Michigan Connected and Automated Vehicle Working Group

July 22, 2020

Meeting Packet

1. Agenda
2. Meeting Notes
3. Attendance List
4. Presentations

Michigan Connected and Automated Vehicle Working Group

July 22, 2020

1 pm - 3 pm

Virtual Meeting Hosted by:

Center for Automotive Research

Meeting Agenda

1:00 PM

Introduction and Update

Zahra Bahrani Fard, Transportation Systems Analyst, Center for Automotive Research

Autonomous Trucking: Challenges and Opportunities

Cetin Mericli, CEO and Founder, Locomotion

Adapting Automated Shuttles During the COVID Crisis

Aaron Foster, Solution Engineer, Navya

Overview of Michigan CAV Activities

Elise Feldpausch, Connected Vehicle Specialist, MDOT

Data & The Global Pandemic

Bret Scott, Vice President of Partnerships, Wejo

3:00 PM **Meeting Adjourned**

Michigan Connected and Automated Vehicle Working Group
July 22, 2020

Meeting Notes

The 2020 summer meeting of the Michigan Connected and Automated Vehicle Working Group was held on July 22, 2020. The event was hosted and attended virtually.

Zahra Bahrani Fard, Transportation Systems Analyst at the Center for Automotive Research (CAR), opened the meeting and discussed the agenda and Working Group's mission. Zahra also highlighted some of the noteworthy industry news. The introduction was concluded by a thanking Michigan Department of Transportation (MDOT), for sponsoring the meeting.

After Zahra's introduction, **Cetin Mericli, CEO and co-founder of Locomation**, discussed the reality of self-driving systems and provided an overview of his company's approach towards convoying trucks systems. Cetin began by acknowledging the early enthusiasm and optimistic projections that surrounded autonomous vehicles in 2016. He proceeded by explaining some of the difficulties in developing fully autonomous systems and highlighted several gaps between human and robotic perception. Finally, Cetin described Locomation's approach to self-driving; following a path that emphasizes patience, practicality, and safe iterations of their product.

Following Cetin's presentation, **Aaron Foster, Solutions Engineer at NAVYA**, talked about his company's development and activities in the autonomous shuttle sector. Aaron started by providing an overview of of NAVYA's fleet; featuring 160+ "Autonom" SAE Level 3 shuttles, each featuring an electric motor, 15-seat occupancy, and up to 9 hours of runtime. NAVYA's deployments operate on fixed routes, which has contributed to a perfect safety record even after hundreds of thousands of passenger trips. Aaron concluded his presentation by describing the company's involvement in pandemic relief efforts in Jacksonville and Lake Nona, FL. These initiatives helped transport critical resources to Mayoclincs and, and feature NAVYA's first deployment without a human on board.

After Aaron's presentation, **Elise Feldpausch, Connected Vehicle Specialist at MDOT**, provided an overview of Michigan's CAV activities. Elise started by mentioning recent and upcoming developments: the official launch of Michigan's Office of Future Mobility and Electrification, and the development of an MDOT CAV Strategic Plan built on department-wide input and considerations. Next, Elise mentioned two research projects set for completion in 2021; a project highlighting MDOT workforce training and recruitment strategies in the advent of transformational transportation technologies and another project to investigate and improve the operational practices regarding roadside digital message signs. Lastly, Elise described MDOT's early efforts to implement a real-time Transportation Infrastructure Data Exchange (TIDE) system, which would function as a centralized platform to support the continuous exchange of transportation data among MDOT and other stakeholders.

Following Elise's presentation, **Brett Scott, Vice President of Partnerships at Wejo**, gave a presentation that highlighted Wejo's ability to capture and analyze relevant vehicle information. By 2021 the company expects to receive information from approximately 1 in 20 U.S. vehicles and 1 in 50 vehicles in Europe. Brett presented several slides that captured shifts in U.S. traffic and destination patterns due to the recent pandemic. Brett concluded the presentation by discussing Wejo's next steps in helping public agencies plot the implementation of effective future roadways.

The meeting adjourned at 3:00 pm.

MDOT maintains a webpage dedicated to its work related to CAV technologies (http://www.michigan.gov/mdot/0,1607,7-151-9621_11041_38217---,00.html). The page includes documents, presentations, and other materials that may be of interest to CAV stakeholders. Meeting packets containing materials (agenda, meeting notes, attendance, and presentation slides) from past Michigan Connected and Automated Vehicle Working Group meetings are also available on this page.

Michigan Connected and Automated Vehicle Working Group

July 22, 2020

Attendance List

Last name	First Name	Organization
Abbey	**Howard**	SBD Automotive
Abraham	**John**	Macomb County Department Of Roads
Alwalie	**Hassen**	Danlaw
Bahrani Fard	**Zahra**	CAR
Baker	**Amanda**	MEDC
Baker	**Bert**	Great Wall Motors
Bartlett	**Kelly**	Michigan Department Of Transportation
Beaubien	**Richard**	Beaubien Engineering
Bergsten	**Jeff**	Michael Baker International
Brogan	**Bridget**	UK Department For International Trade
Burrows	**Mark**	DTMB
Cehaja	**Jasna**	MDOT
Chakraborty	**Prodip**	DTMB
Crawford	**Tim**	Mosaic/Keybanc Capital Markets
Cregger	**Joshua**	USDOT
Cruz	**Benigno**	Macomb Community College

Last name	First Name	Organization
Curtis	**Mark**	Accenture
Dennis	**Eric**	CAR
Deoliveira	**Tanya**	Region 2 Planning Commission
Donaldson	**Andrew**	Danlaw Inc.
Donohue	**Denise**	County Road Association Of Michigan
Dubois	**Dan**	Michigan Speedway
Foster	**Aaron**	Navya
Feldpausch	**Elise**	MDOT
Filson	**Larry**	Walbridge
Frazier	**Sterling**	Atkins
Freeman	**Rochelle**	City Of Southfield
Gasiorowski	**Anthony**	WSP
Gettings	**Eric**	Times Fiber Communications
Gill	**Sarah**	MDOT
Guo	**Xiaoyang**	Neusoft Automotive
Halfon	**Jesse**	Dykema
Hicks	**Terrence M.**	Metro Strategies, Inc
Hill	**Kim**	HWA Analytics
Hong	**Qiang**	CAR
Hutchinson	**Cary**	Survey Solutions Inc - SSI
Jackson	**Gina**	Michigan State University
Jones	**Rachel**	The Road Commission For Oakland County
Jucaitis	**Aud**	Keybanc Capital Markets
Katsafanas	**Jim**	

Last name	First Name	Organization
Kelley	**Sean**	Mannik Smith Group
Kelly	**Nelson**	Macomb Community College
Land	**Barb**	Square One Education Network
Lecz	**Alan**	Washtenaw Community College
Lindenmeyer	**Daniel**	TASKING
Lyimo	**Sia**	Western Michigan University
Mahdi	**Wardah**	
Mbah	**Gipson**	WSP Michigan
Mclaughlin	**Katie**	WSP
Mcnamara	**David**	Brandmotion Solutions
Menon	**Cyrilla**	Danlaw
Merchant	**Adam**	Macomb County Department Of Roads
Mericli	**Cetin**	Locomation
Minarcin	**Monika**	Accenture
Miners	**Ben**	IMS
Morell	**Scott**	Danlaw Inc.
Mueller	**Michele**	MDOT
Muli	**Mahendra**	Dspace Inc.
Nelson	**Amy**	AVL Fuel Cell Canada
Nelson	**Meredith**	Michigan Department Of Transportation
Nikam	**Pratik**	Bosch
Perrin	**Jacob**	Dspace Inc
Nriagu	**Emeka**	CAR
Perry	**Frank**	WSP

Last name	First Name	Organization
Peterson	**Jeff**	First Transit, Inc.
Peterson	**Dave**	Norma Group
Pinnelli	**Venkata**	Danlaw Inc
Pullin	**Joseph**	Cohda Wireless
Reimnitz	**Amber**	Michael Baker International
Remias	**Steve**	Wayne State University
Richer	**Thomas**	MDOT
Rolina	**Thierry**	Danlaw
Rosenmayr	**Marc**	Motherson Innovations
Rouse	**Jason**	Sekisui Chemical
Rupp	**Jeff**	
Scott	**Bret**	Wejo
Schlenker	**Ann**	Argonne National Laboratory
Sherony	**Rini**	Toyota
Shreck	**Bill**	MDOT
Silda	**Camille**	Macomb County Planning And Economic Development Department
Skvarce	**Jeff**	Continental
Smith	**Matt**	Michael Baker International
Smith	**Brett**	CAR
Snyder	**Wayne**	Nextenergy
Suich	**Dale**	Independent
Szpytman	**Jack**	Pilot Systems, Inc.
Talwar	**Chris**	FEV North America Inc.

Last name	First Name	Organization
Thurston	**Karley**	Workforce Intelligence Network
Upton	**Trevor**	KBCM
Walmroth	**David**	Ann Arbor Autonomous Vehicle Group
Whydell	**Andrew**	ZF Group
Williams	**Kyle**	Saferide Technologies
Williams	**Chris**	SEMCOG
Wright	**Brian**	Danlaw Inc.
Yang	**Ken**	AECOM
Zurawski	**Ken**	KJZ Consulting

Michigan Connected and Automated Vehicle Working Group

Zahra Bahrani Fard, Transportation systems Analyst, CAR

July 22, 2020

Hosted by: Center for Automotive Research

Meeting Agenda

1:00 PM

Introductions and Update

Zahra Bahrani Fard, Transportation Systems Analyst, CAR

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3:00 PM

Meeting Adjourned

Working Group Mission

Cooperatively pursue projects and other activities that are best accomplished through partnerships between multiple agencies, companies, universities, and other organizations and that ultimately advance Michigan's leadership position in connected and automated vehicle research, deployment, and operations.

Goals

- Benefit our state and our industry (automotive and more)
- Enhance safety and mobility in Michigan and beyond

Noteworthy Industry News

- CAR Management Briefing Seminars 4-5 August
- Michigan Formally Launched Office of Future Mobility and Electrification, Trevor Paul is the CMO.
- Active Drive Assist will be offered on certain 2021 model-year Ford vehicles.
- Amazon will buy Zoox for $1.2 Billion.
- The Automated Vehicle Safety Consortium (AVSC) has published best practices for "Passenger-Initiated Emergency Trip Interruption"
- CAR COVID-19 Resources: https://www.cargroup.org/coronavirus-update/

Thank you to our sponsor!

Michigan Department of Transportation (MDOT)

LOCOMATION

PRACTICAL AUTONOMOUS TRUCKING FOR TODAY

ÇETIN MERIÇLI, PH.D.
CEO & CO-FOUNDER

TEAM

ÇETIN MERIÇLI, PH.D.
CEO

TEKIN MERIÇLI, PH.D.
CTO

MICHAEL GEORGE
VP OF ENGINEERING

VENKAT RAJAGOPALAN
VP OF PRODUCT

PROF. ALONZO KELLY
CHIEF SCIENTIST

RAY RUSSELL
HARDWARE PRINCIPAL

GLYNN SPANGENBERG
SALES

TOM KROSWEK
BUSINESS DEVELOPMENT

BRETT BATTLES, PH.D.
BOARD ADVISOR

JOHN FORMISANO
BOARD ADVISOR

- ✓ 100+ years founder experience, 50+ AV systems deployed
- ✓ Multiple trucking products launched, thousands of units sold
- ✓ Deep expertise in freight analysis and optimization
- ✓ 22 headcount, average engineer AV experience: **14 years**

SELECT RELEVANT PAST WORK

SELF-DRIVING 2020: RECTIFIED EXPECTATIONS

Q Quartz

Ford (F) will have a self-driving car with no steering wheels or pedals in 2021

At an event in Silicon Valley, Ford CEO Mark Fields announced that in five years' time, the company intends to have a fully autonomous vehicle on the road.

Aug 16, 2016

2016

B Bloomberg

Uber's First Self-Driving Fleet Arrives in Pittsburgh This Month

Sebastian Thrun, the creator of Google's self-driving car project, spent seven years researching autonomous robots at CMU, and the project's former director, ...

Highly Cited · Aug 18, 2016

2016

Los Angeles Times

Look, Ma, no hands: Google to test 200 self-driving cars

Look, Ma, no hands: Google to test 200 self-driving cars ... space for your belongings, buttons to start and stop, and a screen showing where the car is going.

May 28, 2014

2014

Wired

The World's First Self-Driving Semi-Truck Hits the Road

(An autonomous truck could exit the interstate near the end of its journey, park in a designated lot, and wait for a human to come drive it on surface streets to its ...

In-Depth · May 5, 2015

2015

B Bloomberg

Ford CEO Tamps Down Expectations for First Autonomous Vehicles

Too much hype has built up about how soon self-driving cars will hit the road, but they will ultimately change the world, Ford Motor Co.'s chief executive officer ...

Apr 9, 2019

2019

VB VentureBeat

Uber expects a long wait before self-driving cars dominate

Urtasun's comments fall in line with the rest of the self-driving industry, which after much hype and bold promises has tempered expectations and pushed out ...

Apr 8, 2019

2019

CNBC

Alphabet exec says self-driving cars 'have gone through a lot of hype,' but Google helped drive that hype

Waymo executives think people have taken its promises of self-driving cars too seriously. The Alphabet subsidiary went "through a lot of hype that was sort of ...

Oct 23, 2019

2019

wp Washington Post

Shaken by hype, self-driving leaders adopt new strategy: Shutting up

PALO ALTO, Calif. — Three former executives at Google, Tesla and Uber who once raced to be the first to develop self-driving cars have adopted a new ...

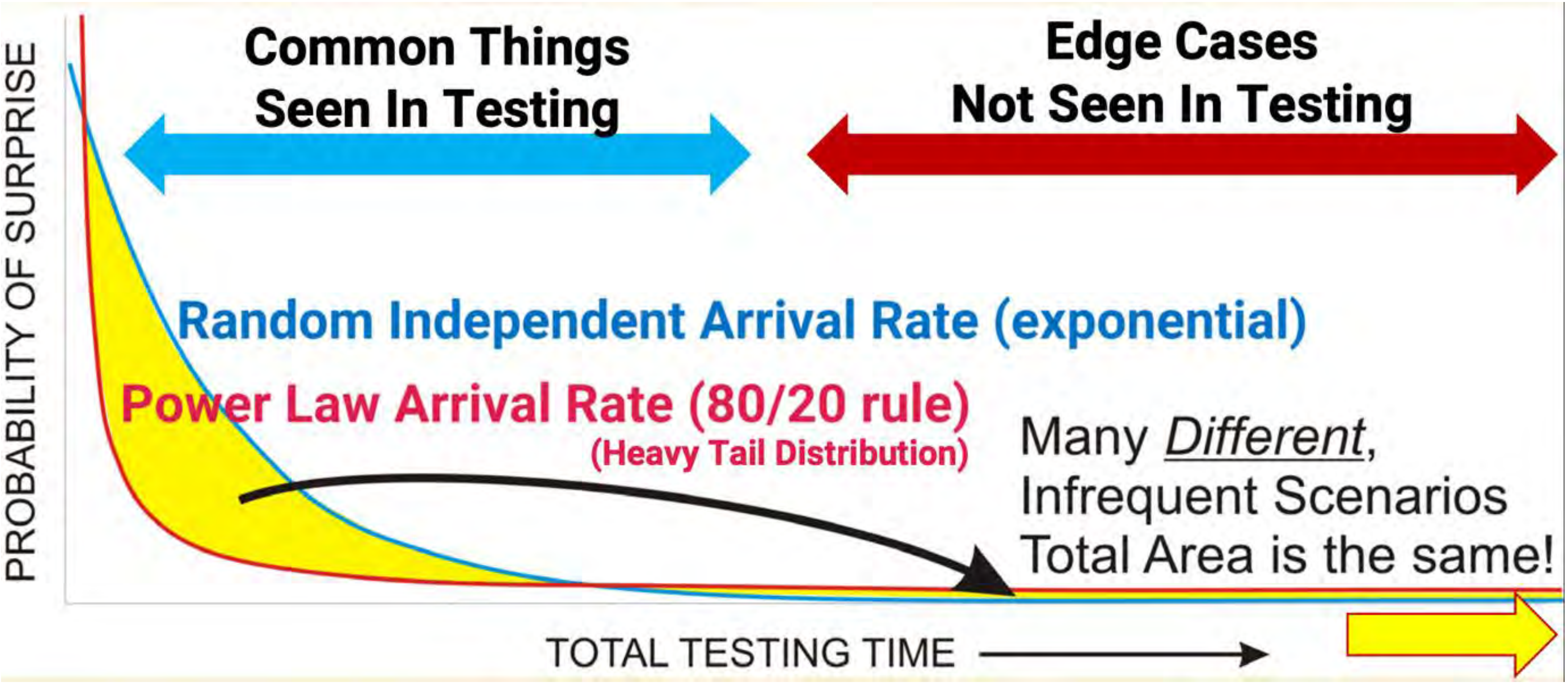
Oct 18, 2018

2018

WHY AUTONOMOUS DRIVING IS HARD?

- Easy to demonstrate, hard to turn into a robust product
- Uncertainty in the real world is very difficult for robots to model and cope with
  - Humans cause most of the uncertainty
  - Humans are very good at interpreting and coping with each other

FIELD TESTING: HEAVY TAIL DISTRIBUTION



https://users.ece.cmu.edu/~koopman/lectures/Koopman19_SSS_slides.pdf

IT IS MORE THAN JUST DETECTING OBJECTS

Maybe careless?

Distracted driver

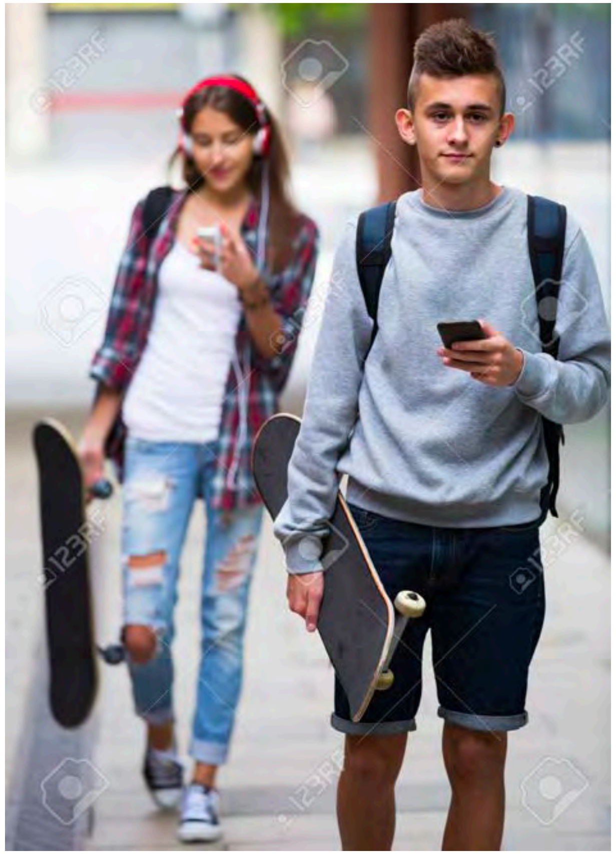
Not a cone, not a stop sign!

Why did the chicken cross the road?

Have a fighter jet in training data?

Is half a pick-up still a pick-up?

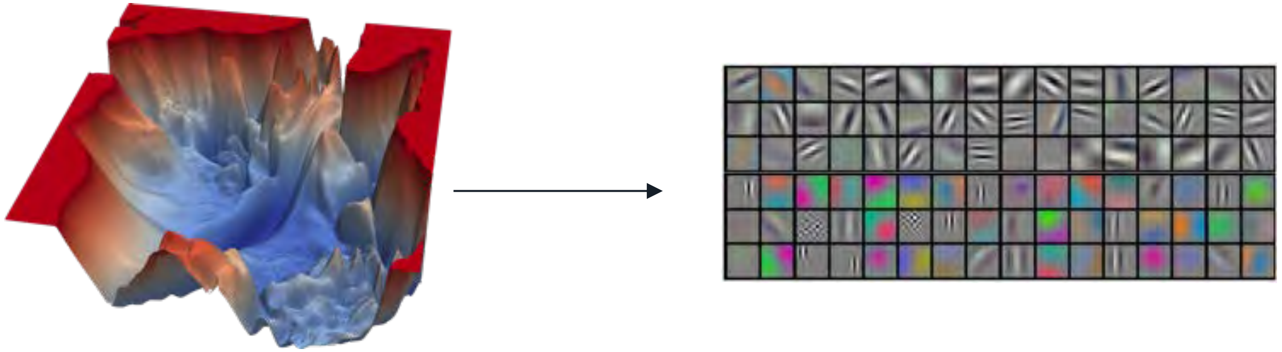
EXAMPLE: PROBABILITY OF JAYWALKING



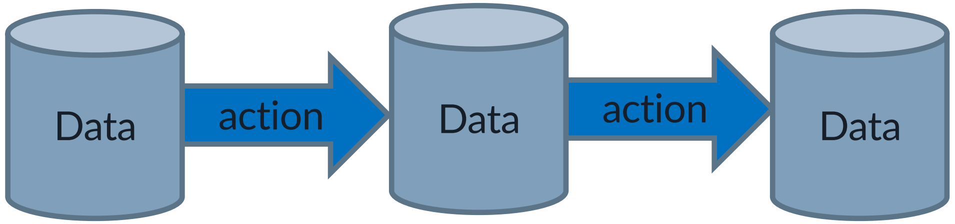
ISSUES WITH ML BASED SYSTEMS

Lack of robustness against adversarial perturbations

Lack of introspection and formal frameworks to provide bounded performance guarantees



Real world continuous data from robots violating the i.i.d. assumption



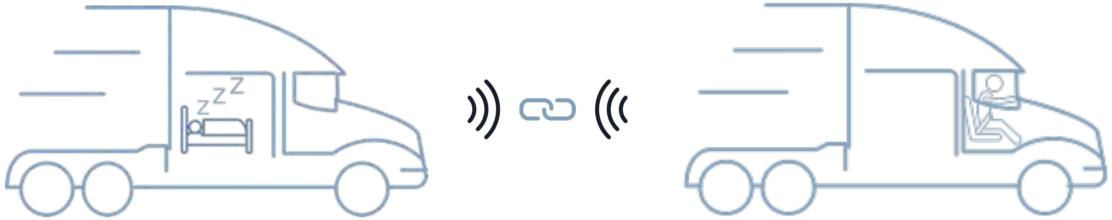
THE LOCOMATION APPROACH TO AUTONOMY

Not an ***"if"***, but a ***"when"***
Not ***"what"***, but ***"how"***

- **Embrace** the long path ahead for full autonomy, start with a **tangible scope**
- Build a true **minimum viable product** and start adding significant value **now**, then iterate quickly
- Make sure there is a **viable business** with **positive unit economics** at every iteration
- **Incrementally validate** the system for increasingly complex applications / domains

LOCOMATION PRODUCT ROADMAP

Mainly long-haul / over-the-road



AUTONOMOUS RELAY CONVOY (ARC™)

(pilot: 2019 – commercial: 2021)

+ Short-haul, dedicated linehaul / relays

AUTONOMOUS DRONE FOLLOWER, 3 TRUCK CONVOYS

(pilot: 2020 – commercial: 2023)

Initially short-haul, expand the range over time

HIGHWAY FULL AUTONOMY

(pilot: 2021 – commercial: 2024)

Initially short-haul, expand the range over time

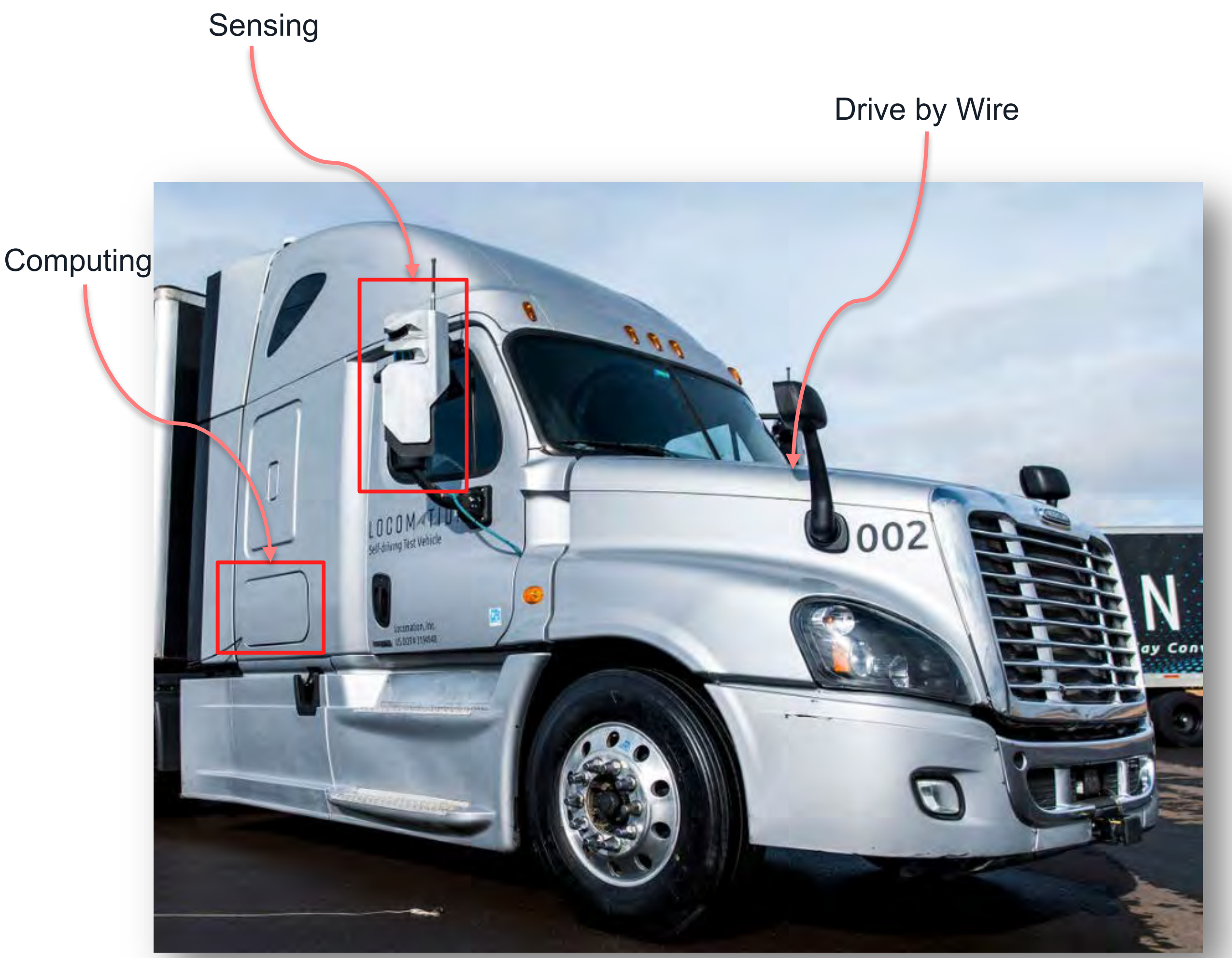
HUB-TO-HUB FULL AUTONOMY

(pilot: 2022 – commercial: 2025+)

AUTONOMOUS RELAY CONVOY

LOCOMATION STACK

- Autonomy retrofit kit
  - OEM installation in the future
- Compatible with major truck makes/models
  - ~70% of all trucks, >90% of large fleets in US
- Robust, safe, future compatible design
  - Full L4 self-driving capable
- Rapid deployment/scaling on new routes
  - No reliance on infrastructure or HD maps
- Integration with the fleet management systems
  - Optimization/scheduling for convoy dispatching



DRIVE-BY-WIRE KIT

Locomation B-Kit

- Steering Control
- Brake Control
- Throttle Control

Platform Control Kit

↔

Locomation A-Kit

Hardware
- Sensors, Computing

Software
- Autonomy Stack

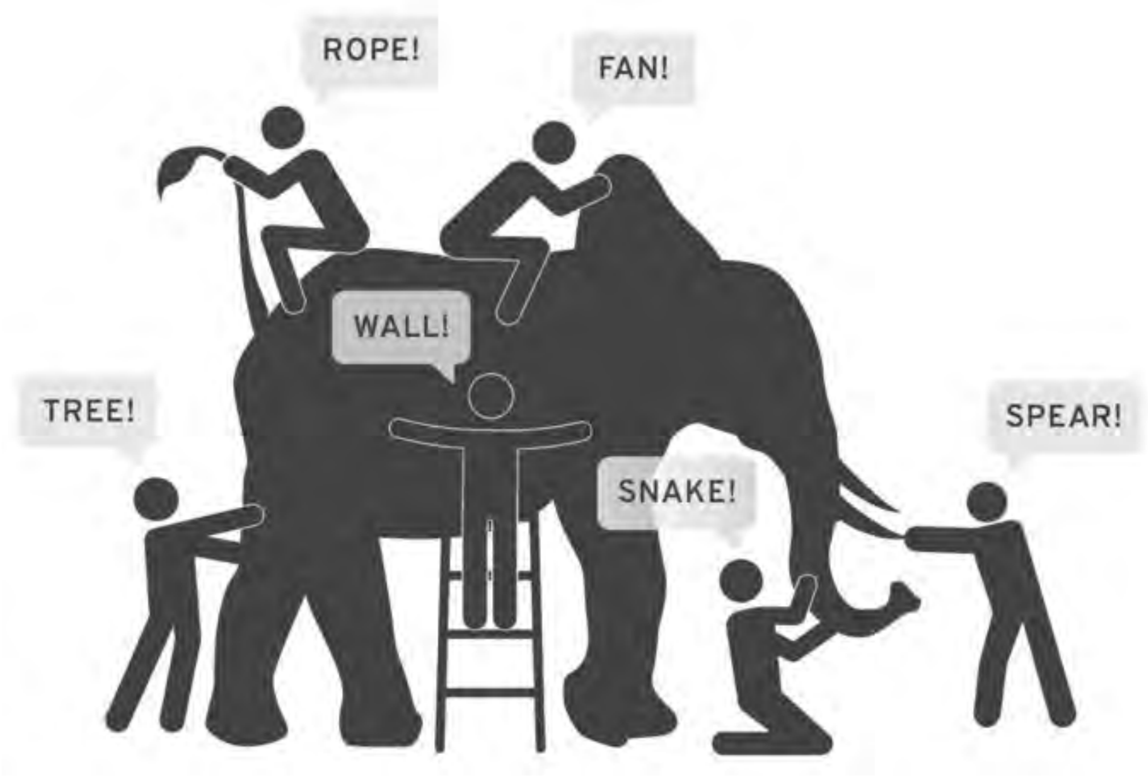
SELF-DRIVING TRUCKS: SAFETY

- A fully loaded truck is a 80,000 pound projectile going at 70mph
  - ~30m/s displacement
- Highways are more structured, but semi-trucks pose higher safety risks
  - Zero room for any mishap
  - All it takes is one bad accident
  - Edge cases are less frequent but equally rich

"If you think safety is expensive, try having an accident."

SAFETY - VALIDATION

- Functional safety – ISO26262, etc.
- Graceful degradation (lizard brain)
- MTBFs - Hardware redundancy
- Top down (e.g., Functional Hazard Analysis, Fault Trees)
- Bottom up (e.g., field testing)
- Safety at the system architecture level



WRAP UP

- Humans are lousy drivers but replacing them with machines is still an open science question
- The industry had been suffering from the “Innovator’s Dilemma”
- A more efficient, “first principles” approach is viable
- Selecting a domain and application is important from sustenance point of view
- Locomation takes a very strong “last mover” position, filters every assumption through the “know-how” and “know how not to” filters
- Autonomy will first come to freight transportation, and incrementally

Thanks!

www https://locomation.ai

@locomationai

@locomationai

cetin@locomation.ai

navya

be fluid

NAVYA IN A NUTSHELL: A FRONTRUNNER IN THE AUTONOMOUS VEHICLE MARKET

Mission: NAVYA works with cities, communities and private sites from all over the world to improve their transportation offer with its autonomous, driverless and electric solutions

- **HEADQUARTERS in France**
- 2 PLANTS **in Lyon, FRANCE and Saline, Michigan**, USA
- 280+ passionate people (December 2019)
- SUBSIDIARY with CHARLATTE MANUTENTION FAYAT GROUP
- 160+ VEHICLES sold (December 2019)
- **STRATEGIC AGREEMENTS** signed with key partners

Valeo KEOLIS AXA

AUTONOM SHUTTLE AT A GLANCE

100% AUTOMATED

100% ELECTRIC

15 PASSENGER MAX CAPACITY

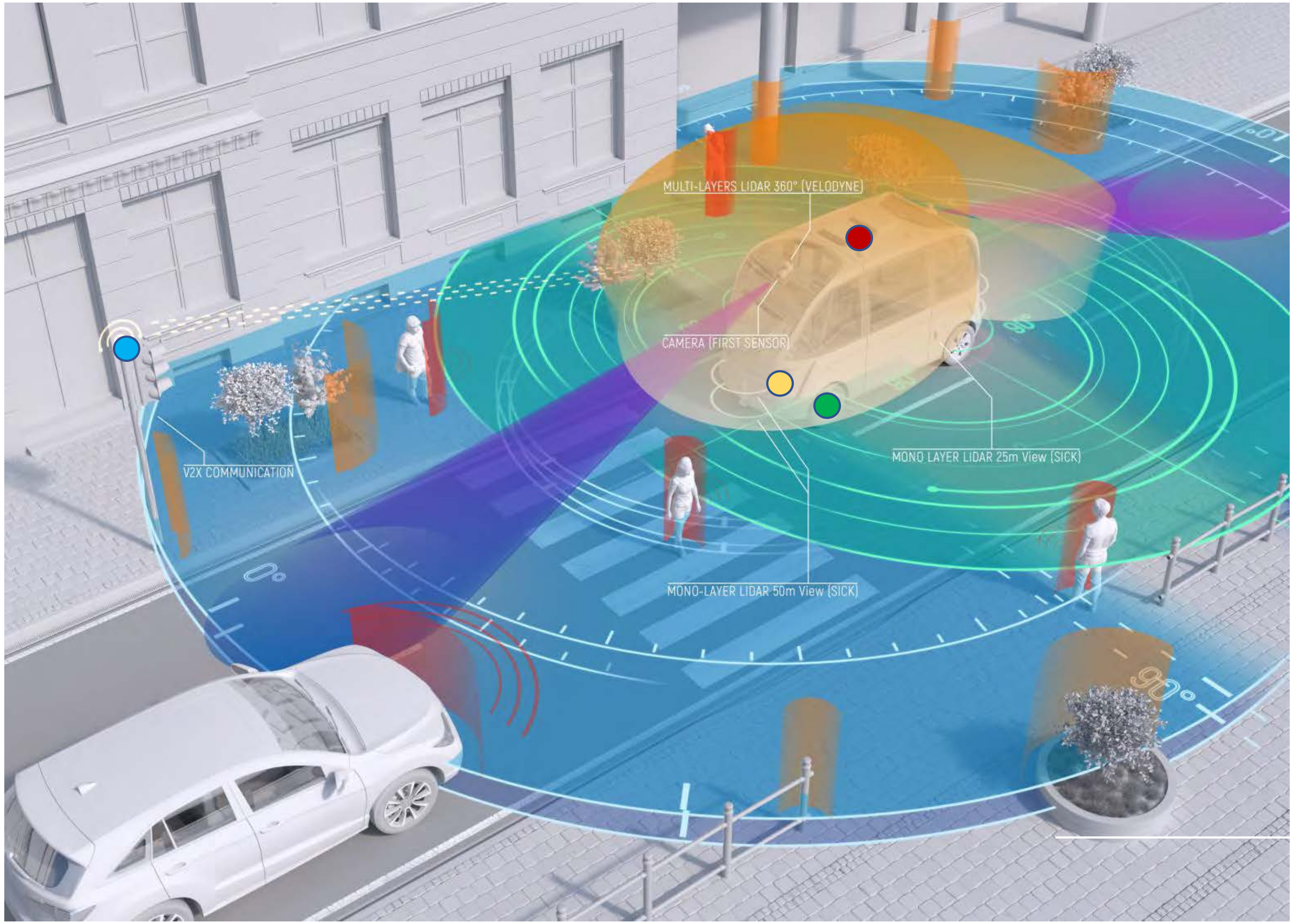
15.5MPH MAX OPERATING SPEED

9H AVERAGE RUN TIME

NO HEAVY INFRASTRUCTURE NEEDED

navya

ON THE CUTTING EDGE OF MULTISENSOR TECHNOLOGY



IN-HOUSE ARTIFICIAL INTELLIGENCE SOFTWARE

COMBINED WITH OUR SPECIFIC SENSOR ARCHITECTURE

- 3-D MULTI-LAYER LiDAR SENSOR x 2
- 2-D MONO-LAYER LIDAR SENSOR x 6
- CAMERAS x 2
- GNSS ANTENNAE x 2
- ODOMETRY SENSORS x 4
- INERTIAL MEASURING UNIT
- V2X OBU x 1

PLAY INTERACTIVE PRESENTATION NOW

A GLOBAL FOOTPRINT

NHTSA ENCOURAGES AV USE DURING PANDEMIC

- Navya & BEEP – Delivering COVID-19 test samples from a testing site to the laboratory at the Mayo Clinic in Jacksonville, FL
- Navya & BEEP – Delivering food to employees at the VA Hospital in Lake Nona, FL
- Hyundai-Aptiv – Delivering food to vulnerable families in Las Vegas, NV
- Kiwibot – Delivering PPE and hygiene-related products in Berkeley, CA & Denver, CO
- Pony.ai – Delivering groceries & packages in Irvine, CA
- Refraction AI – Delivering food and essentials from grocery stores in Ann Arbor, MI
- Nuro – Delivering prescriptions in Houston, TX
- Cruise – Delivering items from food banks to at-risk populations & frontline workers in San Francisco, CA

And many others…

https://www.nhtsa.gov/coronavirus/innovative-automotive-technologies-address-crisis-challenges

JACKSONVILLE TRANSPORTATION AUTHORITY

USE CASE: CRISIS/HOSPITAL

CUSTOMER

MAYO CLINIC

LOCATION

JACKSONVILLE, FLORIDA (US)

SERVICE OPERATOR

beep
Autonomous Mobility Solutions

ENVIRONMENT

CLOSED ROAD LOOP AROUND HOSPITAL

MISSION

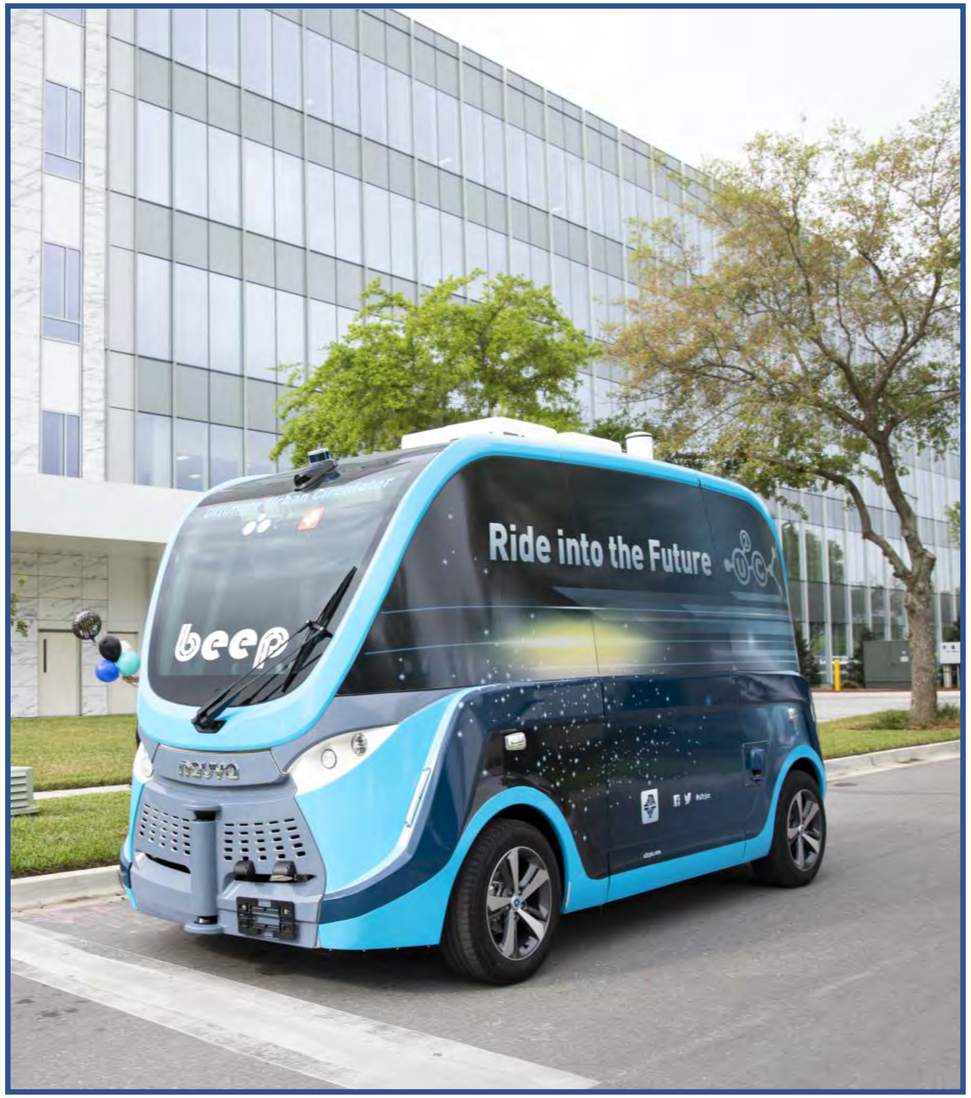
UTILIZE AUTONOMOUS SHUTTLES TO TRANSPORT COVID-19 TEST SAMPLES AND MEDICAL SUPPLIES, MITIGATING RISK AND LIMITING HUMAN INTERACTION TO POTENTIALLY CONTAGIOUS TEST SAMPLES

MAIN NEEDS

- Safe, controlled transport of potentially contagious and deadly COVID-19 test samples
- Reduce human interaction from the collected COVID-19 test samples
- Provide a transport solution capable of assisting when healthcare staff and resources were limited
- Determine the feasibiility of using autonomous shuttles in a crisis

navya

USE CASE: CRISIS/HOSPITAL



VEHICLES

4 AUTONOM SHUTTLES

LAUNCH

March 2020

TRIP

0.8 miles RT (1.28 kilometers)

SCHEDULE

March 30 through May 2020

navya

Overview of Michigan CAV Activities

Elise Feldpausch (MDOT)

CAV Working Group • July 21st 2020

Michigan Department of Transportation

Office of Future Mobility and Electrification

As announced on February 25th, 2020:

Executive Directive 2020-1
Creates Office of Future Mobility and Electrification

As released on July 2nd, 2020:

Formally launched Office of Future Mobility and Electrification

Trevor Pawl named as Chief Mobility Officer to lead Office of Future Mobility

Regulatory

OFME Strategic Objectives

- **Increase Mobility Investment in Michigan**: Generate new investment and job creation from tech companies focused on future mobility, including autonomous and electric vehicle innovation.
- **Expand Michigan's Smart Infrastructure**: Further develop systems for deploying autonomous and shared transportation.
- **Engage More Mobility Startups**: Establish Michigan as a premier location for young companies to start, scale, commercialize and grow technologies redefining the movement of people and goods.
- **Further Enable Michigan's Mobility Workforce:** Develop and attract the skills and talent necessary to meet the changing demands of the mobility sector.
- **Accelerate Electric Vehicle Adoption in Michigan:** Support the transition from internal combustion engine vehicles to electric vehicles and expand access to charging infrastructure.
- **Bolster Michigan's Mobility Manufacturing Core:** Protect the state's competitiveness in electric and autonomous vehicle manufacturing and ability to move technologies into industrial scale manufacturing.

MDOT CAV Strategic Plan

Department Connected and Automated Vehicle Strategic Plan to:

- Articulate the guiding mission, vision, and goals
- Help prepare for the imminent arrival of disruptive technologies
- Educate, engage, and learn from staff
- Encourage thinking about implications, challenges, gaps, and opportunities
- Reflect on what has already been done and identify areas that need further attention
- Define a path for preparedness and technology implementation

Timeline for Completion: End of 2020

Strategic

High-Tech Workforce Preparation for Emerging Transportation Technologies

Conduct research on new technologies and associated implementation strategies

Develop a series of recommendations for MDOT units to aid decision-makers in identifying the expertise gap within MDOT's current construction and operation workforce

Provide a set of recruitment strategies and training material for acquisition and (re)training the current and future workforce

Timeline for Completion: June 2021

Strategic

Recent Initiative Updates

DMS Messaging Effectiveness Research

Developing a data driven methodology to assess the effectiveness of different digital message signs, message types and installation locations.

Generating necessary results to allow better allocation of MDOT's resources by investing in effective sign technologies for traffic improvement.

Improving digital message sign operational practices in the state of Michigan

Timeline for Completion: December 2021

Take poll at www.mi.gov/drive

Strategic

Recent Initiative Updates

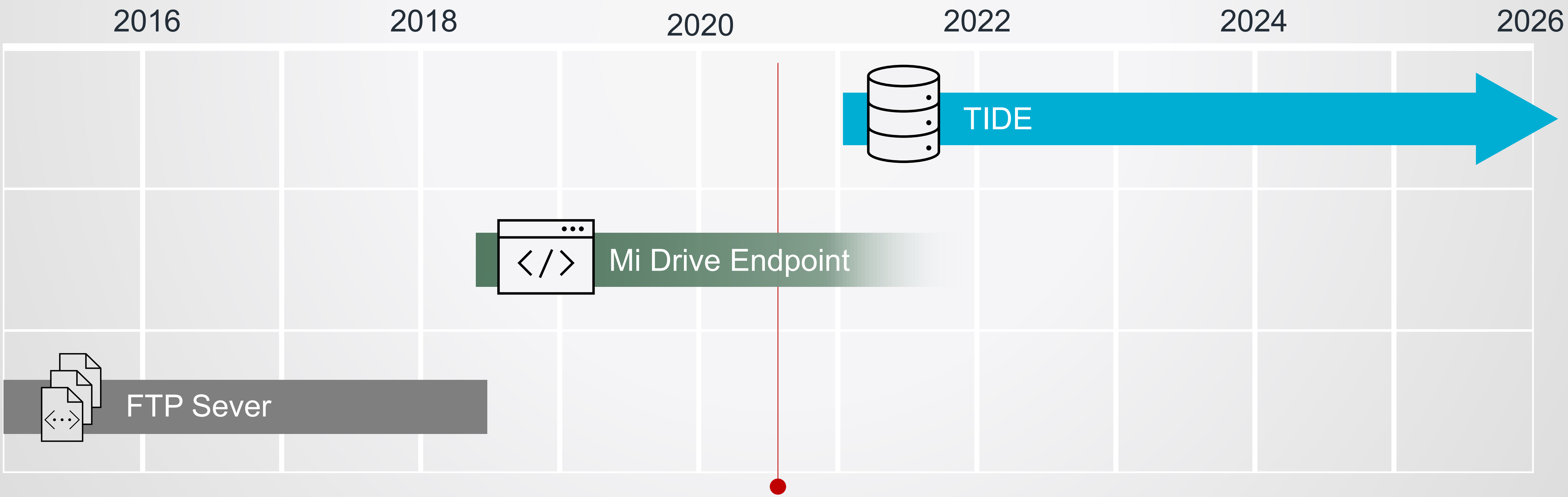
Real-time Transportation Infrastructure Data Exchange (TIDE)

Proposed initiative would create a centralized platform for the real-time exchange of continuous transportation data

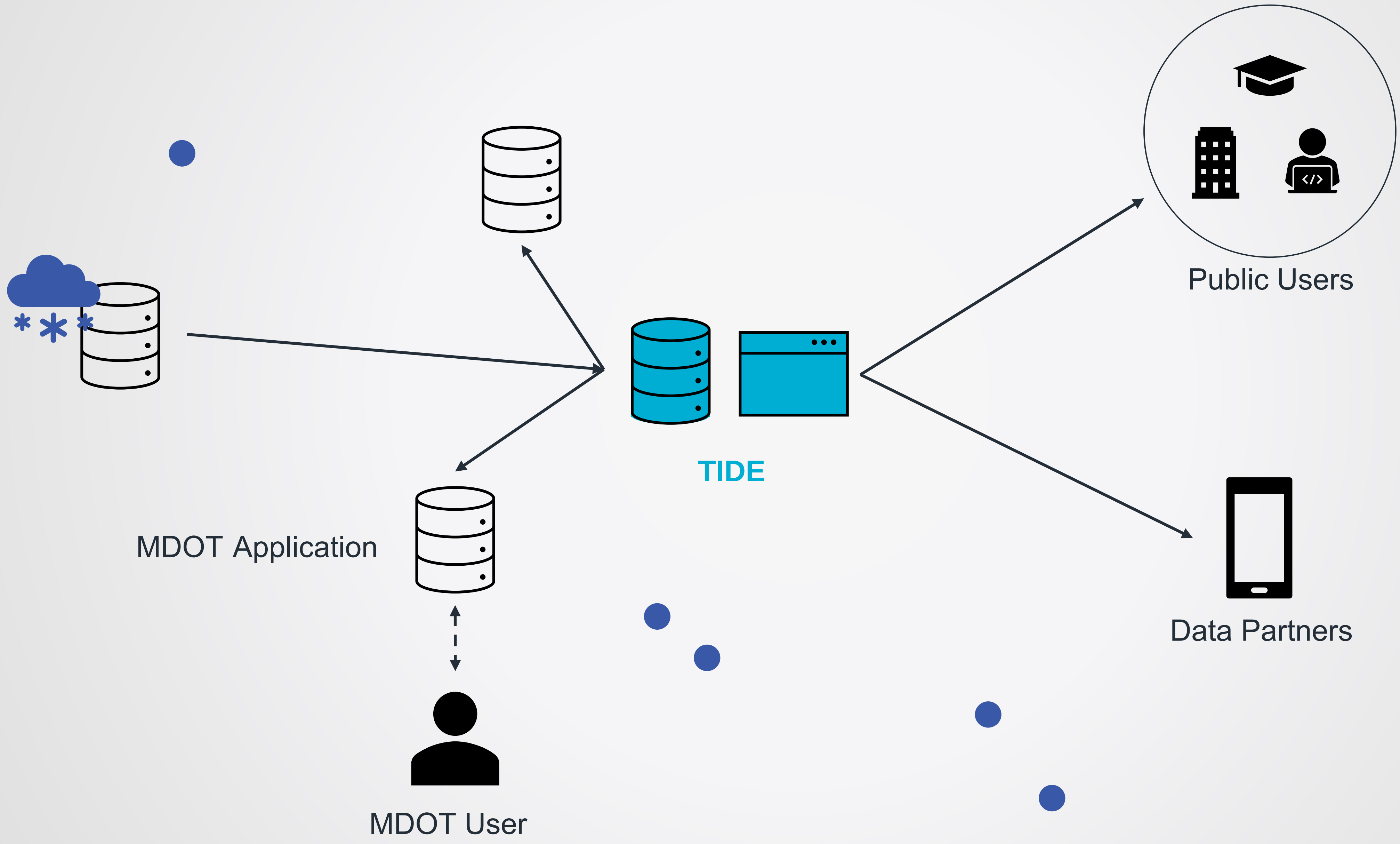
Main Benefits:

- Facilitates centralized and abstracted data sharing between MDOT's operations applications
- Allows for the ingestion and distribution of emerging data sources
- Supports federal requirements for Real-Time System Management Information Program
- Replaces legacy and interim real-time sharing systems
- Supports goals in Five-Year Plan and MM 2045 Plan

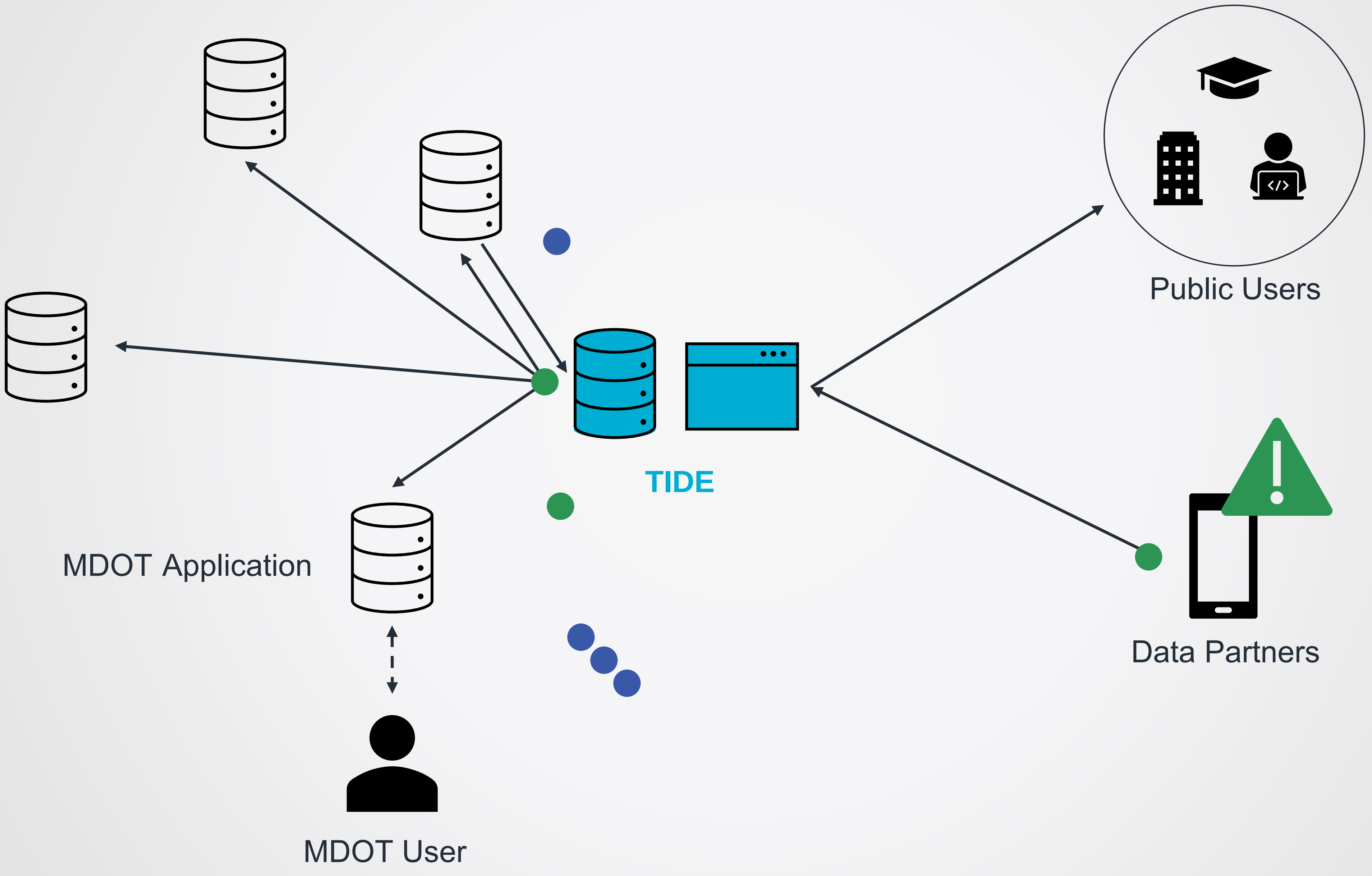
TIDE would replace legacy and interim solutions for real-time data sharing



High-level System Function – MDOT Data



High-level System Function – Data Partners



Thank you

Elise Feldpausch
MDOT ITS Program Office
Feldpausche1@Michigan.gov

Regulatory

wejo

Data & The Global Pandemic: Wejo In Action

Bret Scott, VP of Partnerships
July 22, 2020

2014	84	150bn+	2 trillion+
Founded	Employees	miles curated	data points captured

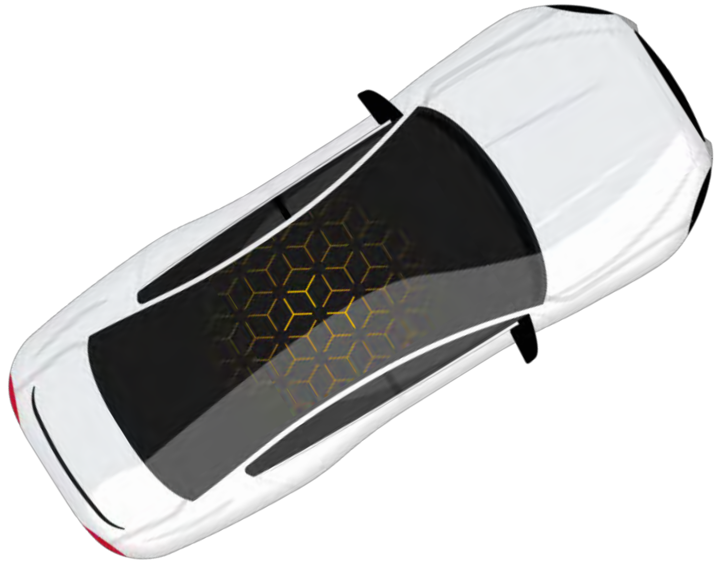
NORTHERN TECH Awards
Presented by GP Bullhound
Winner, Fastest Growing Company 2019

FROST & SULLIVAN
2019 BEST PRACTICES AWARD
Winner, Customer Value Leadership 2019

Agenda

In todays webinar we will cover

- An introduction to Wejo
- Our Covid-19 study
- Q&A



Wejo story

2014
Founded

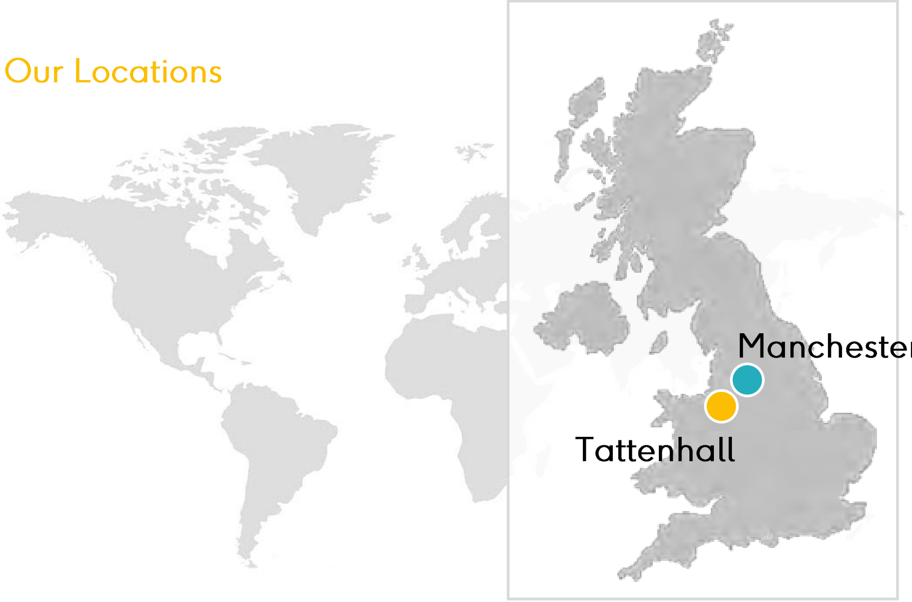
+19M
Accessible vehicles

4.8 Trillion+
Data points captured

24.6B+
Journeys curated

17B
Data points collected daily, streaming & batch

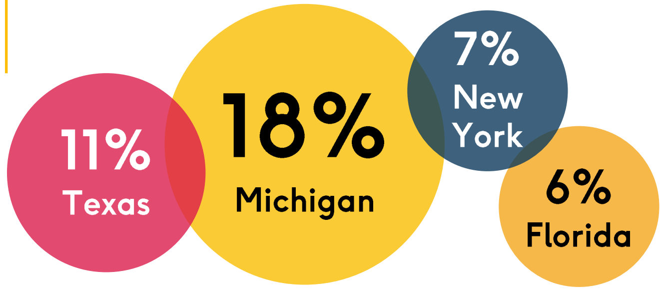
Our Locations



Super-low latency, transmitted every **1-3 seconds** from the vehicles, 95% to customers in under 32 seconds in NA currently

Our data is, **cleaned**, **normalised** and **structured** in a **common data model.**

The anonymised vehicle data that wejo receives represents **one in every 20 vehicles** in the USA:

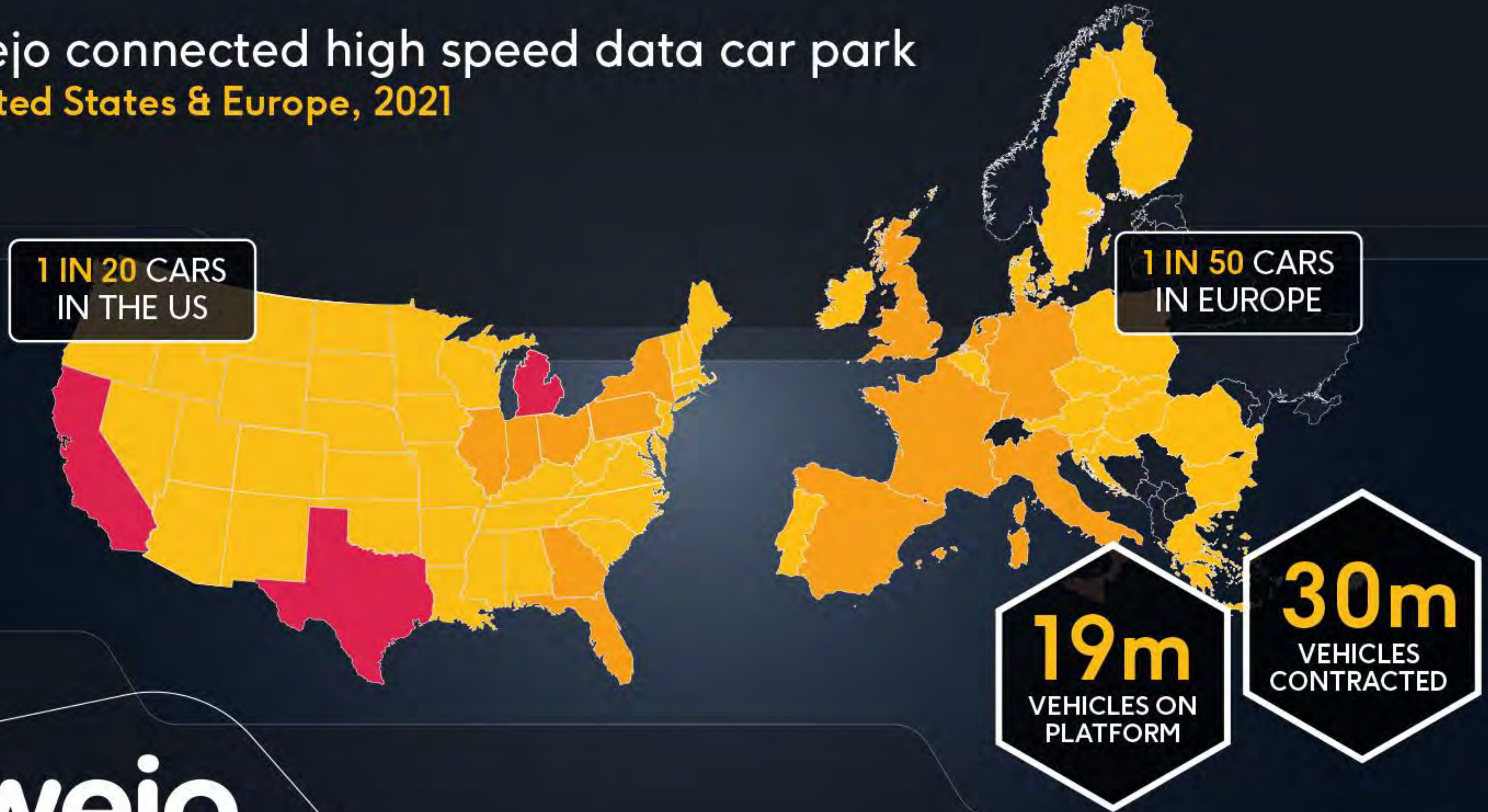


Multiple OEMs, multiple geographies

2
Patent applications

Wejo connected high speed data car park

United States & Europe, 2021



wejo

Coverage of all 50 US states, UK and EU27

wejo

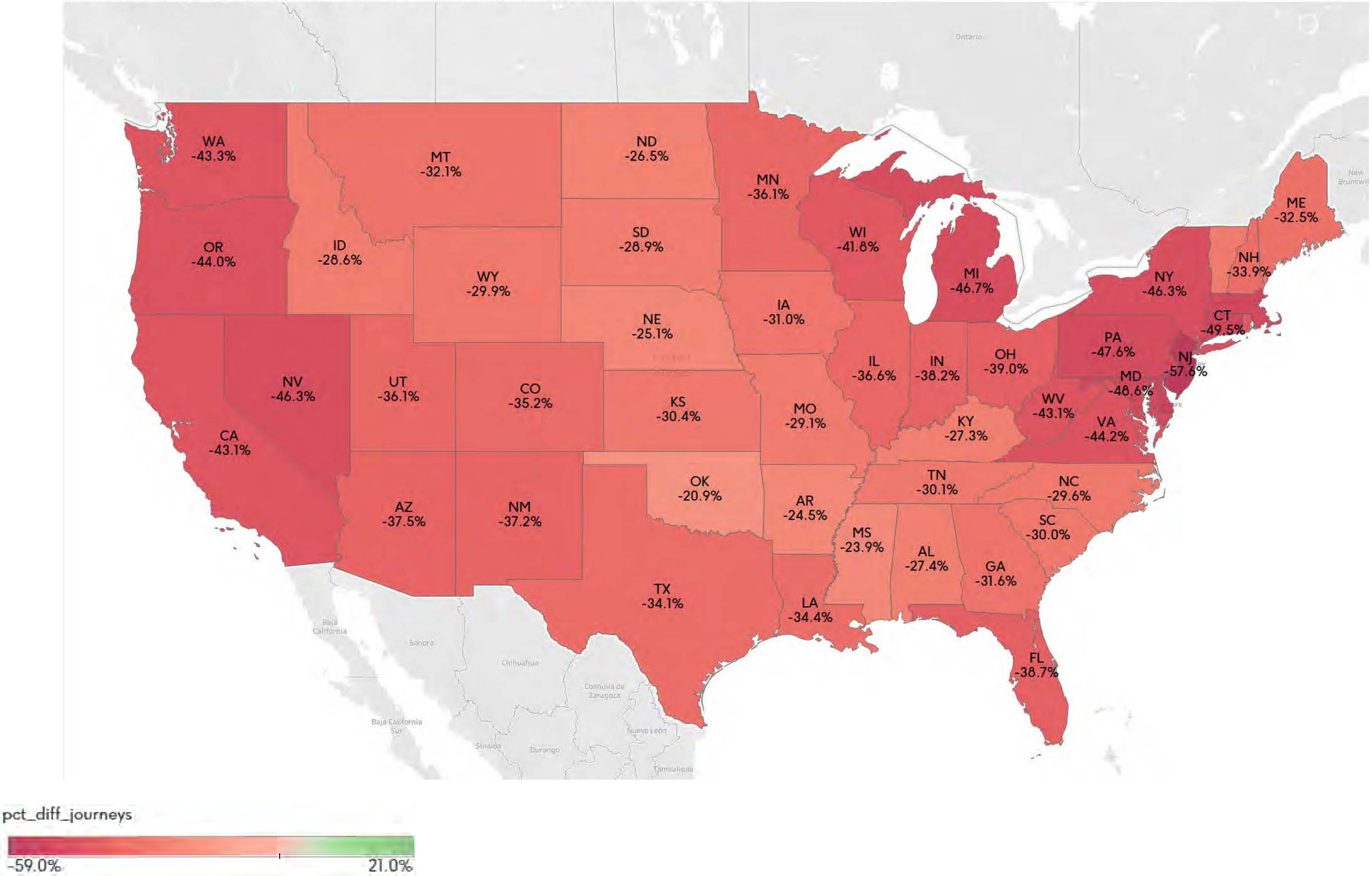
Covid-19 study

What can Wejo see?

Jaap Daniel Jim

All US summary

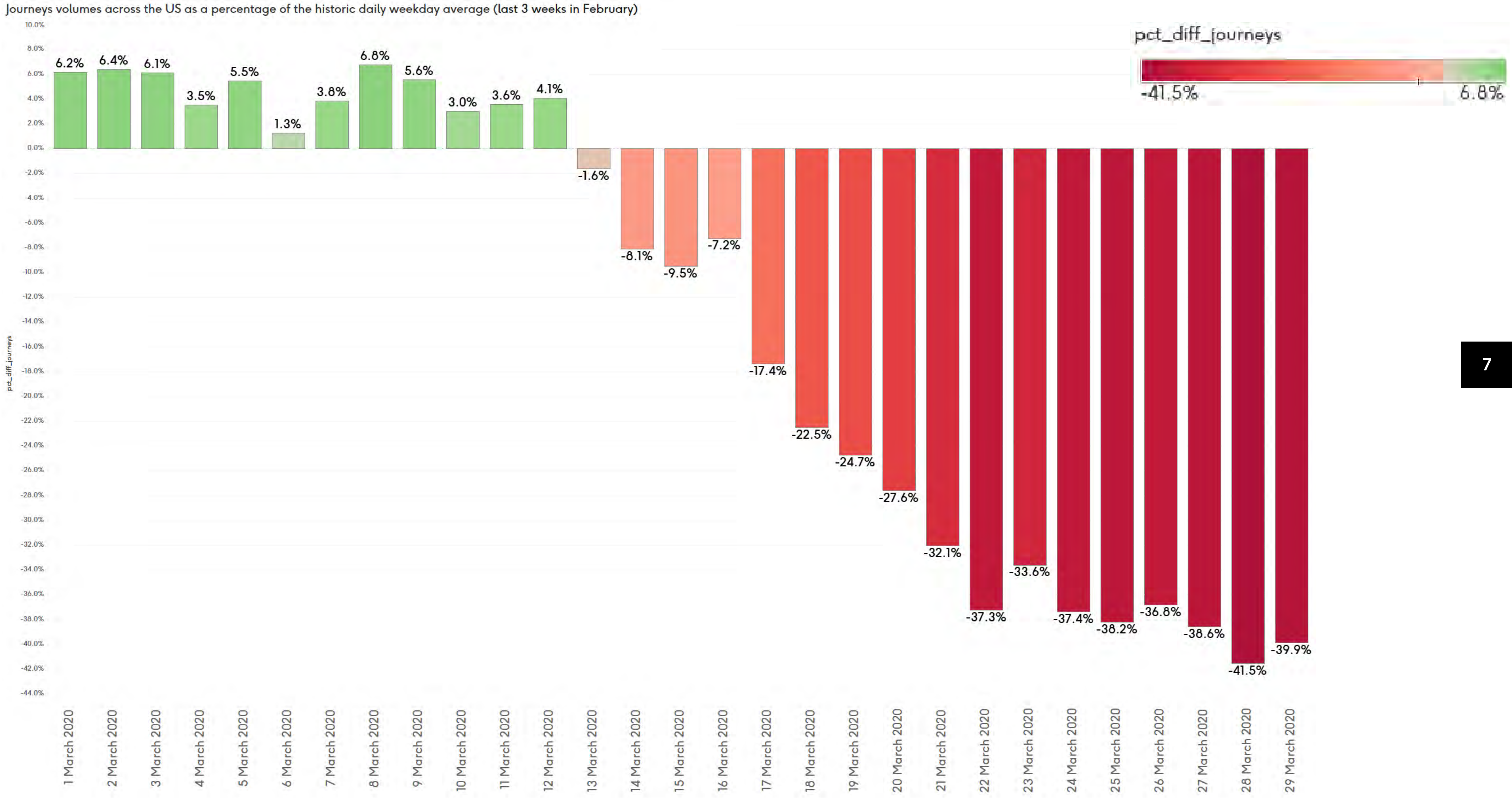
Journeys volumes by state as a percentage of the historic daily weekday average (last 3 weeks in February)



Study across all US shows following trends,

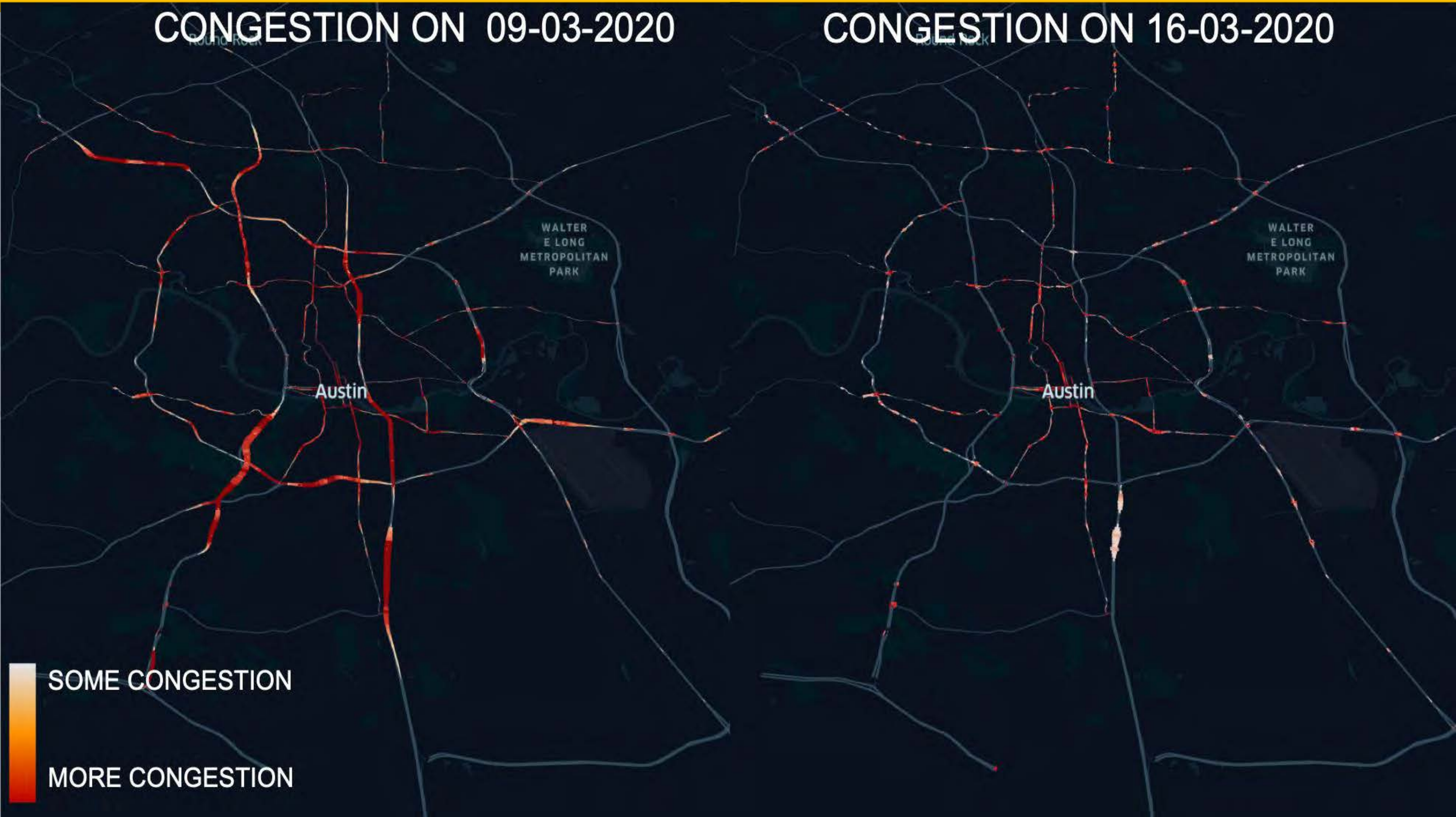
- Reduced overall journeys
- Increased visits to certain store types

All US summary



Austin

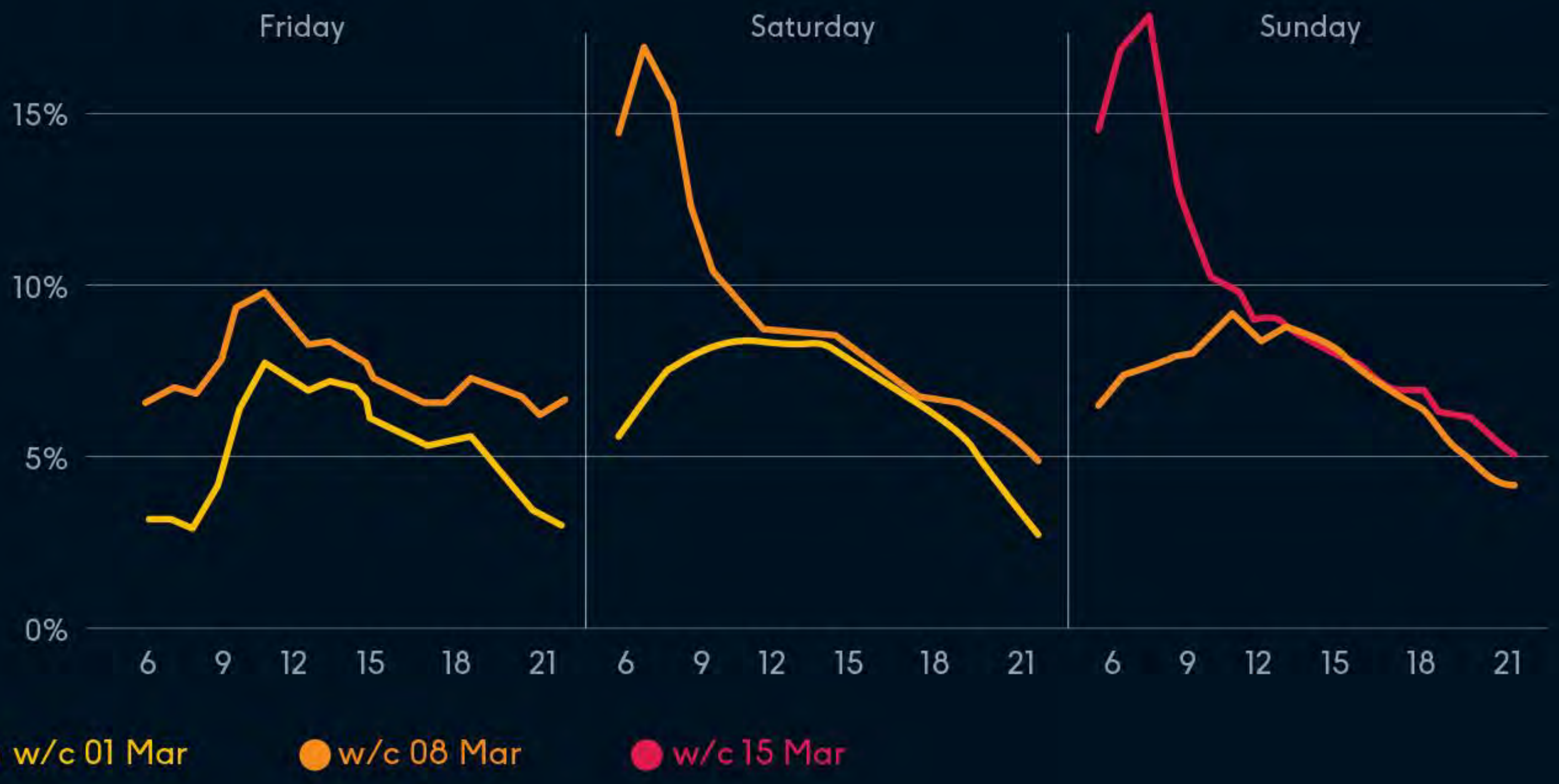
% DIFF IN CONGESTION ON 16-03-2020 VS EXPECTATION


CONGESTION ON 09-03-2020
CONGESTION ON 16-03-2020
WALTER E LONG METROPOLITAN PARK
Austin
WALTER E LONG METROPOLITAN PARK
Austin
SOME CONGESTION
MORE CONGESTION

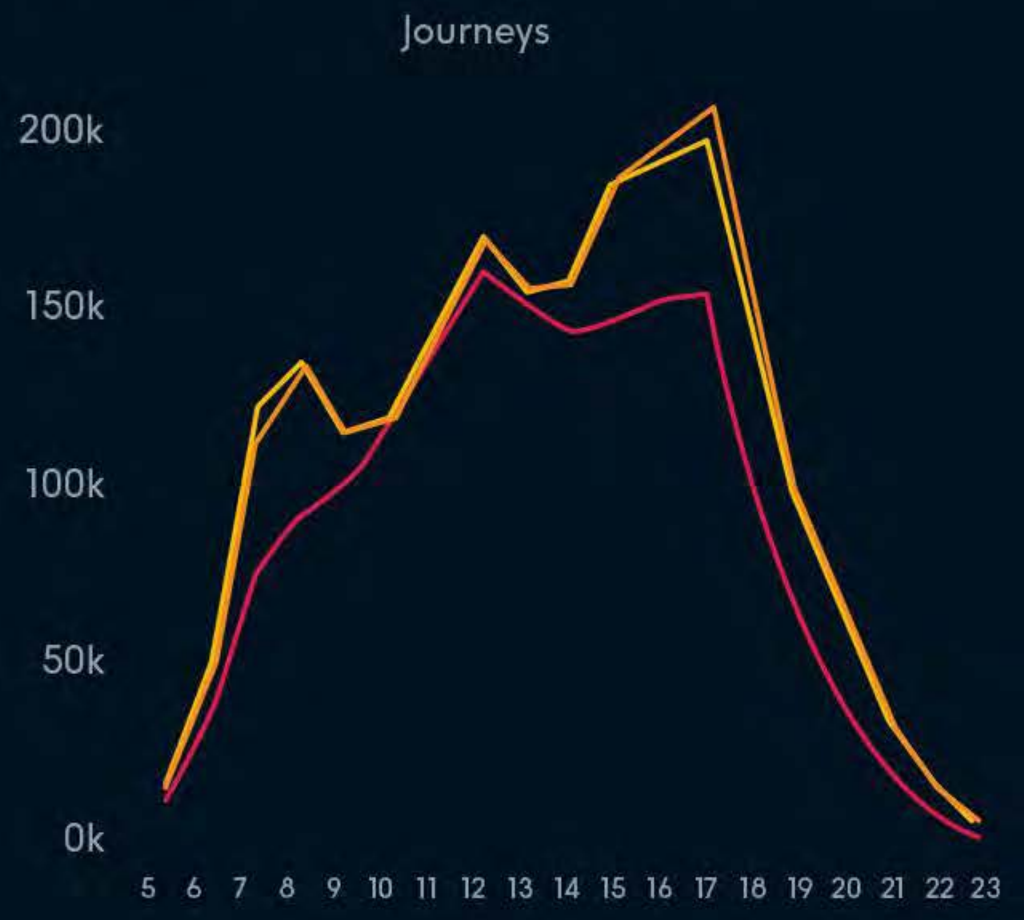
9-10 am, 2020-03-25

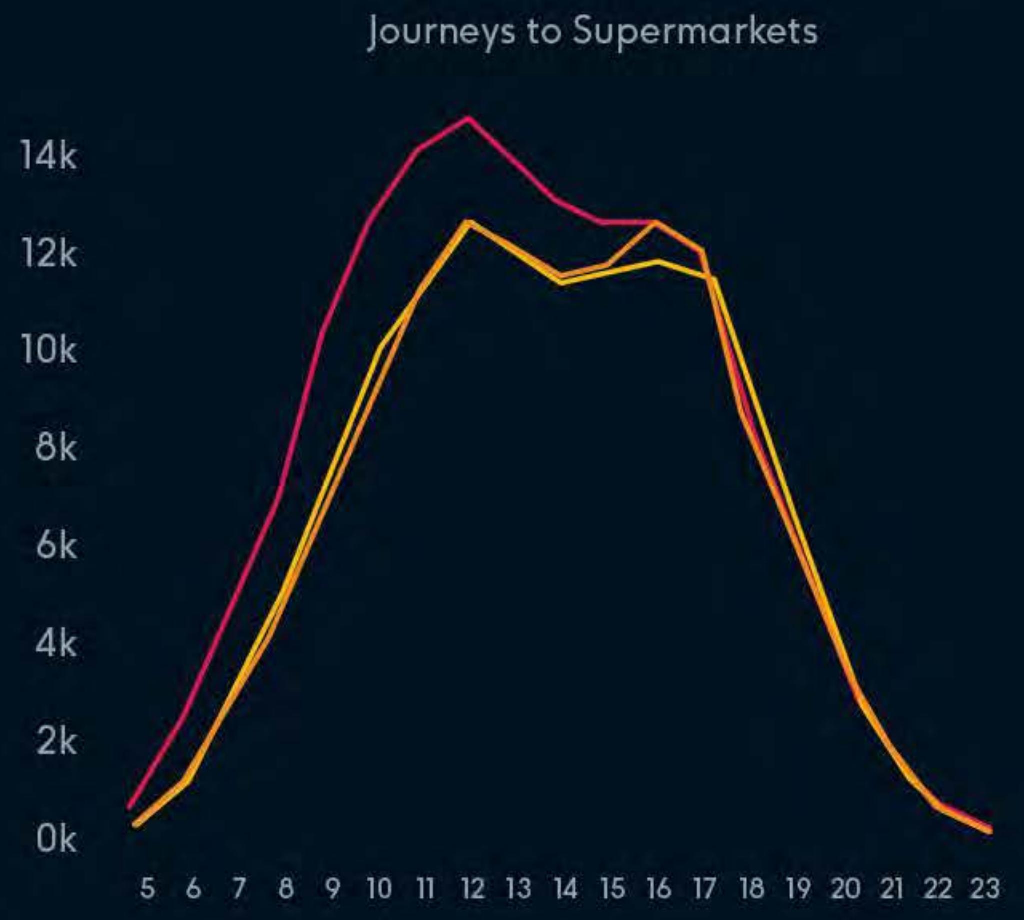
Michigan

Supermarket visits by time of day in Michigan



Total Journeys vs Journeys to Supermarkets in Michigan

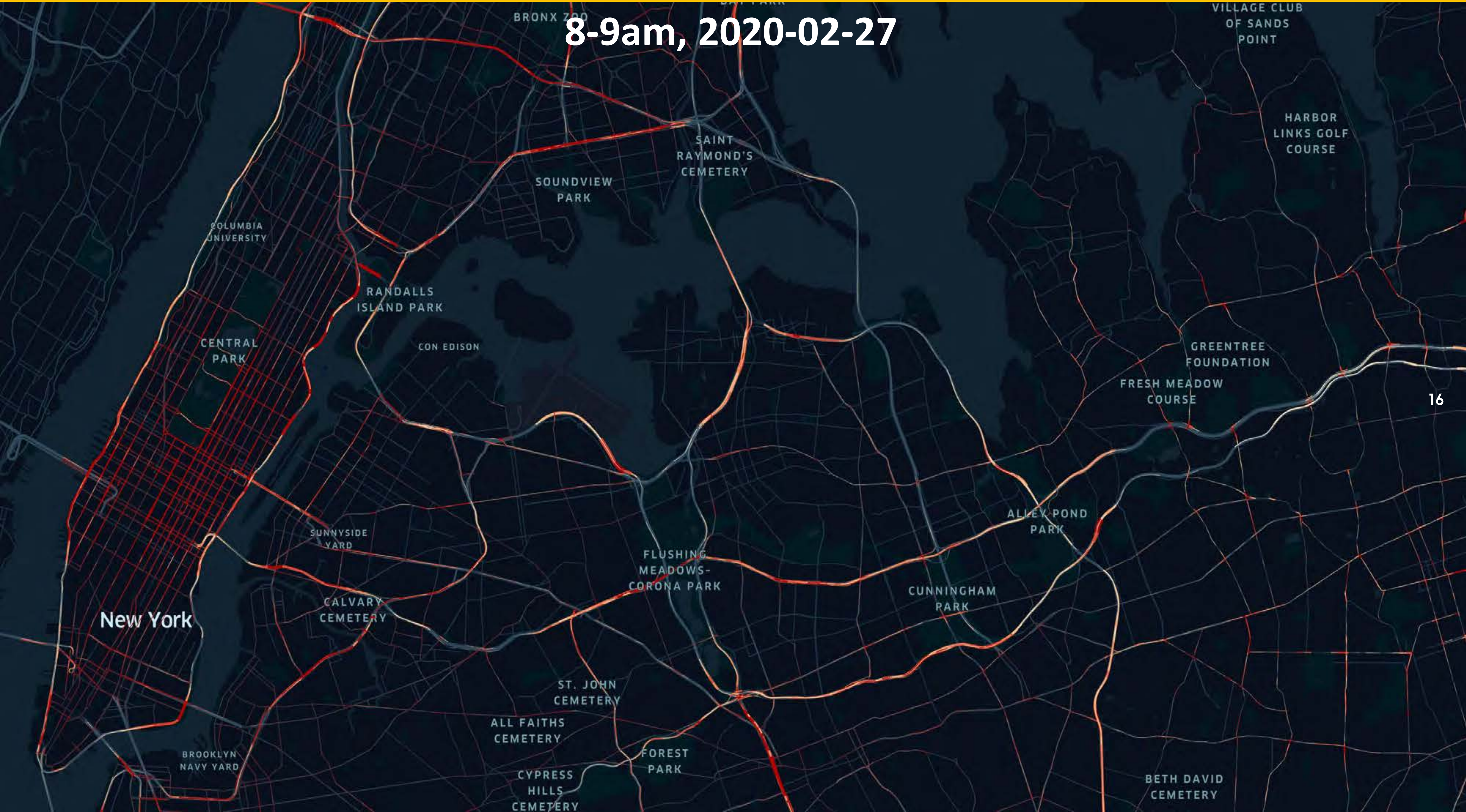




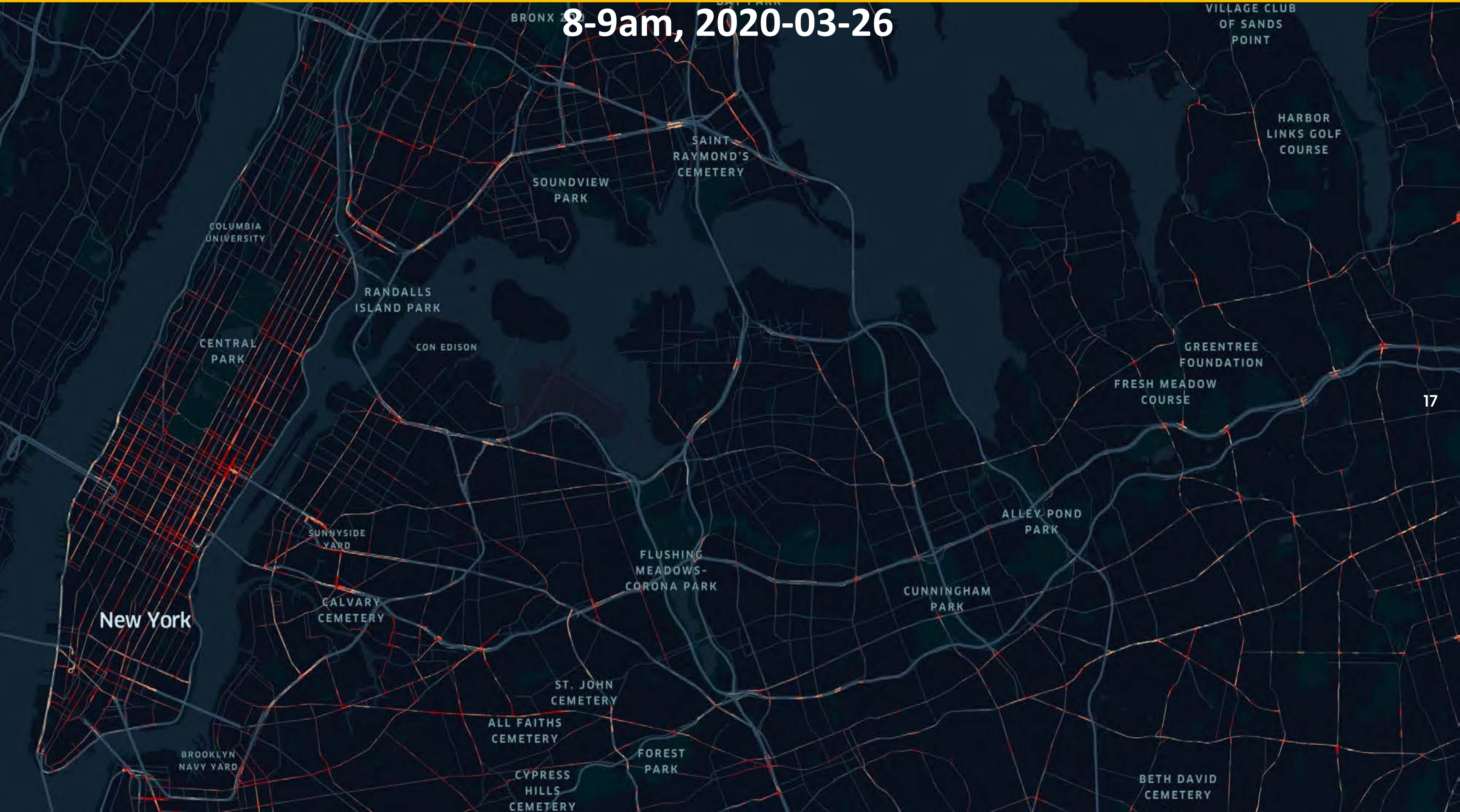
02 Mar
09 Mar
16 Mar

New York

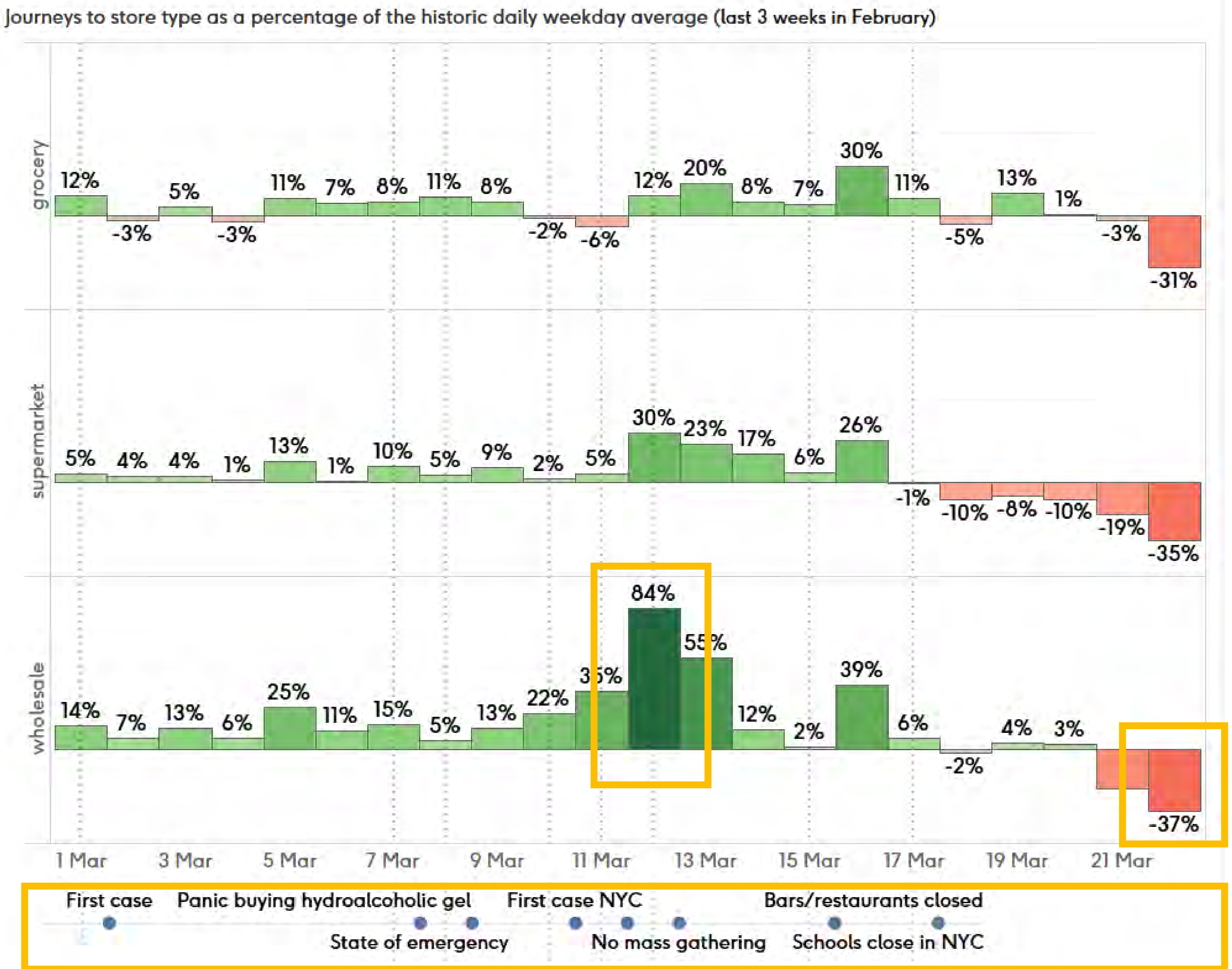
8-9am, 2020-02-27



8-9am, 2020-03-26



Retail establishments in NY State grocery focus



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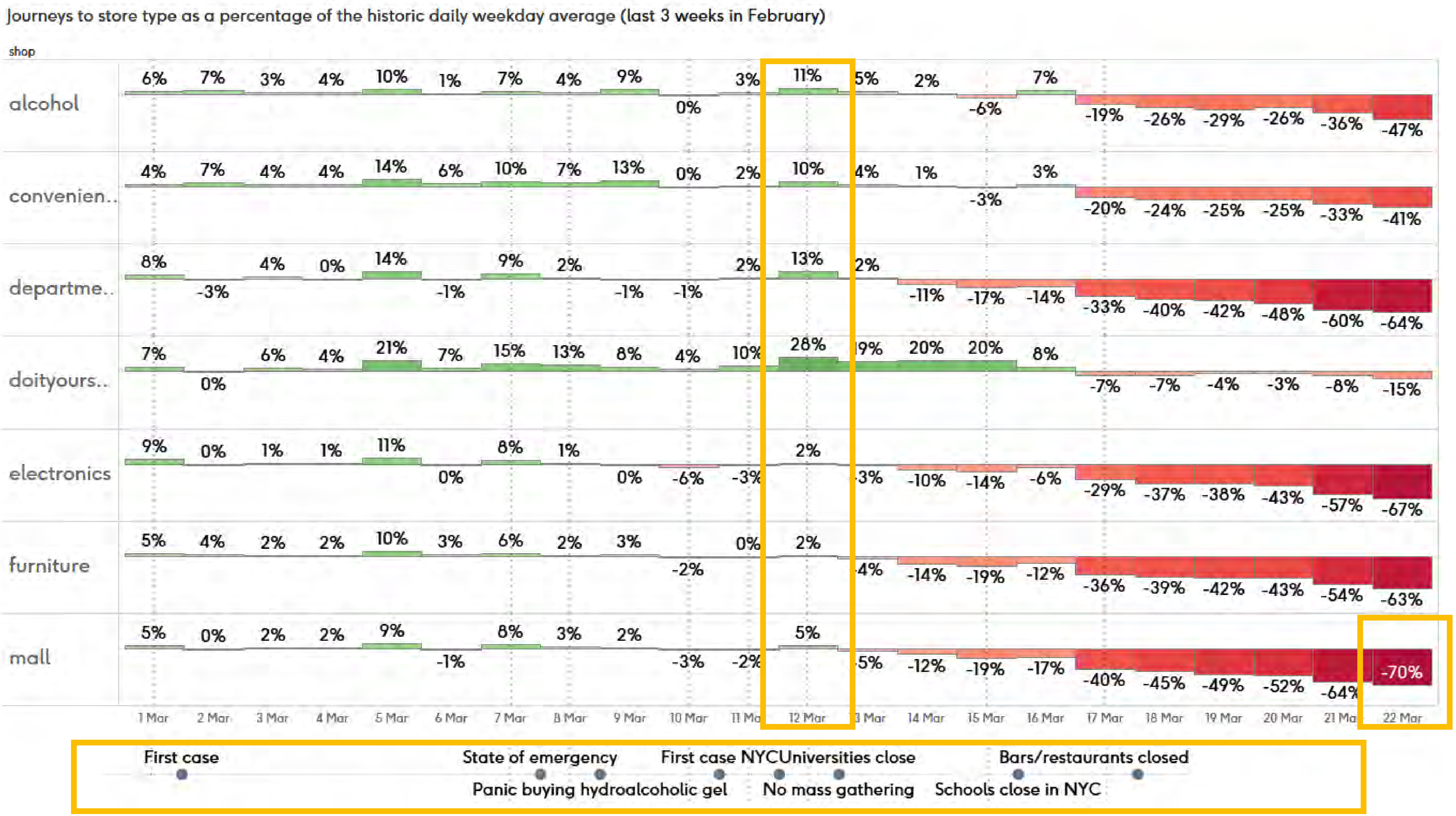
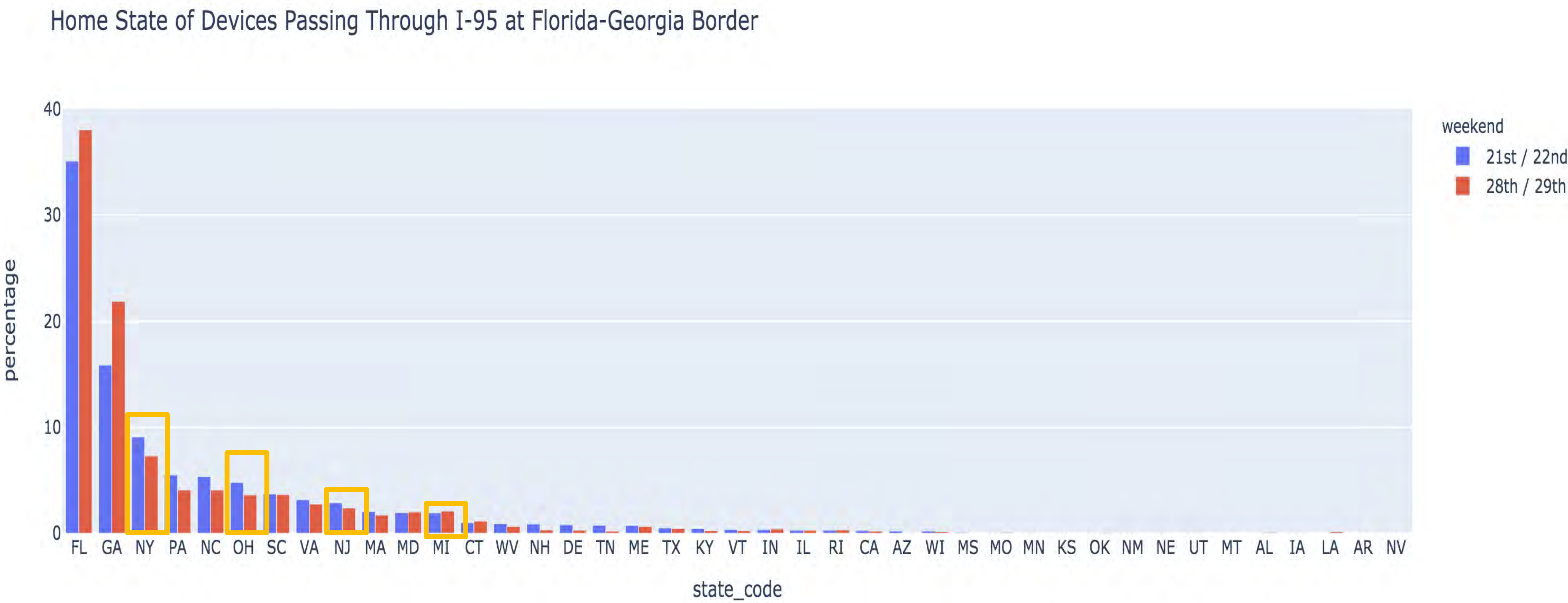
Retail establishments in NY State split by furniture, electronics & malls




Florida

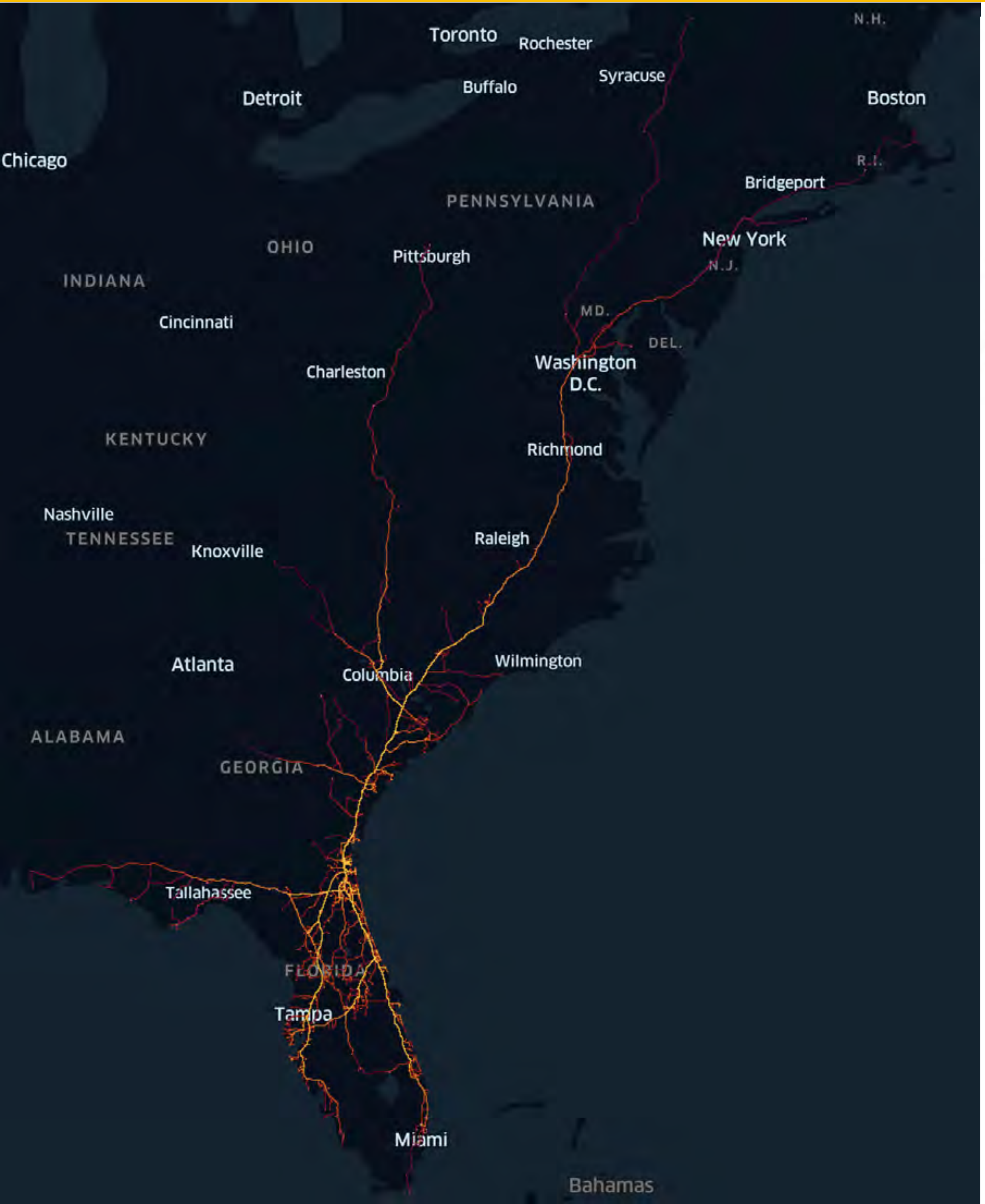
Vehicles traveling to FL during lockdown

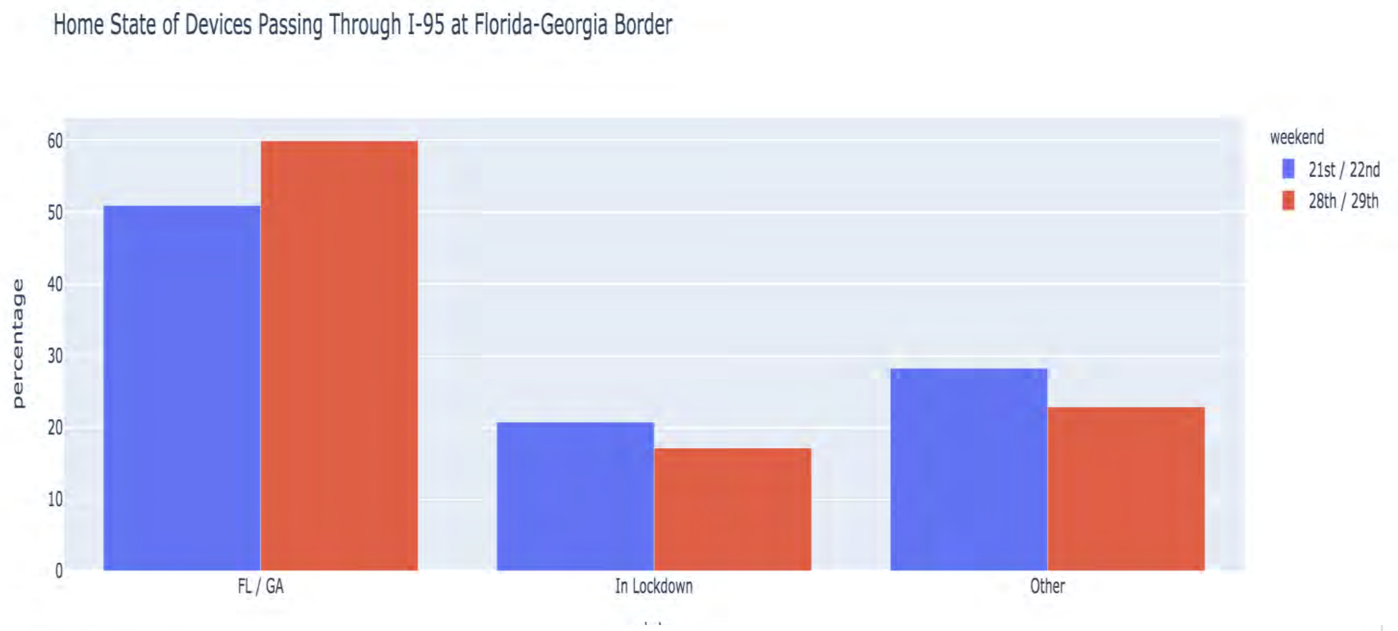


Florida begins coronavirus checkpoints, threatens jail time for out-of-state travelers who don't self-quarantine

Florida coronavirus checkpoints screen for motorists from hardest-hit areas

Gov. DeSantis: Rapid tests, travel checkpoints now part of Florida's fight against coronavirus





7:19 a.m.

Florida checkpoint shut down after causing massive traffic jam on I-95

An attempt to screen out-of-state drivers entering Florida backfired on Sunday when Interstate 95 came to a standstill, creating miles of traffic near the Georgia border.

David Jones
@DavidJonesTV

Wow. I-95 south is stopped at the FL state line as the new checkpoint screening begins. I didn't record past a minute but it keeps going into GA. @FCN2go

♡ 142 5:58 PM - Mar 29, 2020

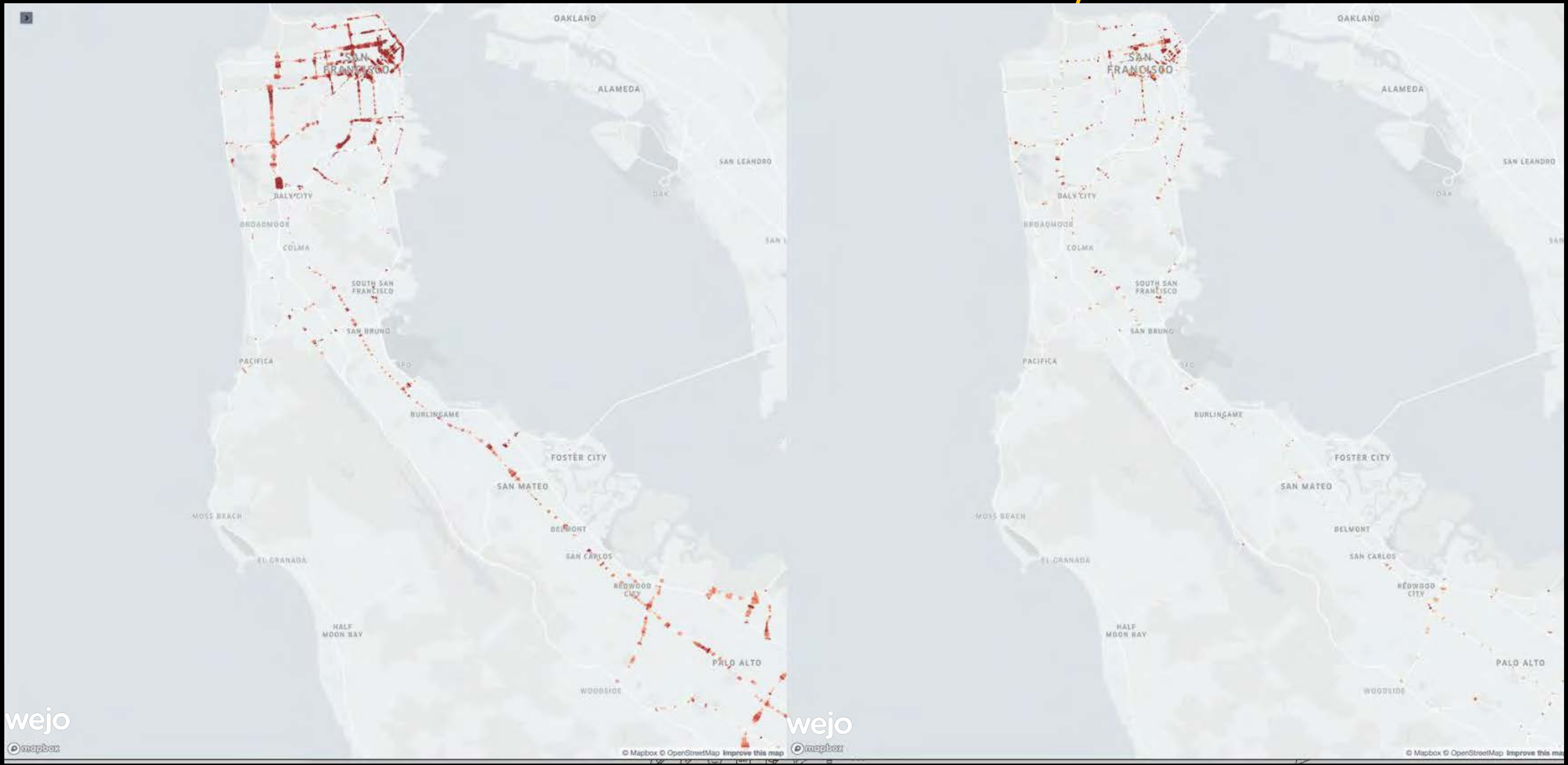
wejo

I-95 near Florida/ Georgia

0 Speed x

San Francisco

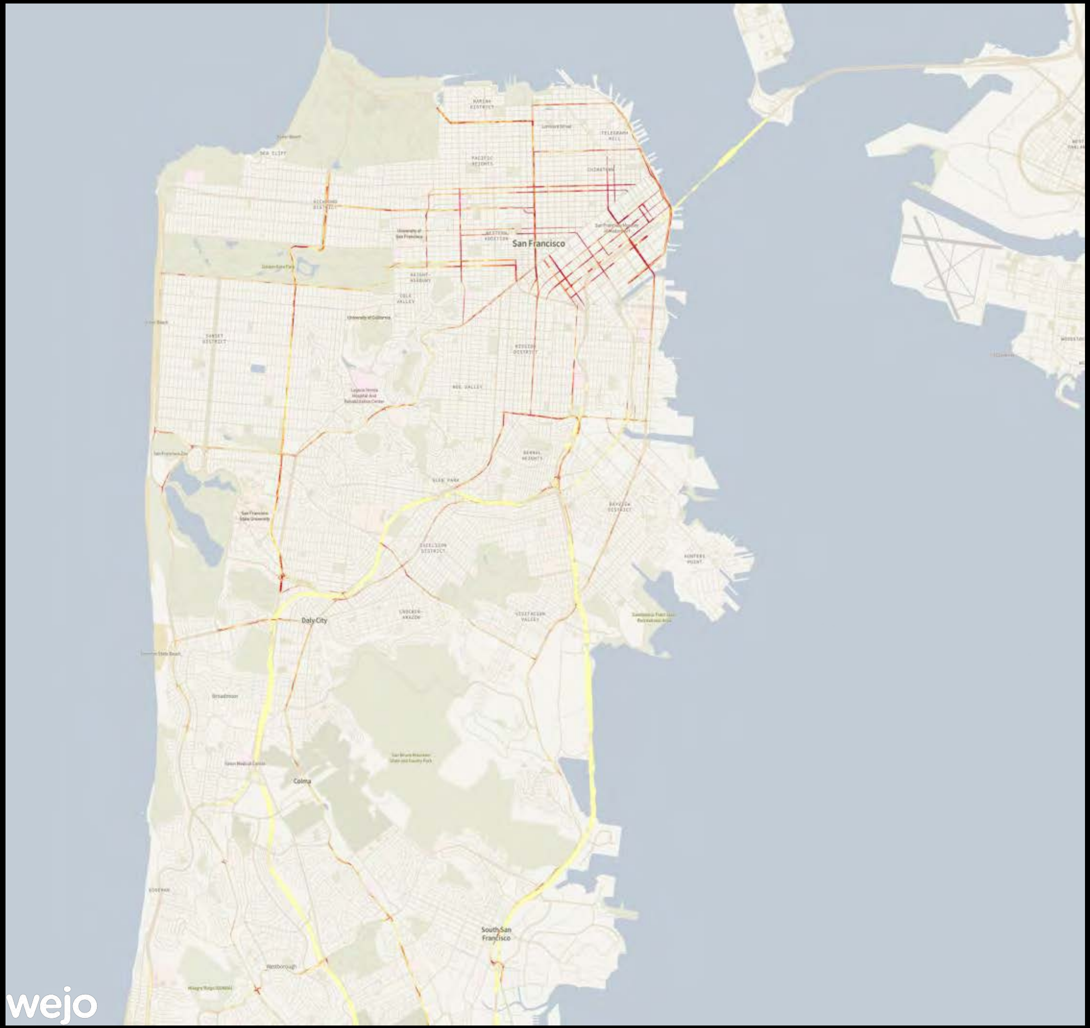
San Francisco case study



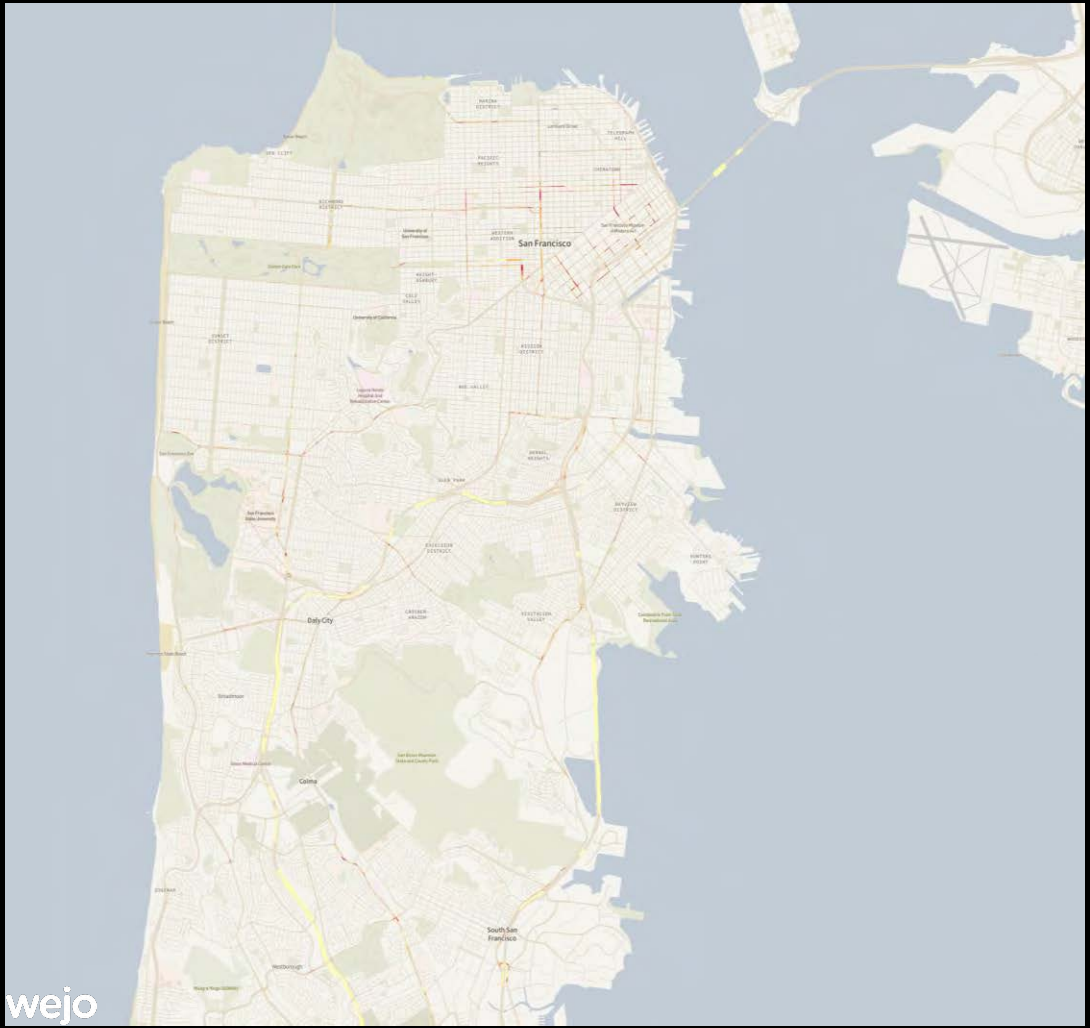
Friday 28th of Feb

Friday 20th of March

San Francisco case study

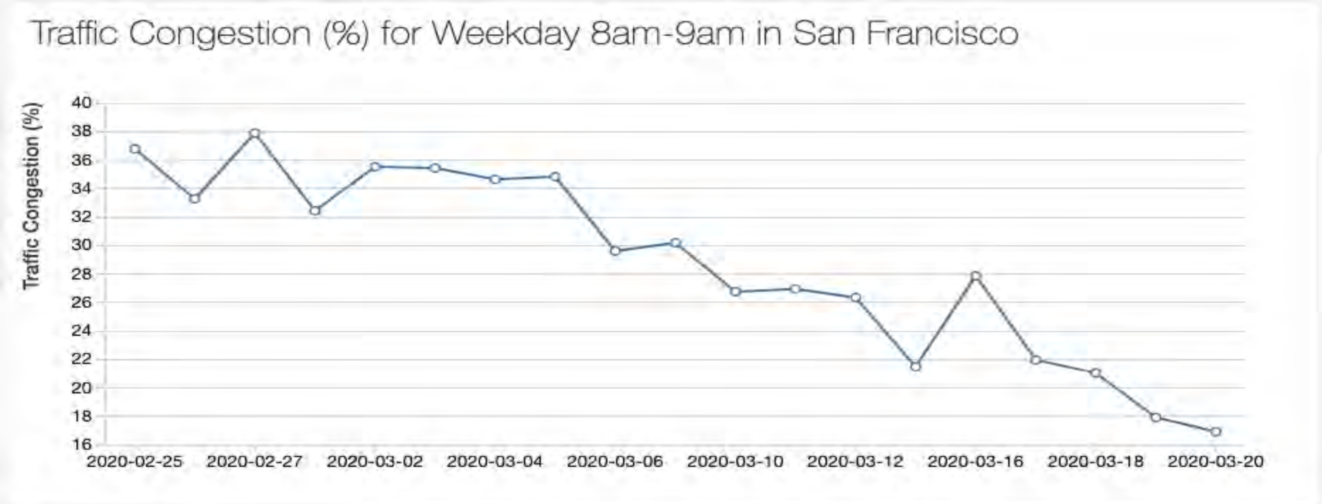


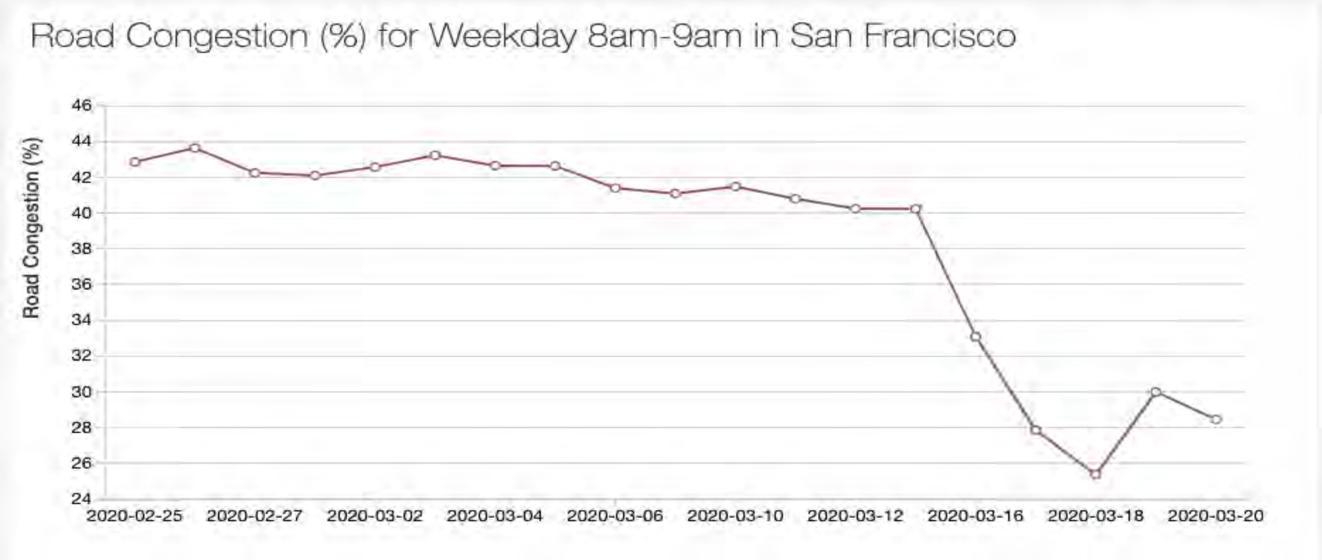
Friday 28th of Feb



Friday 20th of March

San Francisco case study





- In similarity to New York changes in behaviour during announcements over the 3 week period.

wejo

Q&A

Have further questions? email us at

bret.scott@wejo.com

wejo

Data Background

How wejo's data helps studies of this nature

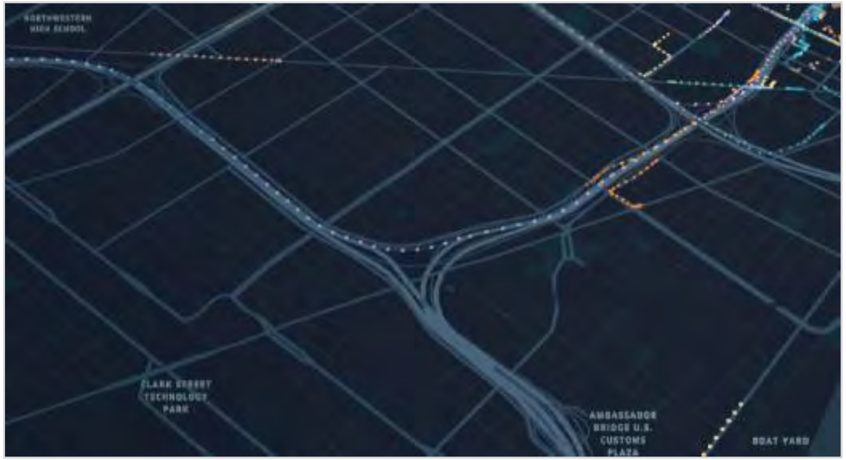
Jaap

Jim

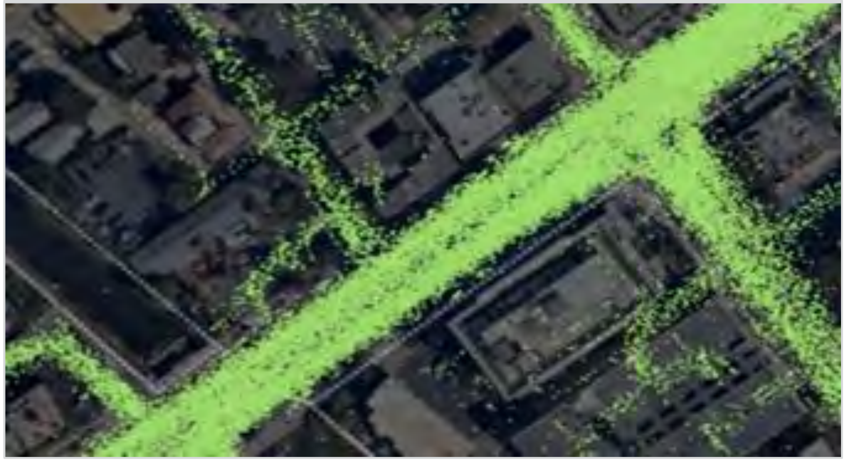
Introducing Wejo's connected car data

Key features of our rapidly growing, high resolution connected car data asset

3 second capture rate, with a latency of 30 seconds*.



High volume of journeys tracked, 1.3 billion per month.



Accuracy down to 3 metres† allowing identification of parking areas and speeds on highway lanes.

Historic events providing insight into incident hotspots.

* 95% of data points received by partners in 30 seconds. wejo SLA 60 seconds

†95% of data points accurate to 3m, biased on location.

Wejo data accuracy and precision

- Our precision is 6 decimal places
    - The blue square illustrates ***precision*** (the size of the square the lat long represents)
- Our accuracy is up to 3m dependant on points that we will cover
    - The Yellow circle's diameter being 3m shows wejo's CVD (Connected vehicle data) ***accuracy*** how much the blue square may move based on how well the lat long provided matches where it is

Data type	Accuracy
CVD yellow	Up to 3m*
Telematics Green	Up to 20m
Mobile Green	Up to 20m
Road sensor blue	10m – 100m

How Maps finds your current location

Maps estimates where you are from sources like:

- GPS: This uses satellites and knows your location up to around 20 meters. **Note:** When you're inside buildings or underground, the GPS is sometimes inaccurate.
- Wi-Fi: The location of nearby Wi-Fi networks helps Maps know where you are.
- Cell tower: Your connection to a cellular network can be accurate up to a few thousand meters.

Source: Google Maps Help https://support.google.com/maps/answer/2839911?hl=en&co=GENIE.Platform=Android

1. **Class 1** transmitting at **100 mW** with a range of **100 meters** or **328 feet**.
2. **Class 2** transmitting at **2.5 mW** with a range of **10 meters** or **33 feet** (most Bluetooth headsets and headphones are common Class 2 devices).
3. **Class 3** transmitting at **1 mW** with a range of fewer than **10 meters**.

Source: Science ABC https://www.scienceabc.com/innovation/what-is-the-range-of-bluetooth-and-how-can-it-be-extended.html

For illustrative purposes not to scale

Core Vehicle Attributes

Vehicle Movement Data

Core Attributes

Name	Description
Data Point ID	Unique identifier for an individual captured datapoint.
Journey ID	Unique identifier for individual vehicle's movements through to an ignition off event happening.
Captured data and time	Timestamp captured for each datapoint. (ISO8601). Including UTC off-set.
Latitude	The North-South positioning of the vehicle on the Earth's surface.
Longitude	The East-West positioning of the vehicle on the Earth's surface.
Speed	The speed in kilometres per hour that the vehicle was travelling at the time datapoint was captured
Heading	The direction that the vehicle was heading at the time the datapoint was captured
Ignition Status	The ignition status as the time the datapoint was captured

Optional Attributes

Name	Description
Geohash	Representation of a square on the Earth's surface.
Zip Code	The zip or postal code in which the vehicle was located at the time of datapoint capture.
State / Region Code	The region/state code in which the vehicle was located at the time of datapoint capture.
Country Code	The country in which the vehicle was location at the time of datapoint capture.
Squish VIN	A subset of the characters in a standard 17 character VIN solely to describe the vehicle make, model and production year and not to identify individual any vehicle. The first 8 characters with the 9^{th} character skipped and then the 10^{th} and 11^{th} characters.
Vehicle Make	The make of the vehicle at the time of datapoint capture.
Vehicle Model	The model of the vehicle at the time of datapoint capture.
Vehicle Year	The year in which the vehicle was manufactured at the time of datapoint capture.

Driver Event Data

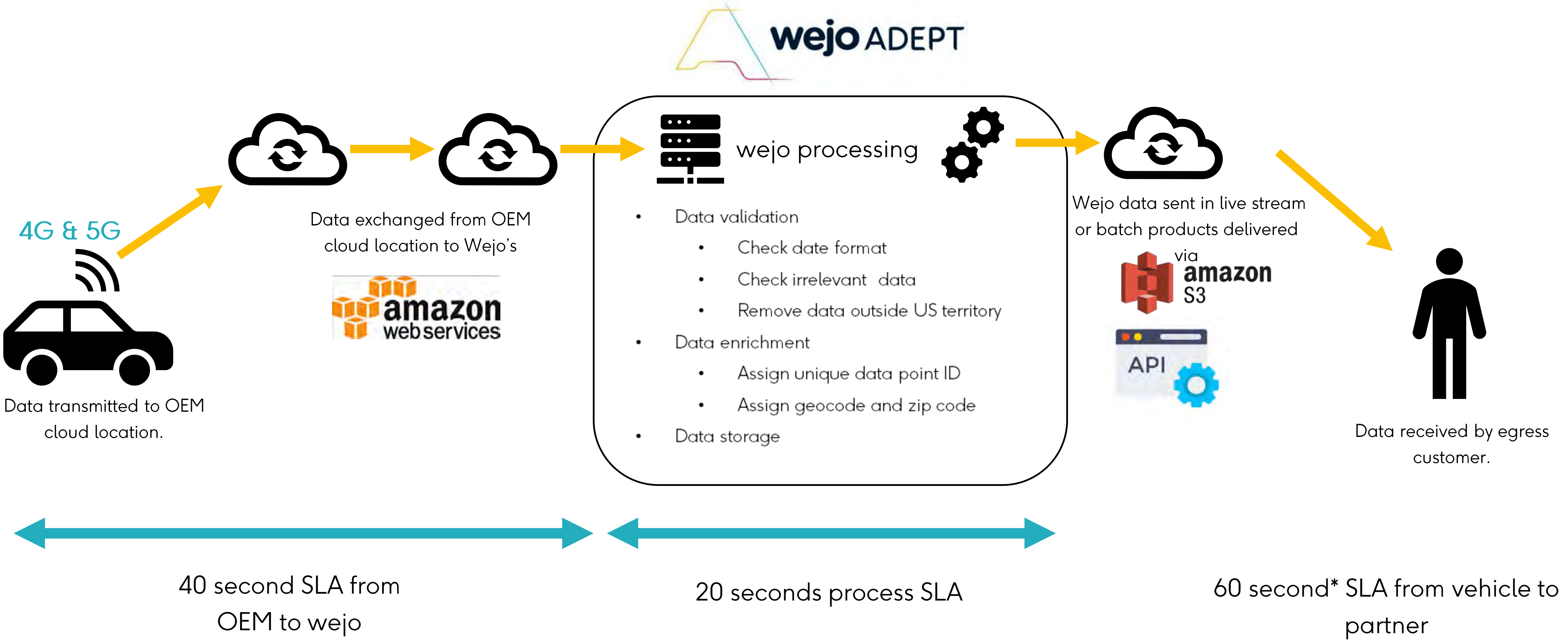
Core Attributes

Name	Description
Datapoint ID	Unique identifier for the for the event
Trip ID	Unique identifier for an individual vehicle's movements through to an ignition off event happening.
Device ID	Unique identifier for the vehicle that the event was recorded by
Captured Date and Time	Timestamp captured for each datapoint.
Time zone offset	Time zone offset of the captured timestamp
Latitude	The North-South positioning of the vehicle on the Earth's surface.
Longitude	The East-West positioning of the vehicle on the Earth's surface.
Speed	The speed in kilometres per hour that the vehicle was travelling at the time datapoint was captured.
Heading	The direction that the vehicle was heading at the time the datapoint was captured
Ignition State	Representation of ignition state when the datapoint was captured
Event Type	An identifier for the recorded event (See "Event Types" section)
Journey Event Change Type	Ignition on or ignition off
Seatbelt Change Type	Latched or unlatched
Acceleration Change Type	Harsh braking or harsh acceleration
Speed Threshold Event Type	Speed above or below threshold

Optional Attributes

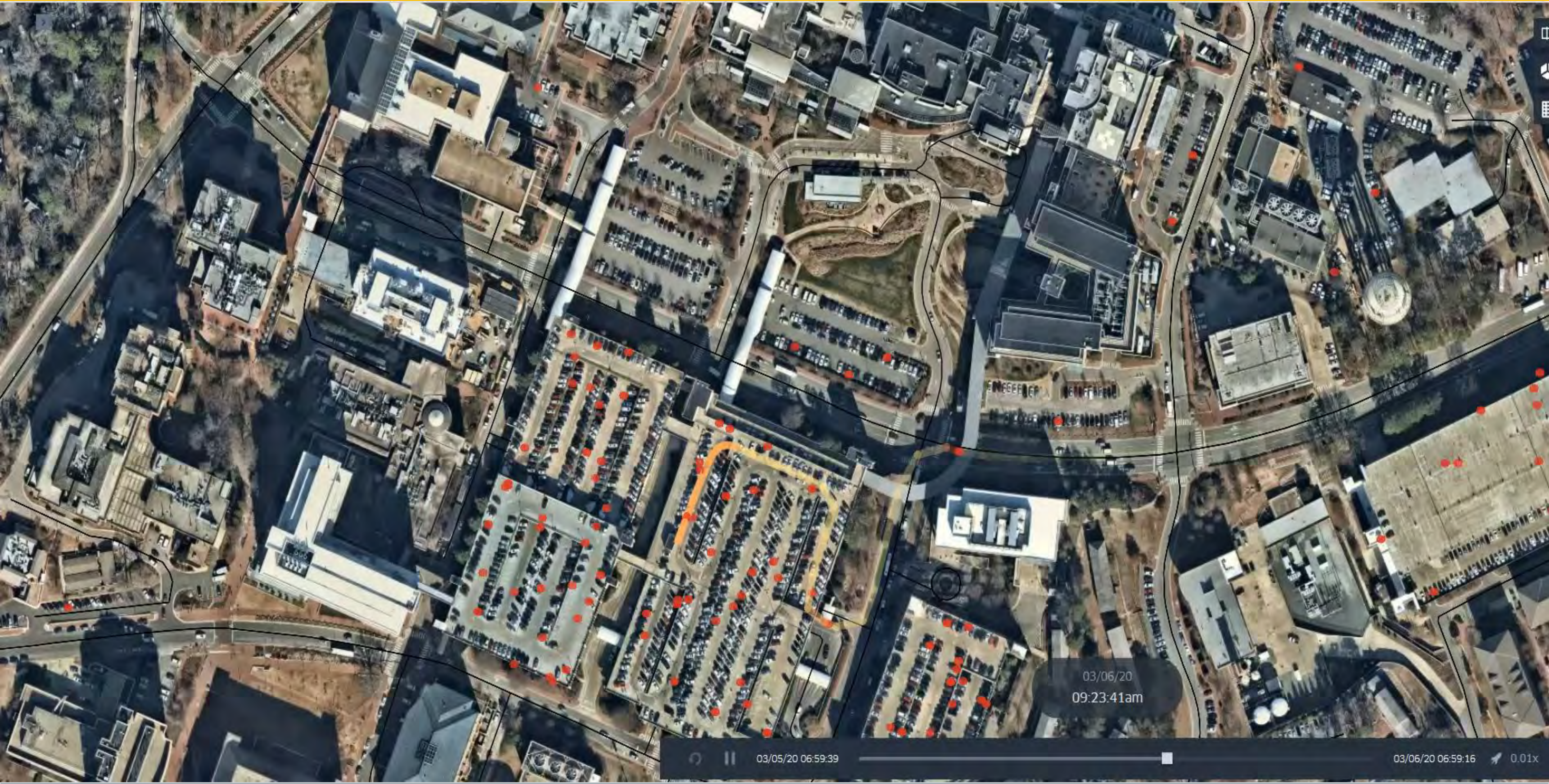
Name	Description
Geohash	Representation of a square on the Earth's surface.
Zip Code	The zip or postal code in which the vehicle was located at the time of datapoint capture.
State / Region Code	The region/state code in which the vehicle was located at the time of datapoint capture.
Country Code	The country in which the vehicle was located at the time of datapoint capture.

Wejo data process



* 95% of data points received by partners in 30 seconds. wejo SLA 60 seconds


Wejo data identifying that the new road construction is complete and in use satellite image has not been updated by provider to show new road
https://goo.gl/maps/LqWDE1P6ZKb9GCax6



North Carolina Hospital

0 Speed x