2023 FAV Summit: Emerging Multimodal Applications

Moderator: Nixon Harwell, ICMA, FCCM
Airport Planning Manager
Florida Department of Transportation

Friday, September 8
10:30 am-12:00 pm

FDOT D2 Rail Detection Technology Initiative

Peter Vega
TSM&O Program Manager
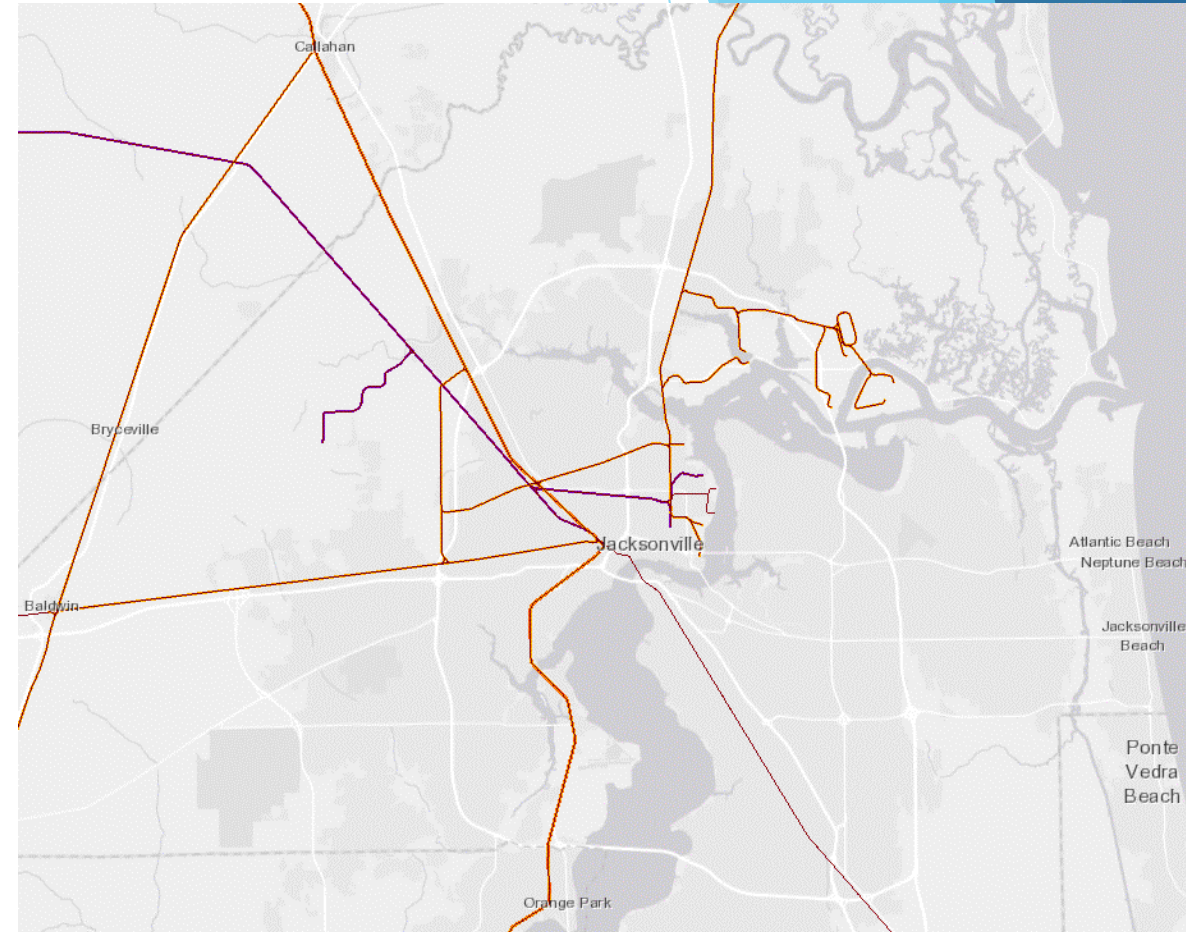Florida Department of Transportation

Rail Detection Initiative FDOT District Two

Peter Vega, PE

FDOT D2 TSM&O Program Manager

Railroads in District Two

- Nine railroads operate within District Two

- Jacksonville alone contains six, and is home to the headquarters of CSX and FEC

- Major routes along US 1, US 17, US 90, US 301

Unique Challenge on the Southbank

▶ Freight rail crossings cause urban congestion

▶ Baptist Medical Center can be blocked

▶ The nearby rail yard can cause long trains to slow or stop on crossings
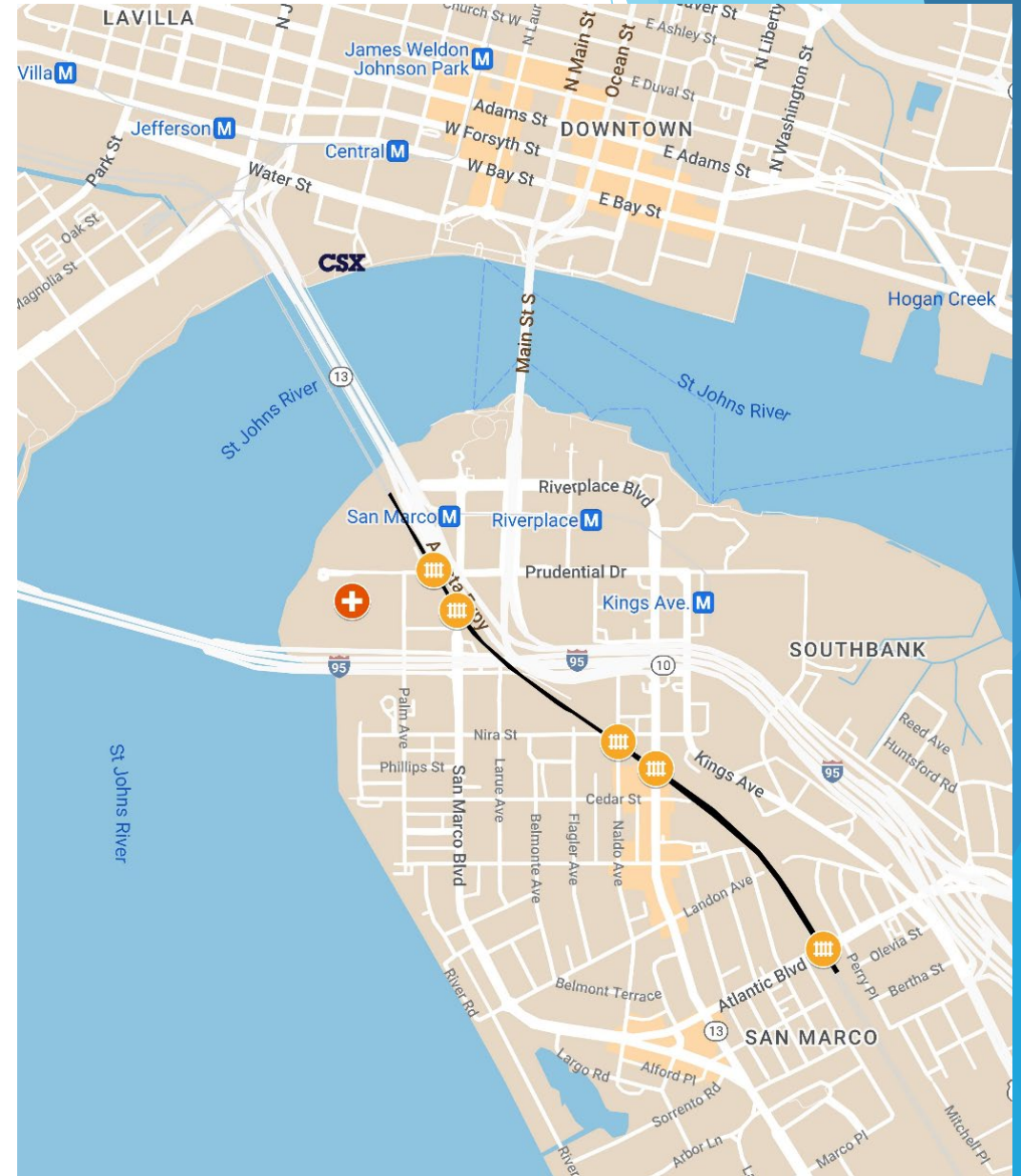
Concept of Operations

- Detect
  - Train presence at each crossing
  - Average speed, length, direction
- Notify
  - RTMC
  - EMS dispatch
  - Drivers (SmartPhone App, OBUs)
- Analyze
  - Historical corridor measures
  - Predict blockages, congestion, schedule, signal timing implications
 - Provide data access to Freight Department

Evaluation

- Determine the best detection technology
  - Microwave
    - Costly, multiple sensors, stringent mounting requirements, car-centric detection
    - Did not evaluate ✘
  - Lidar
    - Price was dropping, technology is improving, very precise data
    - Evaluate ✔
  - Video
    - On-board analytics are getting better, good value, provides visual confirmation
    - Evaluate ✔
  - Acoustic
    - Innovative, simple solution and simple deployment
    - Evaluate ✔
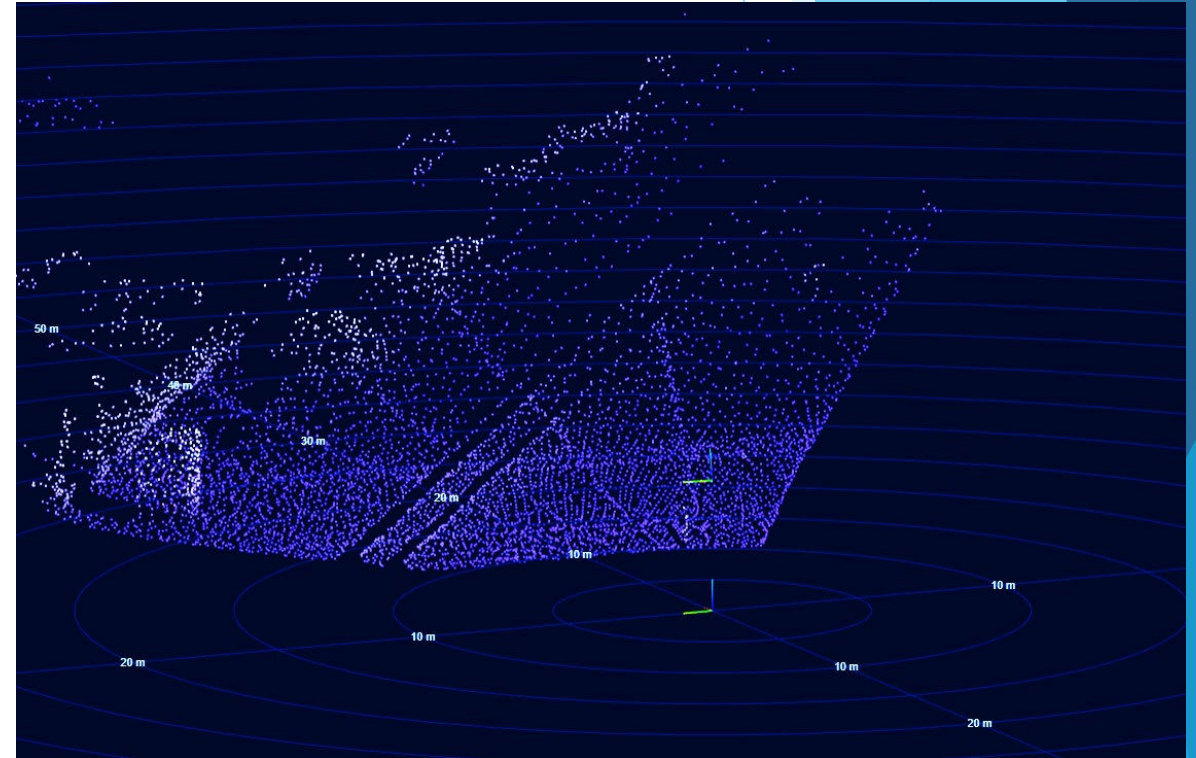- TERL-permitted device test

Lidar & Video Analytics Field Assessment
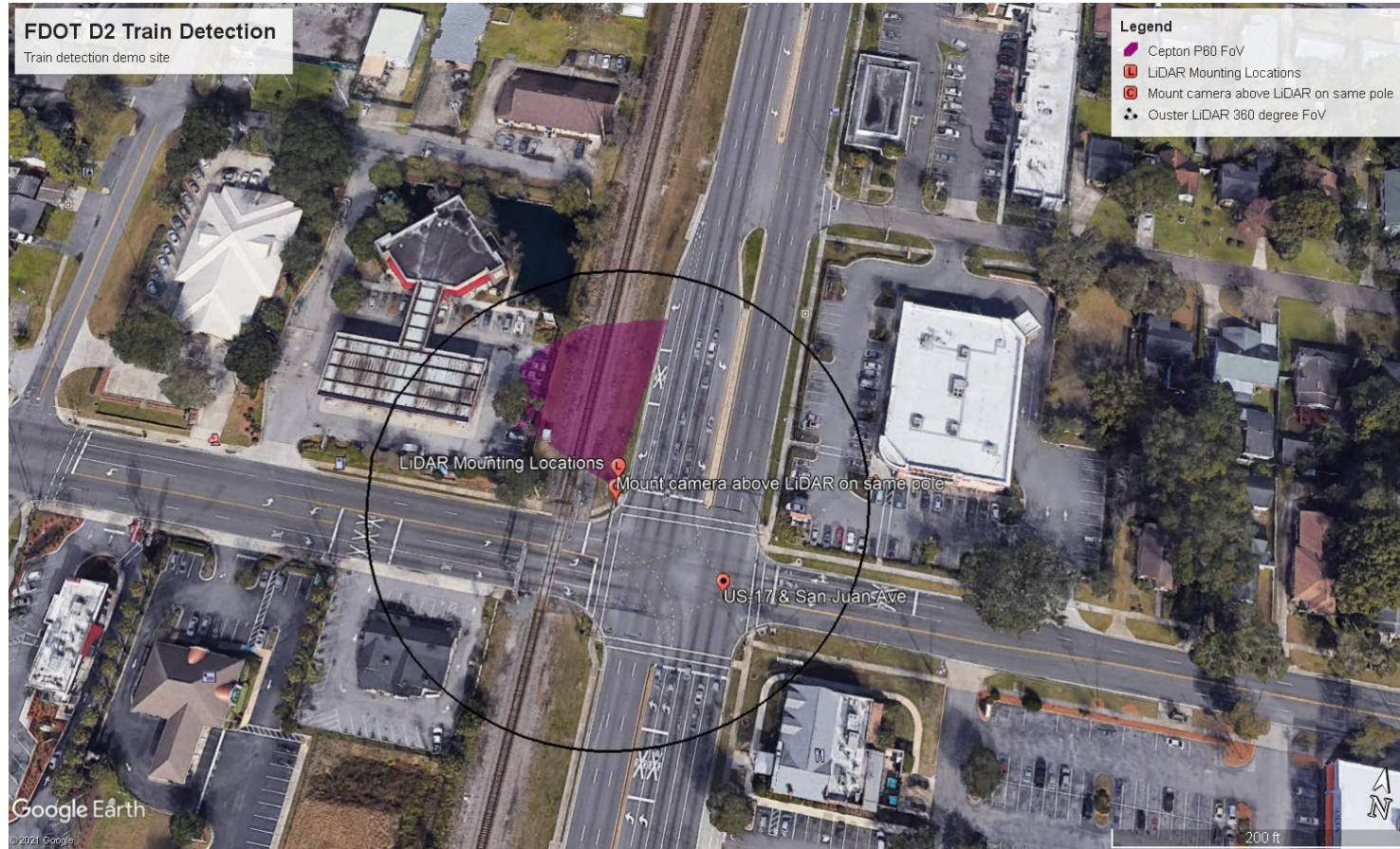
Lidar & Video Analytics Field Assessment
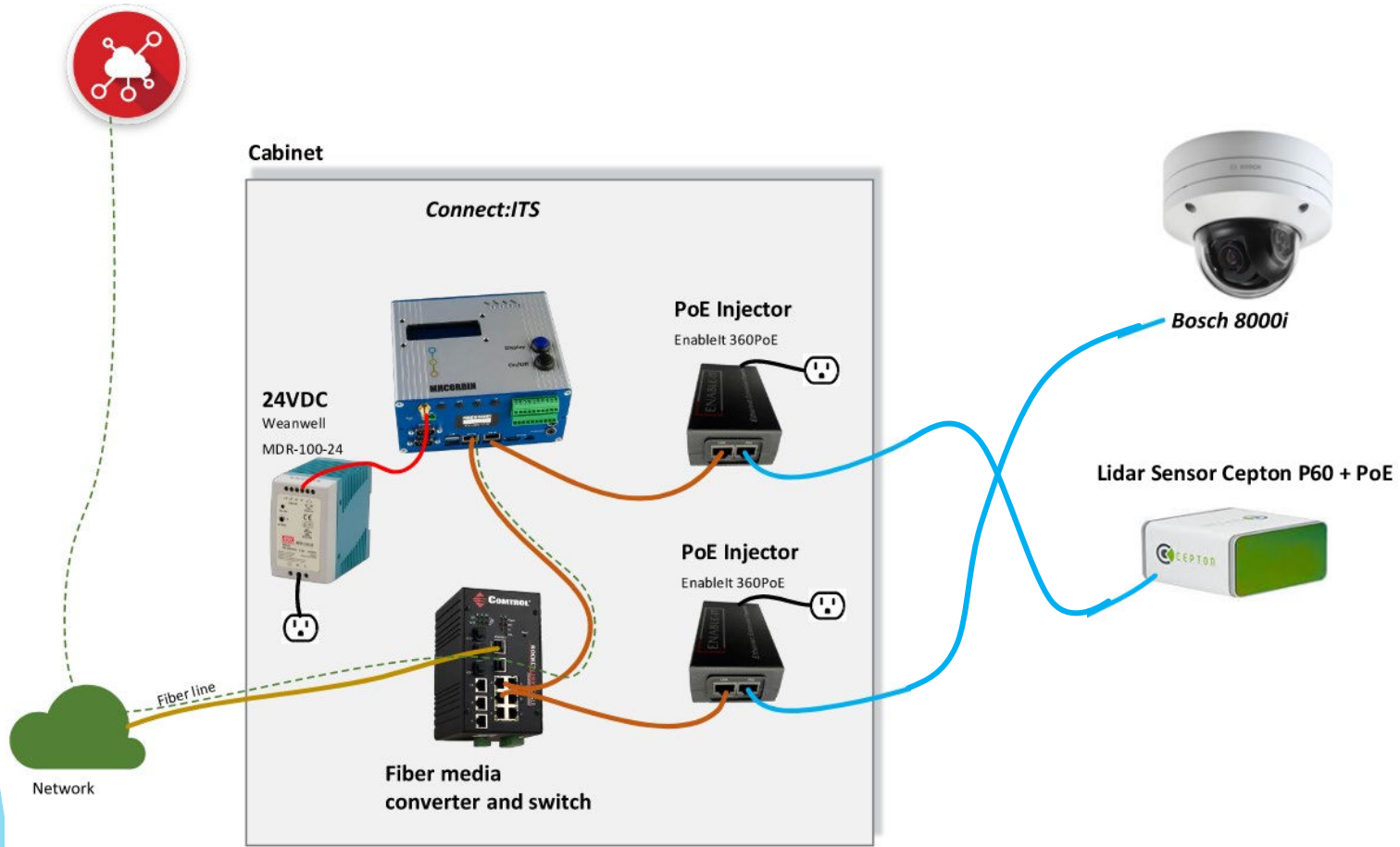
# Lidar & Video Analytics Field Assessment

Video Analytics Results

from 8/26/21 to 9/1/21

ATMS	Prempt	Metiri	Result	Direction
		08/26/21-Thu-12:05:31	Maintenance	southbound
08/26/21-Thu-15:58:09 CYC PRMT		08/26/21-Thu-15:58:44	Match	southbound
08/26/21-Thu-15:59:06 END		08/26/21-Thu-15:58:46	Match	southbound
08/26/21-Thu-16:48:37 CYC PRMT		08/26/21-Thu-16:49:32	Match	northbound
08/26/21-Thu-16:49:41 END		08/26/21-Thu-16:49:35	Match	northbound
08/26/21-Thu-17:13:39 CYC PRMT		08/26/21-Thu-17:14:51	Match	northbound
08/26/21-Thu-17:14:56 END			Short train	
08/26/21-Thu-18:22:09 CYC PRMT		08/26/21-Thu-18:23:13	Match	northbound
08/26/21-Thu-18:24:42 END		08/26/21-Thu-18:23:33	Match	northbound
08/26/21-Thu-22:50:16 CYC PRMT		08/26/21-Thu-22:51:19	Match	northbound
08/26/21-Thu-22:51:33 END		08/26/21-Thu-22:51:28	Match	northbound
08/27/21-Fri-05:55:22 CYC PRMT		08/27/21-Fri-05:56:00	Match	southbound
08/27/21-Fri-05:57:28 END		08/27/21-Fri-05:56:27	Match	southbound
08/27/21-Fri-08:12:56 CYC PRMT		08/27/21-Fri-08:13:32	Match	southbound
08/27/21-Fri-08:13:55 END		08/27/21-Fri-08:13:40	Match	southbound
08/27/21-Fri-10:08:01 CYC PRMT		08/27/21-Fri-10:08:33	Match	southbound
08/27/21-Fri-10:08:51 END		08/27/21-Fri-10:08:35	Match	southbound
		08/27/21-Fri-16:08:01	Maintenance	northbound
08/27/21-Fri-17:02:30 CYC PRMT		08/27/21-Fri-17:03:44	Match	northbound
08/27/21-Fri-17:03:47 END			Short train	
08/27/21-Fri-18:29:15 CYC PRMT		08/27/21-Fri-18:31:38	Match	northbound
08/27/21-Fri-18:31:44 END		08/27/21-Fri-18:31:41	Match	northbound
08/27/21-Fri-21:14:32 CYC PRMT		08/27/21-Fri-21:15:16	Match	southbound
08/27/21-Fri-21:18:20 END		08/27/21-Fri-21:15:31	Match	southbound
08/27/21-Fri-22:17:33 CYC PRMT		08/27/21-Fri-22:18:36	Match	northbound
08/27/21-Fri-22:18:40 END			Short train	
08/28/21-Sat-04:44:47 CYC PRMT		08/28/21-Sat-04:45:44	Match	northbound
08/28/21-Sat-04:48:20 END		08/28/21-Sat-04:46:26	Match	northbound
08/28/21-Sat-06:33:40 CYC PRMT		08/28/21-Sat-06:34:16	Match	southbound
08/28/21-Sat-06:35:46 END		08/28/21-Sat-06:34:36	Match	southbound
08/28/21-Sat-08:08:53 CYC PRMT		08/28/21-Sat-08:10:09	Match	northbound
08/28/21-Sat-08:13:47 END		08/28/21-Sat-08:11:10	Match	northbound
08/28/21-Sat-08:16:36 CYC PRMT		08/28/21-Sat-08:17:11	Match	southbound
08/28/21-Sat-08:17:35 END		08/28/21-Sat-08:17:23	Match	southbound
08/28/21-Sat-09:54:25 CYC PRMT		08/28/21-Sat-09:54:58	Match	southbound
08/28/21-Sat-09:55:24 END			Short train	
08/28/21-Sat-16:32:25 CYC PRMT		08/28/21-Sat-16:33:25	Match	northbound
08/28/21-Sat-16:33:36 END		08/28/21-Sat-16:33:30	Match	northbound
08/28/21-Sat-18:27:49 CYC PRMT			Only caught end	northbound
08/28/21-Sat-18:30:22 END		08/28/21-Sat-18:30:21	Match	
08/28/21-Sat-23:02:01 CYC PRMT		Sat-23:02:55	Match	southbound
		Sat-23		
		at-		

Presence Detection Accuracy

99.06%
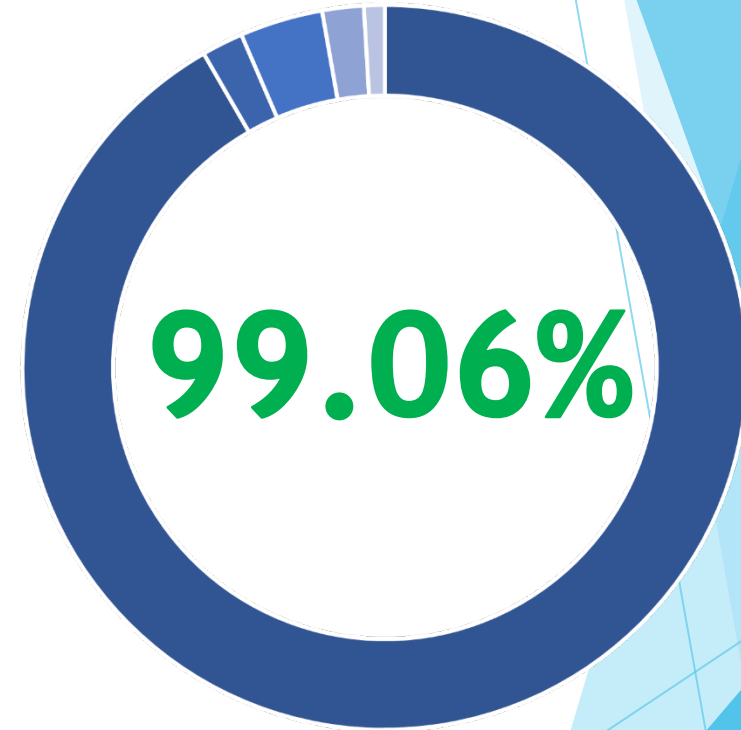
■ True Positive ■ Only Detected End ■ Maintenance Vehicle ■ Wrong Direction ■ False Positive
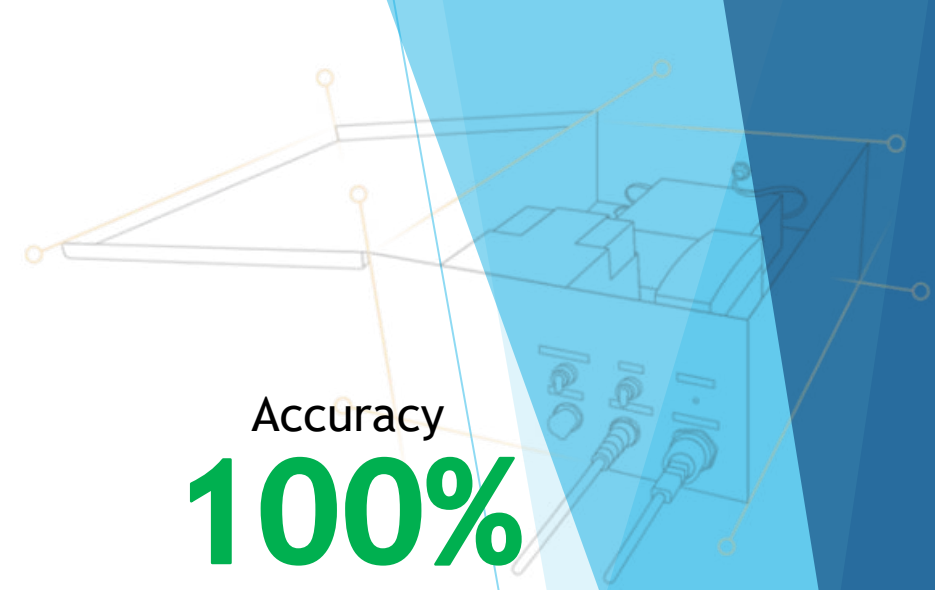
Acoustic Sensor Field Assessment
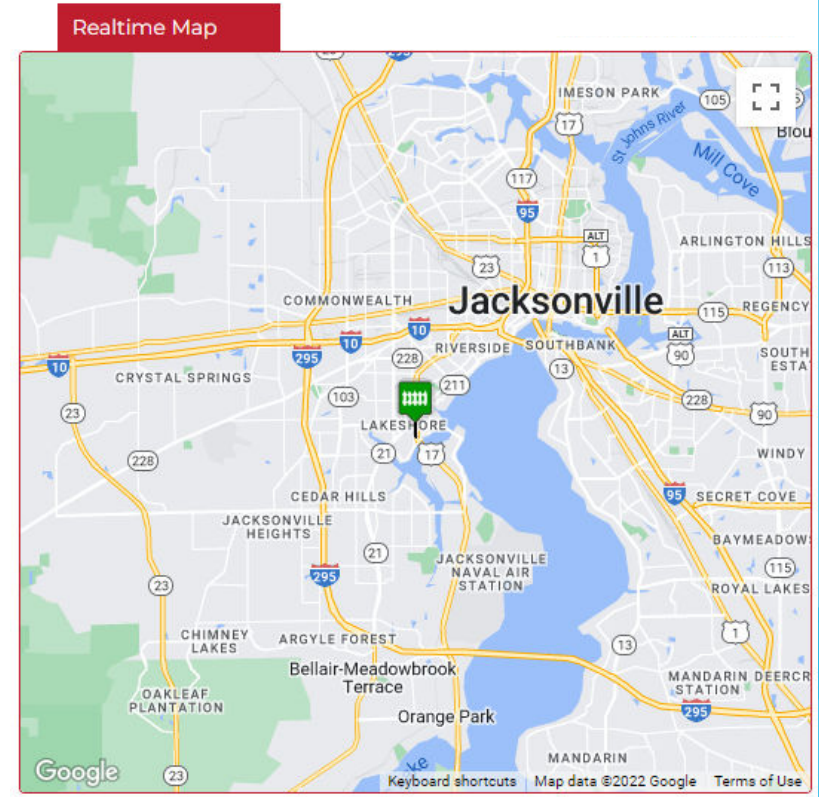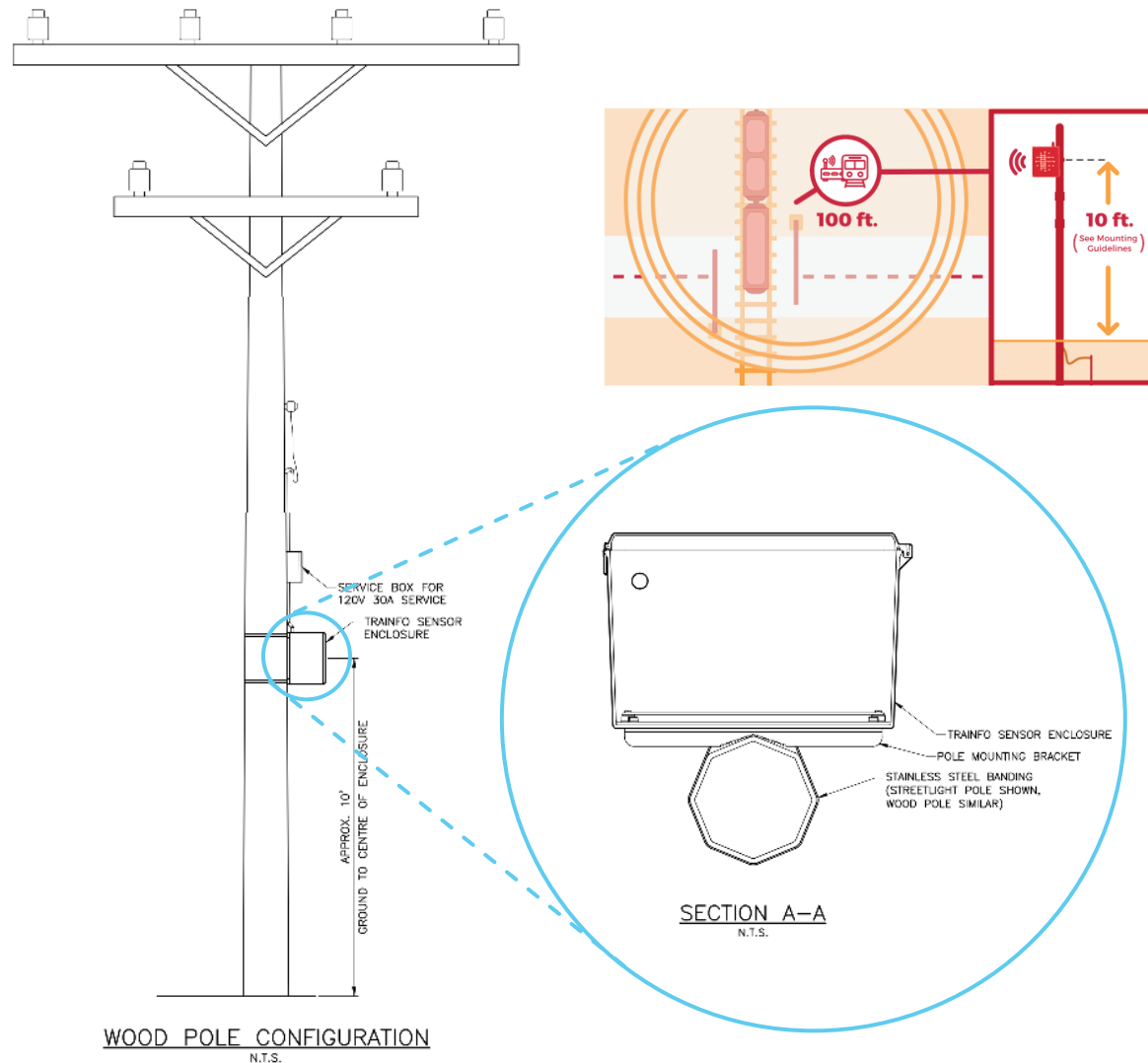
Acoustic Sensor Field Assessment

Acoustic Sensor Results

from 6/27/22 to 7/4/22

ATMS ("Ground Truth")			TRAINFO			Result	Start Time Difference (sec)	Duration Difference (sec)
Date	Time	Duration (min)	Date	Time	Duration (min)			
6/27/2022	5:01:50 PM	1.90	6/27/2022	5:01:53 PM	2.05	Match	3	9.0
6/27/2022	6:26:55 PM	4.13	6/27/2022	6:26:57 PM	4.27	Match	2	8.2
6/27/2022	8:10:02 PM	1.92	6/27/2022	8:10:03 PM	2.08	Match	1	9.8
6/27/2022	10:30:49 PM	1.45	6/27/2022	10:30:49 PM	1.60	Match	0	9.0
6/28/2022	1:04:43 AM	4.17	6/28/2022	1:04:43 AM	4.35	Match	0	11.0
6/28/2022	7:44:25 AM	1.15	6/28/2022	7:44:29 AM	1.25	Match	4	6.0
6/28/2022	8:59:22 AM	1.03	6/28/2022	8:59:32 AM	0.98	Match	10	-3.2
6/28/2022	1:59:36 PM	1.83	6/28/2022	1:59:40 PM	1.92	Match	4	5.2
6/28/2022	4:03:10 PM	1.63	6/28/2022	4:03:12 PM	1.75	Match	2	7.0
6/28/2022	5:45:47 PM	4.27	6/28/2022	5:45:48 PM	4.40	Match	1	8.0
6/28/2022	10:37:27 PM	1.53	6/28/2022	10:37:29 PM	1.55	Match	2	1.0
6/28/2022	11:23:03 PM	4.15	6/28/2022	11:23:04 PM	4.10	Match	1	-3.0
6/29/2022	12:50:42 AM	2.27	6/29/2022	12:50:42 AM	2.15	Match	0	-7.0
6/29/2022	6:48:04 AM	1.60	6/29/2022	6:48:06 AM	1.72	Match	2	7.2
6/29/2022	8:07:25 AM	0.93	6/29/2022	8:07:29 AM	1.05	Match	4	7.0
6/29/2022	8:11:20 AM	1.02	6/29/2022	8:11:42 AM	0.68	Match *	22	-20.2
6/29/2022	12:45:46 PM	1.28	6/29/2022	12:45:50 PM	1.38	Match	4	5.8
6/29/2022	1:51:30 PM	1.10	6/29/2022	1:51:34 PM	1.23	Match	4	7.8
6/29/2022	7:35:44 PM	2.85	6/29/2022	7:35:48 PM	2.97	Match	4	7.2
6/29/2022	11:51:26 PM	1.58	6/29/2022	11:51:29 PM	1.42	Match	3	-9.8
6/30/2022	4:52:20 AM	4.52	6/30/2022	4:52:23 AM	4.43	Match	3	-5.2
6/30/2022	8:40:21 AM	0.93	6/30/2022	8:40:46 AM	0.48	Match	25	-27.2
6/30/2022	8:56:16 AM	1.10	6/30/2022	8:56:41 AM	0.63	Match	25	-28.2
6/30/2022	11:01:36 AM	4.32	6/30/2022	11:01:41 AM	4.42	Match	5	6.2
6/30/2022	1:35:57 PM	2.35	6/30/2022	1:36:00 PM	2.40	Match	3	3.0
6/30/2022	3:59:39 PM	1.05	6/30/2022	3:59:42 PM	1.17	Match	3	7.2
6/30/2022	11:52:40 PM	1.50	6/30/2022	11:52:43 PM	1.50	Match	3	0.0
7/1/2022	12:10:14 AM	2.80	7/1/2022	12:10:14 AM	2.95	Match	0	9.0
7/1/2022	8:05:37 AM	1.65	7/1/2022	8:05:39 AM	1.78	Match	2	7.8
7/1/2022	9:39:00 AM	0.88	7/1/2022	9:39:04 AM	1.00	Match	4	7.0
7/1/2022	7:38:32 PM	2.52	7/1/2022	7:38:36 PM	2.62	Match	4	6.2
7/1/2022	11:25:26 PM	2.07	7/1/2022	11:25:30 PM	1.95	Match	4	-7.0
7/2/2022	9:21:26 AM	0.92	7/2/2022	9:21:29 AM	1.07	Match	3	9.2
7/2/2022	10:33:03 AM	1.72	7/2/2022	10:33:06 AM	1.85	Match	3	8.0
7/2/2022	9:17:28 PM	2.45	7/2/2022	9:17:31 PM	2.57	Match	3	7.2
7/2/2022	11:17:38 PM	1.63	7/2/2022	11:17:42 PM	1.67	Match	4	2.2
7/3/2022	7:05:50 AM	1.48	7/3/2022	7:05:51 AM	1.62	Match	1	8.2
7/3/2022	7:42:46 AM	1.62	7/3/2022	7:42:48 AM	1.77	Match	2	9.2
7/3/2022	10:06:51 AM	0.92	7/3/2022	10:06:55 AM	0.98	Match	4	3.8
7/3/2022	2:27:25 PM	4.48	7/3/2022	2:27:27 PM	4.62	Match	2	8.2
7/3/2022	3:31:13 PM	2.93	7/3/2022	3:31:	3.05	Match	3	7.0
7/3/2022		2.33	7/3/2022		2.45	Match	3	7.0
					1.68			
					1.6			

Accuracy
100%

Average Latency
4 sec

Closure Duration Error
±7.8 sec

NFTPO Southbank Study

▶ Back to the problem statement:
Unique Challenge on the Southbank

    ▶ Data collection using acoustic/video detection systems

    ▶ Congestion analysis, comparing closures against travel time/ origin-destination (Bluetooth sensors)

▶ Evaluating online portal's historical insights

▶ Share portal with RTMC to determine UI improvements and/or potential applications

▶ FDOT to take ownership/maintenance of devices once study is complete
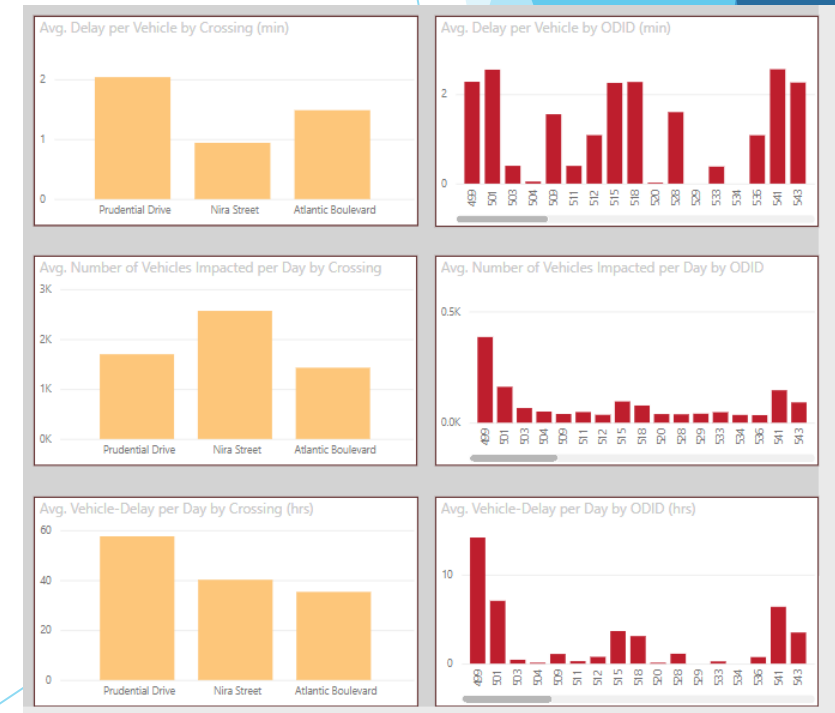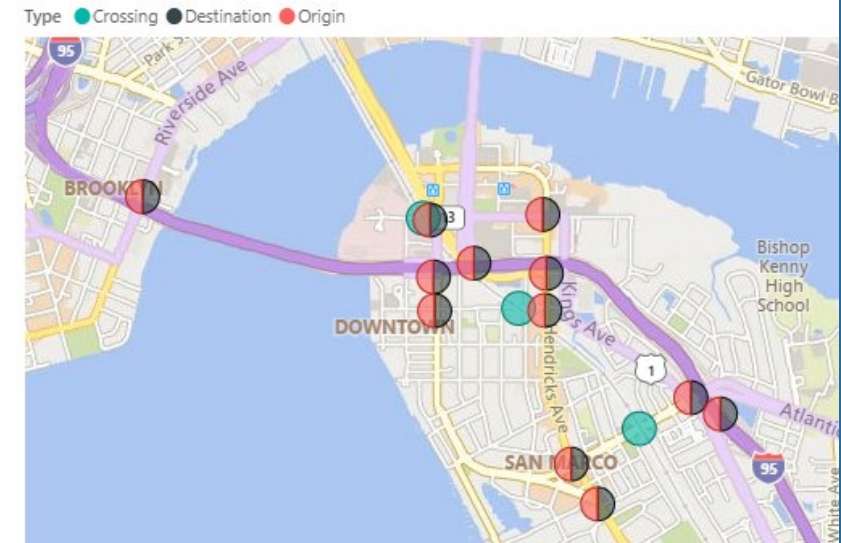
Corridor Evaluation

- How dense must sensor placement be?
  - Realtime presence/rerouting (dense?), predicting crossing TOD/length (sparse?)
  - Good interpolation algorithm, but what if a stopped train blocks an unequipped crossing?
- What data is worth sharing to dispatch, drivers, and/or partner agencies?
- Train behavior and characteristics
  - Freight vs passenger activity, applications, safety
  - How often are blockages longer than 5, 20, 60 minutes?
- Better source of data than complaints, FRA crossing reports, field investigation, preemption logs

Expansion

▶ Cover more corridors

  ▶ 20 crossings along US 17 between I-295 and I-10 for dense corridor evaluation

  ▶ 20 more crossings to work our way out to other counties

    ▶ Nassau (US 17), St Johns (US 1), and Clay (US 17)

  ▶ Mix of acoustic and video for crossing detection

    ▶ Acoustic evaluation: draw bridge horn detection

    ▶ Video evaluation: train characteristics analysis

▶ Dissemination

  ▶ EMS dispatch at high priority crossings

  ▶ FL511 and WAZE for general wayfinding

  ▶ SunGuide®/DMS for complete system integration and automation

  ▶ On-Board Units

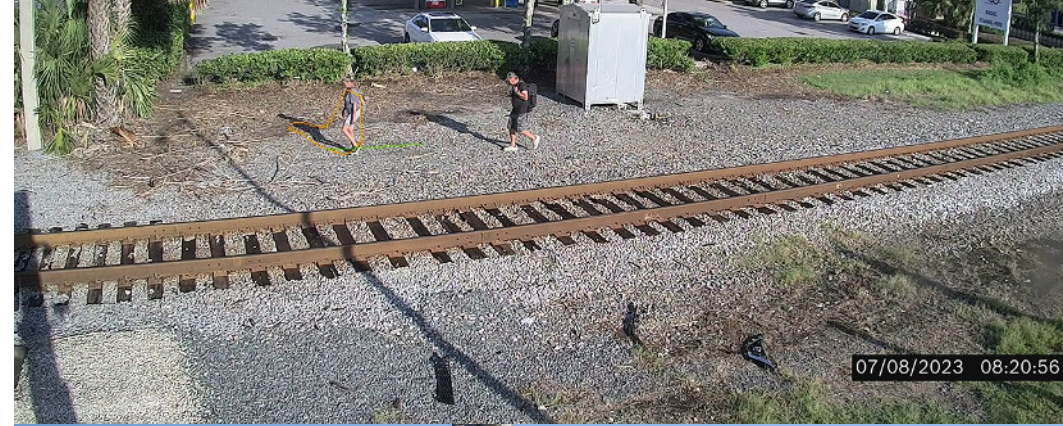 ▶ Beacons for edge cases, similar to draw bridge notification systems
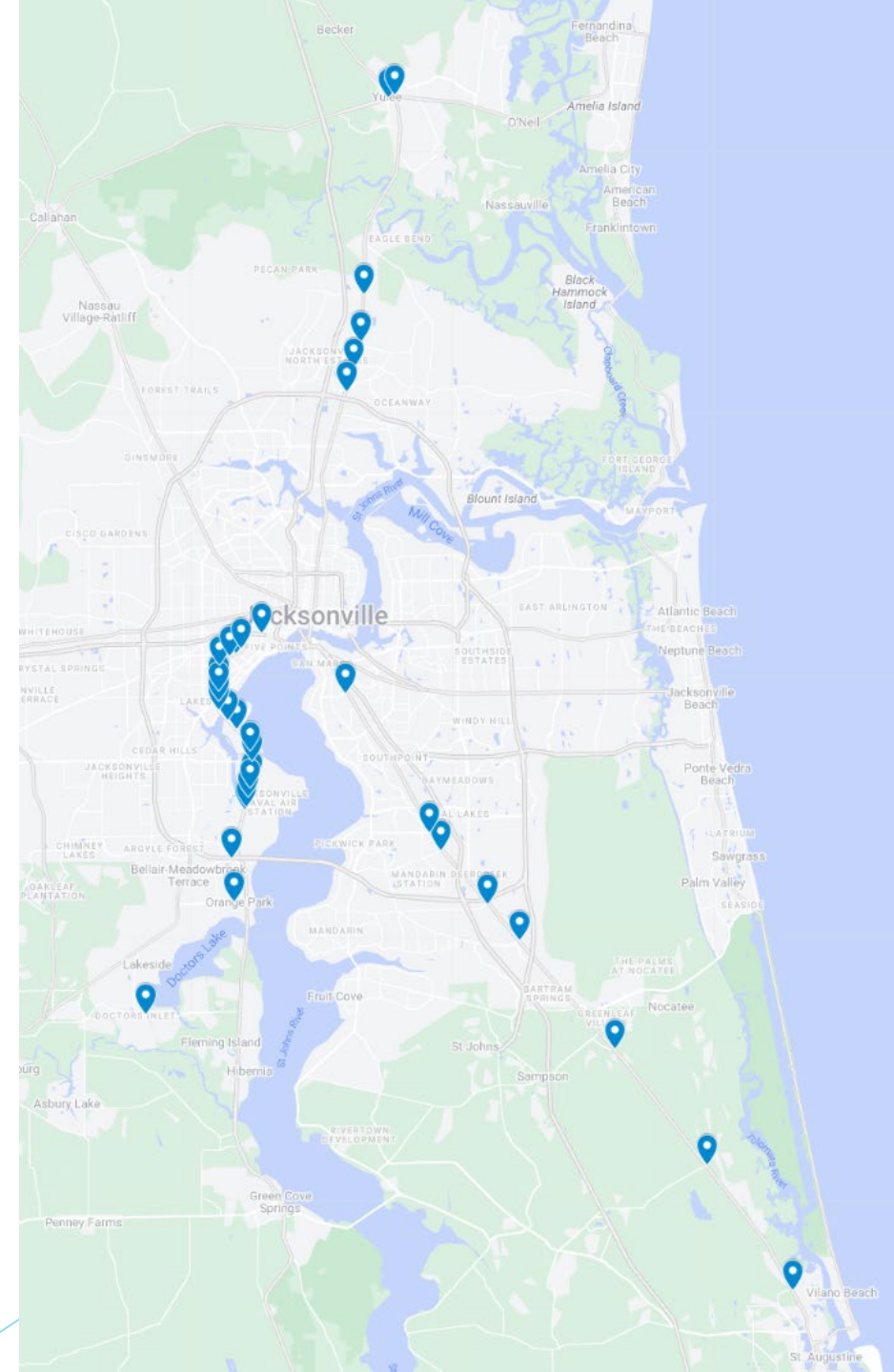
Lessons Learned

- Lidar
  - Still not there yet
  - Perception algorithm needs improvement
  - Price is going up due to "market forces"
- Video
  - Can be used for other "rail crossing interactions"
  - Typical video detection weaknesses
  - Improved by advanced detection algorithms vs on-board
- Acoustic
  - Train sounds are very distinct (bell, horn, rumble)
  - Must be within 100'
  - At some crossings, the warning bell stops ringing
  - Traffic signal, utility pole, or solar mounting options
  - Going through APL process
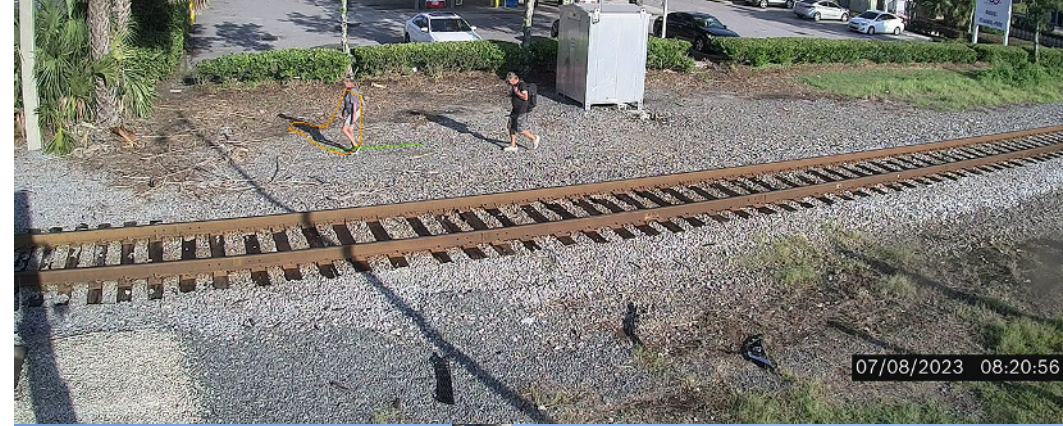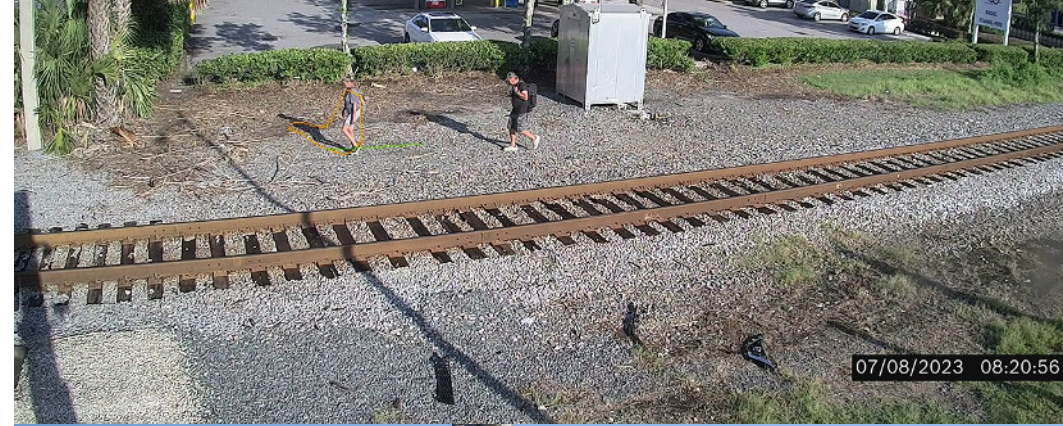
Lessons Learned

- On-Board Units ✔
- SmartPhone Applications ✔
- Automatically Posting on DMS in Advance ✔

07/08/2023 08:20:56

San Juan & US 17

Response from D2 Freight Office

- "Holy Crap!!!"
- "Lot's of valuable data"
- "Can reports be adjusted?"
- "When do you plan to expand the deployment?"

07/08/2023 08:20:56

San Juan & US 17

Questions?

Peter.Vega@dot.state.fl.us
D2 TSM&O Program Manager

Adam.Storm@atkinsglobal.com
ITS/Traffic Engineer

THERE ARE NO SILVER BULLETS!

Building a Bridge to an Autonomous Future

Brian Gettinger
Vice President of Project Development
Flatiron

Building a Bridge to an Autonomous Future

2023 Florida AV Summit

LAX APM

FLATIRON

Agenda

1. Autonomy's Achilles Heel
2. Separate to Succeed
3. Dedicated Benefits
4. Deployment Challenges
5. Example Guideways
6. Transit Mode Comparison
7. Summary
8. Ongoing PRT/GRT Projects

Heathrow ULTra PRT

FLATIRON

Autonomy's Achilles Heel

True autonomous vehicle operation has proven more difficult than expected after >$150 billion has been invested. The pursuit of clean autonomous operation has proven asymptotic.

Challenges for mixed traffic autonomous adoption:

1. Public opposition due to safety concerns
   a) Unable to operate at high speed (>30 mph) due to data processing of collision and obstacle detection
   b) Only able to operate in geofenced areas
   c) Safety drivers are often required, eliminating the OPEX benefit
   d) Difficulty handling unexpected conditions – e.g. weather, construction zones

2. Vehicles contribute to roadway traffic

3. Unable to bypass existing traffic

4. Transit applications require short headways with PRT and GRT vehicles which inhibit perpendicular traffic flow

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Separate to Succeed

Now
Dedicated guideways allow immediate autonomous vehicle deployment on fixed routes.

In the Future
Route expansion with Level 5 autonomy expands the system beyond the fixed guideway for door-to-door service.

The guideways will become express lanes for the autonomous vehicles, improving overall system performance by avoiding traffic.

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San Jose Airport Connector, Glydways PRT

Dedicated Benefits

1. Simpler operating scenario for vehicles

2. Reliable, repeatable routes

3. Capable of high capacity comparable to BRT & LRT

4. Increases ROW transport capacity

5. Guideways are "dumb" and forward adaptable for future vehicle improvements

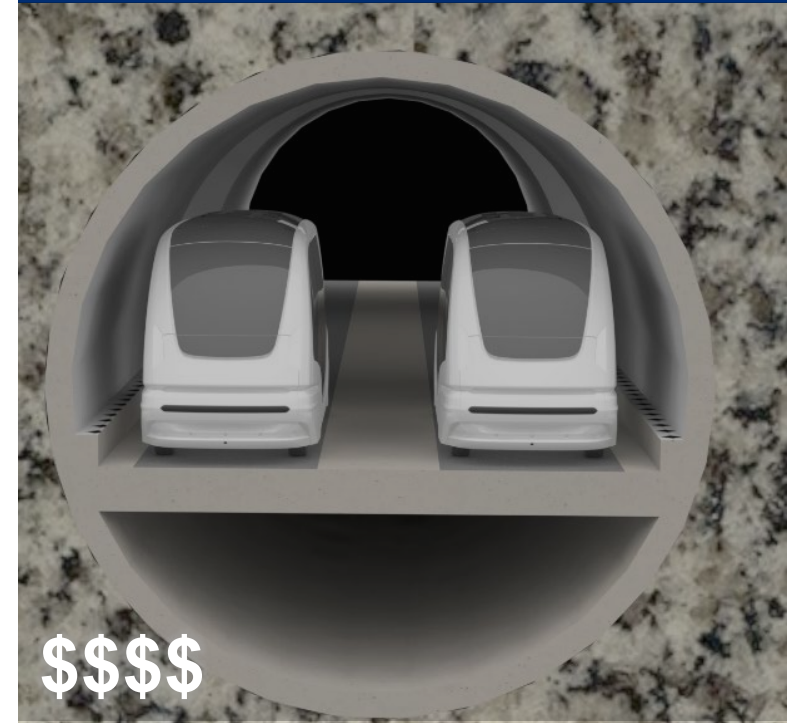6. Opportunity for dynamic inductive charging

Even Better for Grade Separation

1. Express service – no cross-traffic impacts at intersections

2. Limited to no impact on existing traffic flow in right-of-way

3. Even faster operating speeds are possible due to reduced risk of impairments to the guideway

4. Weatherproof – if underground

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Deployment Challenges

1. New or re-allocated infrastructure is required for the guideway
   1. Capital cost for improvements
   2. Permitting timeline

2. Skepticism
   1. System Capacity
   2. Familiarity/preference for traditional modes
   3. Early adopter concerns

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Example Guideways

1 — At Grade — $
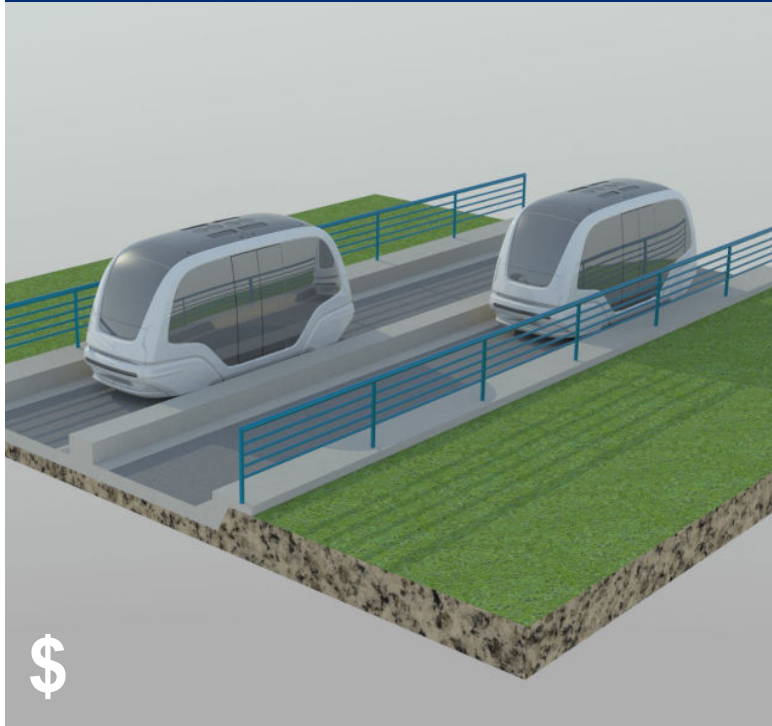
2 — Elevated — $$

3 — Tunneled — $$$$

Images courtesy of Oceaneering

Transit Mode Comparison

System Features	BRT	LRT	Mixed Traffic GRT	Guideway PRT	Guideway GRT
Example	LA Metro G Line	Calgary Green Line	Beep	Glydways	Oceaneering
Electric	Possible	Yes	Yes	Yes	Yes
Battery Powered	Possible	No	Yes	Yes	Yes
Electrified Guideway?	Possible	Yes	No	No	No
Autonomous (in 2023)	No	No	No	Yes	Yes
Level Boarding	Possible	Yes	Possible	Possible	Possible
ADA Accessible	Yes	Yes	Yes	Yes	Yes
Standing Access	Yes	Yes	No (seatbelts req'd)	No	Yes
Express/Skip Stop Service	Possible	No	Possible	Yes	Yes
On Demand Service	No	No	Possible	Yes	Possible
Average Headway	15-20 minutes	15-20 minutes	Varies	<5 minutes	<5 minutes
Passenger Capacity per Hour	XXX	XXXX	X	XX	XXX
Capital Cost	$$$	$$$$	$	$$	$$
Cost per Rider	$$$	$$$$	$	$	$
Operating Speed (2023)	15-30 mph	10-30 mph	15 mph	25 mph	25 mph
Network Expandability	Possible	No	Yes	Yes	Yes
Lane Priority	Possible	Yes	Possible	Yes	Yes
Signal Priority	Possible	Possible	Possible	Possible	Possible

Guideway PRT and GRT offer similar passenger capacity at a lower cost per rider than BRT/LRT while offering a better user experience.

Images courtesy of Oceaneering

Summary

Guideway PRT/GRT systems:

- Cost less than traditional transit

- Can move as many passengers as BRT and low utilization LRT

- Provide a better user experience than traditional transit

- Enable immediate deployment of autonomous vehicles

- Provide a dedicated pathway for future door to door autonomous traffic

- Should be considered as part of every transit analysis

Heathrow ULTra PRT

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![FLATIRON]

Ongoing PRT/GRT Projects

San Jose Airport Connector

Developer: Plenary
Vehicle: Glydways
Length: ~3 miles
Grade Separated: Partial
Status: Negotiating PDA

East Contra Costa County Dynamic Personal Micro Transit Project

Developer: Plenary
Vehicle: Glydways
Length: ~3 miles
Grade Separated: Partial
Status: Negotiating PDA

Greenville-Spartanburg Airport Automated People Mover

Developer: Plenary
Vehicle: Oceaneering
Length: ~1 miles
Grade Separated: Partial
Status: Financial close Q1 2024

There are more than five other projects currently in procurement or entering procurement in the next 6 months focused on deploying guideway PRT/GRT people movers.

Many projects have chosen to utilize developer led procurements that promote innovative solutions.

San Jose Airport Connector, Glydways PRT

Brian Gettinger, PE
VP of Project Development
Flatiron Construction

https://www.linkedin.com/in/briangettinger/
Twitter @talltunnelguy

SCAN ME

QUESTIONS

Autonomous Trucks in Florida

Brett Fabbri
Head of Law Enforcement Policy and Roadway Safety
Kodiak

kodiak

Brett
Fabbri

Head of Law Enforcement
Policy & Roadway Safety

Kodiak Overview

kodiak.ai / 9.23

Autonomous trucking is the only answer to one of the world's biggest economic problems:

the driver shortage and long-term supply chain crisis

Kodiak,
the Industry's Best Solution

Kodiak is scaling safely, efficiently, and rapidly. We are building the right way and seeing the results.

$165M
Capital raised

3,800+
Loads delivered

190+
Employees

33
Class 8 Trucks

2M+
Miles driven

18k+
Miles mapped

Forbes 2019 AI 50 MOST PROMISING AI FIRMS

FAST COMPANY 2020 MOST INNOVATIVE

CES INNOVATION AWARDS 2021 HONOREE

Inc. Best Workplaces 2022

FREIGHTTECH 25 2023

kodiak

Our Technology Solves the Industry's Biggest Pain Points

Traditional Trucking

Preventable Accidents

7 Hours a Day

80,000 Driver Shortage

Significant Emissions

kodiakDriver

Increased Safety

All Day
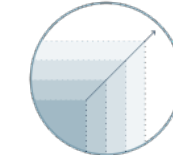
Scalable Capacity

Improved Sustainability

kodiak

Solving Federal Policy Barriers

Federal regulators are working towards regulations enabling AV trucks

FMCSA Rulemaking

SANPRM this spring, NPRM slated for this fall.

Will likely address inspections, may touch on warning triangles.

Standing General Order

Requires AV developers to report all on-road incidents to NHTSA.

AV STEP Program

NHTSA program to raise exemption caps, provide transparency.

Federal Legislation

Congress is (again) considering AV legislation, including for NatSec.

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Supportive Regulatory Environment Fuels Expansion
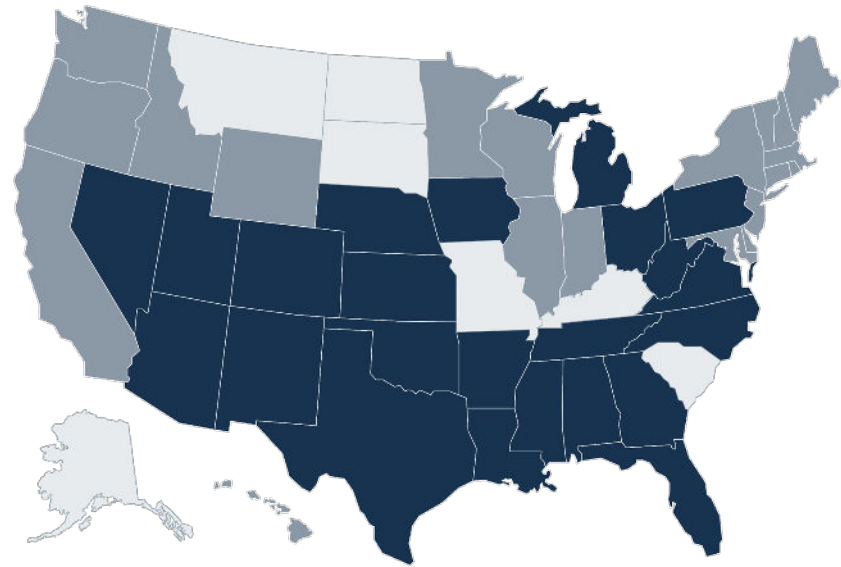
Driverless Ready: states with lawful driverless deployment

Testing Ready: states enabling driver-in testing

No explicit AV policy: states without AV policies

Key Regulatory Barriers Are Solved

Commercial vehicle inspections, state regulatory frameworks, and other blockers have been solved – virtually all other regulations are "nice to haves".

Southern States Offer Path to Deployment

Efforts with state regulators and legislators are unlocking deployment across the country, including the I-10, I-20, and I-40 corridors.

Federal AV Regulations Are Coming

USDOT is moving quickly to create draft rules for AV trucks – officials have publicly stated the draft rules will be done well ahead of the election.

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We're not Just Testing.
Kodiak Delivers 50+ Commercial Loads Weekly.

3,800+
Loads delivered

50+
Loads per week

2M+
Miles driven

18k+
Miles mapped

SFO <> JAX
10 ROADS EXPRESS

DAL <> AUS
ceva LOGISTICS
C.R. England × Tyson

DAL <> HOU
IKEA

DAL <> ATL
U.S. XPRESS

DAL <> JAX
WERNER ENTERPRISES
Forward
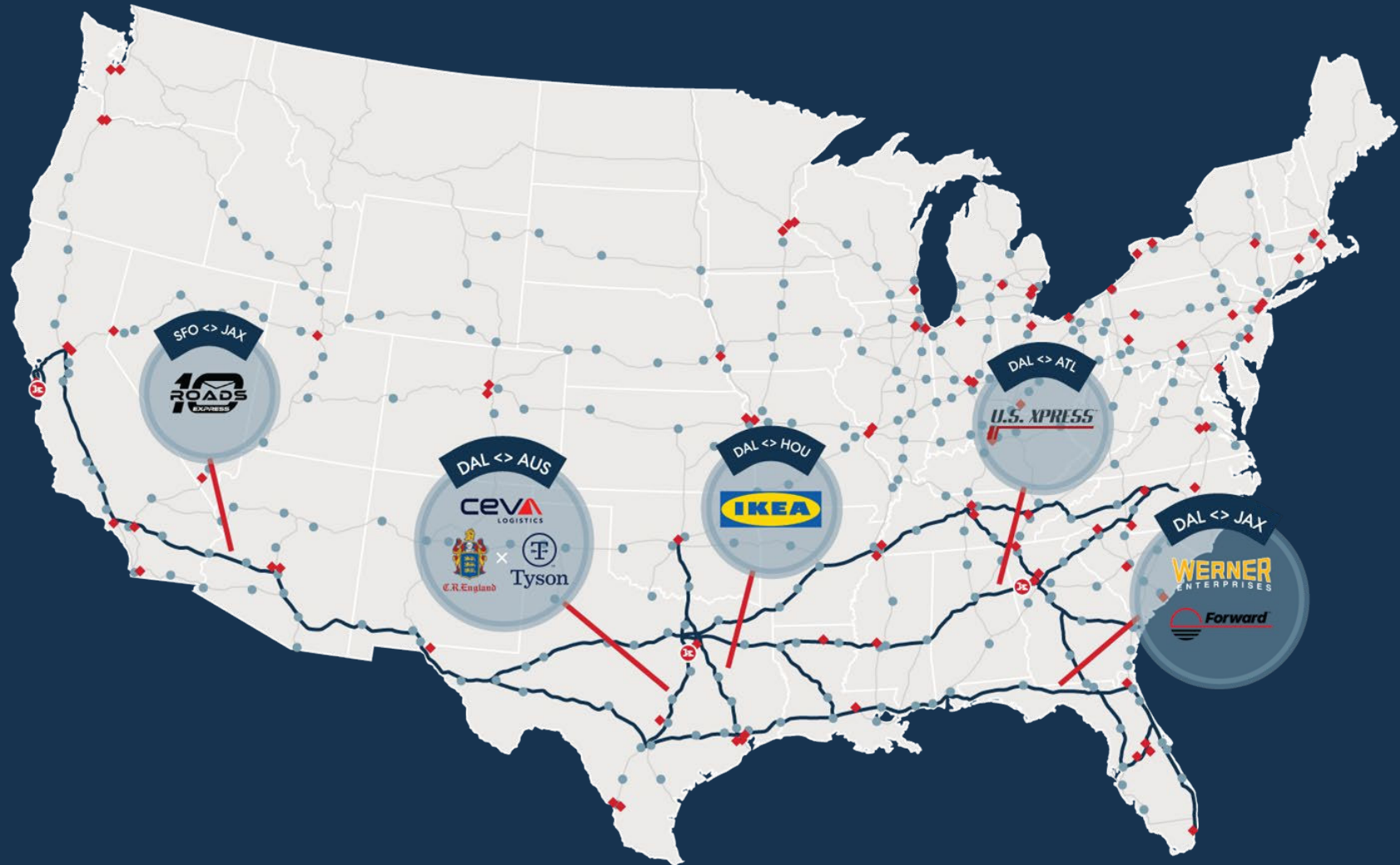
Introducing the kodiak*Driver*, Kodiak's asset-light solution that enables long-haul trucks to operate driverless

DC A — DC B — DC C

First mile / human relay leg

Long Haul / autonomous relay leg

DC D — DC E — DC F

Last mile / human relay leg
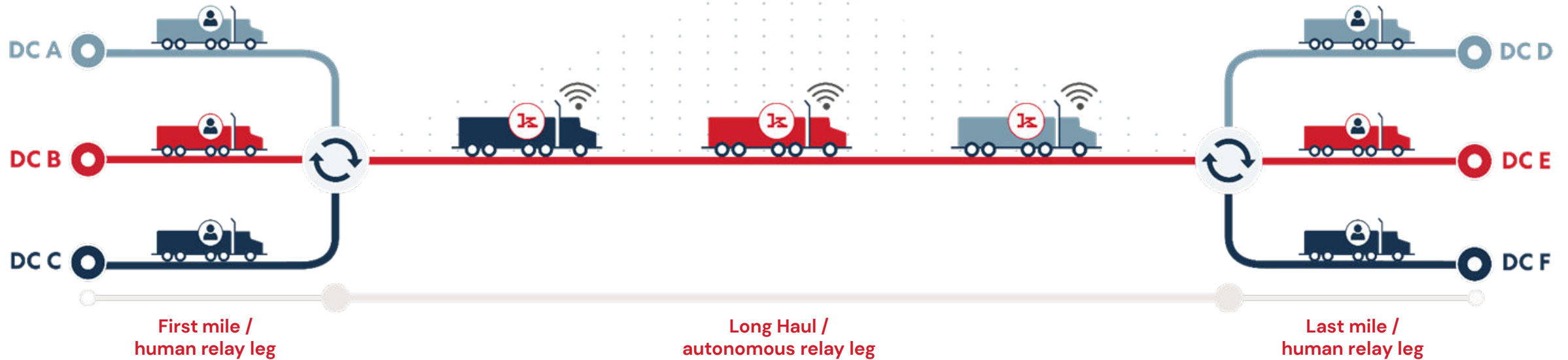
Today | kodiak*Express*

Per mile revenue for transportation service

2025 | kodiak*Driver*

Per mile revenue for technology solution

The kodiak *Driver* Navigates Everything on a Freeway: Common and Corner Cases, Day or Night, Rain or Shine

Kodiak's autonomous driving system has become an industry leader in less than 4 years.
Kodiak has no more policy disengages across its quickly growing map.

❱ Weak lane markings

❱ Pedestrians

❱ Tunnels

❱ Unusual vehicles

❱ Lane change aborts

❱ Construction
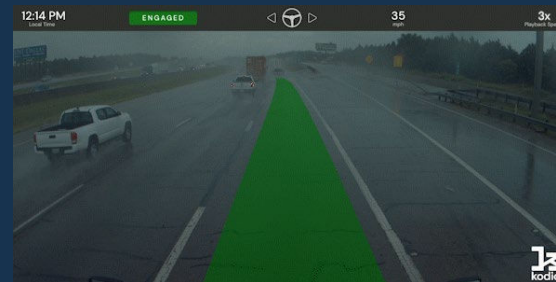
❱ Rain, fog, wind
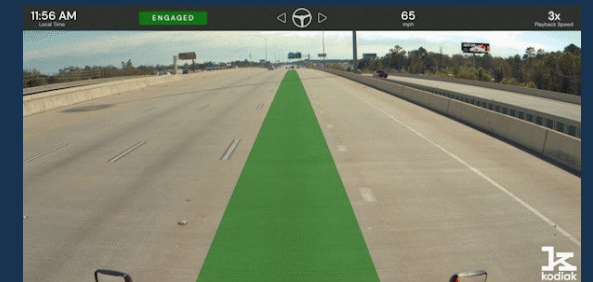
❱ Cut-ins

❱ Merging into heavy traffic

❱ Cloverleafs

❱ Bridges

❱ Off-highway + night driving

Kodiak is Driverless Today on Closed Courses

Our **rigorous internal safety process** enables us to run driverless **at full highway speeds** with a loaded trailer at the Bridgestone Proving Grounds in West Texas, today.

Atlanta (Villa Rica) Truckport

TP facility partner: Pilot Flying J
TP operations partner: None
Location: 95 Liberty Rd, Villa Rica, GA 30180
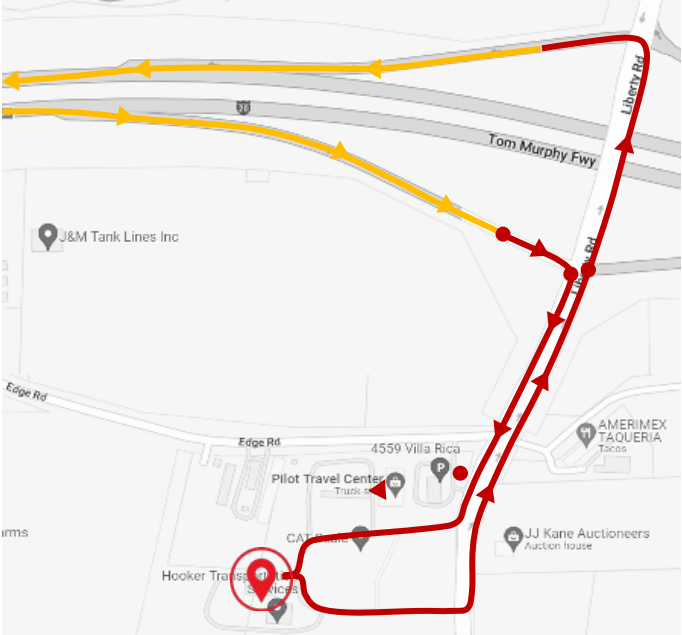
Next steps:

Equip with tools, parts & usables

Coordinate local vendors

Run full "product model" on DFW<>ATL with
commercial partners

Shared with Pilot Travel
Center Customers

Kodiak-Only Areas

Fuel

Entrance

CAT Scale

SDT Tractor Parking

Landing Area

Trailer Parking

Part storage

Office.

Inspections & maintenance

Non-SDT Tractor Parking

Non-SDT Tractor Parking

Exit

Future Steps for AV Trucks

- Law Enforcement Interaction Plans (LEIP)

- CVSA Enhanced Inspection Process for AV Trucks

- AV Industry and Law Enforcement Partnership Building

Solving for Congestion: The Autonomous Shuttle and Multimodal Transit

Simon West

Chief Experience Officer

Beep

Solving For Congestion
Urban Transformation and the Autonomous Shuttle

Meet Beep

125,000
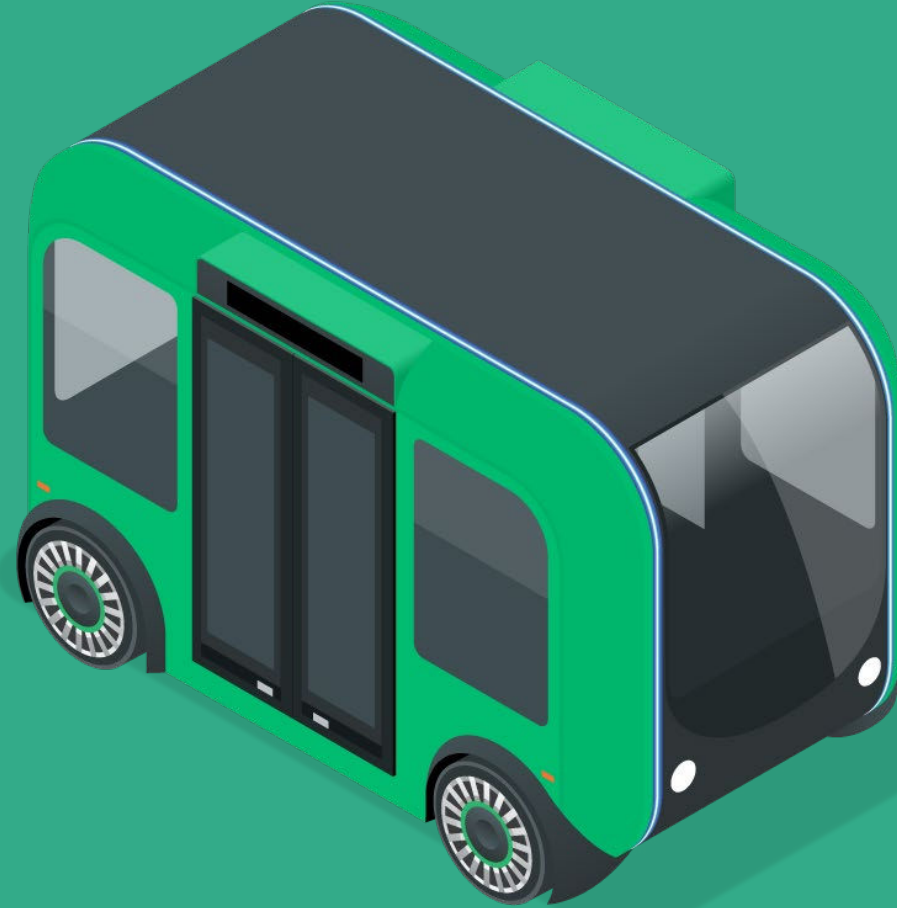Live Road Hours

107,000
Passengers Carried

350
First Responders Trained

After Robotaxis

Solve for Congestion $\left\{\begin{array}{l}\end{array}\right.$ Carbon emissions
Noise pollution
Road safety
Pedestrianization
Green space

Solve for Congestion

Solve for Congestion { **Capacity x Frequency**

60

30

5
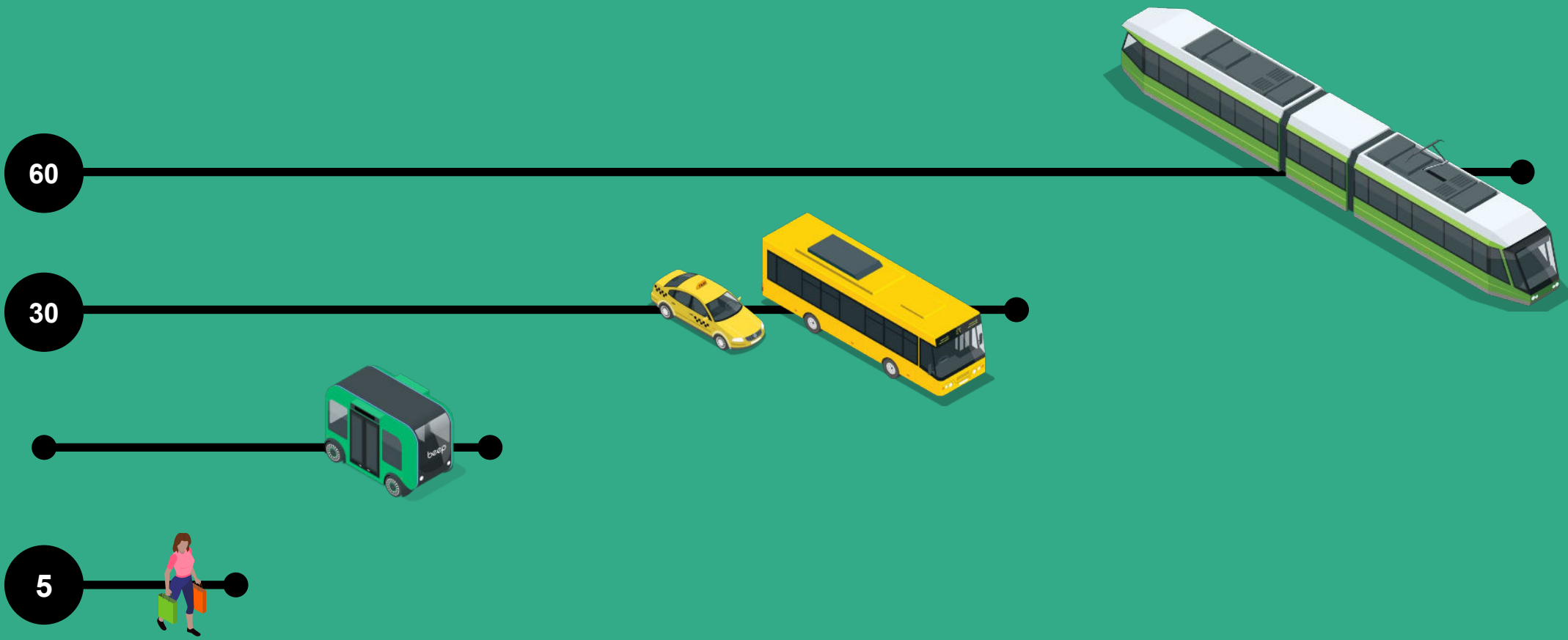
Fill the short-haul urban gap

First/last-mile onramp to public transit
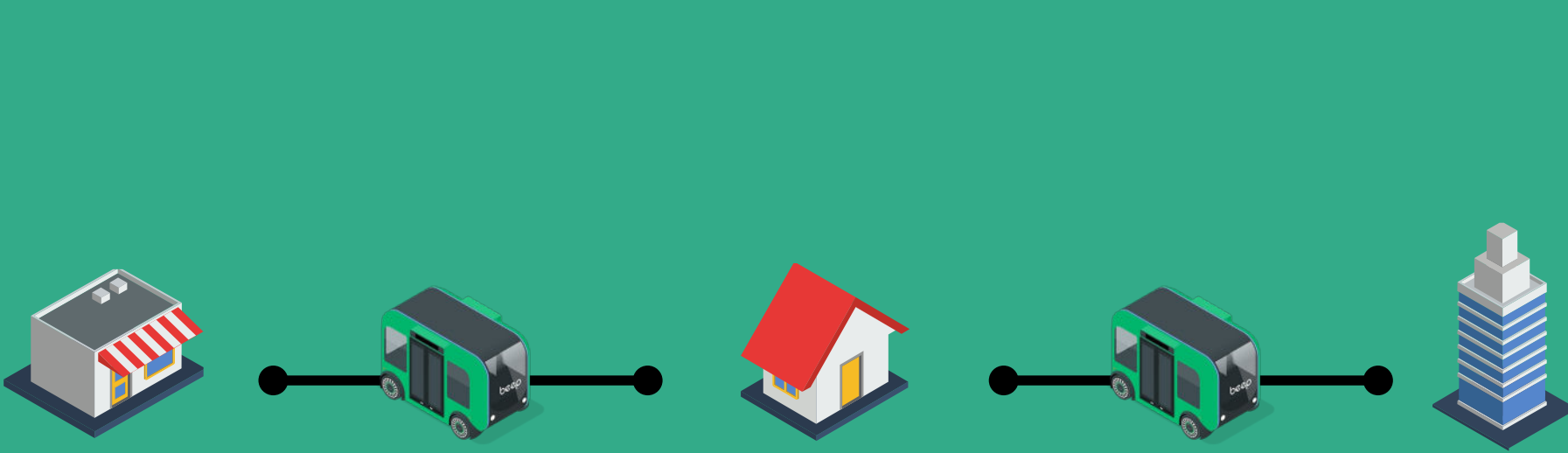
Connect communities

Enable Mobility

404g CO_2 404g CO_2 404g CO_2 404g CO_2 404g CO_2 404g CO_2 404g CO_2

2000 vehicles per hour sound twice as loud as 200 vehicles per hour

Reduce traffic by 4:1–8:1 ratio
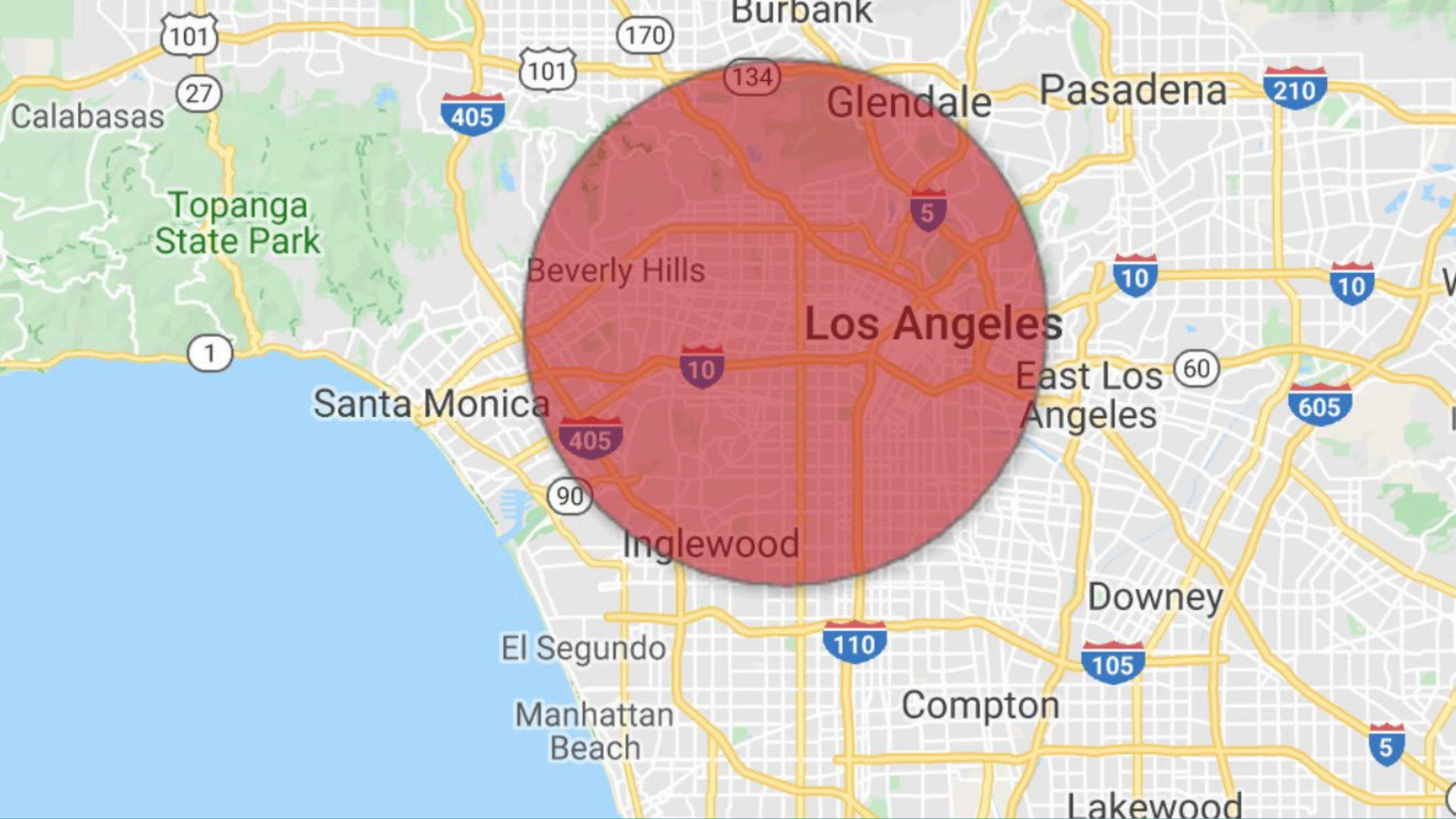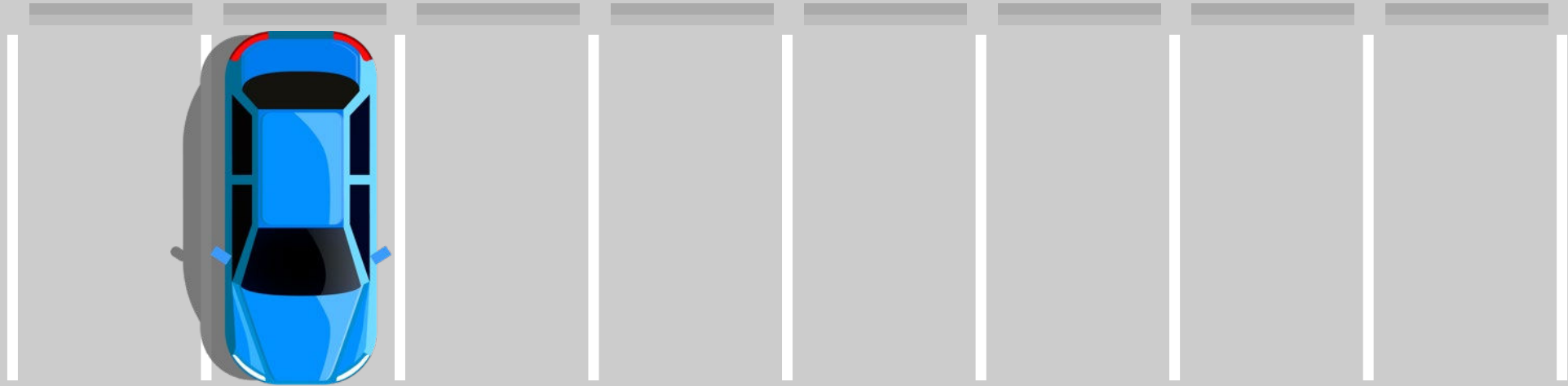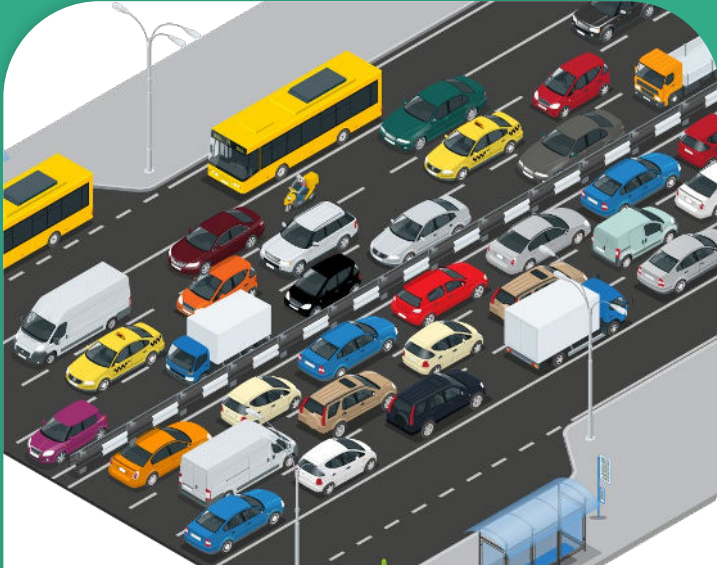
The United States has five to eight parking spaces for every car

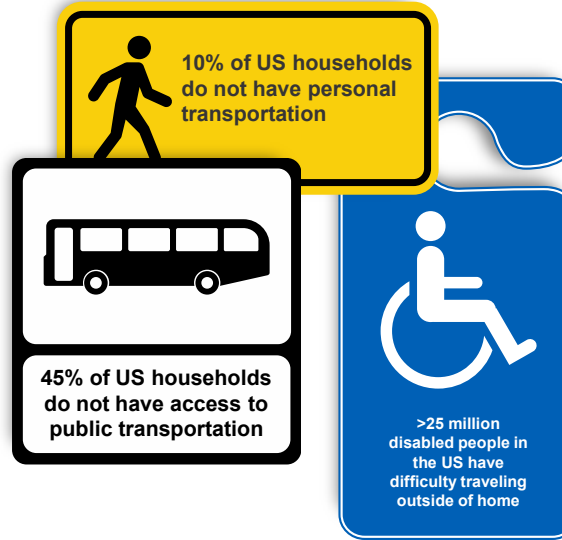**Median cost for a parking structure is $25,000 per space**

Solve for Congestion

Pursue root cause and force multiplier of major transportation issues

Enables urban transformation – pedestrianization, green space, etc.

Reduce infrastructure needs and costs around parking infrastructure

10% of US households do not have personal transportation

45% of US households do not have access to public transportation

>25 million disabled people in the US have difficulty traveling outside of home

Enable Mobility

Connect underserved communities including the 45% of Americans with no access to public transportation

Deliver first and last-mile services to connect people, goods and services

Provide safe and accessible solutions designed around the passenger experience

Transform Public Transit

Leverage autonomous vehicle and smart city tech to provide intelligent mobility networks for improved service efficiency

Increase ridership by providing onramps to public transit

Supplement and extend existing modes with dynamic, data-driven services