

City of Gainesville's experience with

Workforce Development and Transportation AI



Emmanuel Posadas, PE
Traffic Operations Manager

The Frontiers of Artificial Intelligence-Empowered Methods and
Solutions to Urban Transportation Challenges – Gainesville, Florida – December 15

Author and Presentation

Disclaimer

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[UFTI – University of Florida Transportation Institute – Lily and Pruthvi]
[Jesus – Transportation Director | Debbie – Planning Manager]

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Background, the beginning of a partnership,
paradigms and workforce development

What we did (doing)

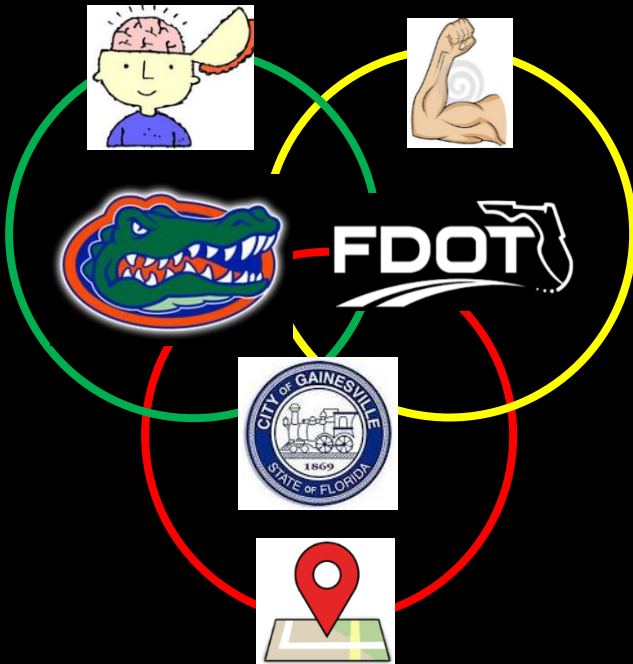
AI spotlight use case: **Intersection Safety**
event filtering and conflict typing for near miss using
ATSPM & Fisheye

Key Contributions and Lessons Learned

Lessons Learned and Discoveries made

The beginning of a partnership

1. Literature and State-of-the-art review
2. Assist FDOT with Peer Exchange



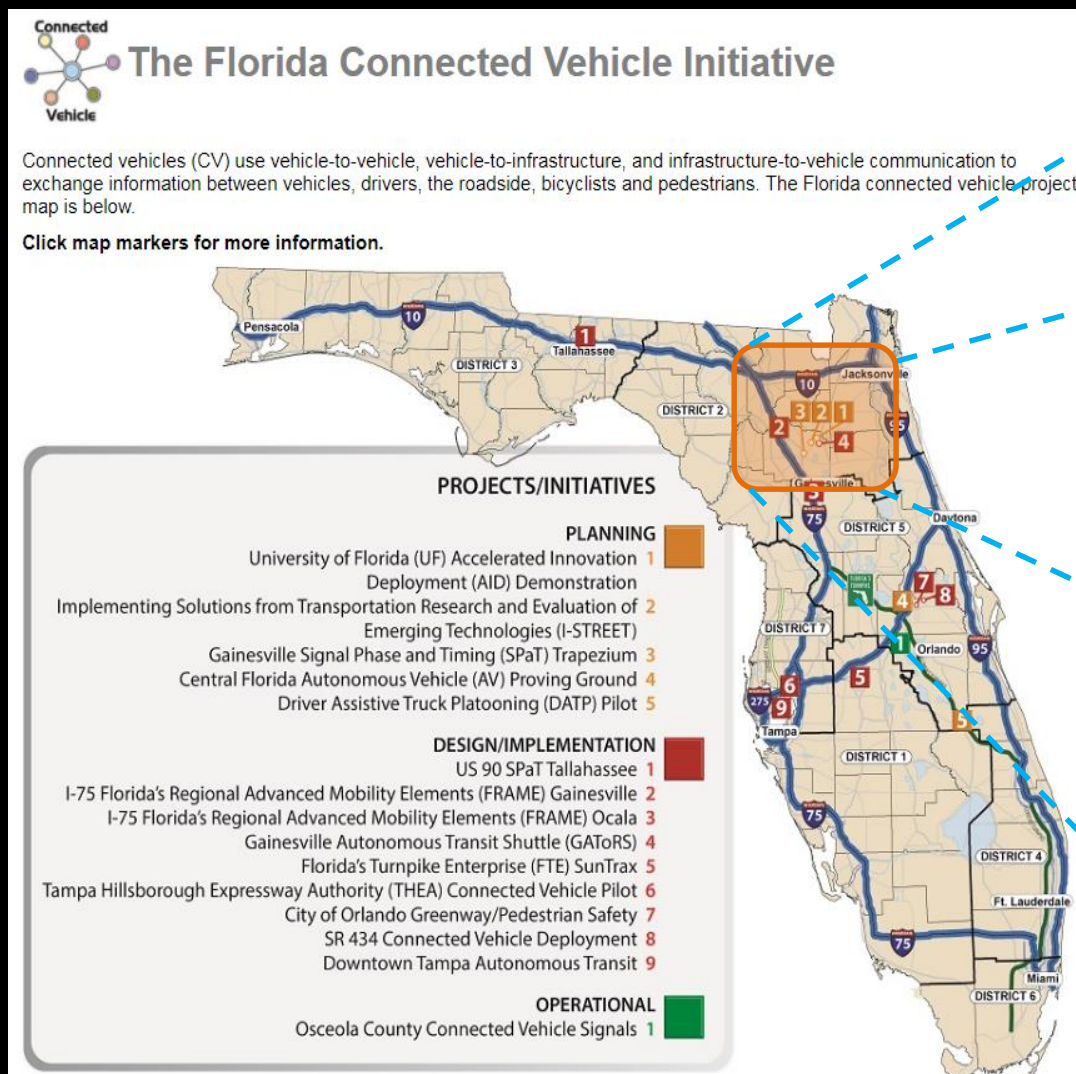
FDOT → Funding and State Level Support

UF → Intelligence and research expertise

GNV → Local level familiarity of issues and field devices O&M

The beginning of a partnership

2016 Version of the Florida Connected Vehicle Initiative



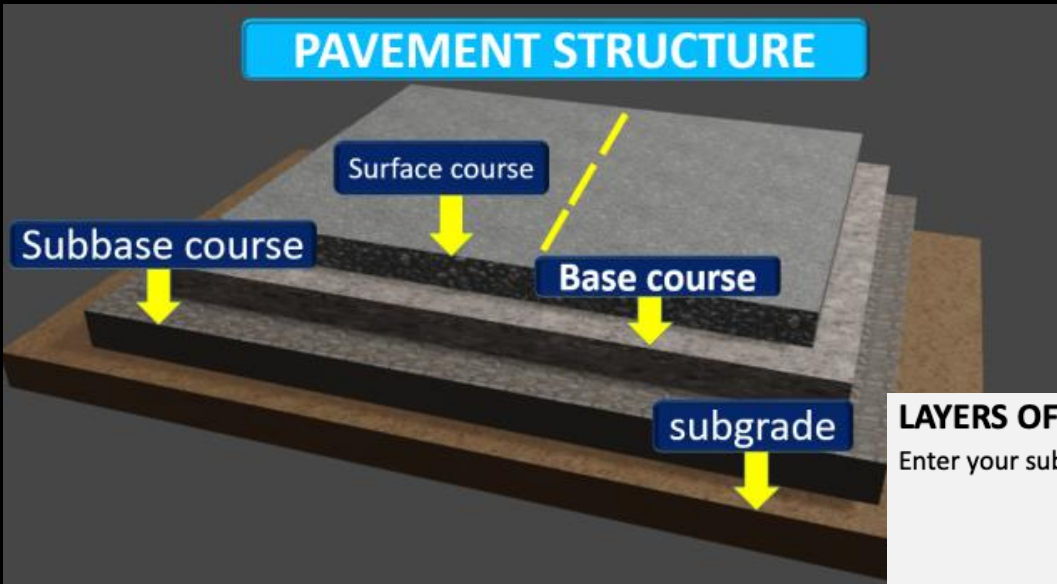
Focus on Gainesville

- **AID** | Accelerated Innovation Deployment
- **I-STREET** | Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies
- **SPaT** | Signal Phasing and Timing
- **FRAME** | Florida Regional Advance Mobility Elements
- **GAToRS** | Gainesville Autonomous Transit Shuttle

[Inter City and Highway | Urban Travel | Transit | Ped & Bike₅]

Where we started: Layer Paradigms

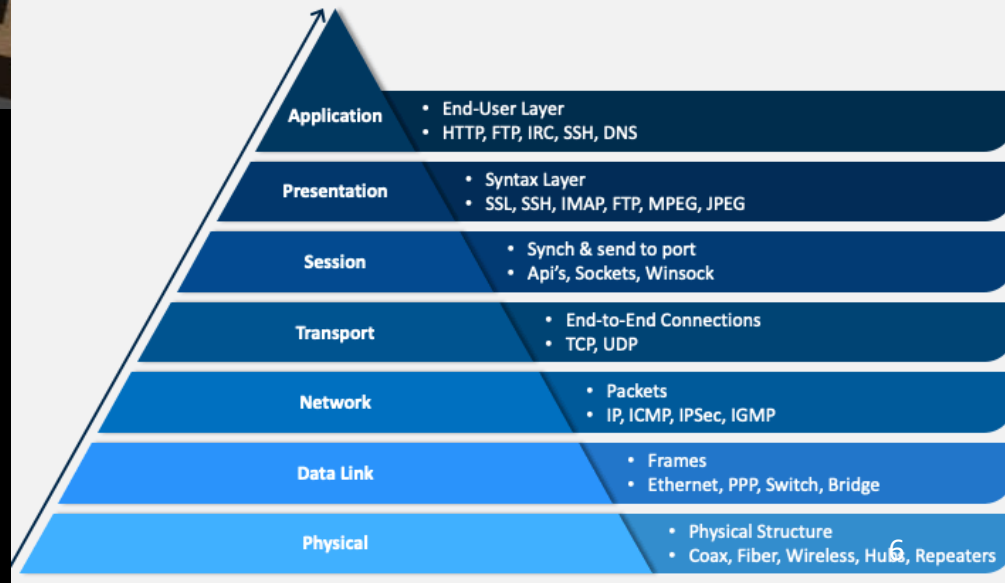
Roadway Layers (for the Civil Engineers)



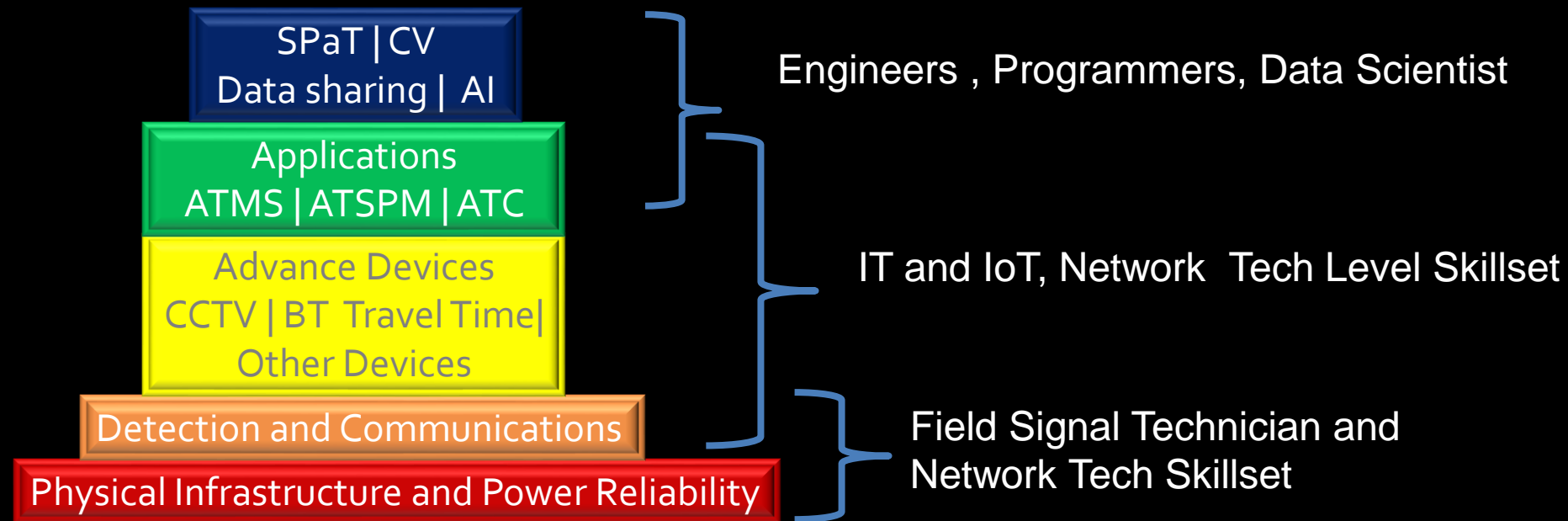
OSI 7 Layer Model (IT Professionals)

LAYERS OF THE OSI MODEL

Enter your sub headline here



Where we started: Layer Paradigms to CV/AV



In 2015/16 - Gainesville started with [85+ miles of fiber & 200+ traffic signals, 85% online | using TS-2, Type II Controllers | 9 Signal technicians | Annual O&M < \$2M]

How do we go up layers?

How can we leverage existing infrastructure, resources, expertise? Workforce and Economic Development ?

Project Spotlight: Intersections Safety



USDOT estimates more than 50% of road crashes leading to fatality or injury happen at or near traffic intersections

<https://highways.dot.gov/research/research-programs/safety/intersection-safety>

Advances in Tech: ATSPM and FISHEYE

Fisheye Camera



Whole Intersection Coverage

ATC

Advance Transportation Controller

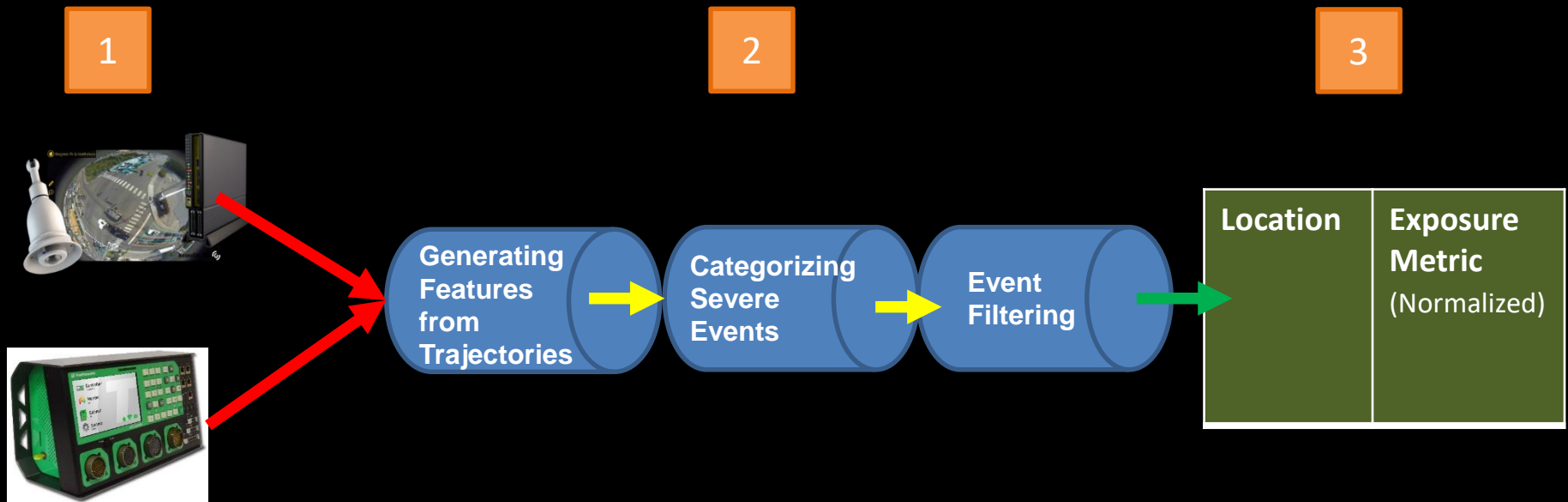


Data is recorded every 0.1 second

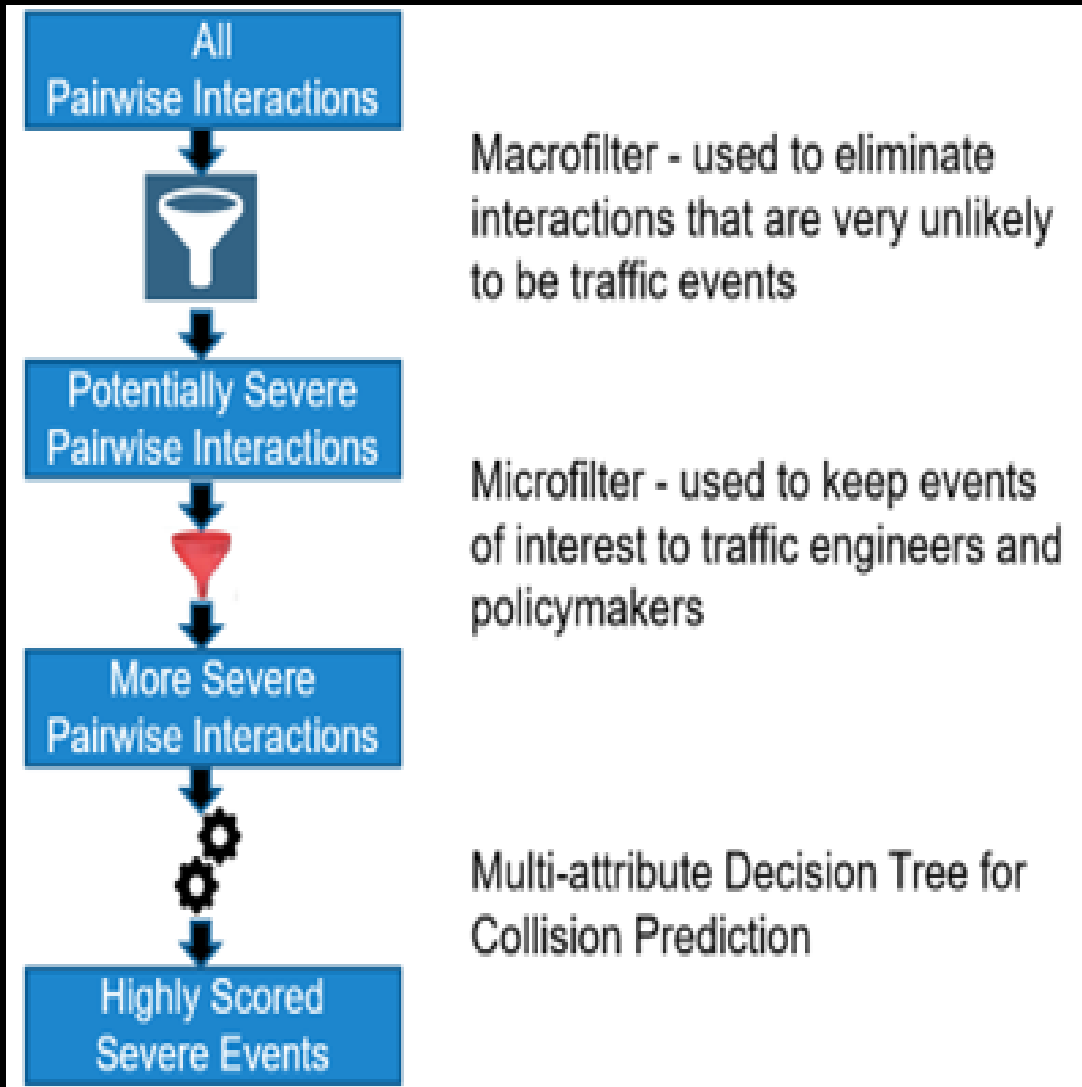
These cost of these sensors, the storage required for the collected data, and the computing resources is becoming cheaper. Thus, fitting intersections with fisheye cameras and ATC devices is becoming viable.

Process: Safety Analysis

1. Starting with video camera footage and ATSPM data
2. Use software pipeline to process and analyze the data
3. Output number of severe events for vehicle to vehicle and pedestrian to vehicle interactions



Multistage Event Filtering: Overview



MACRO

- Spatial Proximity?
- Both Moving?
- $TTC \text{ or } PET < X$

TTC = Time to Collision

PET = Post Encroachment Time

MICRO

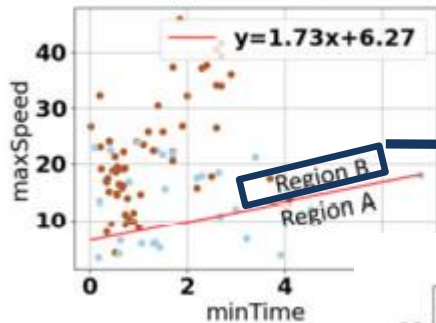
- Multiple PET and TTC
- Duration of PET > Y
- Did moving objects yield?

MADT

Multi Attribute Decision Tree
Volume, Type, Directionality,
max speed, min time, max
deceleration

Attributes in MADT : Sieve and filtering

(a) All Data

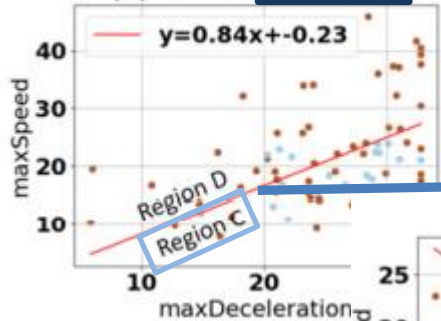


maxSpeed = maximum speed of 2 vehicles

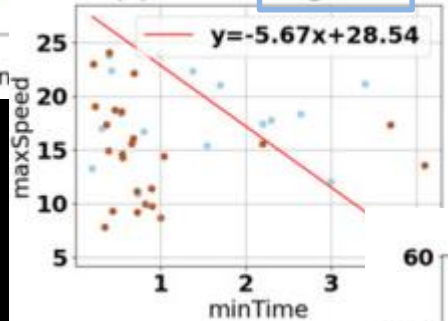
maxDecel = brake application by either of two vehicles

minTime = TTC or PET duration and bounding box

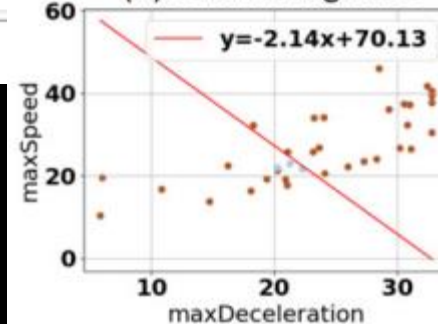
(b) Data in Region B



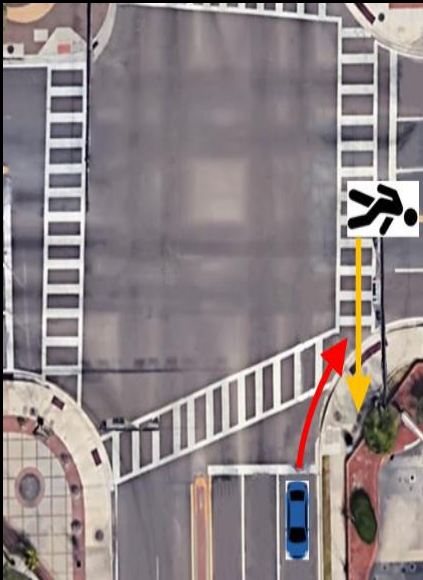
(c) Data in Region C



(d) Data in Region D



Conflict Typing: P2V



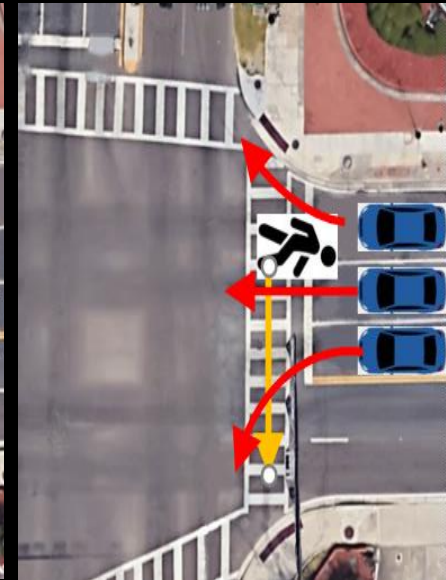
P2V: Conflict Type 1



P2V: Conflict Type 3



P2V: Conflict Type 5

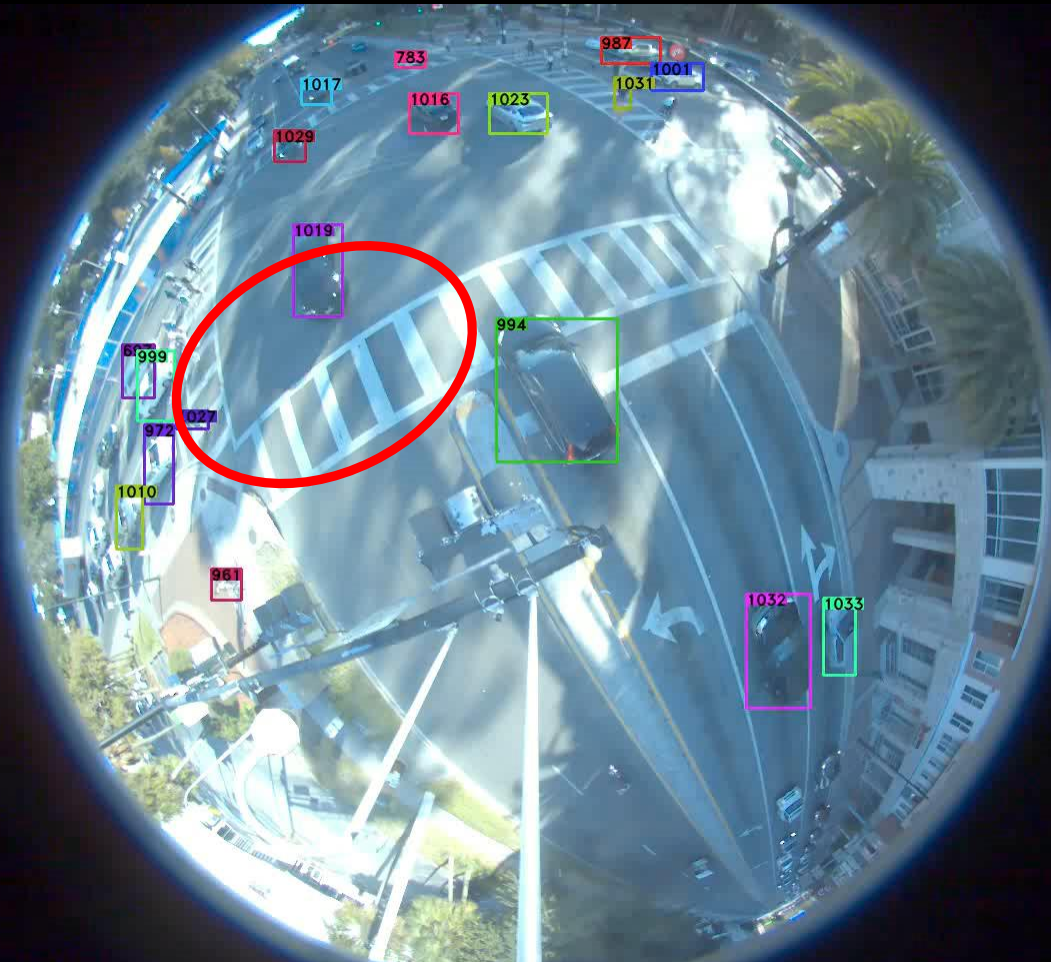


P2V: Conflict Types 2, 4, 6

Pedestrians and Vehicles
East Crosswalk (going North / South)

Conflict Typing Example: P2V

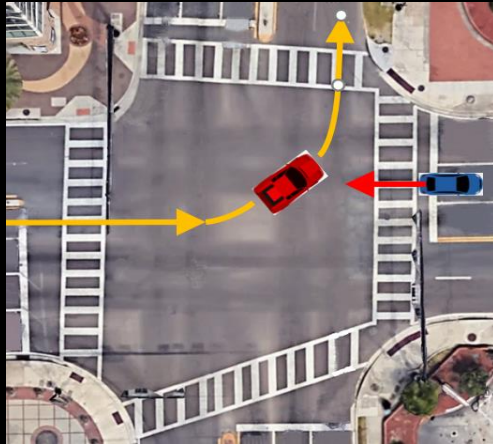
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11-15_15-



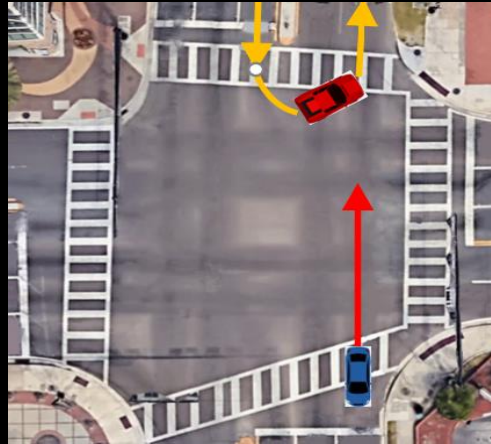
intersection_id	5060
camera_id	7
timestamp	2021-11-15 15:59:43.200
dow	0
hod	15
frame_id	5921
conflict_x	389.436
conflict_y	371.485
unique_ID1	721111515501089
unique_ID2	721111515501091
class1	car
class2	pedestrian
phase1	6
phase2	4
time	0.423888
bb_time	0.328779
ttc_rank	1.14898
p2v	1
city	Gainesville
state	FL
cluster1	NBT_lane2
cluster2	ped_EW
is_conflicting	1
speed1	29.0027
speed2	6.49109
distance	2.26572
bb_distance	0.0217647
deceleration1	3.9808
deceleration2	0.148851
decel1_ts	2021-11-15 15:59:43.400
decel2_ts	2021-11-15 15:59:43.500
type	1
signal_state	4400bb

- pedestrian maneuver, check around 22 seconds for a ped right under the camera

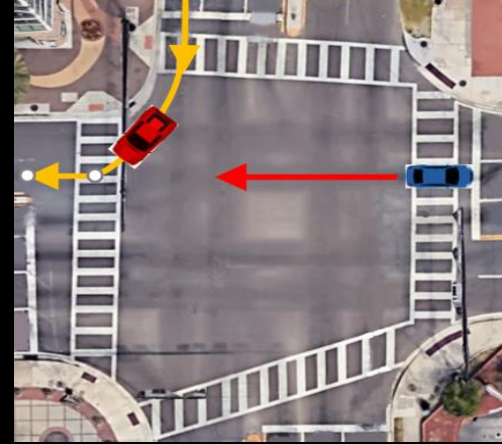
Conflict Typing: V2V



V2V: LOT



V2V: UOT



V2V: RMT



V2V: UFL



V2V: RFT



V2V: LCC

Conflict Typing Example: V2V

Basler-23355772 2021-11-01 17:51:53 UTC 10.0

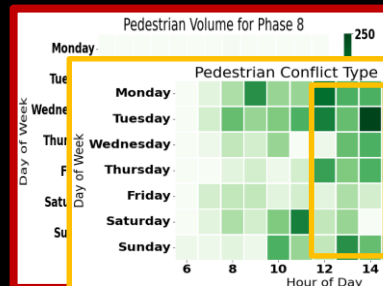
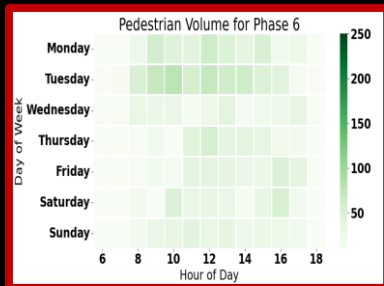
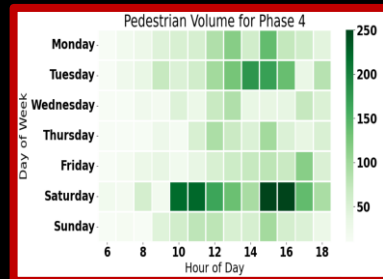
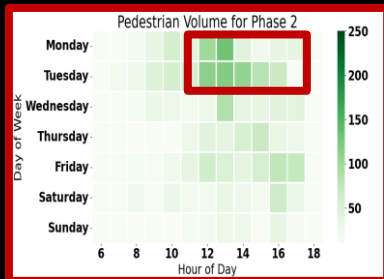


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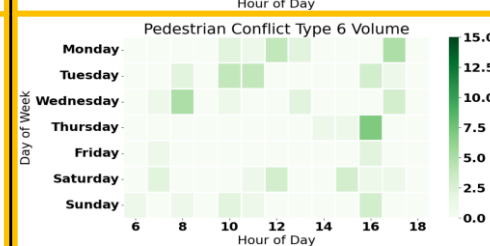
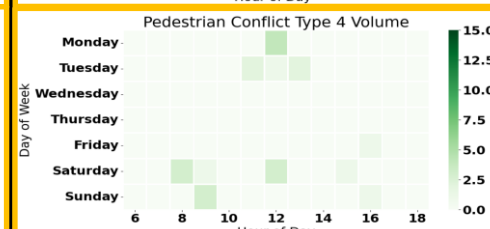
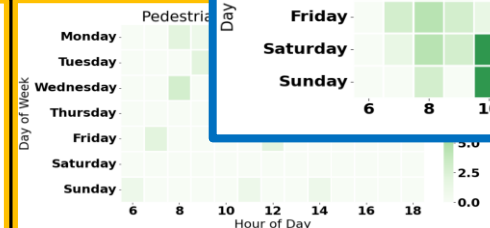
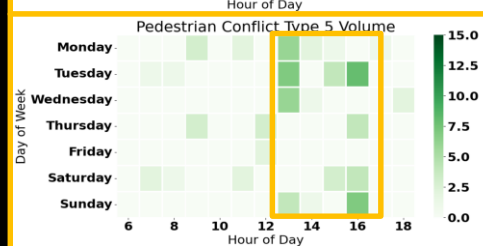
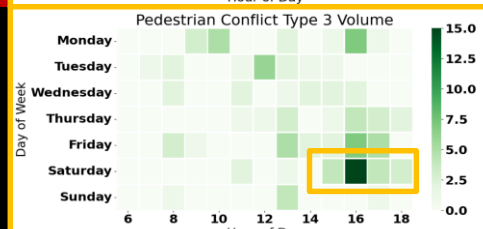
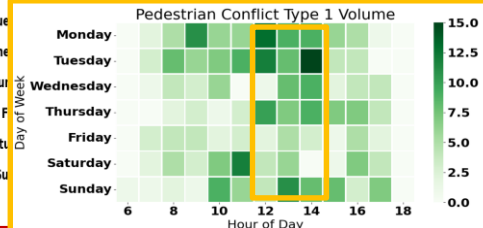
intersection_id	3533
camera_id	10
timestamp	2021-11-01 17:50:07.400
dow	0
hod	17
frame_id	172
conflict_x	457.597
conflict_y	597.936
unique_ID1	1021110117501
unique_ID2	1021110117509
class1	car
class2	car
phase1	8
phase2	7
time	1.41025
bb_time	0.760878
ttc_rank	2.93262
p2v	0
city	Gainesville
state	FL
cluster1	SBT_lane1
cluster2	NBL_lane2
is_conflicting	1
speed1	10.331
speed2	16.1275
distance	7.56842
bb_distance	0.794482
deceleration1	1.52373
deceleration2	7.57187
decel1_ts	2021-11-01 17:50:07.000
decel2_ts	2021-11-01 17:50:07.600
type	1

- Dangerous: left/through conflict

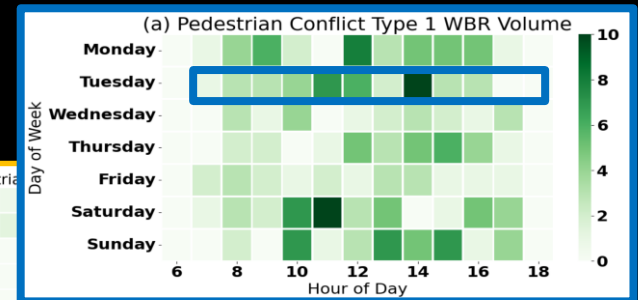
Attributes in MADT



Ped Volume



P2V Conflict Type
with Veh Directionality



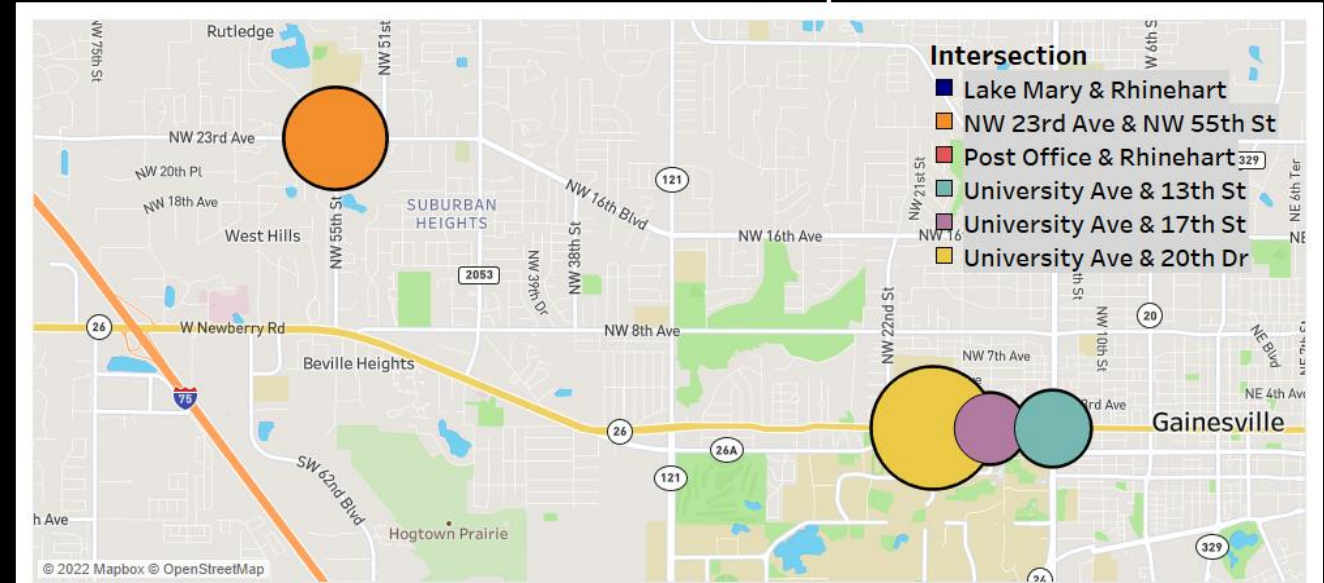
P2V Conflict Type

CASE STUDY: Results (Visual)

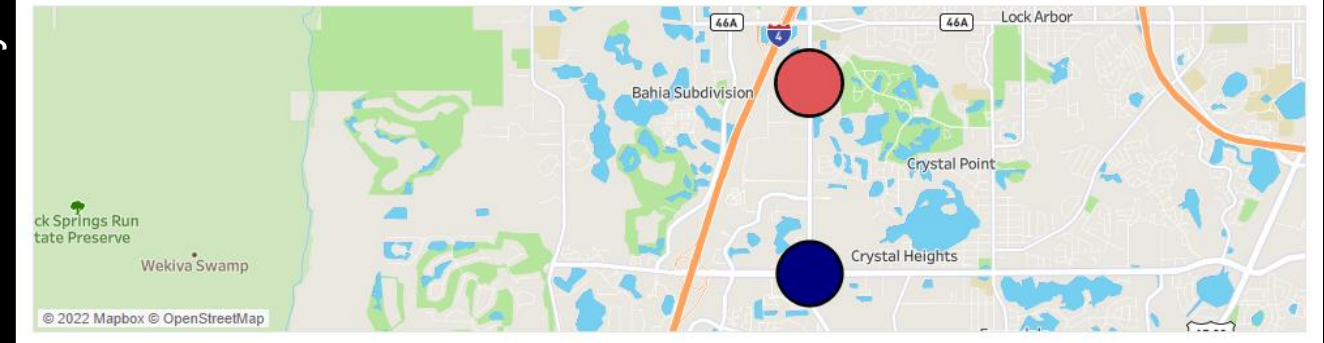
Legend

- Left Opposing Through
- Right Following Through
- Rear-End Conflict
- Right Merging Through
- Others

Gainesville



Lake Mary



Normalized Impact

CASE STUDY: Results (Tabular)

Intersection	Conflicts	Macrofilter	Microfilter	P2V Events	V2V	V2V MADT
University Ave & 13 th St	1,918,822	5152	888	722	166	125
University Ave & 17 th St	459,995	5370	1045	959	86	42
University Ave & 20 th Dr	2,247,395	5433	403	259	144	85
NW 23 rd Ave & NW 55 th St	947,921	5938	217	63	154	112
Post Office & Rhinehart	362,354	344	95	67	28	28
Lake Mary & Rhinehart	1,279,019	956	28	0	28	28

Millions,
100K+

Thousands
Hundreds

Hundreds
Tens

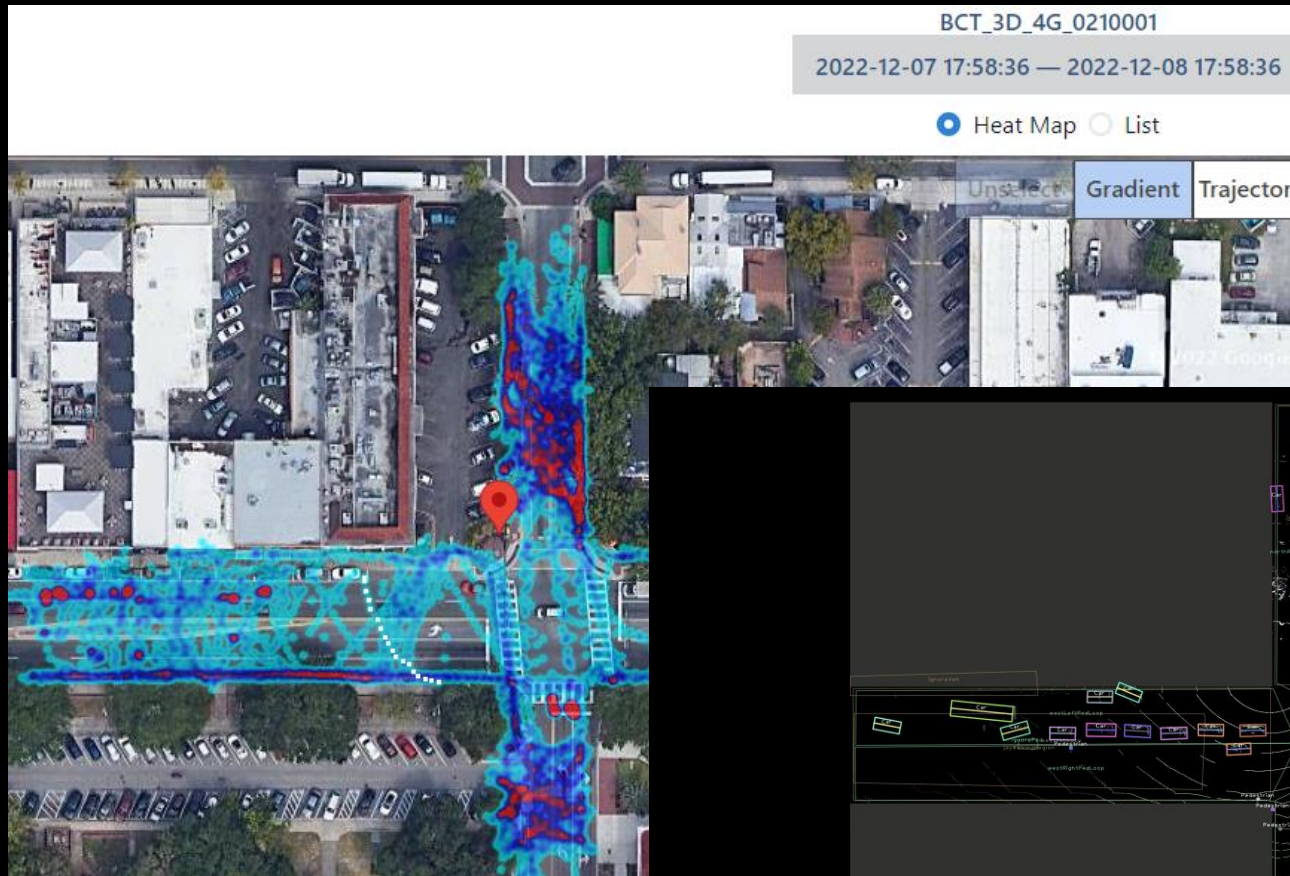
Manageable 😊

starting from millions of potential conflict interactions, our filtering scheme reduced the events to a small set of severe events

Intersection	Left Opposing Through	Right Merging Through	Right Following Through	Rear-End Conflict	Others	Total	Weighted	Normalized
University Ave & 13 th St	15	2	37	28	84	166	211	24
University Ave & 17 th St	33	2	15	9	27	86	185	21
University Ave & 20 th Dr	91	5	9	3	36	144	417	62
NW 23 rd Ave & NW 55 th St	73	6	22	6	47	154	373	43
Post Office & Rhinehart	12	0	7	1	8	28	64	15
Lake Mary & Rhinehart	1	1	0	2	24	28	31	14

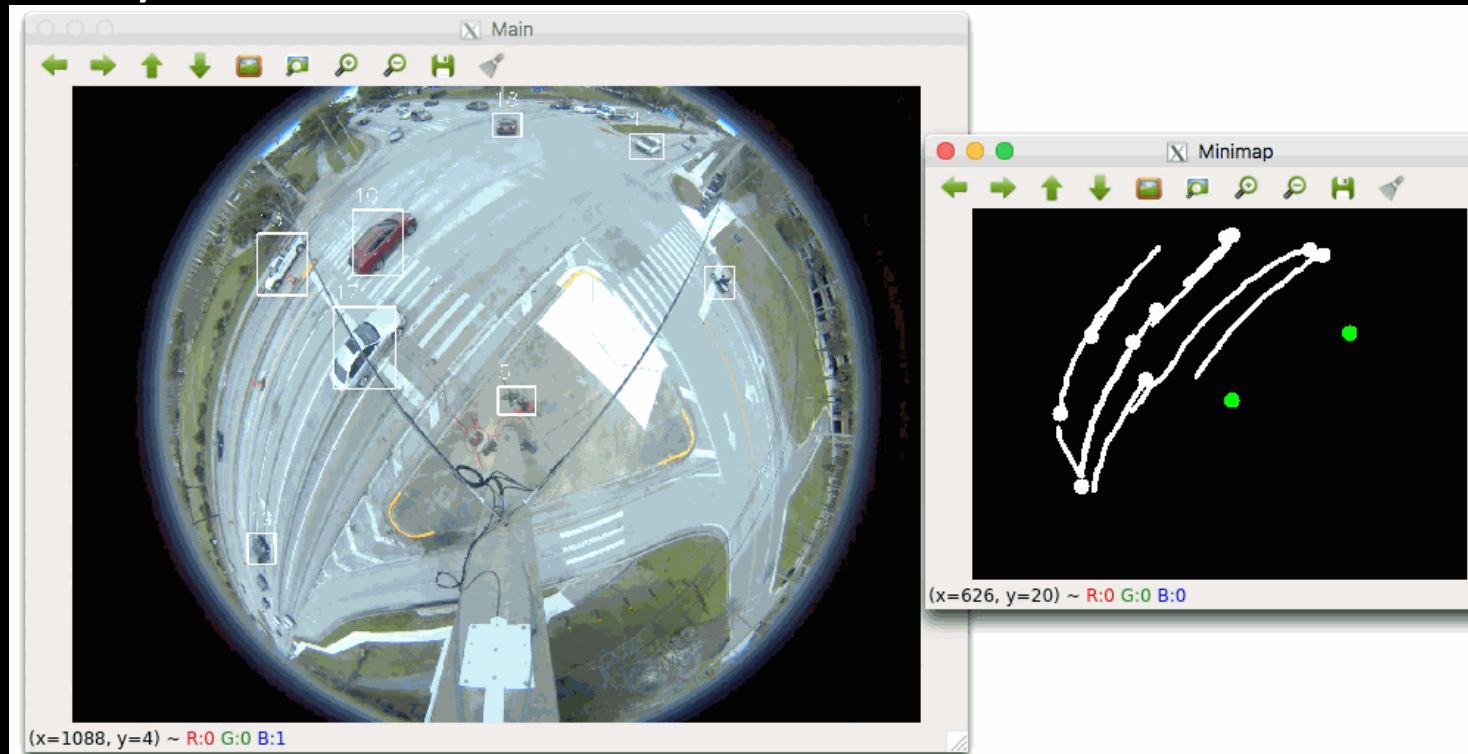
Exposure: Normalized Tables per 10,000 vehicles making the same movement

Future Tools: Infrastructure LIDAR



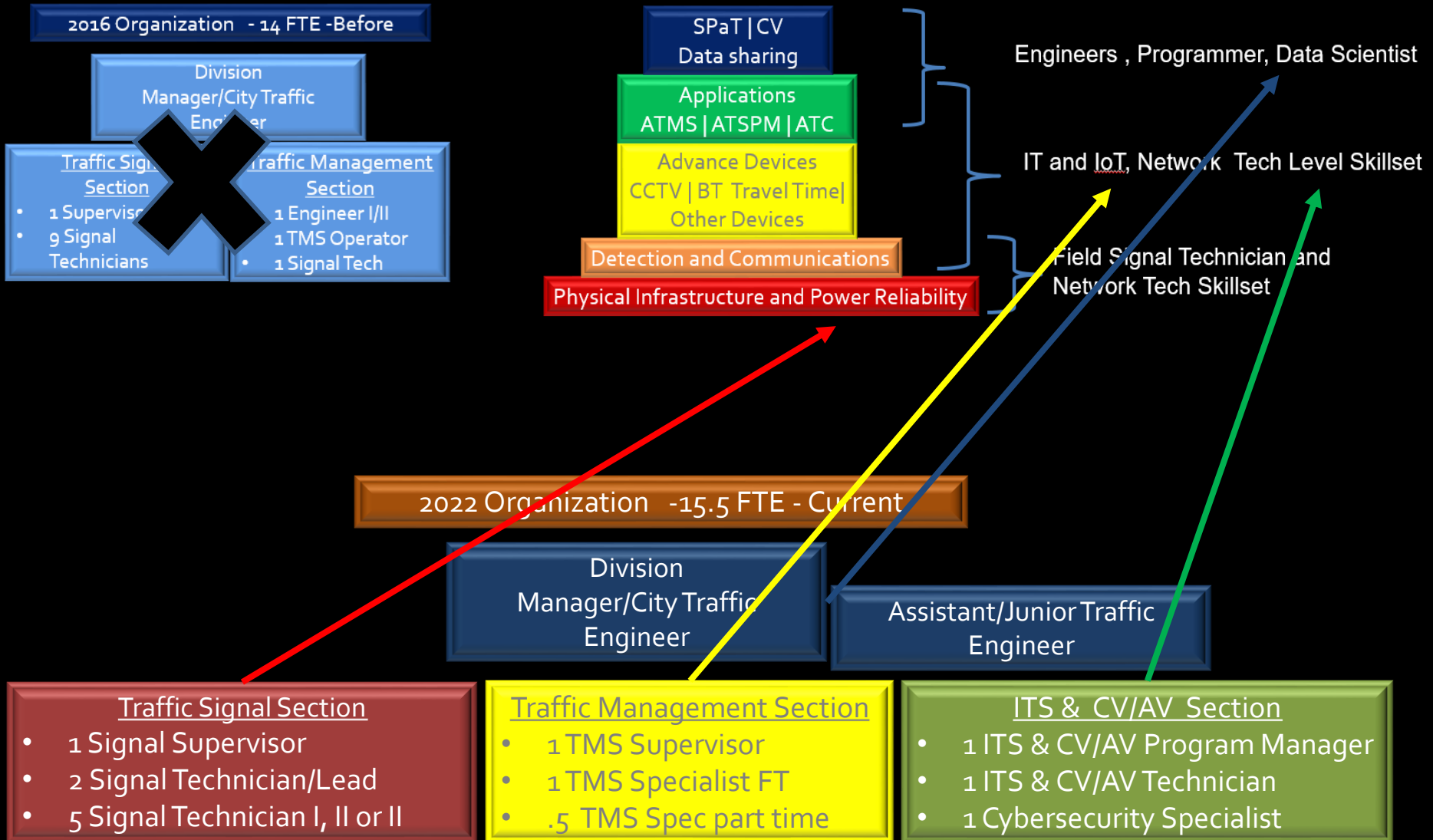
Lessons Learned and Further Research

- Nighttime?
- Before and After testing?
- Additional devices for better resolution (Lidar and IR?)
- Privacy?



Lessons Learned

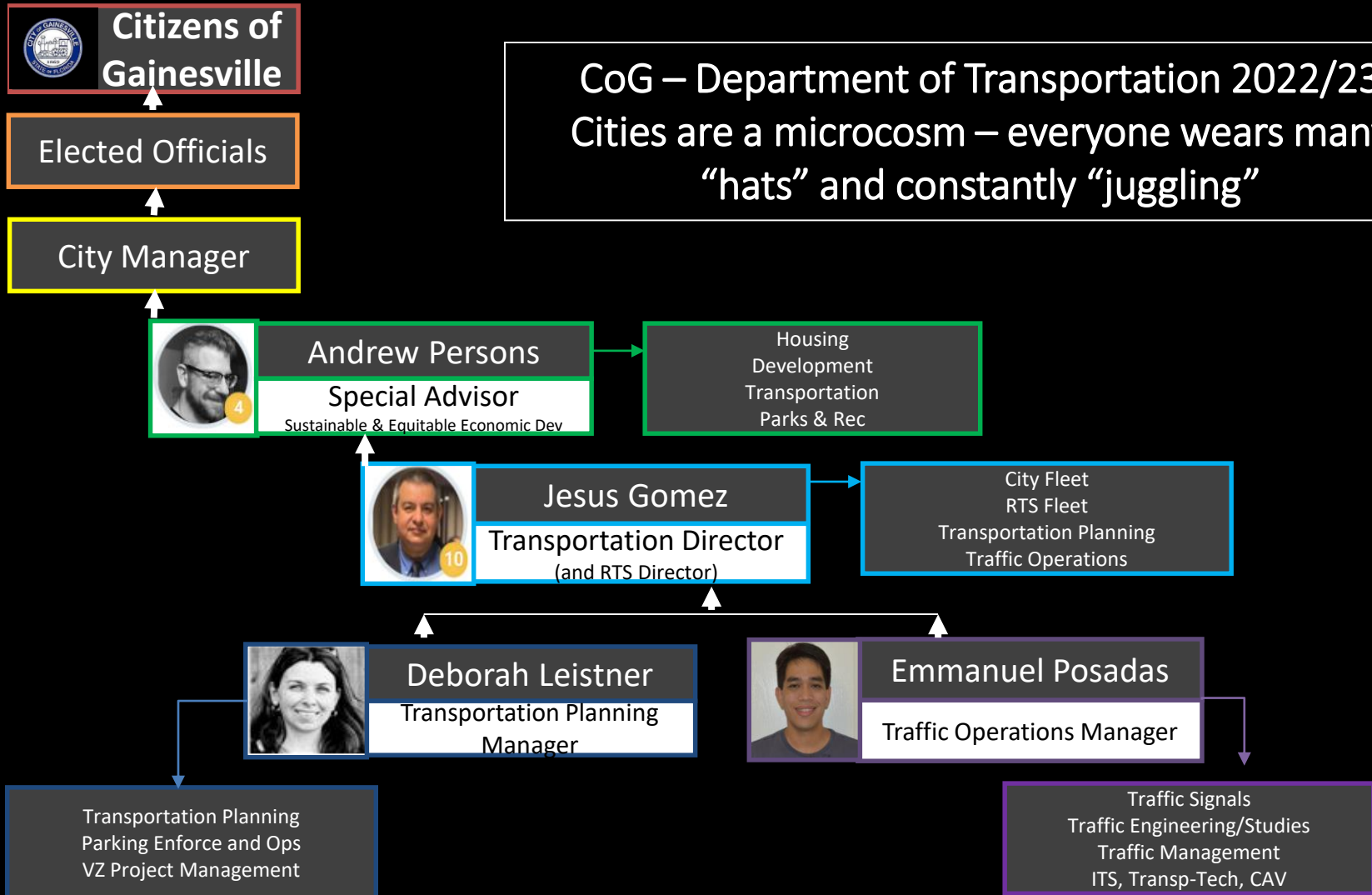
People: Workforce Development & Organizational Functions



Lessons Learned

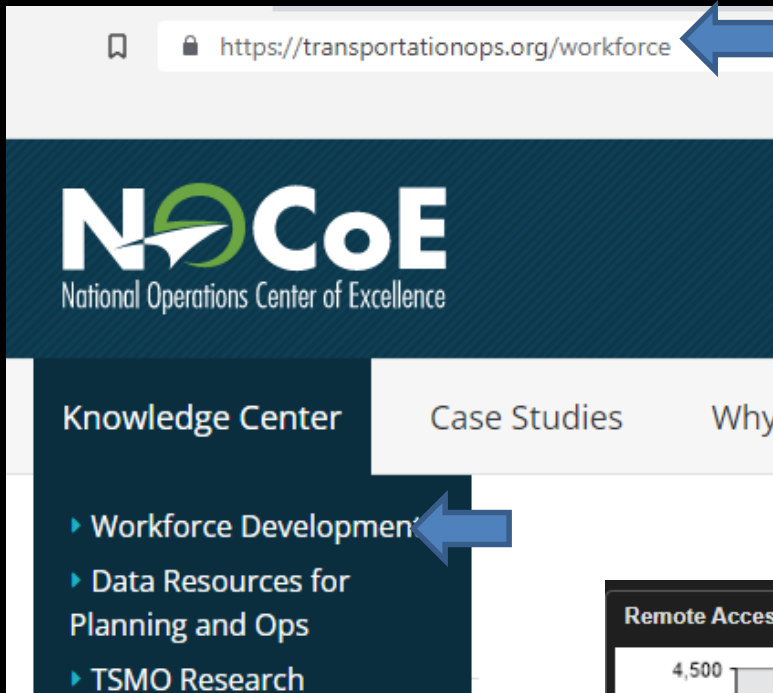
People: Workforce Development & Organizational Functions

CoG – Department of Transportation 2022/23
Cities are a microcosm – everyone wears many “hats” and constantly “juggling”

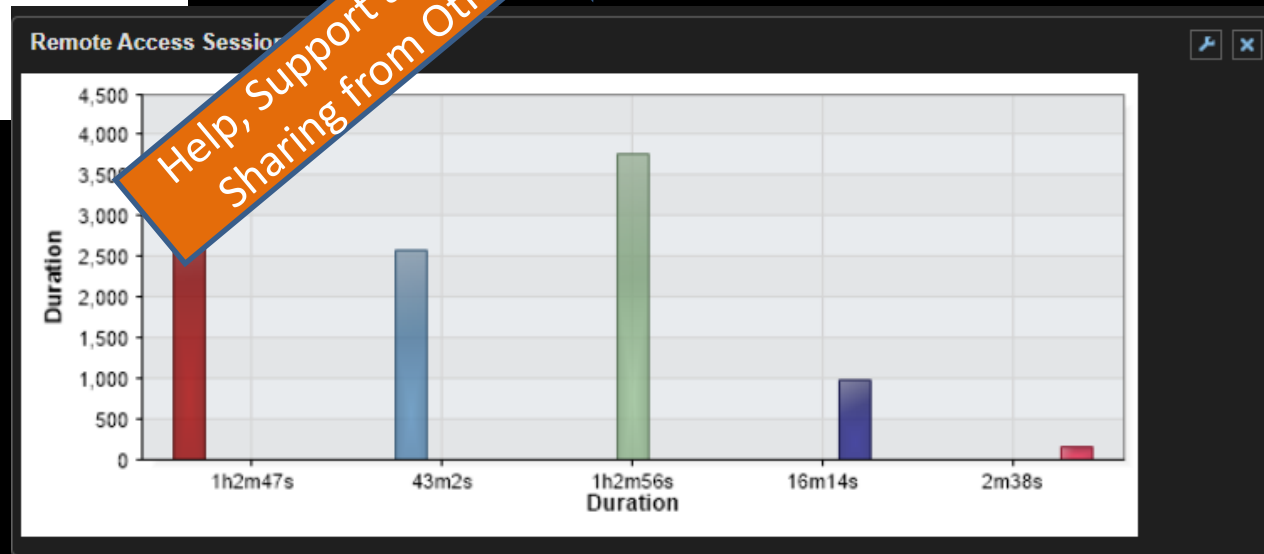
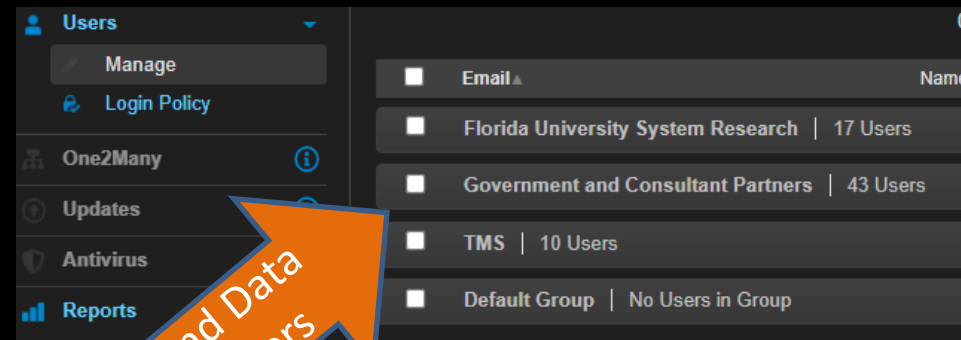


Lessons Learned

People: Workforce Development & Organizational Functions



TSM&O Workforce Development

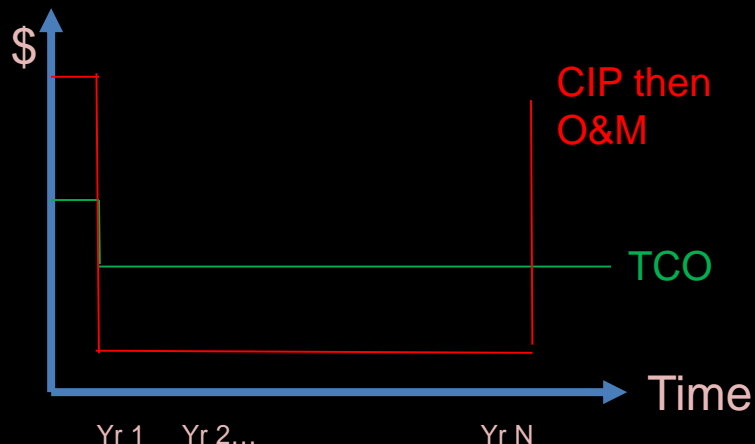


Lessons Learned

Process: TCO vs CIP & O&M Paradigm ; Standards vs Ad-Hoc

TCO – Total Cost of Ownership

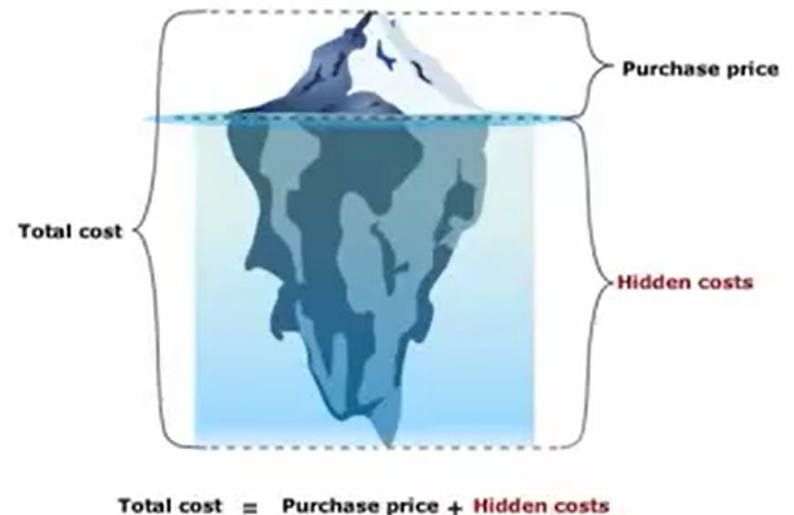
- Acquisition/Physical Cost
- Operating Cost
 - Materials and Supplies
 - Software and SaaS
- Personnel Cost
 - Training
 - Safety
- Capital recovery (replacement)
 - Examples: Computers/Fleet Replacement
 - 5-10 year lifespan



Initial Capital Infrastructure (CIP) then
O&M - Operating and Maintenance

Examples: Civil Infrastructure Projects, Roadways – 20+
year lifespans,

Importance of understanding total cost



Standardize: to Scale, to be efficient

Ad-hoc: to try, prove - limited test case

2022 version of

Florida CV Initiative & UF I-STREET

Thank You

Progress...

I-STREET (Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies) is a "living lab" on the University of Florida (UF) campus and surrounding roadway network where advanced technologies such as autonomous vehicles, smart devices, and sensors are tested and deployed to enhance mobility and safety. It is a collaboration between the Florida Department of Transportation (FDOT), the City of Gainesville (CoG), and UF.

TRANSPORTATION INSTITUTE
UNIVERSITY OF FLORIDA

FDOT funds project to plan I-STREET Living Lab. I-STREET is born. RFI issued for collaboration with industry. FDOT funds I-75 connected vehicle (CV) instrumentation project.

2017

Real-time signal control optimizer for AVs tested. CoG residents meet the AV shuttle.

2018

Work begins to develop data analytics database. 27 intersections instrumented (SPaT Trapezium). Pilot project for pedestrian safety system on UF campus.

2019

CoG/RTS launch AV shuttle in Gainesville. School zone/bike warning project completed. Bike rack sensor project for transit buses completed.

2020

Evaluation of connected system along I-4 begins. AV shuttle Phase II, new route to UF campus. I-STREET/Co-Motion Miami for Mobility Challenge.

2021

