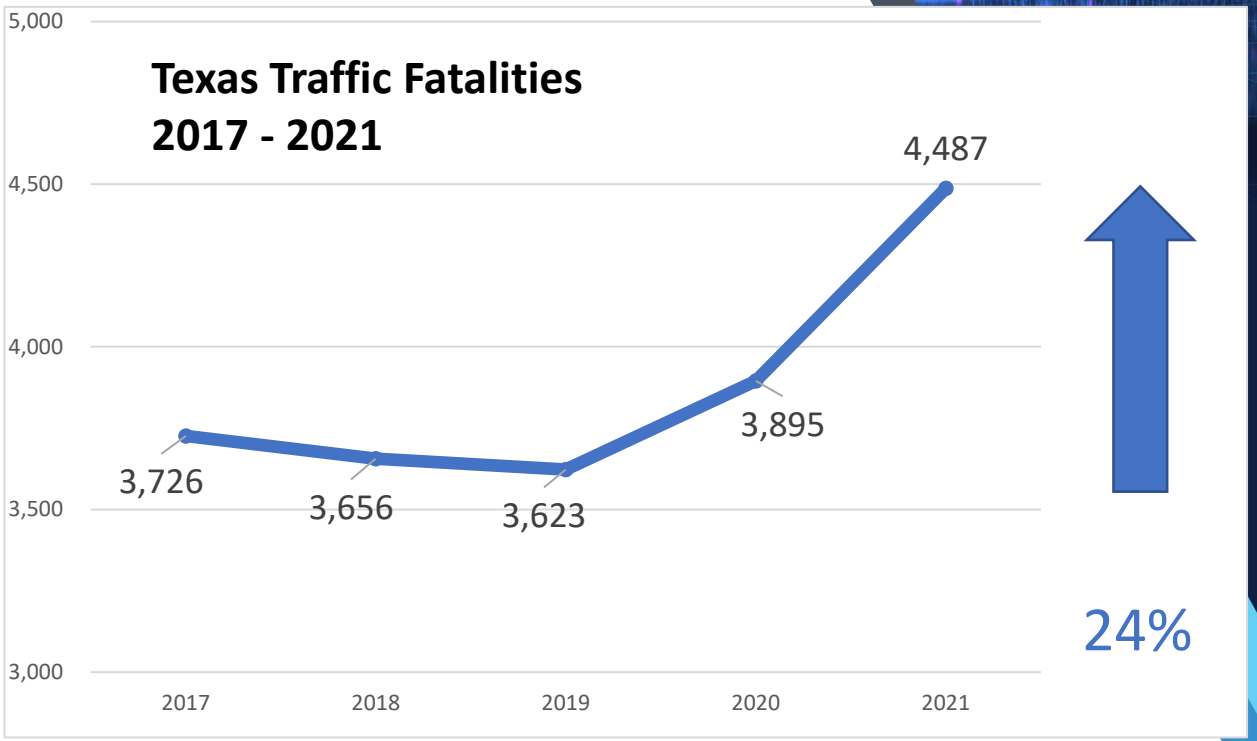


Figure 4-1. Roadway Safety Management Process

How to generate meaningful safety analytics from connected vehicle data

Suggestions:

- Narrow your focus
- Pull together data fundamentals
- Use existing science-based methods
- HSM Network screening
  - Roadway “wellness check”
  - Predictive methods (SPF + EB)
  - Determine influential factors
- Remember context matters



How to generate meaningful safety analytics from connected vehicle data

Current SPFs

- Crashes
- Exposure
- Traffic
- Roadway characteristics

Next Generation of SPFs

- Crashes
- Exposure
- Traffic
- Roadway characteristics
- Driving behaviors
- Weather

How to generate meaningful safety analytics from connected vehicle data

Driver behaviours matter – A study (Part 1: road segments)

Objectives: Determine the accuracy of driver behaviors in predicting accidents and what driver behaviors are the most important for predicting accidents.

- 1,710 road segments in Bellevue, WA, are considered for this study
- The crash data of Bellevue for a period of 5 years (2015-2019) is used as the baseline
- Accident severity levels vary (e.g., no injury, minor and serious injury, death etc.)
- Each accident is assigned to a road segment that's closest to the location where it occurred
- **We brought in the following variables to our model:**
  - (Driver behaviour) Count of harsh acceleration/deceleration
  - (Traffic) Average speed and standard deviation of speed
  - (Exposure) Average annual daily traffic (AADT), segment length

How to generate meaningful safety analytics from connected vehicle data

Generalized linear (Negative Binomial) modeling techniques were used to fit the models (road segments)

$$E(Y) = e^{\alpha_0} \times e^{\alpha_1 \times \ln(L)} \times e^{\alpha_2 \times \ln(ADT)} \times e^{b_1 \times hard\ acc\ count + b_2 \times hard\ dec\ count + b_3 \times avg\ speed + b_4 \times stddev\ speed}$$

How to generate meaningful safety analytics from connected vehicle data

Driver behaviours matter – Regression Analysis (road segments)

- The next step is to find out about the importance of each variable in modeling
- To do so, we take out each variable one at a time to see how the AIC of the model changes

AIC is most often used to compare the relative goodness-of-fit among different models under consideration and to then choose the model that best fits

	Negative Binomial Model			
Removed variable	AIC	P-value (Chi-square)	Importance rank	Relative importance
none	6287	-	-	
Ln(Length)	6301	3.189e-5	4	5%
Ln(AADT)	6331	6.378e-12	3	15%
Hard Acc Count	6359	<2.2e-16	2	25%
Hard Dec Count	6299	8.954e-5	5	4%
AVG Speed	6435	<2.2e-16	1	50%
STD DEV Speed	6291	0.005418	6	1%

How to generate meaningful safety analytics from connected vehicle data

Driver behaviours matter – A study (part 2: intersections)

- 109 intersections in Bellevue, WA, are considered for this study
- The crash data of Bellevue for a period of 5 years (2015-2019) is used as the baseline
- Accident severity levels vary (e.g., no injury, minor and serious injury, death etc.)
- Each accident is assigned to a road segment that's closest to the location where it occurred, accidents more than 20 meters from the intersection center are not counted
- **We brought in the following variables to our model:**
  - (Driver behaviour) Count of harsh acceleration/deceleration
  - (Traffic) Average speed and standard deviation of speed
  - (Exposure) Average annual daily traffic (AADT), segment length

How to generate meaningful safety analytics from connected vehicle data

Generalized linear (Negative Binomial) modeling techniques were used to fit the models (intersections)

$$E(Y) = e^{\alpha_0} \times e^{\alpha_1 \times \ln(ADT_{maj} + ADT_{min})} \times e^{b_1 \times hard\ acc\ count + b_2 \times hard\ dec\ count + b_3 \times avg\ speed + b_4 \times stddev\ speed}$$

How to generate meaningful safety analytics from connected vehicle data

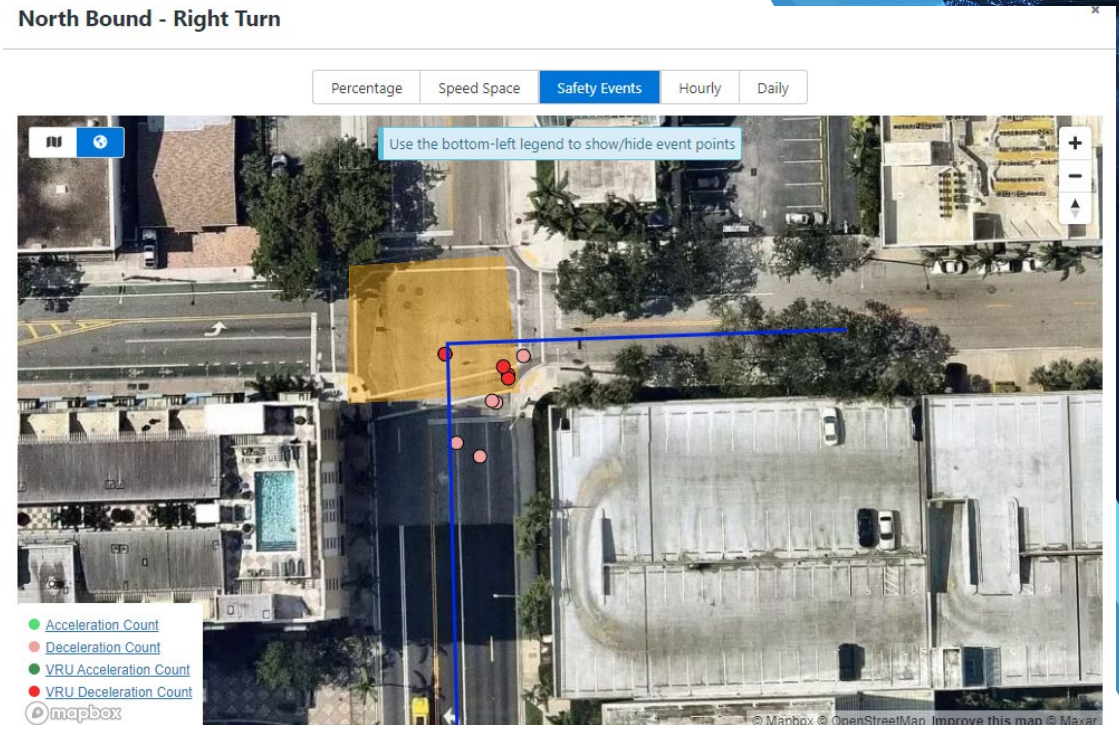
Driver behaviours matter – Regression Analysis (intersections)

	Negative Binomial Model			
Removed variable	AIC	P-value (Chi-square)	Importance rank	Relative importance
None	772.70	-	-	
$Ln(AADT_{maj} + AADT_{min})$	801.26	1.16E-08	1	56%
Hard Acc Count	782.68	0.0002	2	19%
Hard Dec Count	770.38	0.2	5	0%
AVG Speed	782.10	0.0003	3	18%
STD DEV Speed	776.03	0.007	4	6%

How to generate meaningful safety analytics from connected vehicle data

Bringing VRUs in the picture

- Limited SFPs for VRU
- Many years to get statically significant amount of crash data
- Pedestrian expose (volume) data is difficult to be collected in scale
- High positional accuracy allows for the detection of safety events near pedestrian and bike crossings
- The VRU events can be used as surrogate safety measures since VRU accident data are very zero inflated



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How to generate meaningful safety analytics from connected vehicle data

The takeaways

- Driver behaviors can now be collected and quantified at scale using connected car event data, making it possible to use them as a surrogate safety measure in risk screening models.
- Connected car event data is highly correlated with historical crashes for both road segments and intersections. Specifically, harsh acceleration and deceleration rank higher than AADT and speed in importance as accident predictors.
- Network wide traditional safety metrics such as AADT, turning movements can be generated more efficiently and accurately using connected car for traditional SPFs.
- Connected car data enables network wide VRU safety risk assessment.

V2X and Video Data for Safety Analytics

Raman Jafroudi

Kapsch TrafficCom Canada

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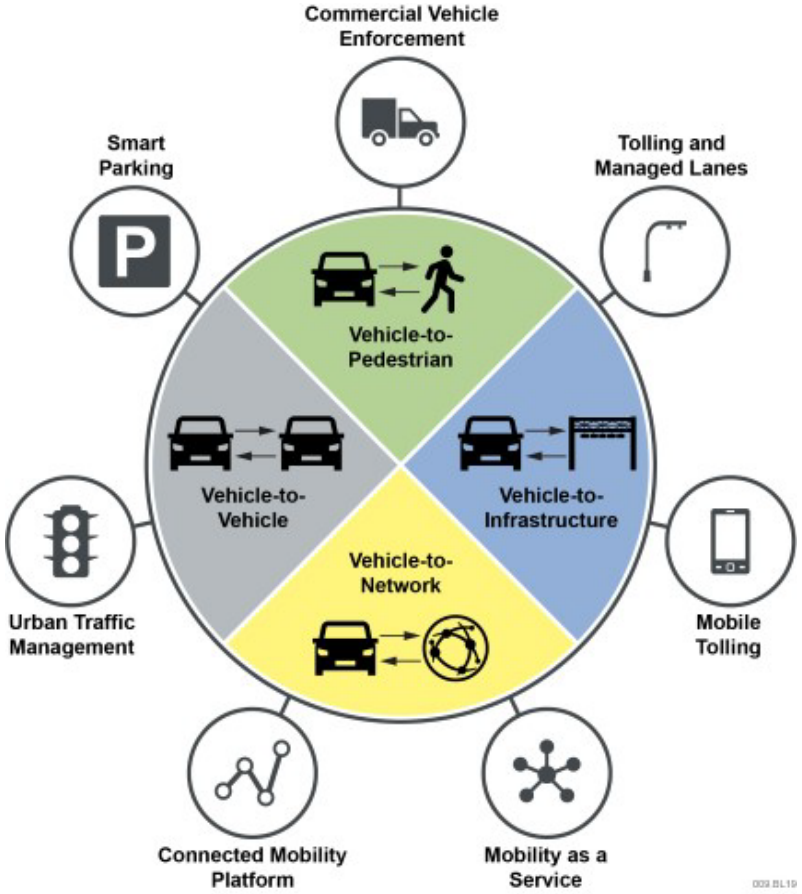
Readying today's corridors for tomorrow's transportation evolution



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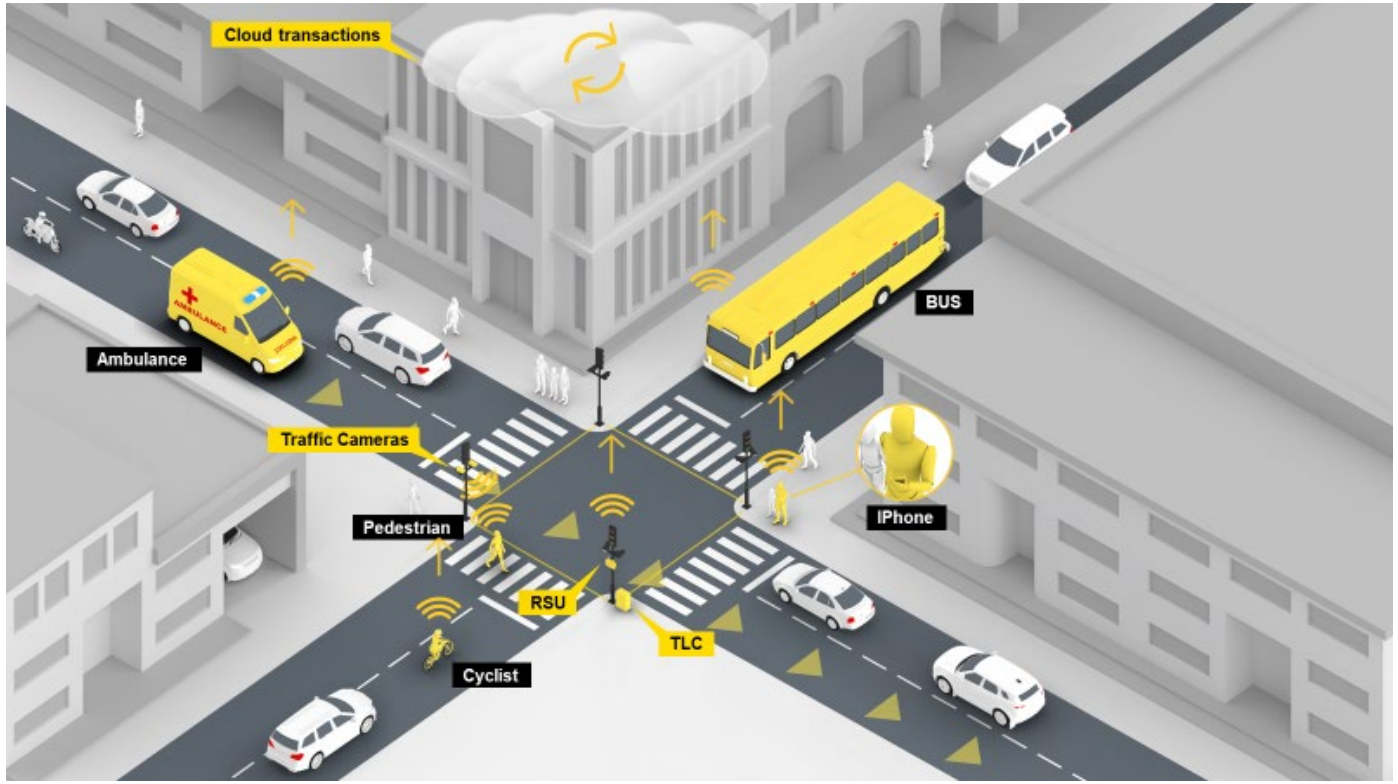
Deep Learning Versatile Platform (DLVP) & connected vehicles ecosystem



System components & connectivity

Hybrid CV & Cellular communication

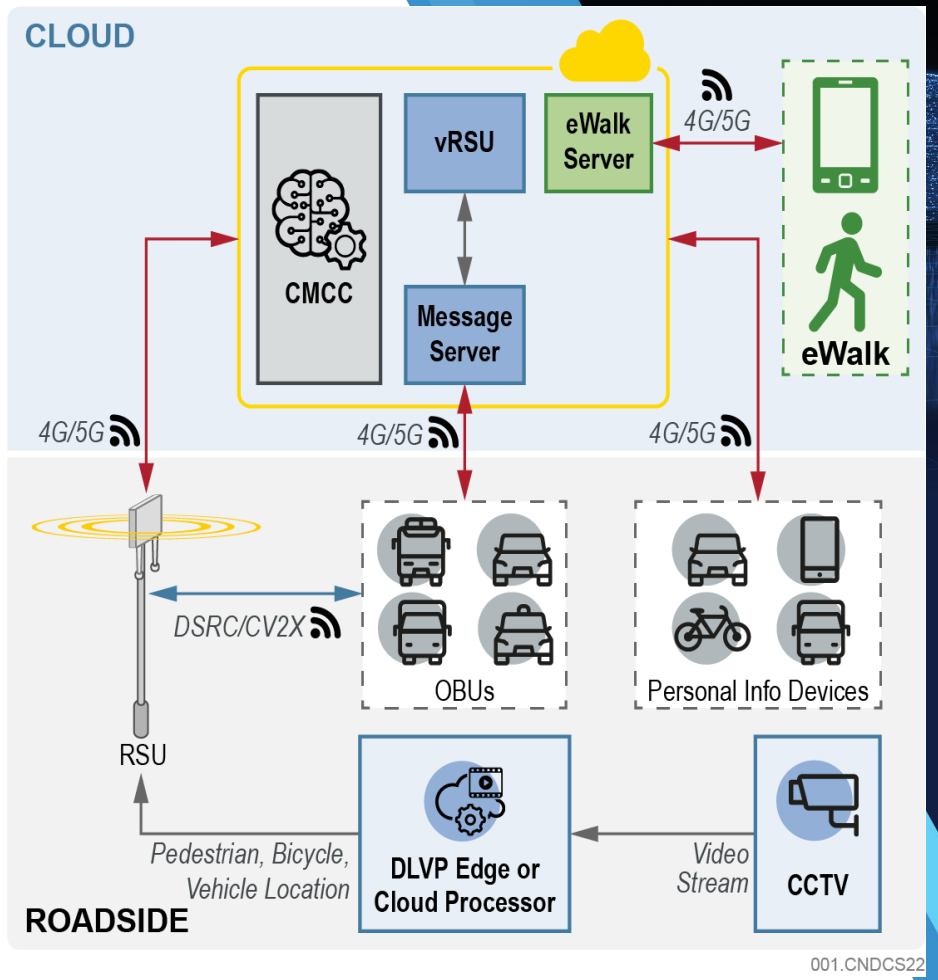
The CV web server or “hybrid CV” enables a cellular based communication and CV message exchange with registered CV onboard units equipped in vehicles.

It consists of a fully functional “virtual RSU” and a message broker to distribute the CV messages properly

Communication with mobile Onboard Units (OBUs)

The CV messages are already signed to ensure authenticity, therefore an additional interface to a PKI Provider must be given.

CMCC sends & receives C-ITS data via the CV web server.



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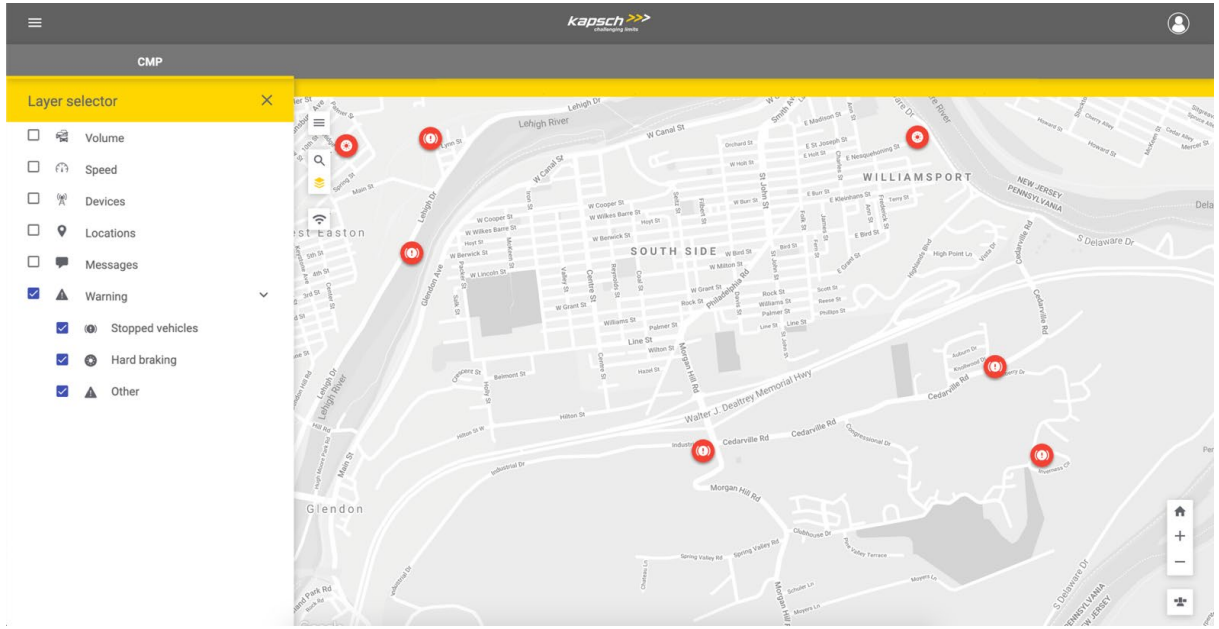
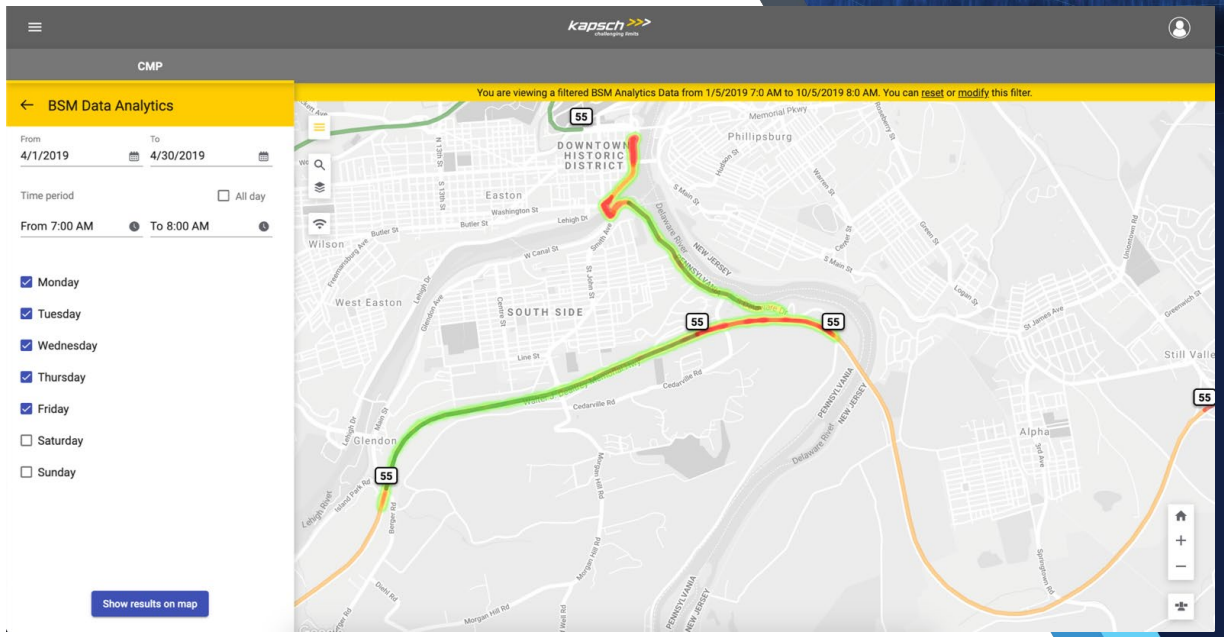
traffic flow
optimization


safety
applications

Mobility Data Platform (MDP)

Use Streaming Analytics to Identify Events/Incidents (Stopped Vehicle and Hard Braking)
View historical traffic speeds/volume based on date, date range, and/or day of the week





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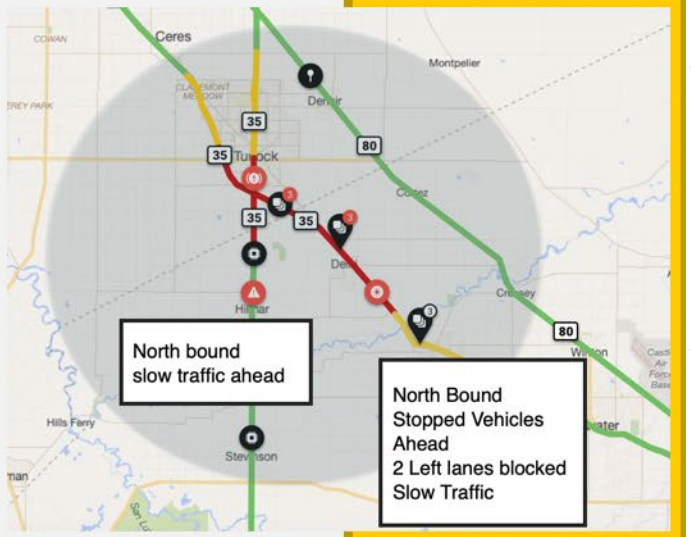
MDP – ATMS – CMCC

MDP	ATMS	CMCC
Streaming Analytics Identifies an incident	MDP sends incident alert to ATMS, with auto-populated response plan	TMS operator validates and initiates response plan	ATMS response plan initiates Virtual sign(s) sent to CMCC	CMCC transmits TIMs to RSUs to broadcast to OBUs

Advanced Analytics identify correlated incidents & affected area



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Perspective from the field: TxDOT

Erika Kemp

TxDOT

Perspective from the field: Implementation

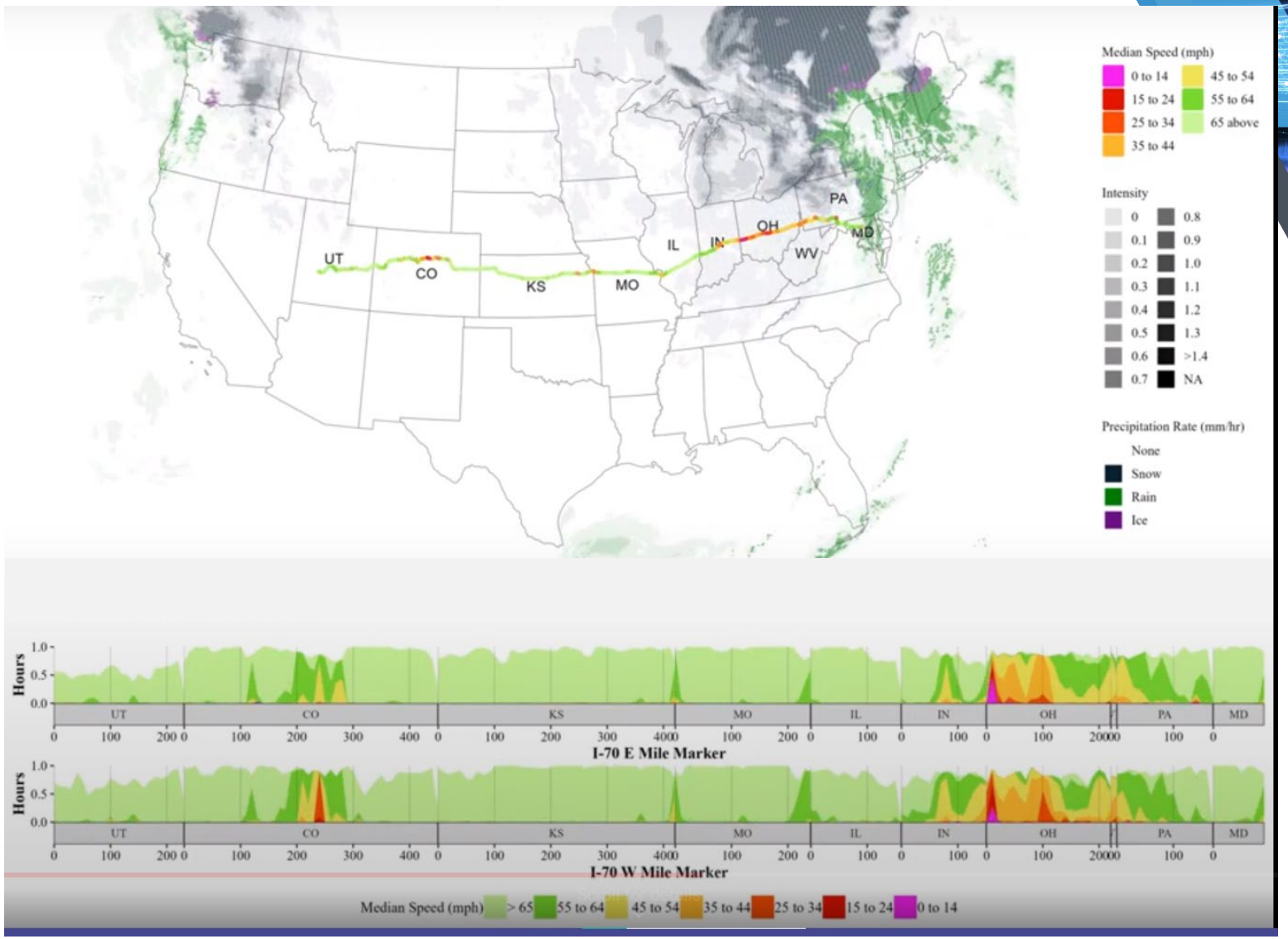
- Prioritized List of Use Cases
- Stakeholder Driven Solutions
- Easy to Use Tools
- Communication Plan

Use cases: Connected car data for safety projects

Carl Novelli

Wejo

Use case: Analysing the impact of December 2022 storm on the i70



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Use case: Planning and Safety – Work Zone Performance Analysis

Objective

Analyze driver behaviors approaching work zones to assess traffic control plan performance.

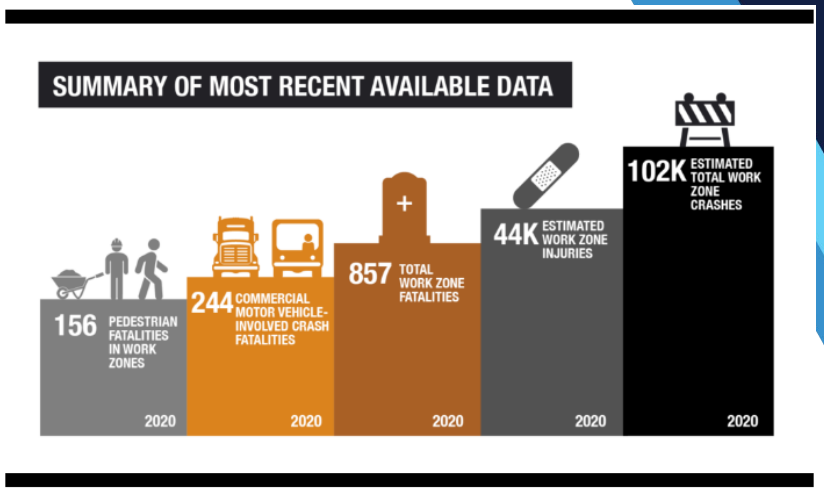
Approach

- Analyze Vehicle Movement Data at lane drop and lane shift locations
- Evaluate acceleration/deceleration
- Compare performance of multiple work zones

Anticipated Outcomes

Potential changes to traffic control plans for current or future projects

Image from **epermittest.com**



Via National Workzone Safety Information Clearinghouse – **www.workzonesafety.org**

Use case: Analysing the impact of Hurricane Ian

Traffic is flowing at fairly high speeds, and moving efficiently. We can see a build up of congestion and slower speeds in residential areas & on/off ramps.

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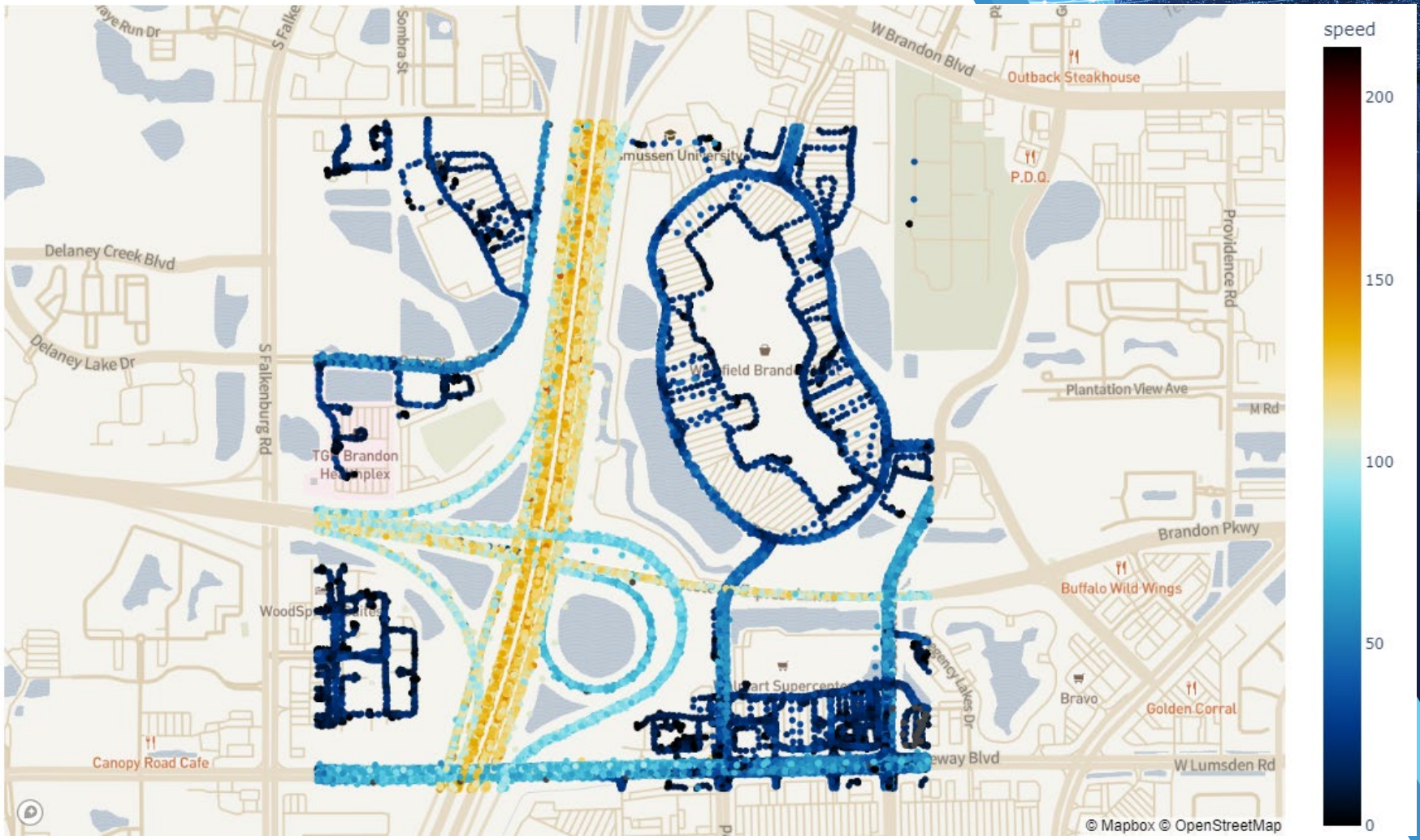
Use case: Analysing the impact of Hurricane Ian, September 29, 2022

Slow speeds & congestion shown on the on/off ramps onto the main interstate evacuating Tampa. In comparison from data taken the day prior we can see more traffic is ensuing as people evacuate.



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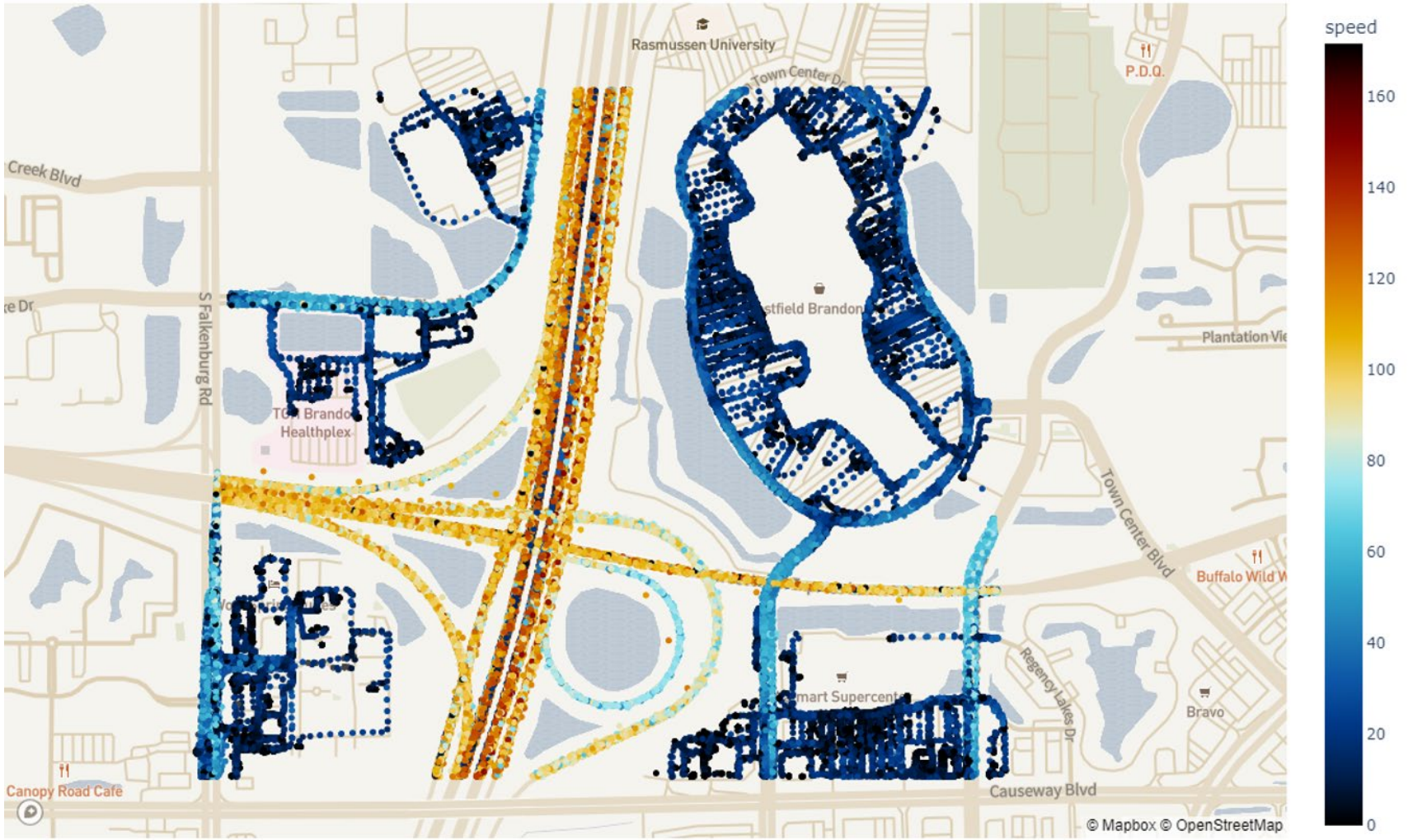
Use case: Analysing the impact of Hurricane Ian, September 29, 2022

- During the evacuation, various people evacuated to nearby shopping centres for safety, as you can see lots of completely parked vehicles. Interesting to see the places people fled to for cover from the storm.
- High speeds on the inner lanes of the interstate, and congestion clearly building up on the routes out of Tampa.
- You can visually see the difference in journeys & road activity between the same snapshot over the three days 28/29/30th September.



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Panel Discussion

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It’s your turn: Questions?