THEA CV PILOT – PREPARING FOR CV IN COMMUNITIES

BRINGING CONNECTED VEHICLES TO YOUR TOWN

Walk. Ride. Drive. *Smarter.*

TAMPA HILLSBOROUGH
EXPRESSWAY
AUTHORITY

WHAT IS THEA?

- **A local, user-financed public agency**
  - Financed through revenue bonds
  - Supported by user tolls
  - No tax funding
  - Tolls stay local

- **Seven Member Board**
  - 4 Appointed by Governor
  - Mayor (or Council Chair)
  - Hillsborough County Commissioner
  - FDOT District 7 Secretary

- **Regional Capabilities**
  - Hillsborough County
  - Adjacent Counties by Invitation
    - Interlocal Agreement(s) in Place with Pinellas County

INDEPENDENT
Agency of the State

THEA STRATEGIC OVERVIEW

Mission
Our mission is to provide safe, reliable, and financially-sustainable transportation services to the Tampa Bay region while reinvesting customer-based revenues back into the community.

Vision
Our vision is to lead, partner, and implement safe, economically-sound, and innovative multi-modal transportation solutions for our Tampa Bay community.

Provide THEA customers with the safest, most efficient drive possible.

Advance Mobility Technology

Promote Tampa Bay

BENEFITS OF CONNECTED VEHICLE COMMUNICATION
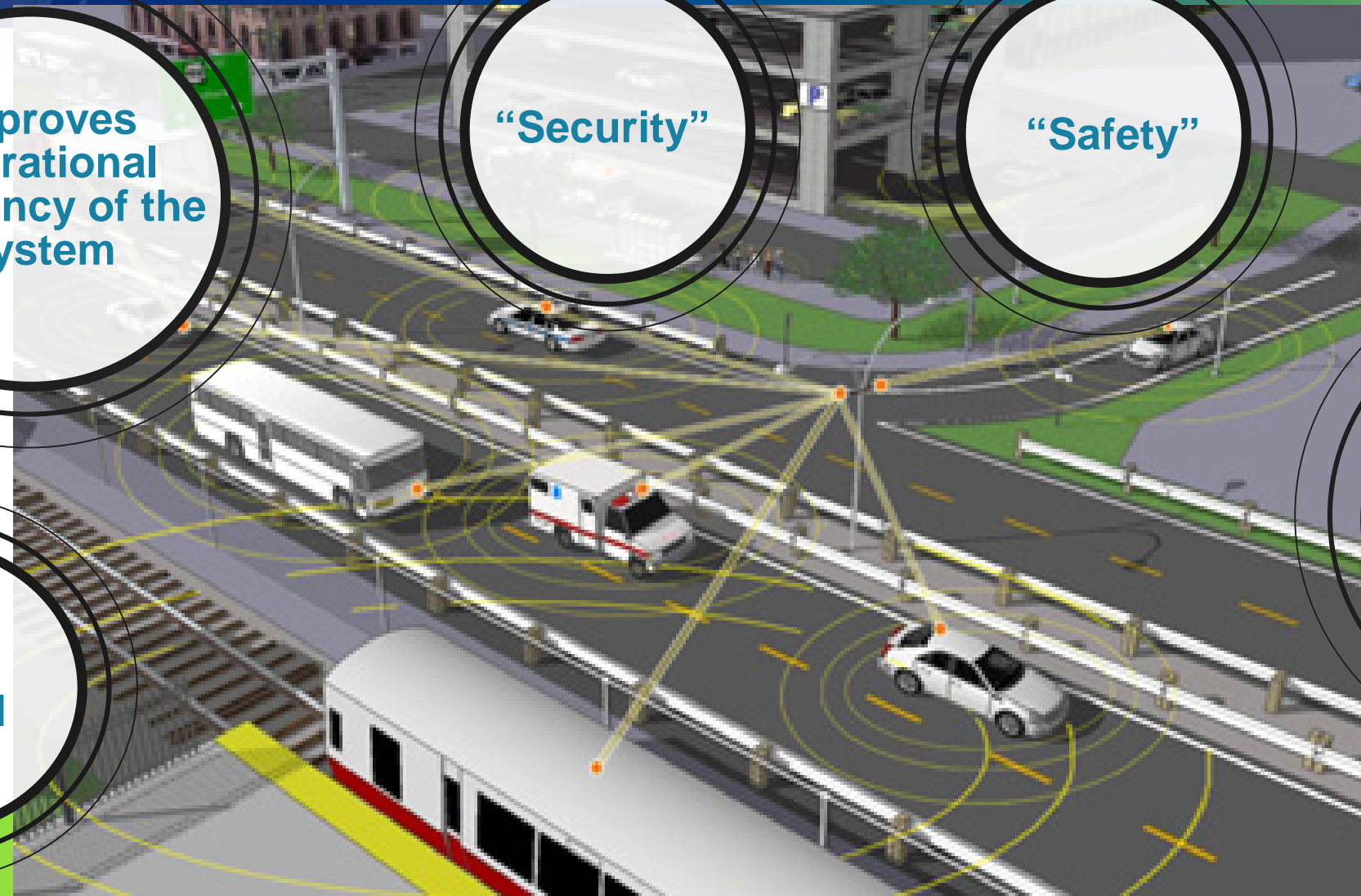
CONNECTED
VEHICLE PILOT
TAMPA

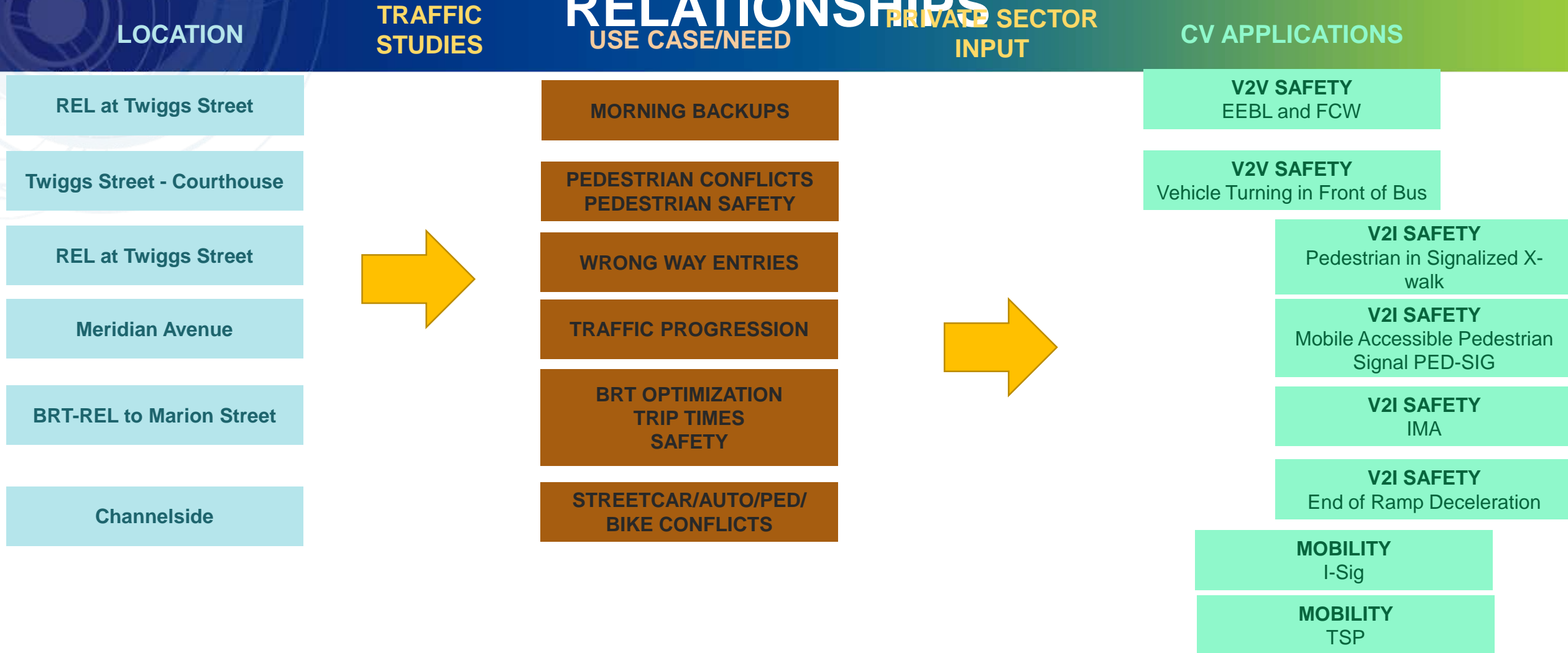**Improves operational efficiency of the system**

"Security"

"Safety"

Track Record

Ability for all residents to experience benefits of technology…

SOLVING REAL PROBLEMS – PILOT DEPLOYMENT ISSUES AND APPLICATIONS RELATIONSHIPS

LOCATION	TRAFFIC STUDIES	USE CASE/NEED	PRIVATE SECTOR INPUT	CV APPLICATIONS
REL at Twiggs Street		MORNING BACKUPS		**V2V SAFETY** EEBL and FCW
Twiggs Street - Courthouse		PEDESTRIAN CONFLICTS PEDESTRIAN SAFETY		**V2V SAFETY** Vehicle Turning in Front of Bus
REL at Twiggs Street		WRONG WAY ENTRIES		**V2I SAFETY** Pedestrian in Signalized X-walk
Meridian Avenue		TRAFFIC PROGRESSION		**V2I SAFETY** Mobile Accessible Pedestrian Signal PED-SIG
BRT-REL to Marion Street		BRT OPTIMIZATION TRIP TIMES SAFETY		**V2I SAFETY** IMA
				V2I SAFETY End of Ramp Deceleration
Channelside		STREETCAR/AUTO/PED/ BIKE CONFLICTS		**MOBILITY** I-Sig
				MOBILITY TSP

CONNECTED VEHICLE PILOT DEPLOYMENT PROGRAM

PROGRAM GOALS

Spur Early CV Tech Deployment
- Wirelessly Connected Vehicles
- Mobile Devices
- Infrastructure

Measure Deployment Benefits
- Safety (LIMIT 35)
- Mobility
- Environment

Resolve Deployment Issues
- Technical (ERROR)
- Institutional
- Financial

Connected Vehicle Pilot Deployment (up to 50 months)

PHASE 1 (up to 12 months)	PHASE 2 (up to 20 months)	PHASE 3 (minimum 18 months)	Routine Operations (ongoing)
Concept Dev.	Design/Deploy/Test	Maintain/Operate Pilot	Post-Pilot Operations

Progress Gate — Progress Gate — Transition

PILOT SITES

SELMON EXPRESSWAY

ICF/Wyoming DOT

NYCDOT

Tampa (THEA)

U.S. Department of Transportation
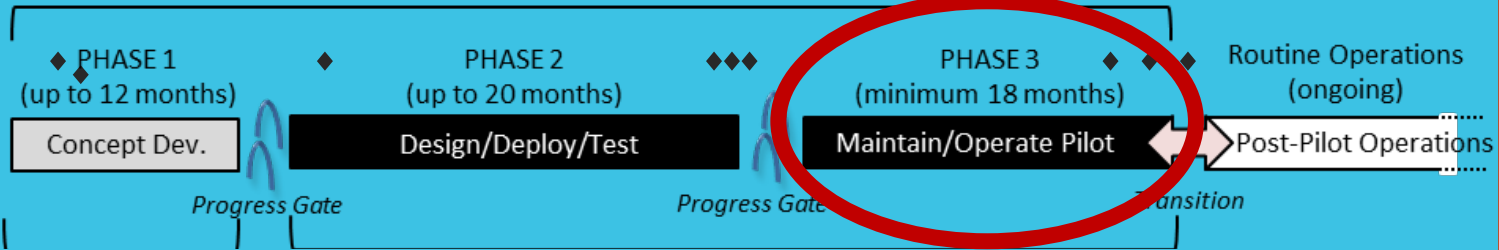
COMPARTMENTED STUDY AREAS - THEA PILOT DEPLOYMENT AREA
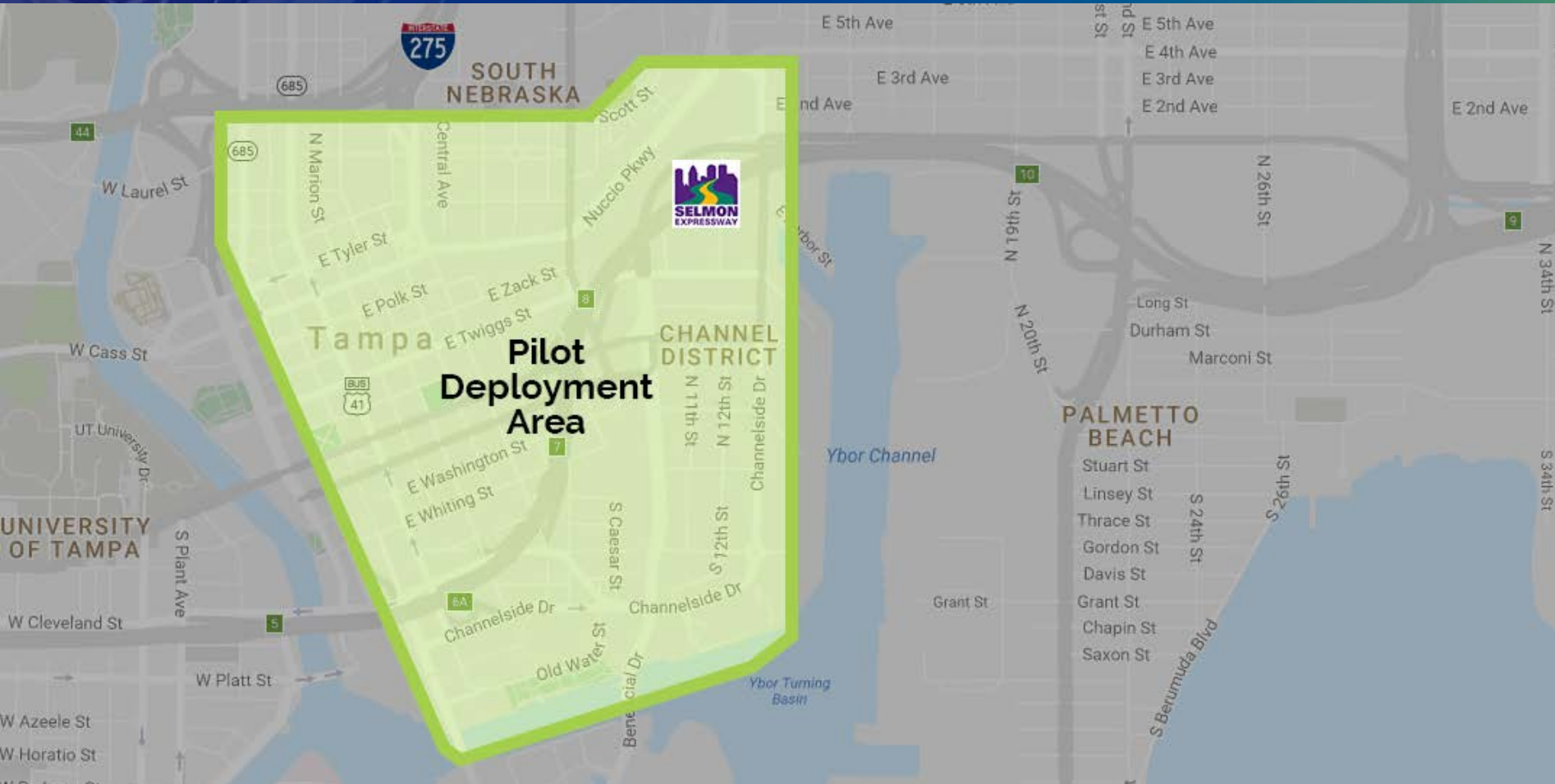
PERFORMANCE MEASUREMENT - PREPARATION

Work completed to support Performance Measurement and Evaluation

- CUTR Server setup (hourly uploads from RSUs)
- SQL Databases (CV and non-CV Data)
- SDC & ITS Public Data Hub data nightly upload
- Data parsing and analysis
- Participant misbehavior detection protocol
- Modeling and inference
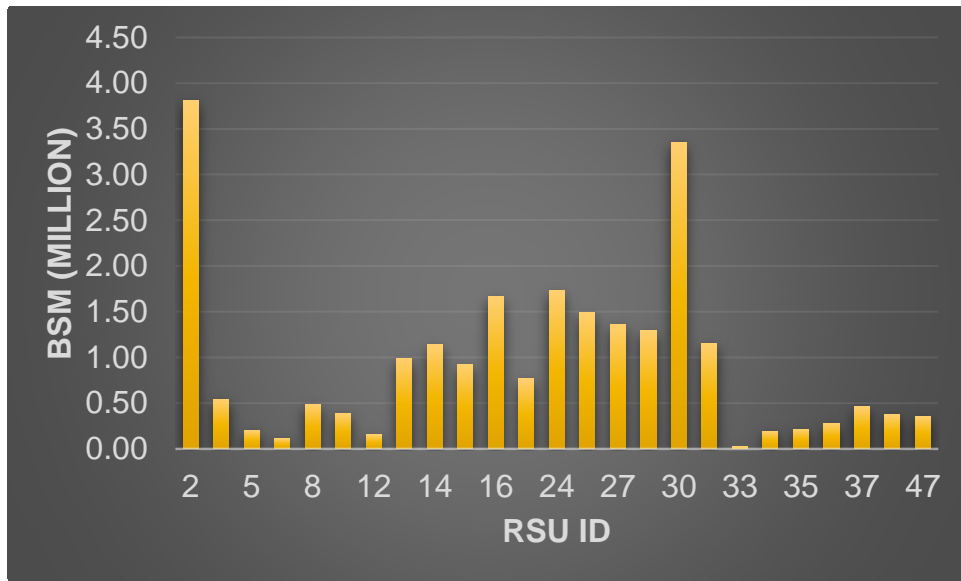- OBU vendor support to validate OBU Data Logs

BENEFITS – BSM AND RSU: STUDY AREA

- Some RSU receive more BSM than others
- Coverage of entire study area ensured

PARTICIPANT RECRUITMENT

- Total of 1,028 On Board Units (OBU) installations
  - 1,006 are participants.
- Total of 780 participants actively coming to the study area (first two weeks of March 2019)
  - 77.5 percent participation rate
- Continuing support to troubleshoot, install, reinstall OBUs.

OBU Type	Count	Share
Participants	780	94.9
Bus	10	1.2
Trolley	7	0.9
City of Tampa	13	1.6
Friend of the Pilot	7	0.9
Total	817	99.4

Install Appointments — Monthly and Cumulative install appointments Mar-18 through Feb-19: Mar-18: 5, Apr-18: 145, May-18: 140, Jun-18: 140, Jul-18: 64, Aug-18: 168, Sep-18: 127, Oct-18: 96, Nov-18: 103, Dec-18: 40, Jan-19: 0, Feb-19: 0
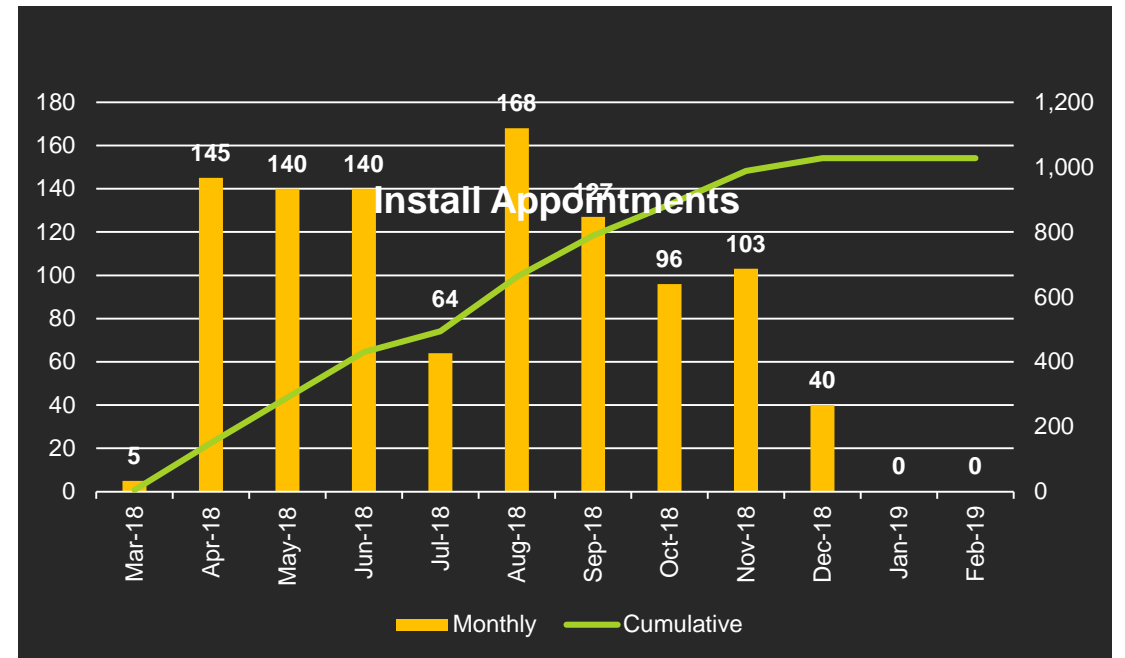
CONNECTED VEHICLE APPLICATIONS

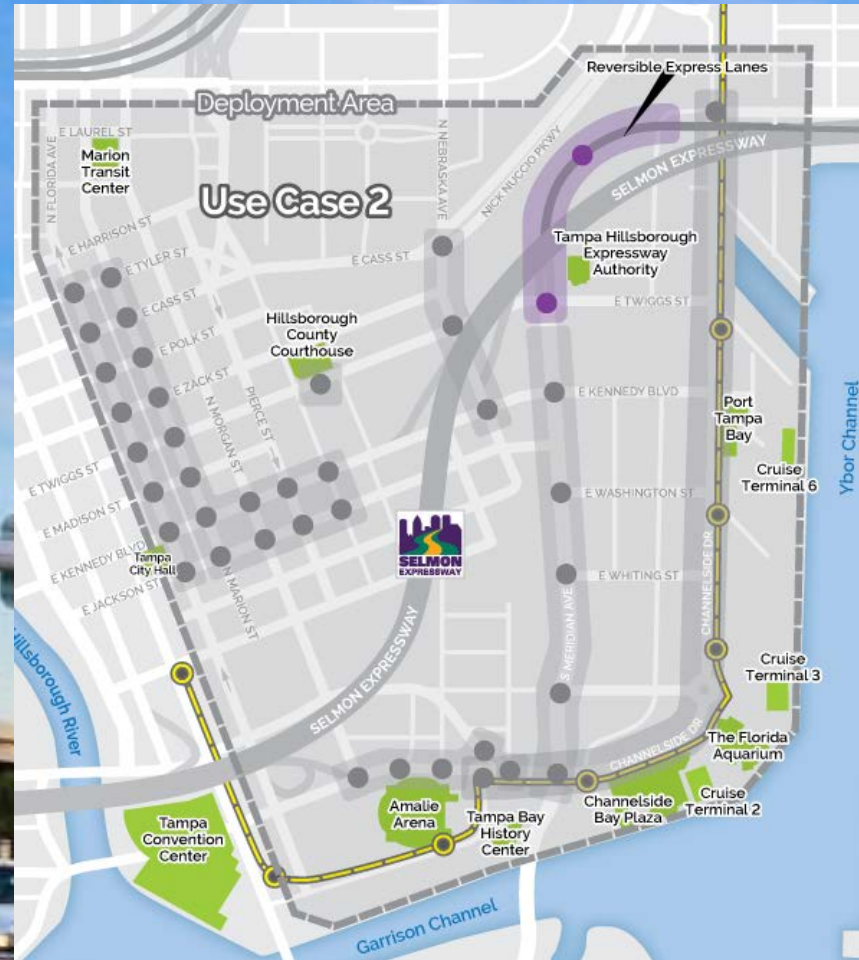| APPLICATION	DESCRIPTION
End of Ramp Deceleration Warning (ERDW)	Alerts driver approaching curve with speed safety warning
Emergency Electronic Brake Light (EEBL)	Enables broadcast to surrounding vehicles of severe braking
Forward Collision Warning (FCW)	Warns driver of impending collision ahead in same lane
Intersection Movement Assist (IMA)	Indicates unsafe (i.e., wrong way) entry into an intersection
Intelligent Traffic Signal System (I-SIG)	Adjusts signal timing for optimal flow along with PED-SIG and TSP
Pedestrian Collision Warning (PCW)	Warns driver of impending conflict with pedestrian
Transit Signal Priority (TSP)	Allows transit vehicle to request and receive priority at a traffic signal
Vehicle Turning Right in Front of a Transit Vehicle (VTRFTV)	Alerts transit vehicle driver that a car is attempting to turn right in front of the transit vehicle as well as the driver of the car.
Wrong Way Entry (WWE)	Warns driver of potential and actual Wrong Way travel direction

MORNING BACKUPS
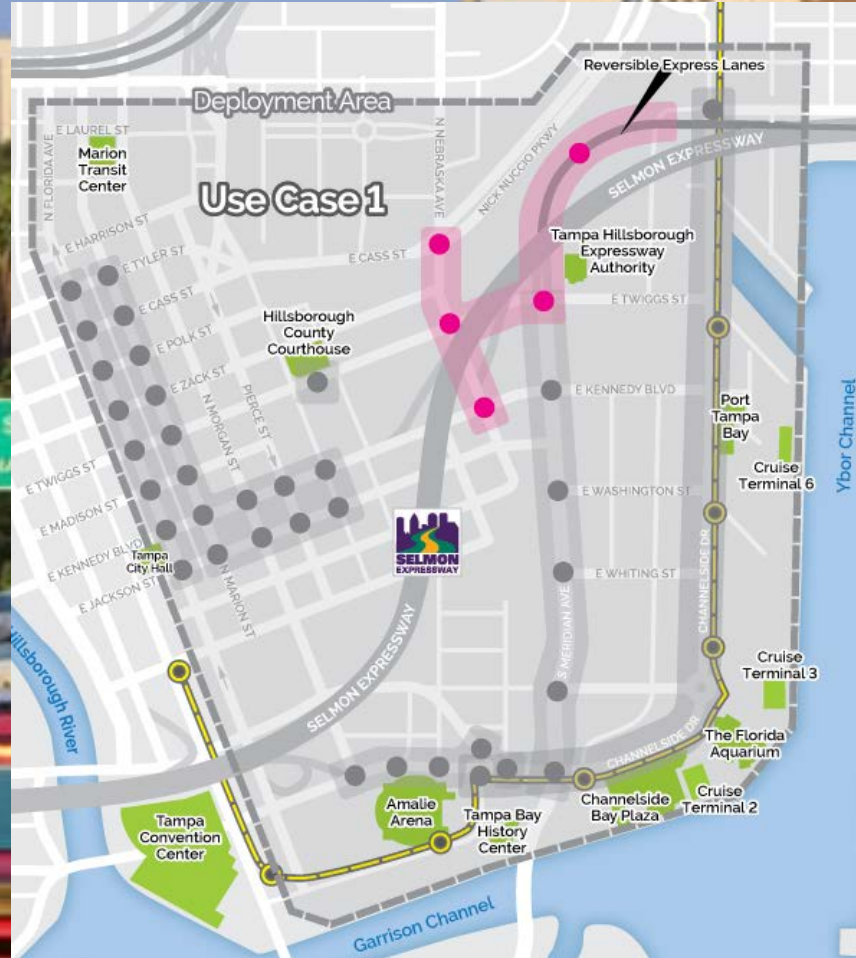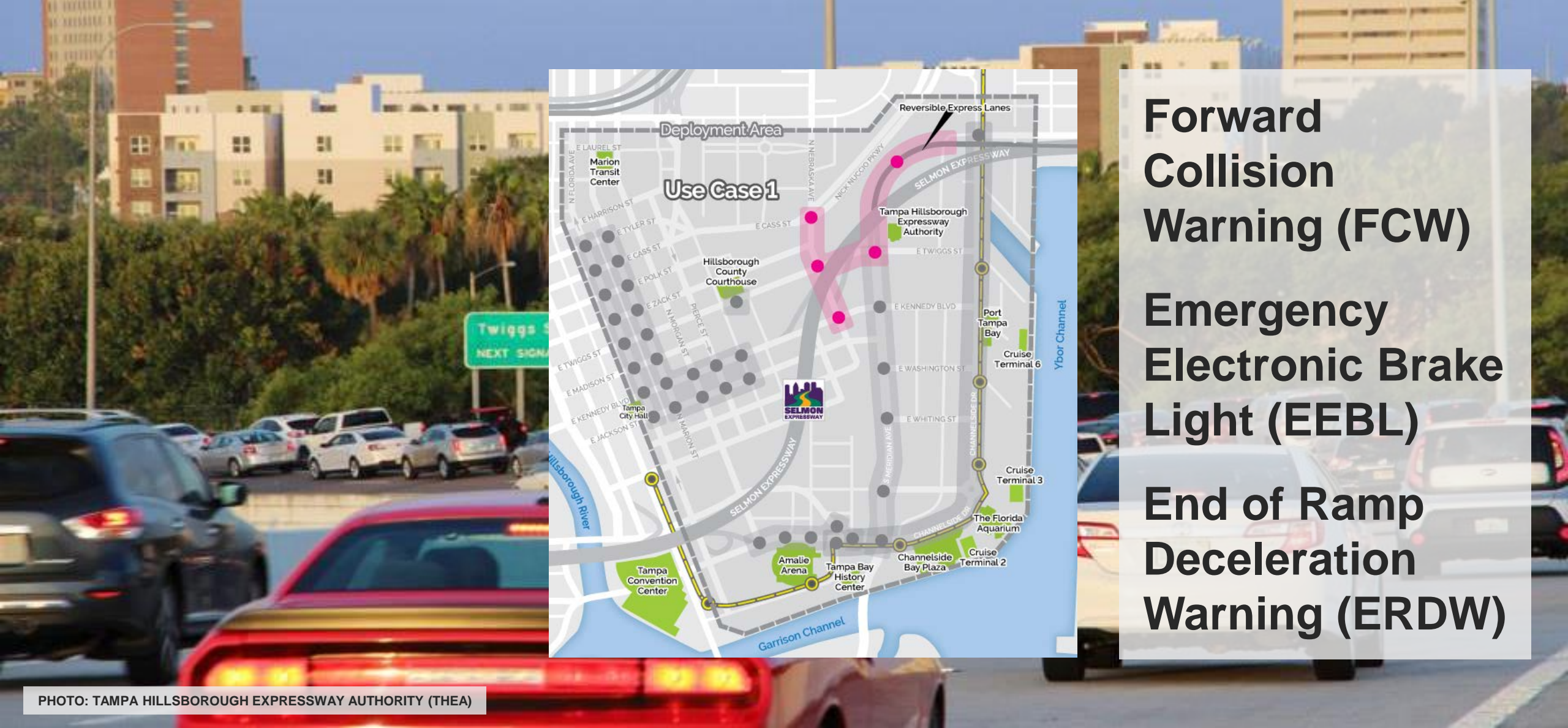
Forward Collision Warning (FCW)

Emergency Electronic Brake Light (EEBL)

End of Ramp Deceleration Warning (ERDW)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

WRONG-WAY DRIVERS

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

Wrong-way Entry

Intersection Movement Assist (IMA)

MAP

Signal Phasing and Timing (SPaT)

PEDESTRIAN SAFETY

Pedestrian Collision Warning (PCW)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

TRANSIT SIGNAL PRIORITY

Intelligent Traffic Signal System (I-SIG)

Transit Signal Priority (TSP)

Intersection Movement Assist (IMA)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

STREETCAR CONFLICTS

Vehicle Turning Right in Front of Transit Vehicle (VTRFTV)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

TRAFFIC PROGRESSION

Probe Data Enabled Traffic Monitoring

Intelligent Traffic Signal System (I-SIG)

Intersection Movement Assist (IMA)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

PERFORMANCE MEASUREMENT AND EVALUATION

- THEA tasked the Center for Urban Transportation Research (CUTR):

  - Perform overall performance measurement and evaluation
  - Provide participant recruitment support
  - Support Independent Evaluators
  - USDOT data sharing
    - Secure Data Commons (SDC)
    - ITS Public Data Hub
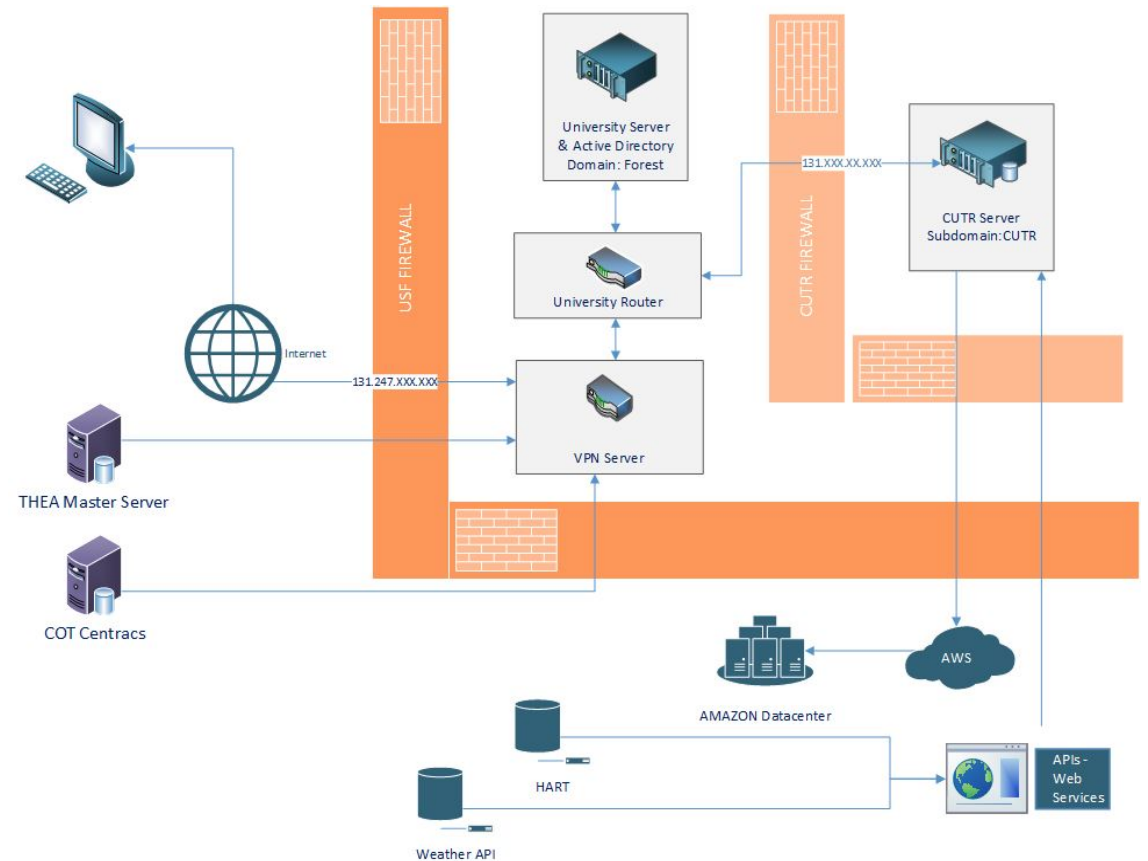
- Finalize OBU Data Log over-the-air transfers

- Turn-on warnings to Treatment

- Support to participant sample refreshments

- Continue data collection, processing analysis and reporting

  □ Finalize dashboard

  ❑ Reporting to AOR designated US DOT entities
  ❑ Internal team and stakeholders
  ❑ SDC and ITS Public Data Hub

- Independent Evaluator Support
- System Impact Assessment
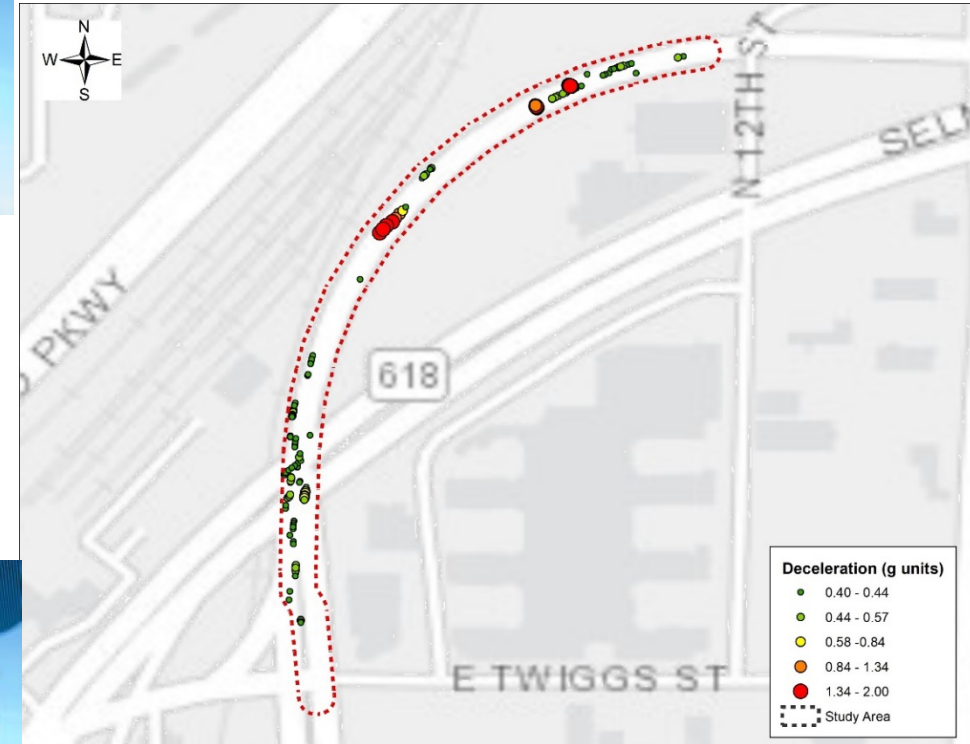
DATA GENERATION

- Data collection Feb – Sep 23, 2018
  - 657 participants
  - 64,430 files
  - 146.8 GB of highly compressed data (uncompressed is 20+ times larger)
- Compiling comprehensive SQL database to process
  - ✓ BSM
  - ✓ SPAT
  - ✓ TIM
  - ✓ SSM
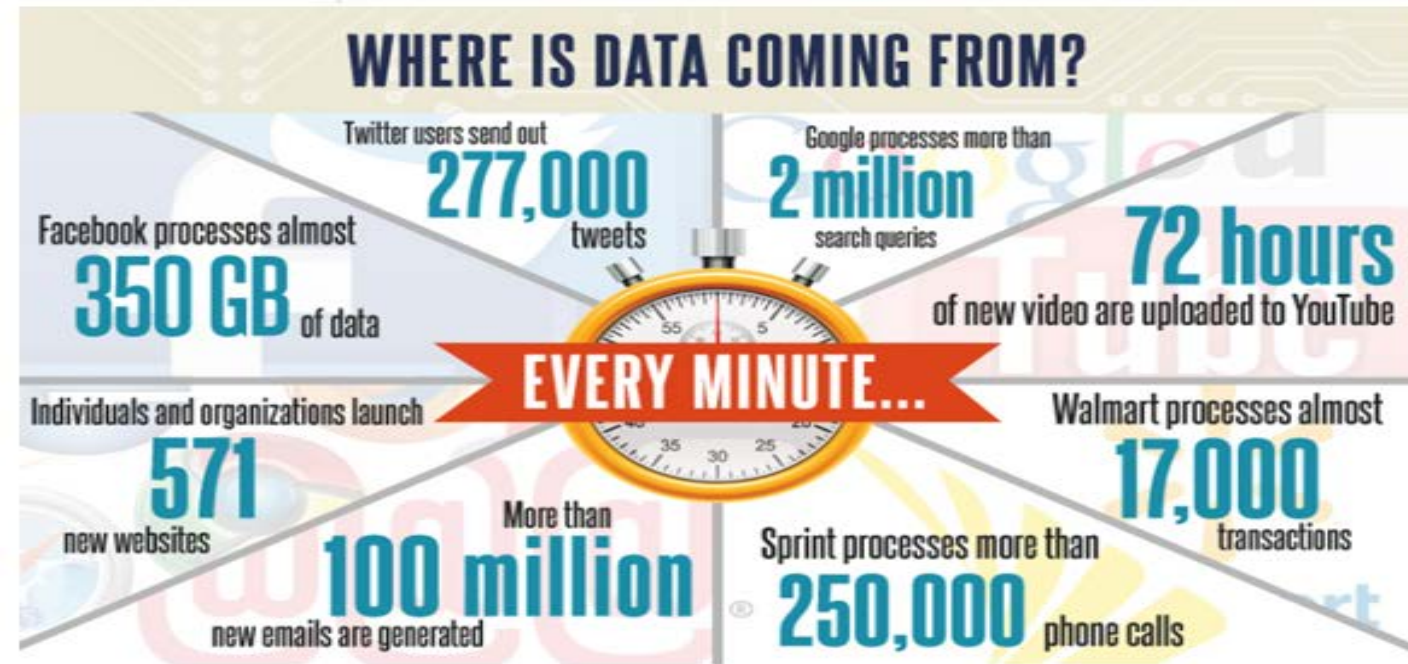 - ✓ SRM
  - ✓ MMITTS
  - OBU Logs (in process)
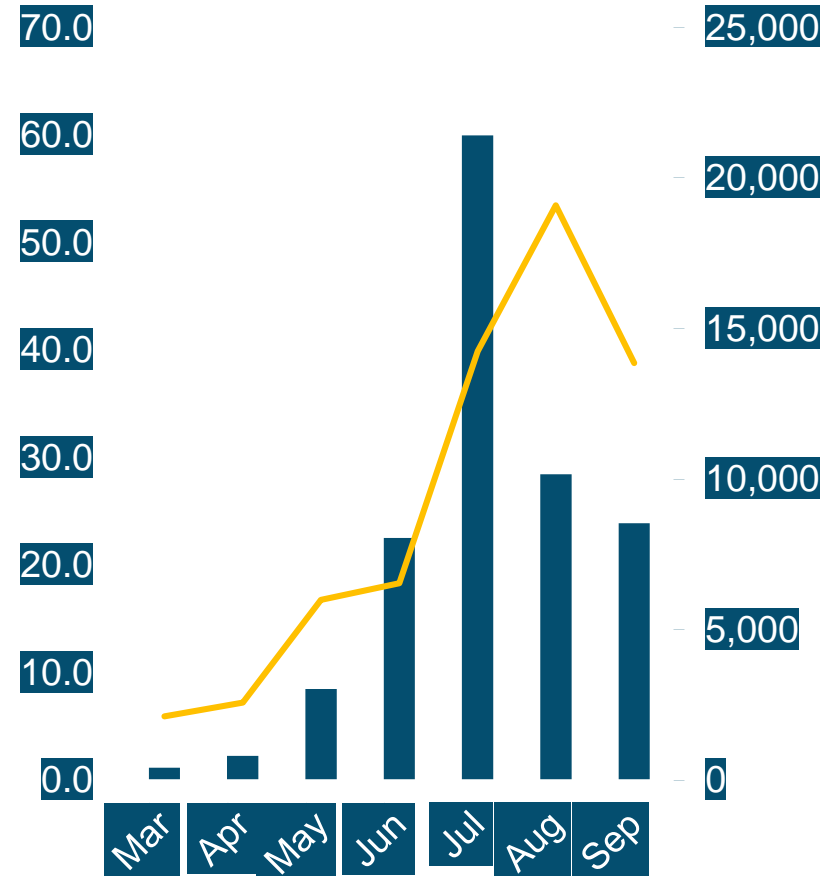
BENEFITS – TRAVEL DATA

September Data
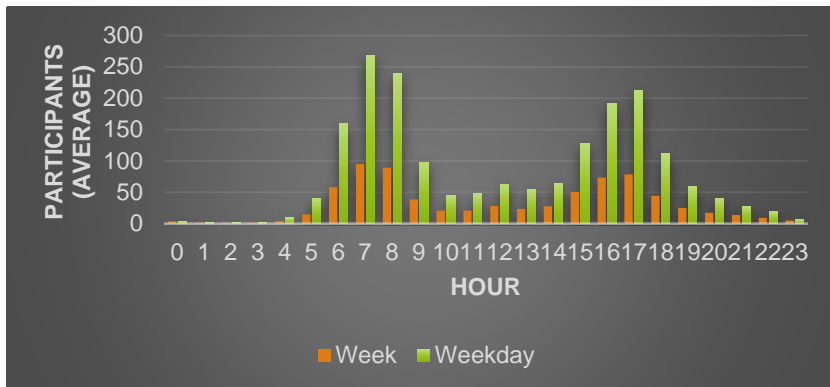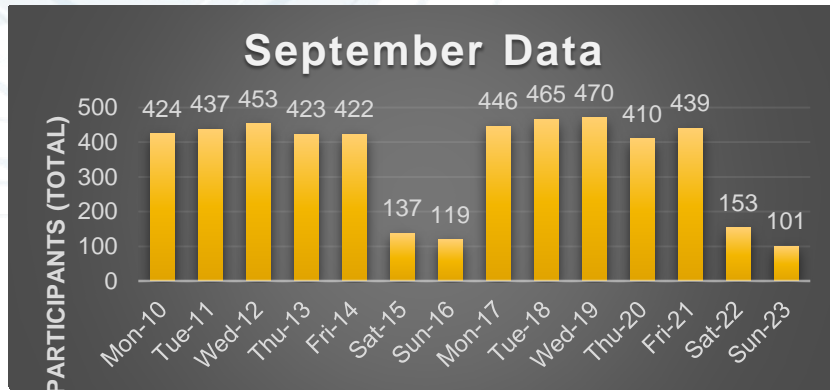
- Average of 1.7 million BSM/day

- About 0.9 million BSM/RSU

- Weekday travel patterns with a.m. and p.m. peak periods

- Up to 270 participants per hour on average at a.m. peak hour

Big Data

- **70B**
  connected devices (2050)

- **2.8T**
  sensors by 2019

- **Autonomous Vehicles (L2)**
  80+ processors;
  200+ sensors;
  100M+ lines of code (GM)

What kind of data are we creating?

20%

STRUCTURED DATA
data governed by a relational table, like in a database

80%

UNSTRUCTURED DATA
everything else, including tweets, facebook posts, network log files, photos, word documents, email, spreadsheets, cat memes, etc.

WHERE IS DATA COMING FROM?

Facebook processes almost 350 GB of data

Twitter users send out 277,000 tweets

Google processes more than 2 million search queries

72 hours of new video are uploaded to YouTube

Individuals and organizations launch 571 new websites

More than 100 million new emails are generated

Sprint processes more than 250,000 phone calls

Walmart processes almost 17,000 transactions

EVERY MINUTE...

2,500,000,000,000,000,000
2.5 Quintillion bytes EVERY DAY

DATA COLLECTION

Pre-Deployment Performance Data Collection

- CV Data
  - BSM
  - SPAT
  - TIM
  - MAP
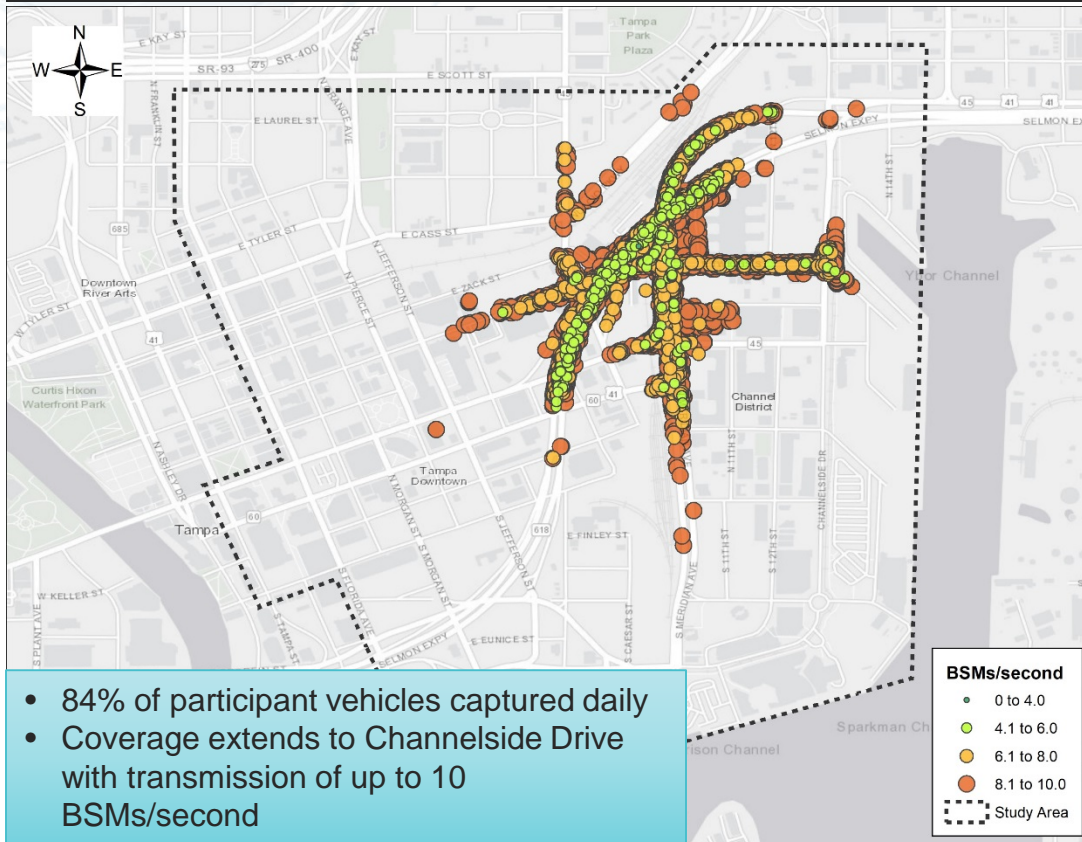 - MMITTS
  - SSM and SRM
  - OBU Logs
- Non-CV Data
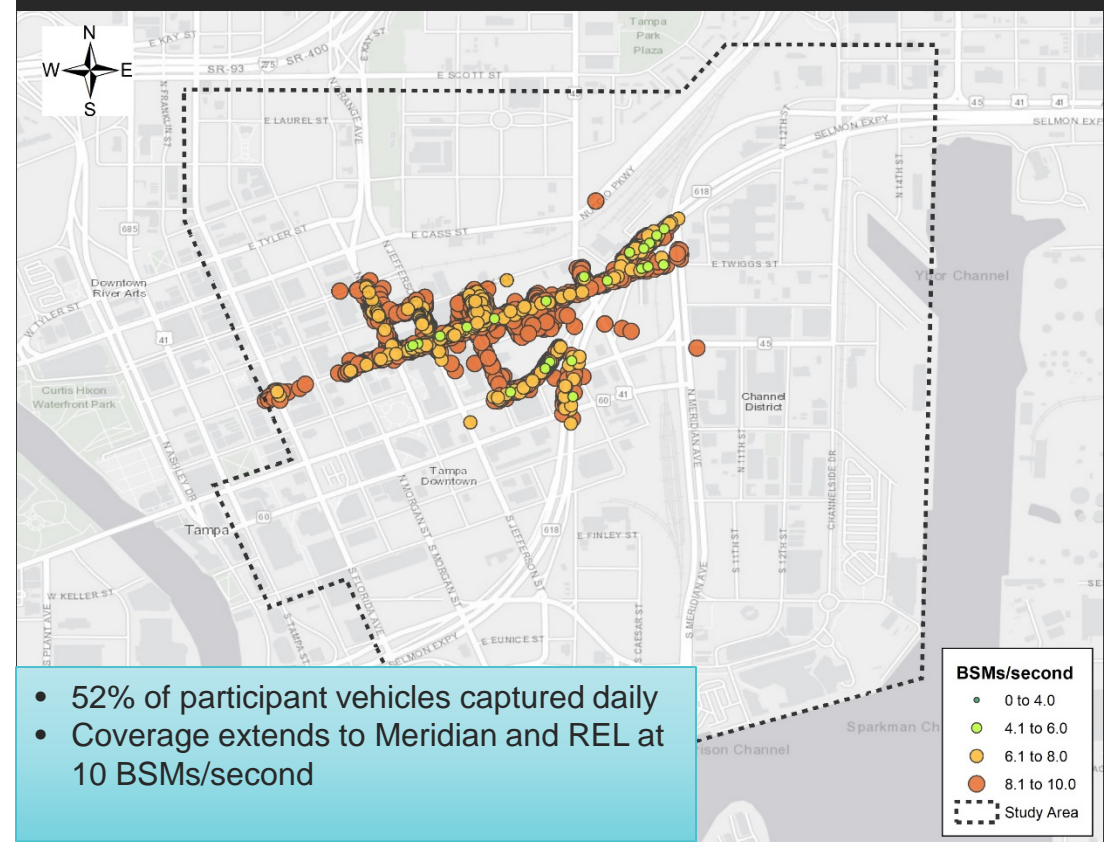 - Weather
  - Transit
  - Bluetooth
  - City of Tampa Centrax
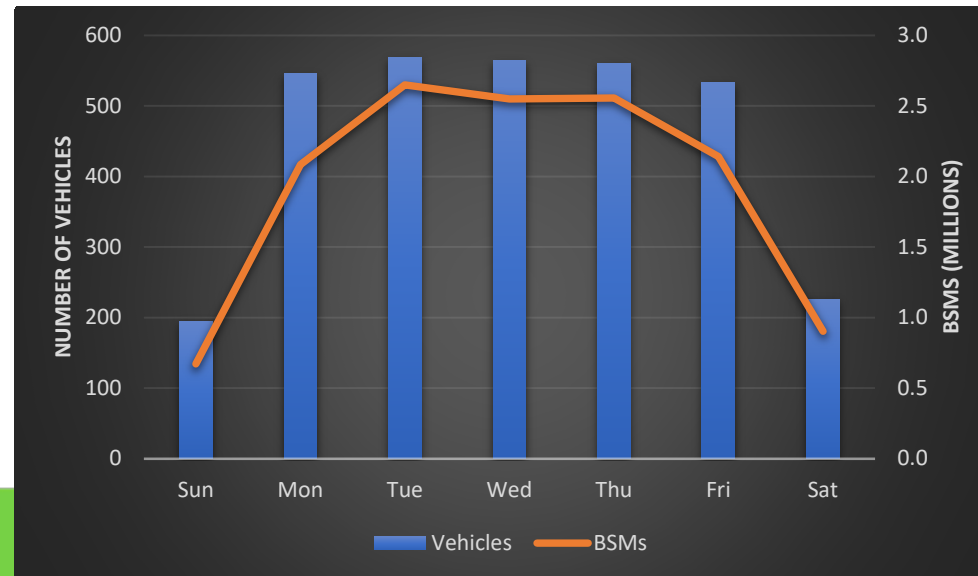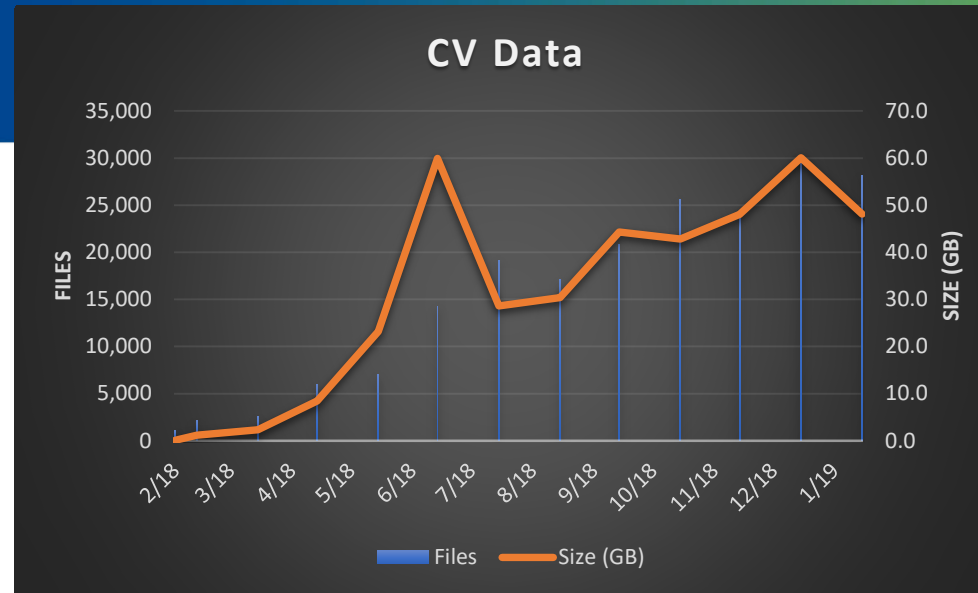
# PRELIMINARY ANALYSIS

RSU 2 – Twiggs and Meridian

BSMs/second
- 0 to 4.0
- 4.1 to 6.0
- 6.1 to 8.0
- 8.1 to 10.0
- Study Area

- 84% of participant vehicles captured daily
- Coverage extends to Channelside Drive with transmission of up to 10 BSMs/second

RSU 3 – Twiggs and Courthouse

BSMs/second
- 0 to 4.0
- 4.1 to 6.0
- 6.1 to 8.0
- 8.1 to 10.0
- Study Area

- 52% of participant vehicles captured daily
- Coverage extends to Meridian and REL at 10 BSMs/second

CONNECTED VEHICLE PILOT TAMPA

BENEFITS – BSM AND MOBILITY

- RSU collected BSM allow generating mobility performance measures by Use Case
- Cluster analysis of events to spot areas prone to accidents

BSM Density

USE CASE 1 – MOBILITY EVALUATION

Speed Heat Map - REL to Meridian and Twiggs
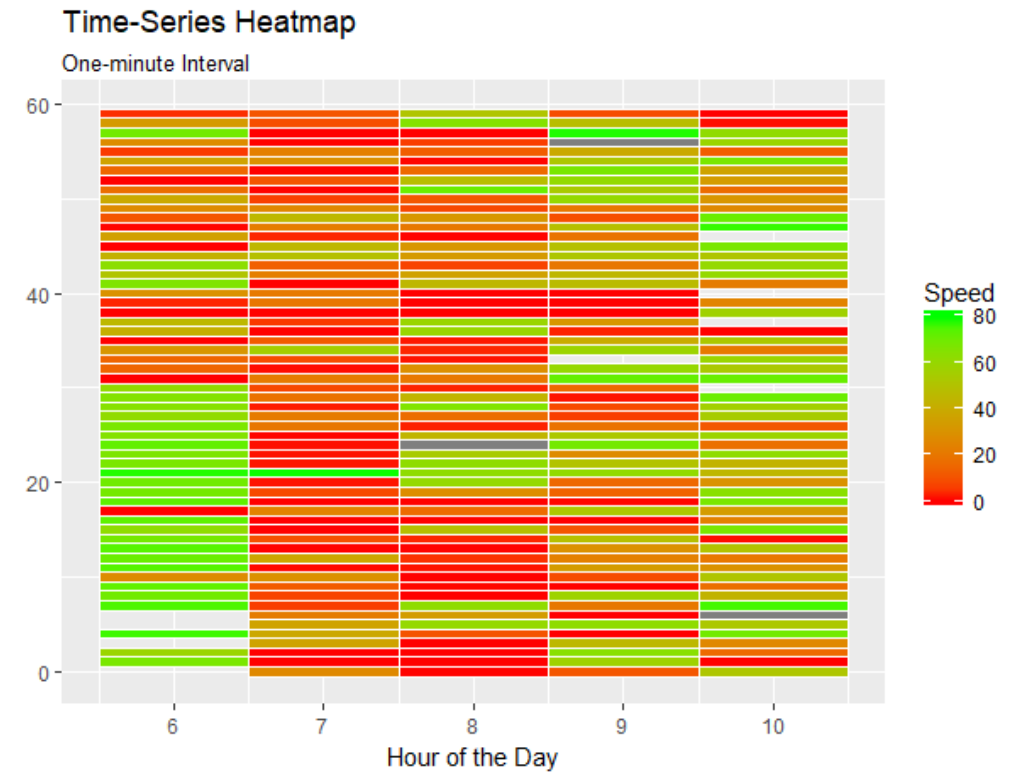
USE CASE 1 – MOBILITY EVALUATION
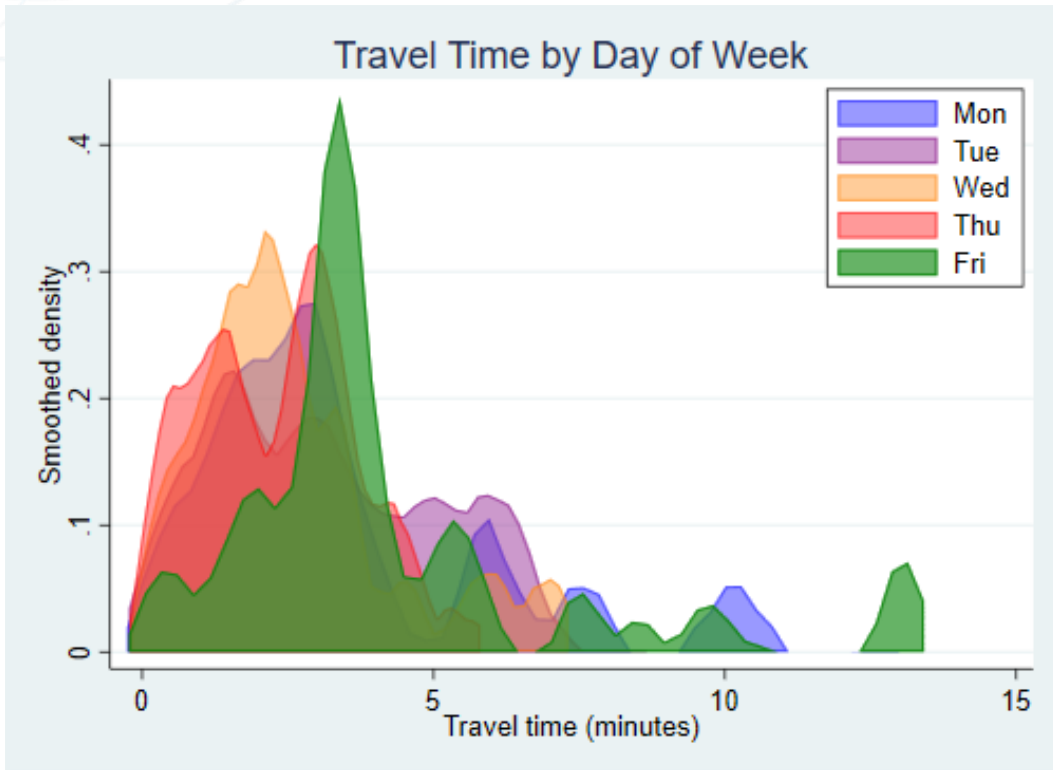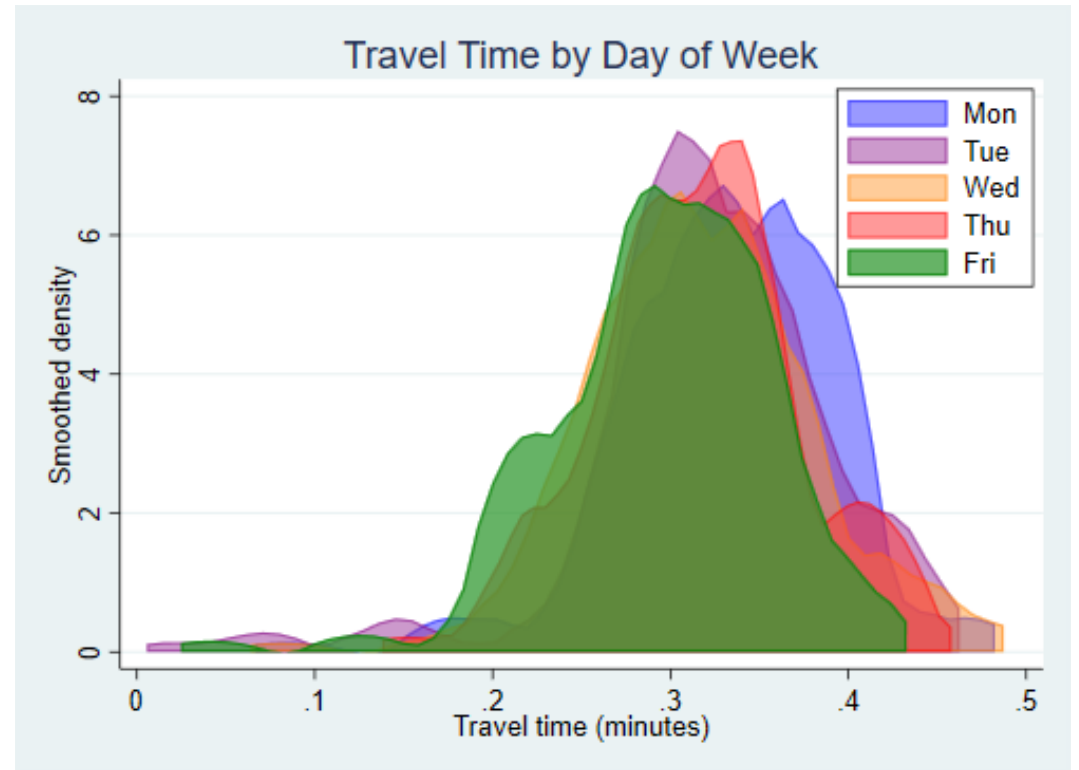
WHAT WE KNOW NOW -

- Solidified Standards Earlier
- Obtain a Better Understanding of "Available" Applications' Maturity
- Obtain a Better Understanding of Vendors' Depth and Resources
- Device Certification Process From Vendors
- Complete Integration Testing Before Private Vehicle Installs Begin
- Identify the Need to Use Traditional ITS Devices as Part of Solution Earlier
- Contracting – Fixed Fee and "Experimental Sole Source" way to go
- Cross functional coordination is absolutely critical
- Importance of face to face progress meetings
- OBUS - DON'T DO IT!!! Hire auto professionals to manage! We need OEM coordination

Focus on what we can control – Infrastructure, Public Transportation, Safety

OPPORTUNITIES –
ROLE OF INTEROPERABILITY
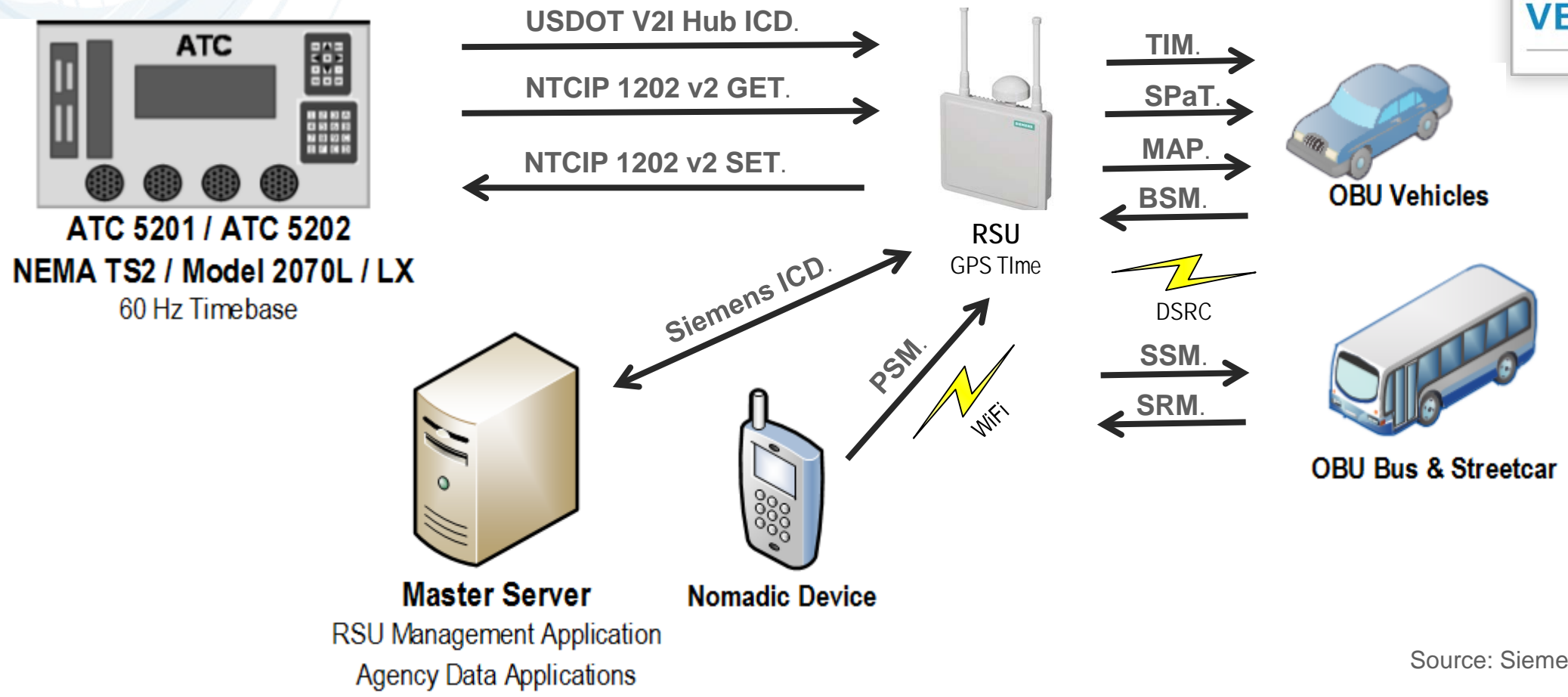
Source: Siemens Industry Inc.

DATA FLOW TO US DOT

Tampa CV Data flow to two USDOT Platforms:

1. **ITS Public Data Hub.** This platform hosts data available to the public and research community at large
   - ❑ BSM, SPAT, TIM
   - ❑ Automated nightly batch uploading
   - ❑ Data available since March 5, 2019
2. **Secure Data Commons.** This platform is restricted to UDOT analysist and independent evaluators.
   - ❑ BSM, SPAT, TIM
   - ❑ Data flowing nightly since Sep. 2018
   - ❑ OBU Logs starting April 2019

CAN A LOCAL AGENCY PREPARE FOR PARADIGM SHIFTING TECHNOLOGY?

- "Contract for CUTR study "Tampa Bay: An Automated Vehicle Catalyst?" (THEA Board action 6/24/13)

- THEA hosted multiple AV/CV Summits in Florida & to support the State's initiatives

- Participating in FDOT's Statewide initiative by being on working group, bring local and tolling perspective

- Actively marketed Test Bed
  - Audi was the first to test in Florida on facility the week of July 21, 2014

- USDOT CV Pilot
  - THEA lead the Tampa CV Pilot and paid all local matches to bring this technology to Tampa.
  - Created a public/private partnership team on US DOT Pilot Deployment

- Next Steps – How do we create transportation solutions?

LOCAL AGENCIES CAN LEAD INITIATIVES THAT BENEFIT CUSTOMERS, CONSISTENT WITH NATIONAL AND STATEWIDE INITIATIVES.