



FEDERAL HIGHWAY ADMINISTRATION

# CONNECTED VEHICLE PILOT DEPLOYMENT PROGRAM PHASE 1

CV Pilots Joint Technical Kickoff  
Session 1: Site Concepts, Tampa  
September 30, 2015

*FLORIDA! A Bold Vision*



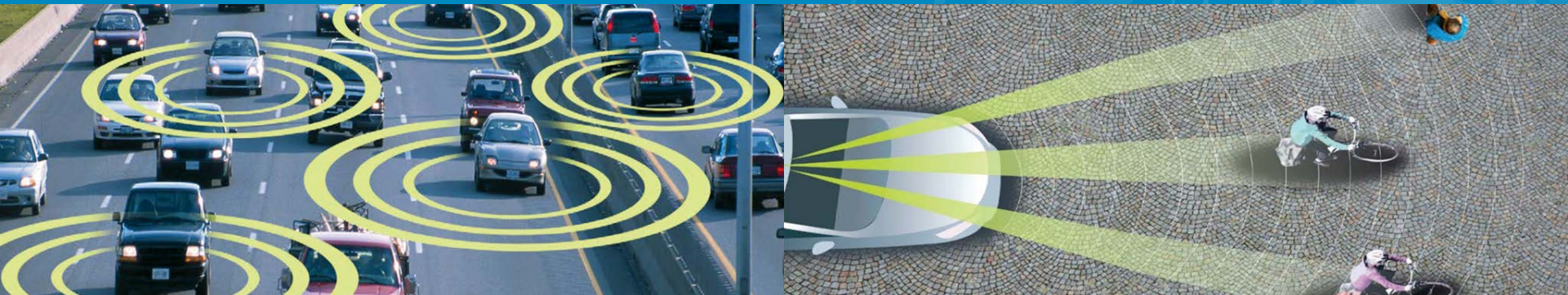
# JOE WAGGONER

Executive Director, CEO

Tampa Hillsborough Expressway Authority (THEA)

# CONNECTED VEHICLE TECHNOLOGIES

*Advances that will Transform  
Life, Business and Global Economy*





# INNOVATION

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Forward Thinking Transportation Agencies Tampa Hillsborough Expressway Authority (THEA), City of Tampa, Hillsborough Regional Transit Authority (HART) and Florida Department of Transportation (FDOT) District 7

# OBJECTIVITY

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Nationally Recognized Educational Institutions like Center for Urban Transportation Research (CUTR) at University of South Florida (USF)

Performance Measurements

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# OPPORTUNITY

Strong Economic Development Council and Supportive Chamber of Commerce

***We have the Right Resources***

# *Opportunities*

Test Bed for Connected Vehicle (CV), Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) Systems



**SELMON EXPRESSWAY**



# *Opportunities*

Test Bed for Connected Vehicle (CV), Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) Systems



**MERIDIAN AVENUE AND BRANDON PARKWAY**



# Opportunities

Test Bed for Connected Vehicle (CV), Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) Systems



CITY OF TAMPA – TRAFFIC MANAGEMENT CENTER

CONNECTED VEHICLE TECHNOLOGIES

# OPPORTUNITIES



*FLORIDA! A Bold Vision*





## Bob Frey, AICP

**THEA Program Director and Task 10 Lead - Partnership Coordination**  
Tampa Hillsborough Expressway Authority (THEA)

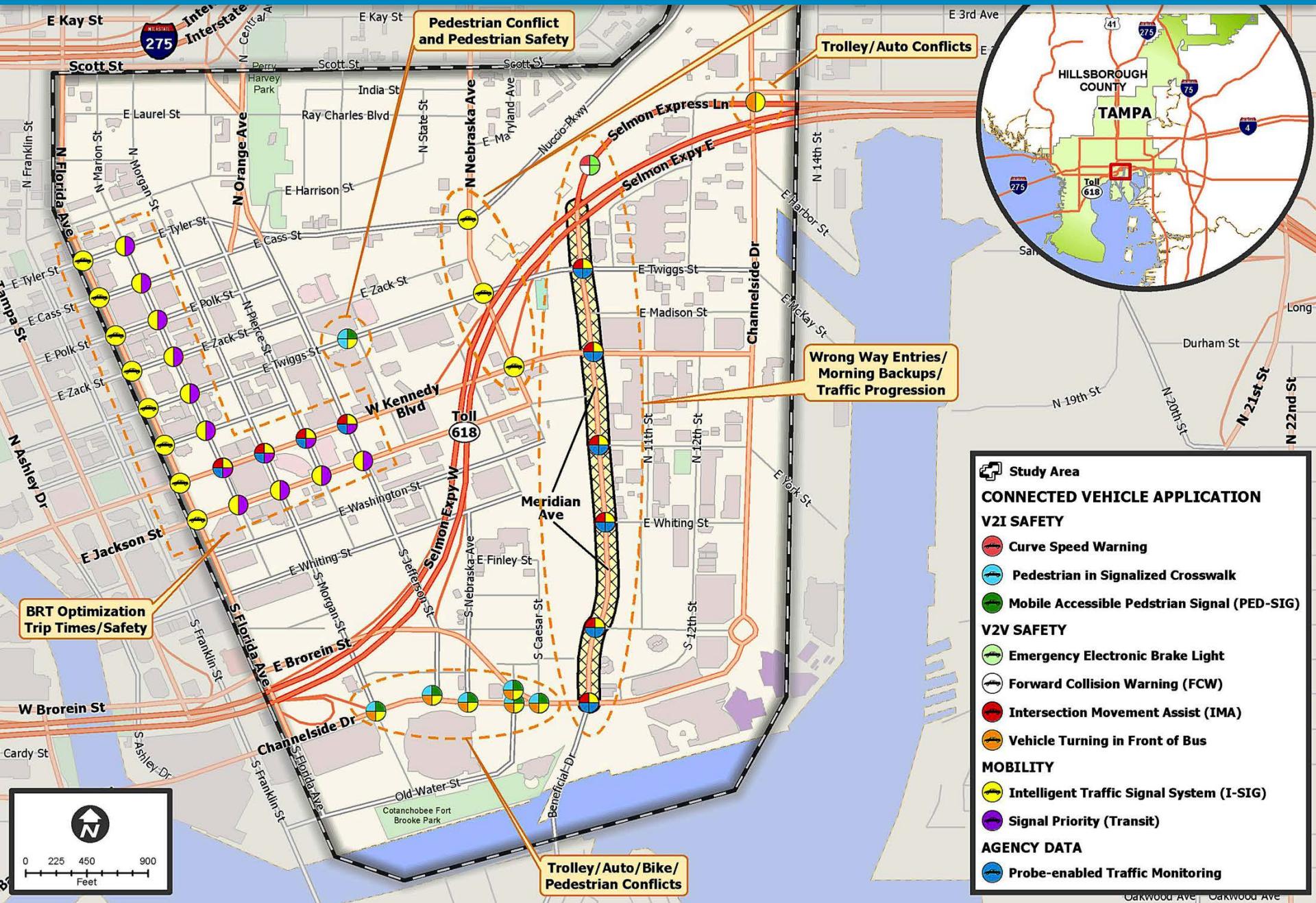
- Main Point of Contact for USDOT and Other Pilots
- Facilitate/Moderate Communication between THEA and Consultant Team
- Facilitate Communications with Wyoming and New York City Pilots for Sharing of Data, Lessons Learned, etc.

# SELMON EXPRESSWAY





# CONNECTED VEHICLE PILOT DEPLOYMENT – DOWNTOWN TAMPA



**BRT Optimization  
Trip Times/Safety**

**Pedestrian Conflict  
and Pedestrian Safety**

**Trolley/Auto Conflicts**

**Wrong Way Entries/  
Morning Backups/  
Traffic Progression**

**Trolley/Auto/Bike/  
Pedestrian Conflicts**

**Study Area**

**CONNECTED VEHICLE APPLICATION**

**V2I SAFETY**

- Curve Speed Warning
- Pedestrian in Signalized Crosswalk
- Mobile Accessible Pedestrian Signal (PED-SIG)

**V2V SAFETY**

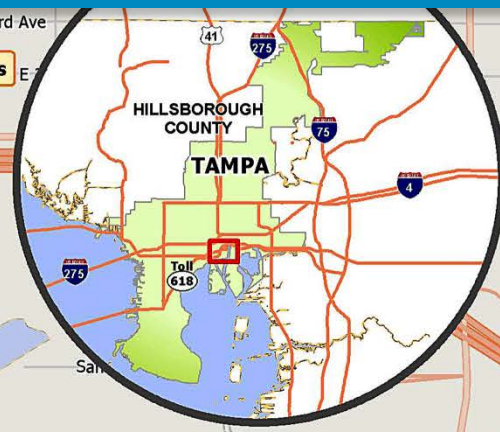
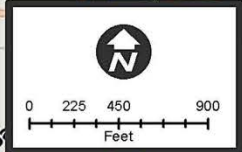
- Emergency Electronic Brake Light
- Forward Collision Warning (FCW)
- Intersection Movement Assist (IMA)
- Vehicle Turning in Front of Bus

**MOBILITY**

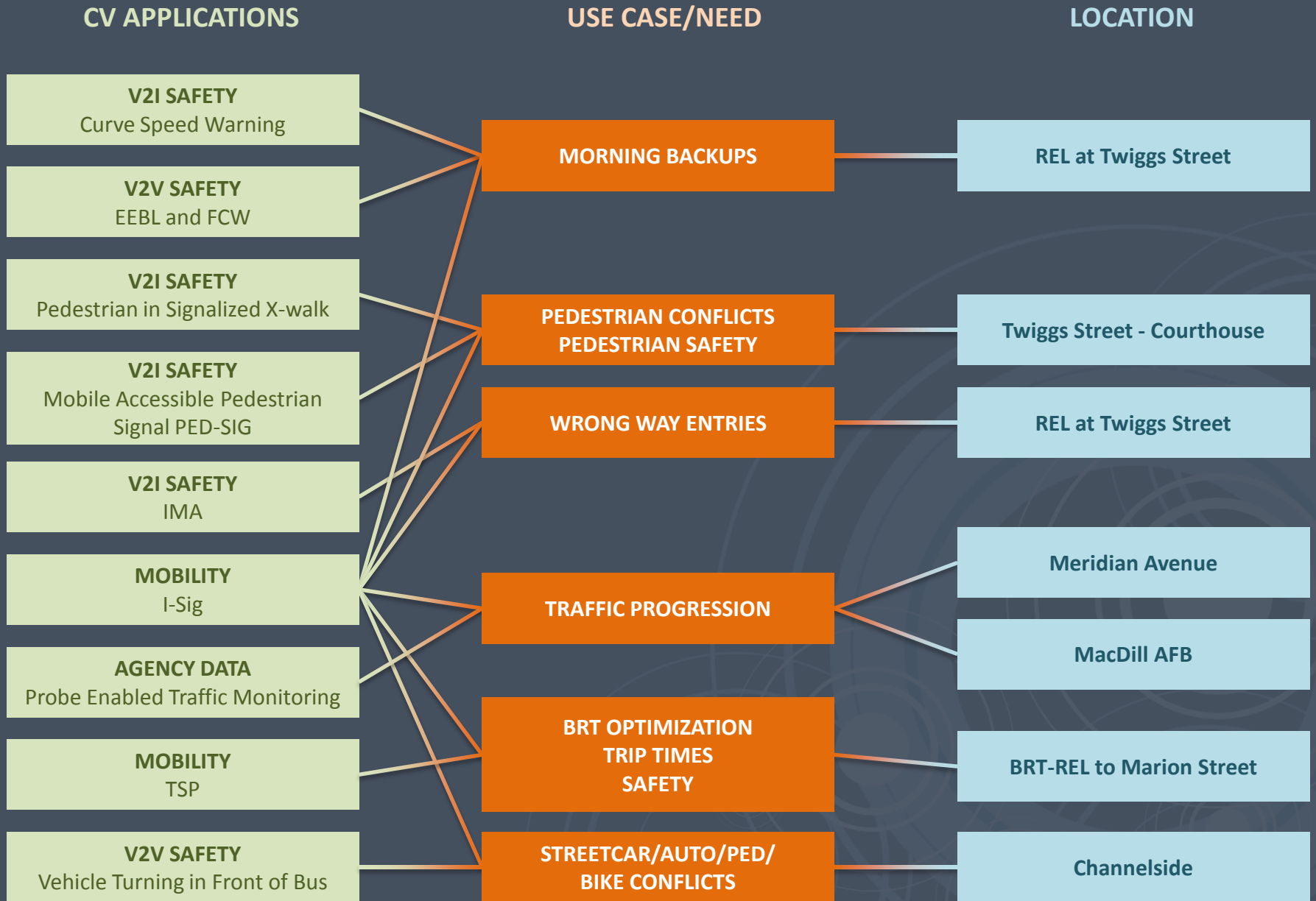
- Intelligent Traffic Signal System (I-SIG)
- Signal Priority (Transit)

**AGENCY DATA**

- Probe-enabled Traffic Monitoring



# PILOT DEPLOYMENT ISSUES AND APPLICATIONS RELATIONSHIP





# OUR TECHNICAL SUPPORT TEAM



**THEA EXECUTIVE DIRECTOR**  
**Joe Waggoner (CDL)**

**THEA COMMUNICATION DIRECTOR**  
 Susan Chrzan

**THEA PROGRAM MANAGER**  
**Bob Frey, AICP**

**SYSTEM DEVELOPMENT LEAD**  
 Jason JonMichael (H)

**TASK 10**  
**Partnership Coordination & Finalization**

**LEAD**  
**Bob Frey, AICP (T)**

**SUPPORT**  
 HNTB

**THEA COMMUNICATION DIRECTOR**  
**Susan Chrzan**

**TASK 5**  
**Performance Measurement & Evaluation Support**

**LEAD**  
 Steve Reich (C)

**SUPPORT**  
 HNTB  
 Booz Allen Hamilton  
 CUTR

**TASK 11**  
**Outreach Plan**

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**Susan Chrzan (T)**

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 Global-5

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**LEAD**  
 Jason JonMichael (H)

**SUPPORT**  
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 Booz Allen Hamilton

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**Application Deployment Plan**

**LEAD**  
 Dwayne Henclewood (B)

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**TASK 8**  
**Human Use Approval**

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**Deployment Readiness Review**

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**OUR TECHNICAL SUPPORT TEAM**



**QA/QC**  
**Jim Drapp, PE (H)**

**PROGRAM MANAGEMENT  
 LEAD - TASK 1**  
**Steven Johnson, CVP (H)**

**SR. TECHNICAL ADVISOR**  
**Jim Barbaresso (H)**

**SYSTEM DEVELOPMENT  
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**Jason JonMichael (H)**

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 Pilot Deployment  
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**TASK 3**

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# OUR TECHNICAL SUPPORT TEAM

**Booz | Allen | Hamilton**

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**Security Management**  
**Operating Concept**

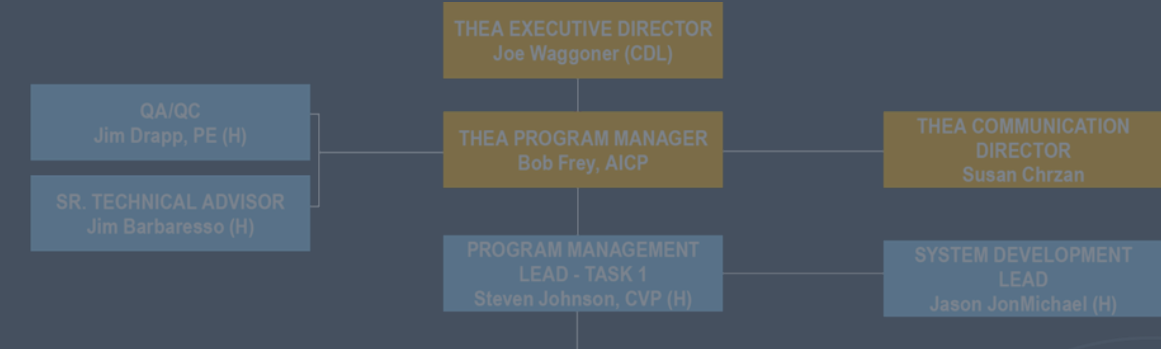
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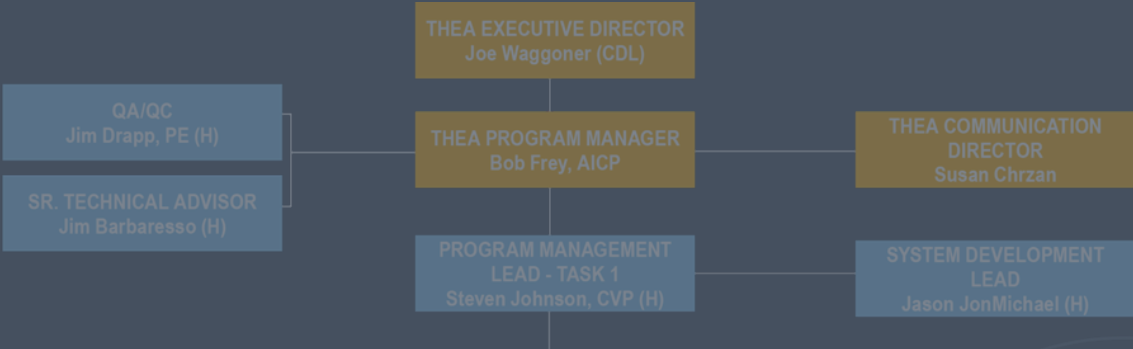
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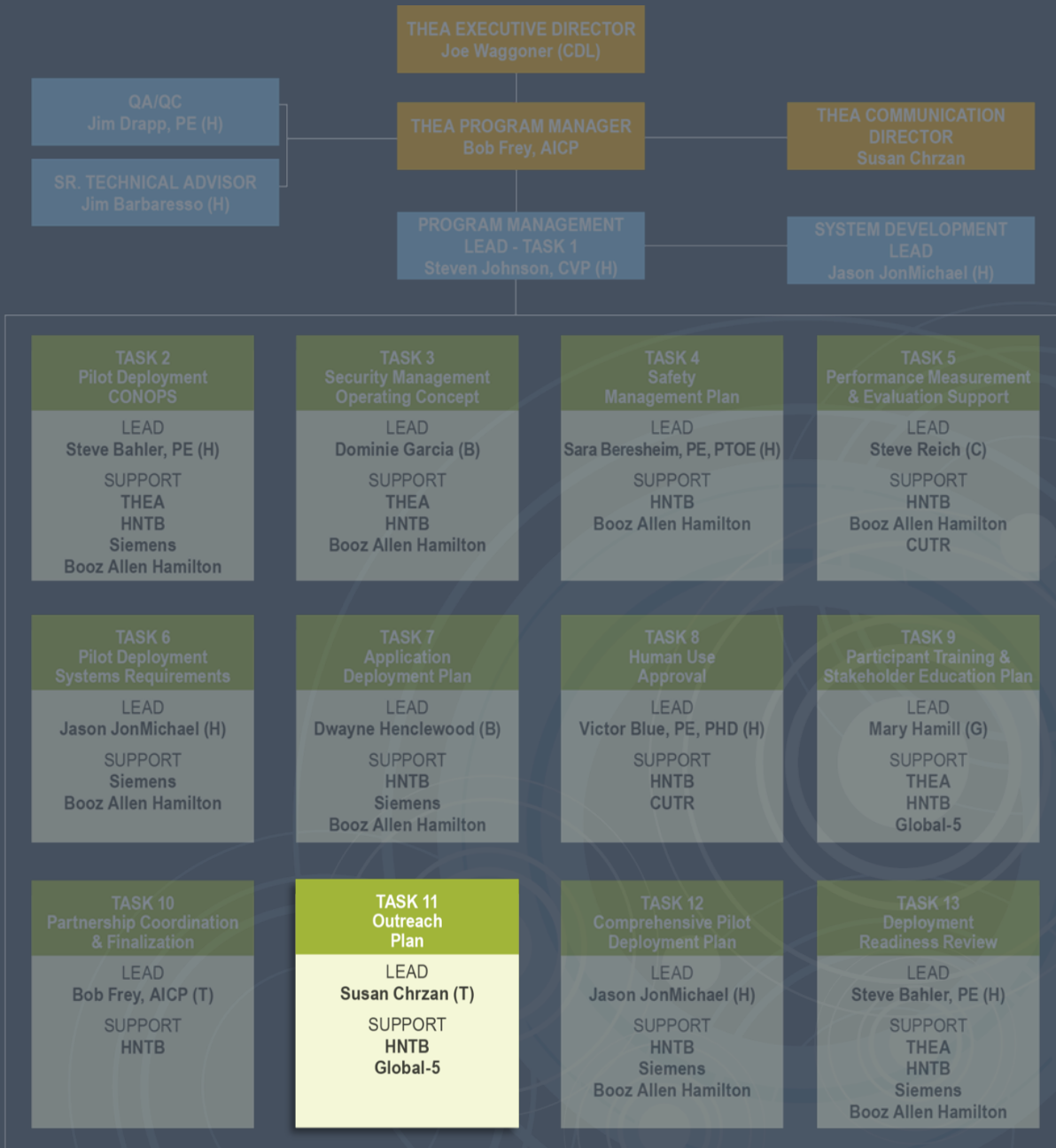
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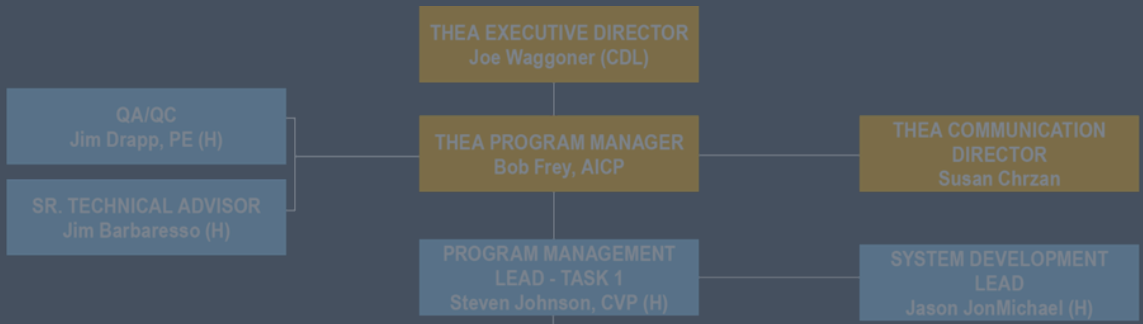
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CONOPS

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Booz Allen Hamilton



# Steve Johnson, CVP

Task 1 Lead - Program Management  
HNTB Corporation

- Point of Contact for Inter-team Coordination and Communication
- Technical Level Communications with Wyoming and New York City for Data Sharing and Lessons Learned
- Critical Path Method Schedule
- Programmatic Reporting
  - Monthly and Annual Reports
  - Project Financials
- Project Controls
- Contribute to Tasks as-needed

# PLAN RISK MANAGEMENT: INPUTS, TOOLS AND TECHNIQUES, AND OUTPUTS

## INPUTS

- Project Management Plan
- Stakeholder Register
- Enterprise Environmental Factors
- Organizational Process Assets

## TOOLS/ TECHNIQUES

- Analytical Techniques
- Expert judgment
- Meetings

## OUTPUTS

- Risk Management Plan



# PRELIMINARY RISK REGISTER

## USDOT RISK REGISTER TEMPLATE

RISK NO.	TASK	RISK OWNER	RISK IDENTIFICATION	PROBABILITY (1-5)	IMPACT (1-5)	SEVERITY (P*I)	RISK RESPONSE	RISK MITIGATION STRATEGY
	Title or Description of Task	Owner of Risk	Brief Description of Risk	1 - Low 5 - High	1 - Low 5 - High	Formula Calculated risk (Probability * Impact)	Avoid, Mitigate, Accept, Contingency, Transfer the risk	Overall Approach to Reduce Risk Impact Severity and/or Probability of Occurrence
P1-1	ConOps/ Schedule/ System Requirements	THEA	Unknown System/ Device Compatibility Issues	2	2	4	Mitigate	Early Engagement with FDOT-TERL and Float in Deployment Schedule
P1-2	Program Management	THEA	Loss of Key Staff	2	1	2	Contingency	Succession Plan
P1-3	Stakeholder Education	THEA	Public Opposition/ Privacy or Safety Concerns	2	2	4	Mitigate	Effective Outreach Plan
P2/3-1	Deployment Plan	THEA	Extended Road Closures - Planned Private Development	4	2	8	Mitigate	Close Coordination with City of Tampa/Developer
P2/3-2	Deployment Plan	THEA/ Stakeholder FDOT District 7	Conflicting Construction Projects - Managed Lanes 2018	3	3	9	Mitigate	Close Coordination with FDOT District 7 - Opportunity for Shared Cost
P2/3-3	Deployment Plan	THEA/ Partner City of Tampa	Conflicting Construction Projects - City of Tampa Planned Signal Upgrades in Pilot Area	4	4	16	Mitigate	Close Coordination with City of Tampa (Pilot Partner) - Opportunity for Shared Cost
P2/3-4	Safety Plan/ Outreach Plan	THEA/USDOT Pilots	Accident in Pilot Area with Litigation	1	5	5	Mitigate/ Transfer	Mitigate Risk Through Safety Plan and Outreach Plan. Transfer Financial Risk via Insurance.

# Dominie Garcia

Task 3 Lead - Privacy and Security Management Operating Concept

Booz Allen Hamilton

- Led Several Projects for USDOT Developing and Analyzing Technical and Policy Aspects of the V2V Security Credentials Management System (SCMS)
- Currently Leading the Team Developing Security Requirements for DSRC Devices and has Authored Papers about Governance and Policy Needs for Connected Vehicle Security
- Extensive Experience with State and Local Agency Connected Vehicle Development and Implementation Efforts
- The Booz Allen Connected Vehicle Security and Privacy Team has Additional Expertise in Security and Privacy and Strong Relationships with Key Security Industry Technical Experts

## PRIVACY AND SECURITY MANAGEMENT OPERATING CONCEPT (PSMOC)

- Current SCMS Design Includes Protections Against Traceability – the Solution Being Prototyped Now will Include Technical Measures to Protect Privacy and Secure Information Flows
- Team will Build off the SCMS Design and Prototype to Plan for Multiple Kinds of Security Threats:
  - Internal and External
  - Accidental or Intentional
- Team will Determine the Roles, Processes, Data Flows, Physical Components and Communications Protocols Necessary for Privacy and Security Operations Using the Connected Vehicle Reference Implementation Architecture (CVRIA) and the SCMS Prototype
- Team will use National Institute of Standards and Technology (NIST) Guidance for Identifying Appropriate Levels of Security for all Objects and Information Flows across the System to Ensure Appropriate Levels of Security and Privacy



## Booz Allen Hamilton has been Part of the Development of the SCMS for V2V and V2I Safety Applications

### Our Security Solution will Address:

- Confidentiality, Integrity, Availability, Authenticity and Non-repudiation Needs Across the Systems
  - SCMS and Back-End Interface
  - Interface and Coordination with Other Systems
  - Measures of Performance
  - Data Access Protections
- Understanding of the Technical Design In-depth (Being Prototyped by CAMP Now) and the Policy Needs and Implications
    - V2V and V2I communications are covered but additional applications have not yet been designed into the system
    - For the THEA Pilot, we will ensure protection of all objects, information flows, and applications being deployed
  - Ensure Privacy Protection at all Levels:
    - Technical protection based on credential design and certificates
    - Additional protection based on data collection, storage, access and management processes as needed for different applications

## ADDITIONAL SECURITY AND PRIVACY CONSIDERATIONS

- The USDOT/NHTSA NPRM is Expected to Contain Security Requirements, which will be the Core of the Security System and Conformance to it
  - Booz Allen Hamilton is leading the work to develop performance and security requirements for NHTSA
  - Compliance testing is part of this work, and we will use NPRM requirements or recommendations and current compliance testing designs that are being developed within USDOT
  - Booz Allen Hamilton has internal Common Criteria and FIPS 140-2 testing labs
- Physical Security of Devices and Infrastructure (along with Device Software/OS Security) will be Part of the Overall Security Solution
- Misbehavior Detection will be Built into the SCMS Based on the CAMP Prototype and Updated Designs (it is still TBD)

# Susan Chrzan

THEA Communications Director and Task 11 Lead - Outreach Plan  
Tampa Hillsborough Expressway Authority

- THEA Communications Director Since 2007
- More than 27 Years of Marketing and Communications Experience in Varied Industries
- IBTTA Communications Committee Member and Webinar Training Coordinator
- THEA Coordinator for USF STEM 3 Scholarship and College of Engineering Youth Bridge Building Competition
- Coordination with National Media for Audi Autonomous Vehicle Demonstration on THEA Test Bed Facility



## TASK 9: PARTICIPANT TRAINING AND STAKEHOLDER EDUCATION PLAN

**Identify Stakeholders and Participation Groups**

**Draft Training and Education Plan**

**Solicit Feedback to Evaluate Training**

**Identify Participant/Stakeholder Roles and Responsibilities**

**Recruit and Engage Participant Groups**

## TASK 11: OUTREACH PLAN

**Interaction and Coordination with USDOT and Other CV Pilots**

**Public Relations and Marketing Activities**

**Web and Social Media Presence**

**Trade Show Strategy and Budgets**

**Strong Return on Investment**

**Initiatives to Increase Community Awareness**

**Crisis Communications Plan**

# STEVE REICH

**Task 5 Lead -Performance Measurement and Evaluation Support**  
Center for Urban Transportation Research (CUTR) at  
University of South Florida (USF)

- Measures of Changes in Mobility, Emissions, Safety and Agency Efficiency are Anticipated
- Tailored Approach for Each of the Locations and Use Cases
- Combines Area University Expertise with Connected Vehicle Evaluation Experience



## KEY CONSIDERATIONS

- Work on Earlier Connected Vehicle Phases
- Appropriate Evaluation Criteria
- Data Availability vs. Cost
- Target Development - Analysis and Modeling Simulation (AMS) Tool
- Site-Specific Impacts and Corridor Impacts
- Coordination with Stakeholders
- Benefit/Cost
- Participant Training
- Qualitative and Quantitative Measures
- Mitigation of Confounding Factors
- Data Sharing

# EXAMPLES OF CONTEMPLATED METRICS

## MOBILITY

Travel Time and Reliability, Transit Ridership, Congestion Impact

## SAFETY

Wrong Way Incidents, Transit/Auto/Pedestrian Conflicts, Application Acceptance

## EMISSIONS

Impact on Criteria and Non-Criteria Pollutants

## EFFICIENCY

City TMC Operation Enhancements, Transit Agency Scheduling and Routing, REL Operation

## POTENTIAL MEASUREMENT APPROACHES

**Control vs. Treatment**

**Before and After**

**Systemwide Impacts**

**Modeling**

**User Feedback**

(e.g. acceptance, perception of benefits)

**Benefits Estimation**

**Observational**

**Applicability to Wider  
Implementation**

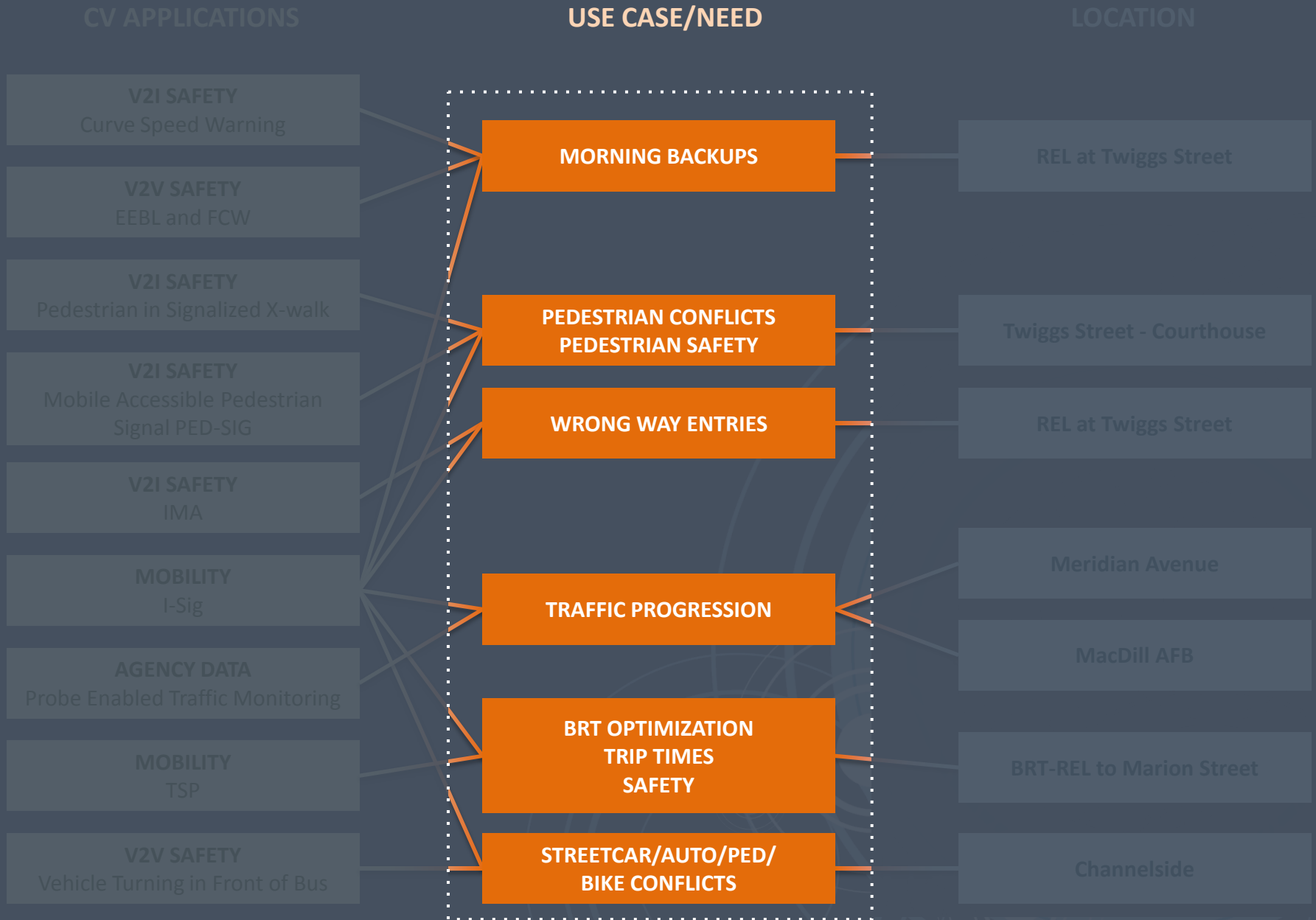


# STEVE NOVOSAD

System Development Lead (Interim for Jason JonMichael)  
HNTB Corporation

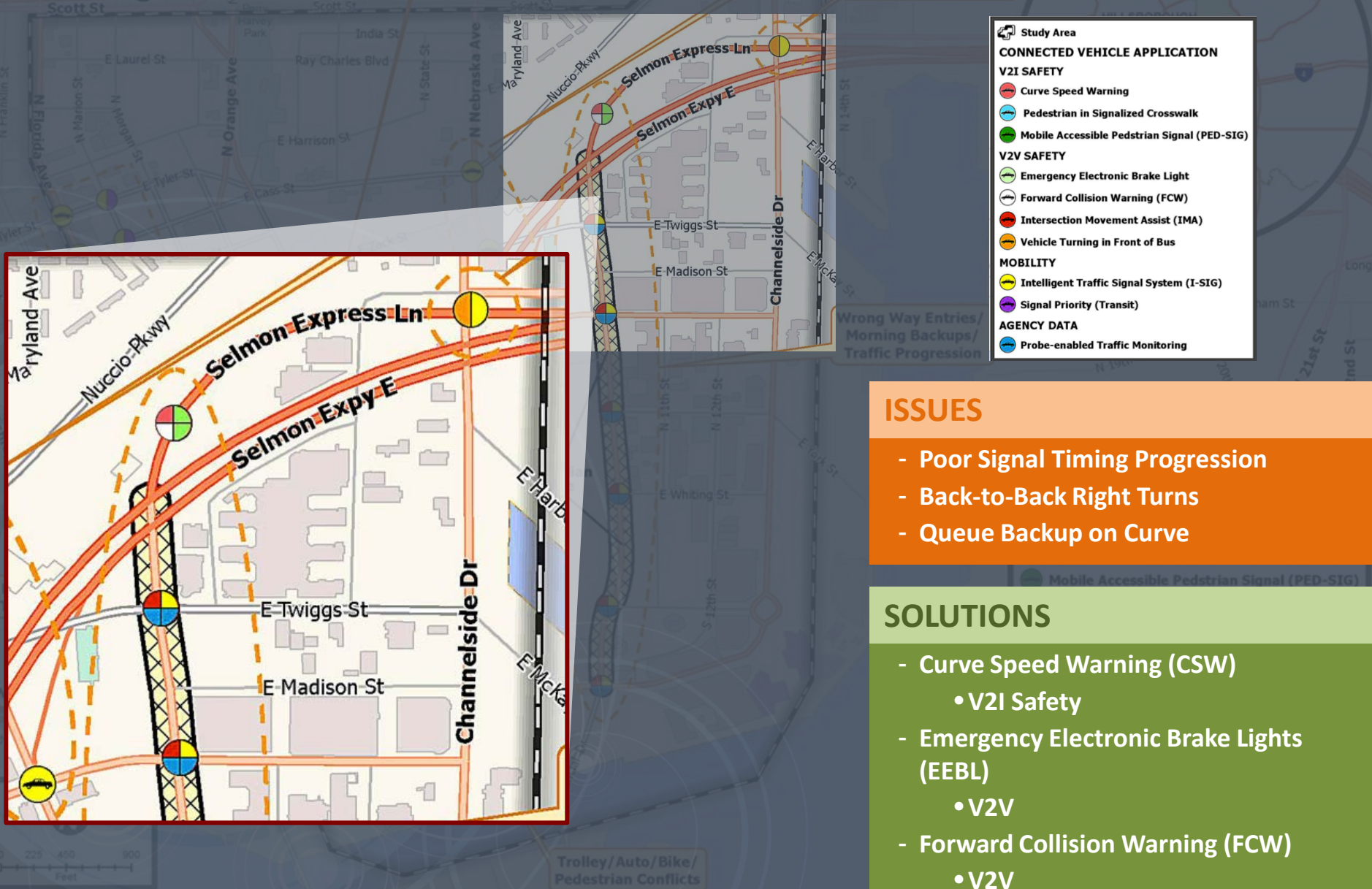
- Vehicle Infrastructure Integration (VII) (2003)
- 2011 World Congress Connected Vehicle Demonstrations and SunGuide® Connected Vehicle Software
- Qualification and Certification Testing of IntelliDrive<sup>SM</sup> (OmniAir Consortium)
- Standards Compliance and Interoperability Certification Program for Connected Vehicle Hardware and Software
- Vehicle to Infrastructure (V2I) Integrated Prototype Development and Deployment
- FDOT Connected Vehicle Activities (2011 – 2015)
- OmniAir Vice Chairman (2013 – 2015)
- Connected Vehicle Working Group (Member)
- Sustainability Transportation Working Group (Member)

# PILOT DEPLOYMENT ISSUES AND APPLICATIONS RELATIONSHIP



# MORNING PEAK HOUR QUEUES

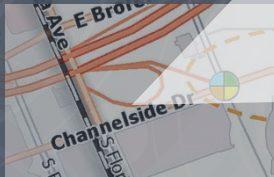
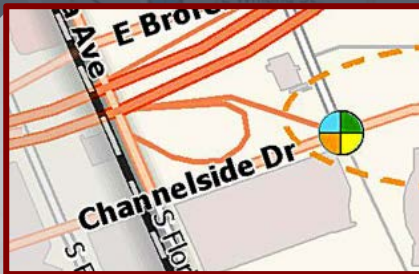
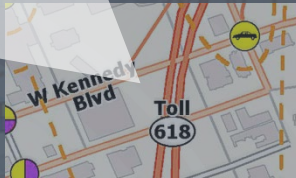
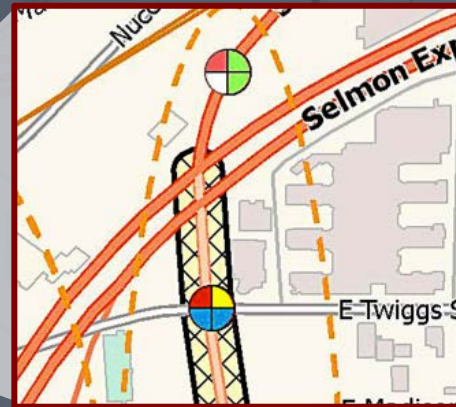
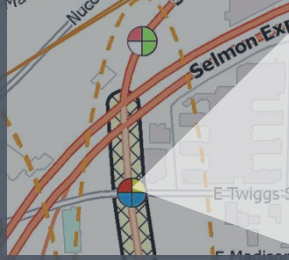
## Intersection of Twiggs Street and Meridian Avenue at Reversible Express Lanes Entrance/Exit





# WRONG-WAY ENTRIES

## Entry/Exit Points Along Selmon and Reversible Express Lanes (REL)



### ISSUES

- Unique Intersection Reversible Express Lane Open/Close Dynamic Signing to Drivers

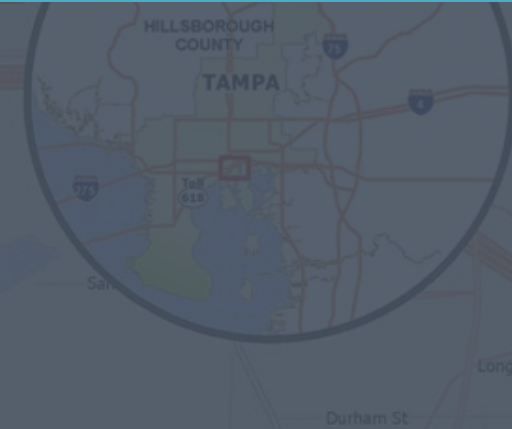
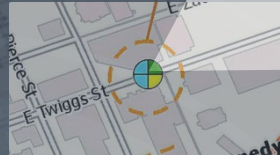
### SOLUTIONS

- Intersection Movement Assist (IMA)
  - V2V Safety
- Intelligent Traffic Signal System (I-SIG)
  - Mobility
- Probe Enabled Traffic Monitoring
  - Agency Data



# PEDESTRIAN SAFETY

## Midblock of Twiggs Street at Hillsborough County Courthouse



### ISSUES

- Midblock Crossing with no Protected Left Turn
- Pedestrians Crossing at Unmarked Locations

### SOLUTIONS

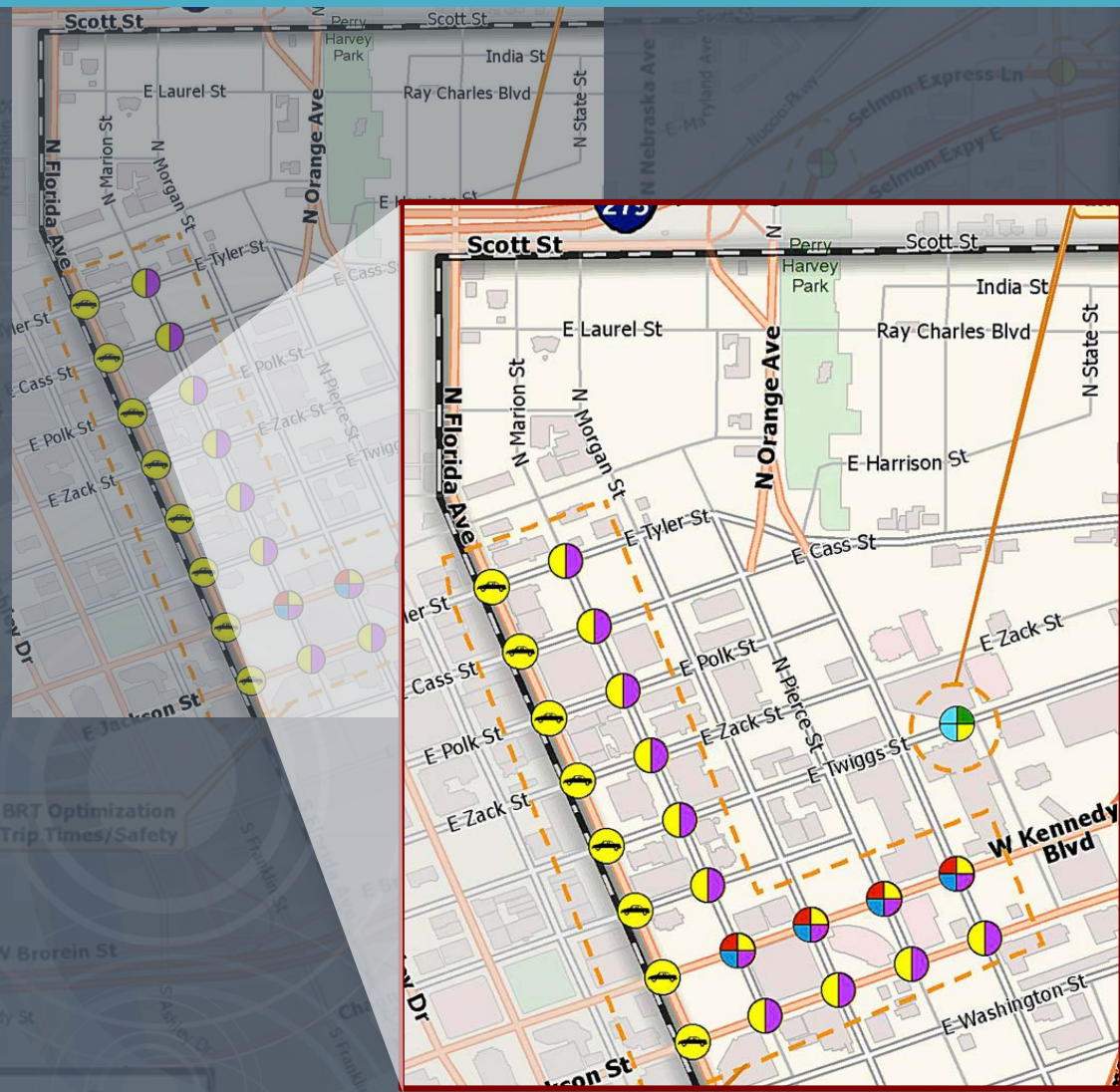
- Pedestrian in Signalized Crosswalk Warning
  - V2I Safety
- Mobile Accessible Pedestrian Signal (PED I-SIG)
  - V2I Safety
- Intelligent Traffic Signal System (I-SIG)
  - Mobility



Trolley/Auto/Bike/  
Pedestrian Conflicts

# BRT/TRANSIT SIGNAL PRIORITY, OPTIMIZATION AND SAFETY

## Express Route through Downtown City Streets to Marion Street Transit Station



**Study Area**

**CONNECTED VEHICLE APPLICATION**

**V2I SAFETY**

- Curve Speed Warning
- Pedestrian in Signalized Crosswalk
- Mobile Accessible Pedestrian Signal (PED-SIG)

**V2V SAFETY**

- Emergency Electronic Brake Light
- Forward Collision Warning (FCW)
- Intersection Movement Assist (IMA)
- Vehicle Turning in Front of Bus

**MOBILITY**

- Intelligent Traffic Signal System (I-SIG)
- Signal Priority (Transit)

**AGENCY DATA**

- Probe-enabled Traffic Monitoring

### ISSUES

- Poor Signal Timing Progression
- Passenger Vehicles Blocking Access to Stops

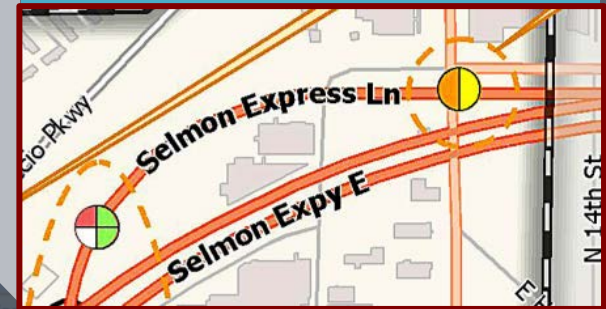
### SOLUTIONS

- Intelligent Traffic Signal System (I-SIG)
  - Mobility
- Transit Signal Priority (TSP)
  - Mobility

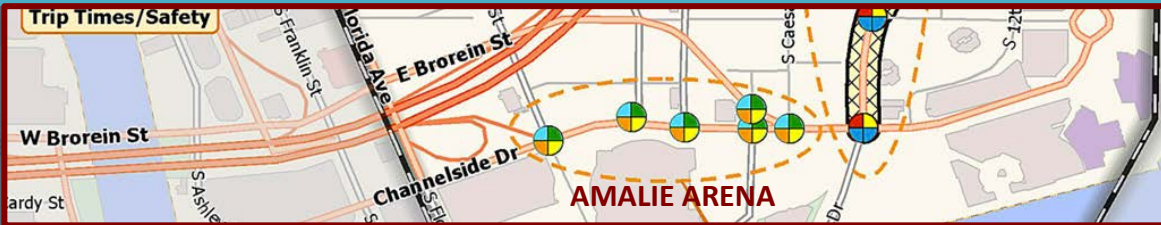


# TECO LINE STREETCAR CONFLICTS

## Adamo Drive (SR 60)/Channelside Drive



## Amalie Arena/Channelside Drive Area



## ISSUES

- Streetcar/Ped/Vehicle/Cyclist Conflicts/Safety
- Afternoon Peak Alternate Routes
- Special Events

## SOLUTIONS

- Vehicle Turning Right in Front of Bus Warning
  - V2I Safety
- Intelligent Traffic Signal System (I-SIG)
  - Mobility

# ENHANCED SIGNAL COORDINATION AND TRAFFIC PROGRESSION

## Along Meridian Avenue from REL to Channelside Drive

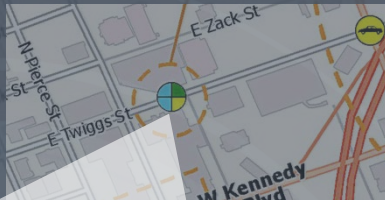
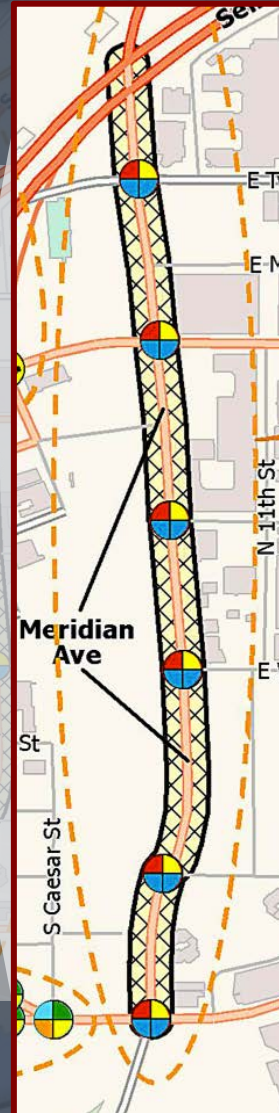
### ISSUES

- Morning Peak Queuing and Congestion
- Special Events Queuing and Congestion
- MacDill Air Force Base Controlled Access Points

### SOLUTIONS

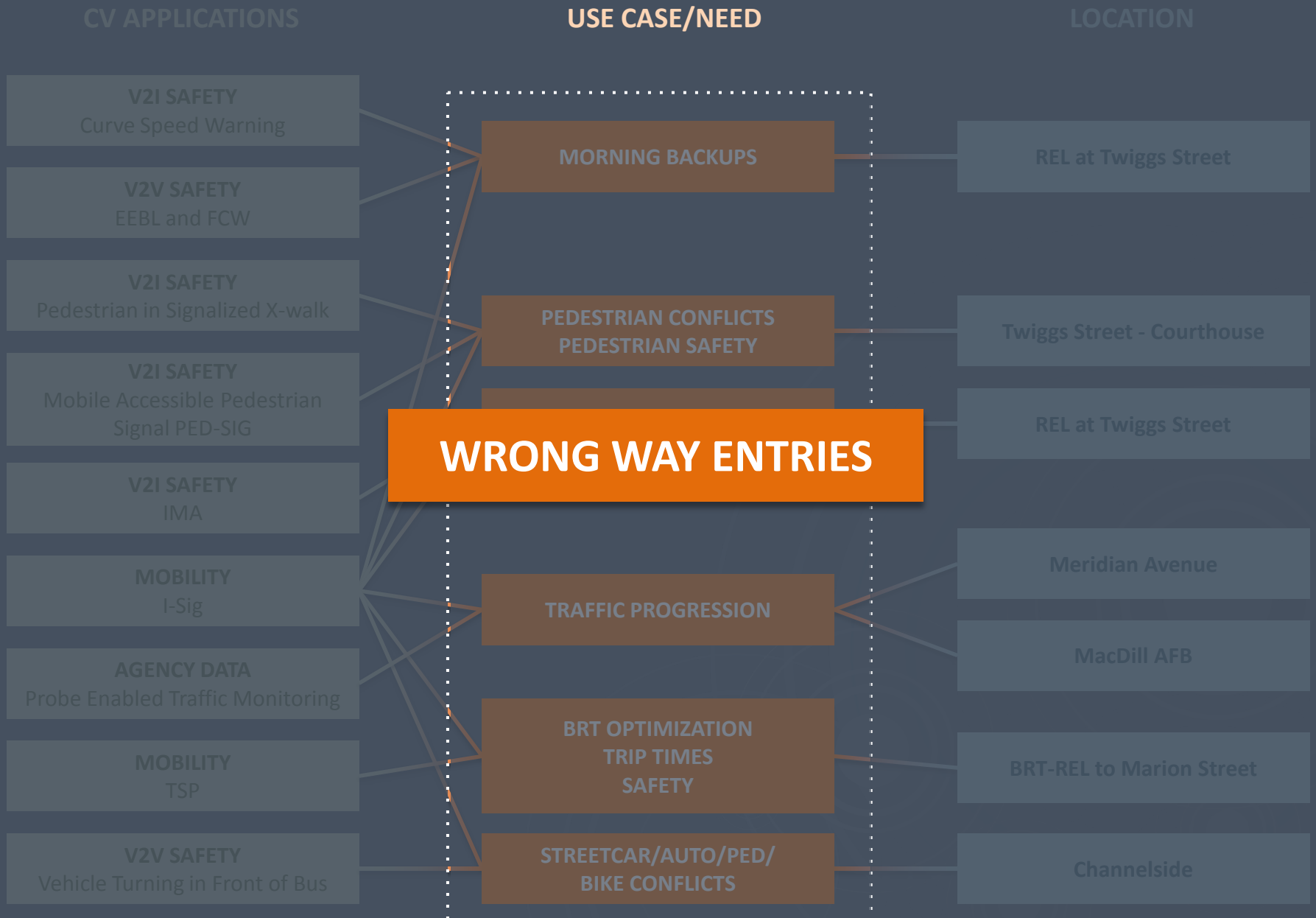
- Probe Enabled Traffic Monitoring
  - Agency Data
- Intelligent Traffic Signal System (I-SIG)
  - Mobility

## Along Twiggs Street from Selmon to Marion Street





# DETAILS OF APPLICATION TYPES SELECTED AND HOW THEY FULFILL STATED NEEDS

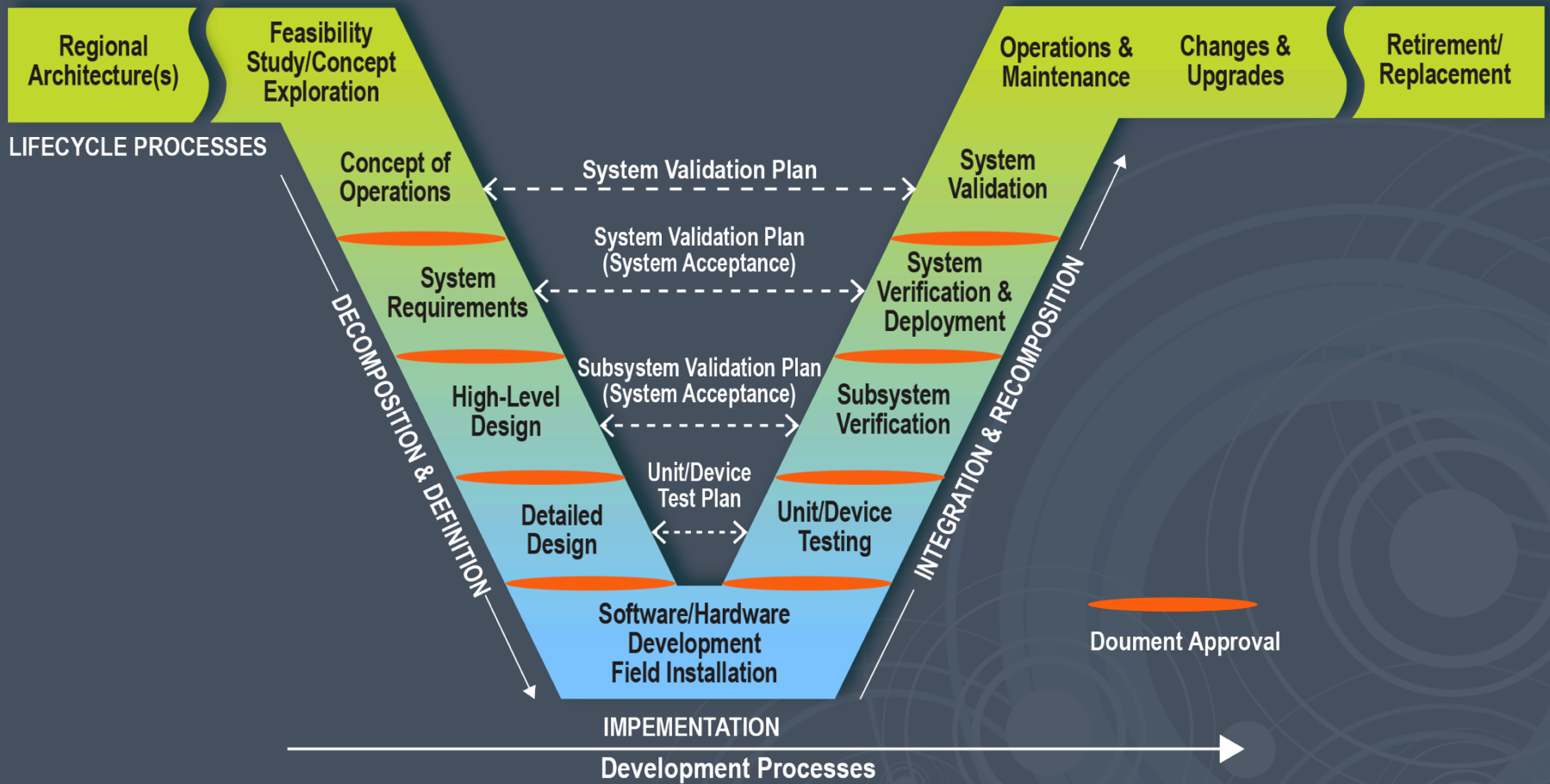


# DAVE MILLER

System Engineering and Deployment Support  
Siemens

- Principal Systems Engineer, Siemens ITS
- Part of Mobility Including Rail Grade Crossing Control, Positive Train Control and LRT Manufacturing
- Project Role:
  - Concept of Operations (ConOPs)
  - Pilot Systems Deployment Requirements
  - Pilot Deployments
- Chair of USDOT-Funded NEMA/AASHTO/ITE Joint Committee on Advanced Transportation Control (ATC)
- Chair of NEMA 3TS Technical Committee for Transportation Control Systems
- Member of ITE Connected Vehicle Task Force (Systems Engineering and Policy)
- Member of V2I Deployment Coalition Standards Working Group
- J2735 Harmonization WG for USA, Europe and Japan
- Supplied the Controllers and Software for USDOT CV Test Beds beginning in 2007
- USDOT CV Test Bed Affiliate

# THEA THREE PHASE WORK FLOW DIAGRAM APPLIED TO THE SYSTEMS ENGINEERING FRAMEWORK



# USE CASE 1: REVERSIBLE LANE WRONG-WAY VEHICLE

**1.1 TOLLING CUSTOMER**

**Advanced Wrong Way Warning**

**Avoid Entering Ramp**

**1.2 ENFORCEMENT**

**Wrong-Way Vehicle Location**

**Issue Citation**

**1.3 TOLLING CUSTOMER**

**Collision Avoidance Warning**

**Avoid Oncoming Vehicle**

**1.4 TOLLING AUTHORITY**

**Wrong-Way Event Log**

**Measure Effectiveness**

**1.5 MAINTENANCE**

**Self Test and Maintenance Log**

**Verify System Operation**

**1.6 LEGAL**

**Maintenance Logs**

**Liability Discovery Response**



# CONCEPT OF OPERATION (CONOPS) DOCUMENT

**USE CASE 1: REVERSIBLE LANE WRONG WAY WARNING**

**CONCEPT OF OPERATIONS DOCUMENT**

**Rev: DRAFT 1**

**Date:**

**Contract No:**

**Data Item:**

**Prepared for:**

Example ConOps Traceable to Needs ID:


“[N1.1] An RSU is connected to an ATC that is programmed to dwell as RED phase approaching the lane entrance. A wrong-way tolling customer will receive a violation warning in advance of entering the ramp via the THEA Smartphone application. ”

# Jim Barbaresso

Senior Technical Advisor  
HNTB Corporation

- More than 37 years of Experience in Transportation Operations and ITS
- Program Manager of One of the Original ITS Operational Field Tests – FAST-TRAC – in Oakland County, Michigan
- Program Manager for the 180-mile Design-Expansion-Integration-Maintenance of the Detroit Area Freeway Management System
- Safety Pilot Outreach Lead
- Author of the Report, “Connected Vehicle Infrastructure Deployment Considerations: Lessons Learned from Safety Pilot and Other Connected Vehicle Programs”
- Co-Author of the USDOT ITS Strategic Plan 2015-2019
- Chairman of the 2014 ITS World Congress in Detroit
- HNTB Lead on the AASHTO Near-Term V2I Transition and Phasing Analysis
- HNTB Lead on the Ann Arbor Connected Vehicle Test Environment

## SYNERGISTIC VALUE

- THEA's Connected Vehicle Pilot Offers a Synergistic Suite of Safety and Mobility Applications Across Modes and Jurisdictions
  - The Goal is to Create and Sustain a Connected Downtown that Offers Unprecedented Safety and Mobility for Pedestrians, Motorists and Transit Users
  - Needs-Based and Performance-Driven
- 

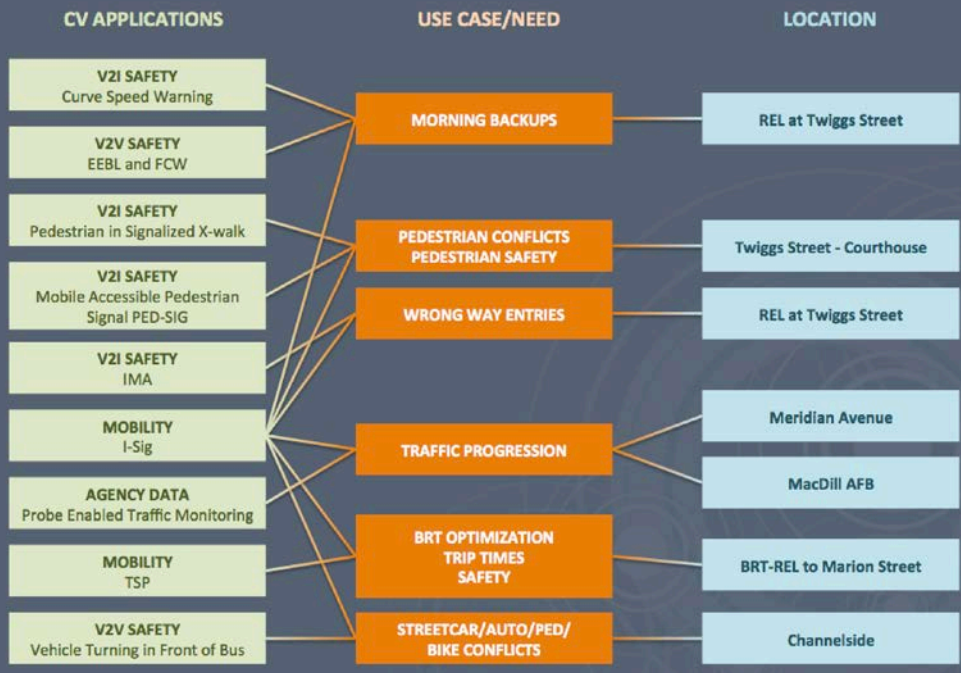
## SYNERGISTIC VALUE ILLUSTRATIONS

- Joint Use TMC
- Condensed Downtown Deployment Area Facilitates Multiple, Concurrent Use Cases
- City of Tampa Traffic Signal Upgrades will Support Deployment with Cost Sharing Opportunities
- Ability to Close the Selmon REL for Closed Track Testing and Demonstrations – No MOT Cost
- Ability to Leverage Lessons Learned from Safety Pilot, AACVTE, V2I Reference Implementation, AASHTO Footprint Analysis and Other USDOT Program Outputs
- MacDill Air Force Base offers Fleet Opportunity and Partnering with DOD
- HART BRT Applications will Leverage a New Pilot Route on the Selmon REL
- Multiple Bus Routes Utilizing Same Egress Corridors Allow for Comparison Data Between Non-Equipped Vehicles vs. Connected Vehicle-Pilot Buses
- City of Tampa and HART Both Offer Large Fleet of Vehicles with Maintenance Shops which Could be Trained to Install/Maintain On Board Unit (UBT)



# MULTIPLE APPLICATIONS EFFICIENCY

PILOT DEPLOYMENT ISSUES AND APPLICATIONS RELATIONSHIP



- Proposed Applications were Selected to Address Multiple Needs, while Optimizing Resources
- USDOT Research Results and AMS Tools Developed by USDOT will be used to Help Identify Logical Combinations of Applications for Deployment, Maximize Impacts/Benefits while Minimizing Capital and Operating Costs



THEA will Deliver a Comprehensive Pilot Deployment Plan that will Provide the Framework for Successful Implementation – On Time and Within Budget

## Closing Remarks

## Questions and Answers

*FLORIDA! A Bold Vision*

TAMPA-HILLSBOROUGH  
**EXPRESSWAY**  
AUTHORITY