USDOT CONNECTED VEHICLE PILOT

LESSONS LEARNED FROM PILOTS

- 2007 USDOT Test Bed, Oakland Co. MI
- 2008 Telegraph Road, Oakland Co. MI
- 2011 World Congress, Orlando FL
- 2011 USDOT Contract DTFH61-06-D-00007
  - Engineering for SPaT and Related Messages
  - USDOT V2I Hub on Open Source Portal
- 2013 Model Deployment, Ann Arbor MI
- 2014 Vienna to Rotterdam corridor, EU
- 2015 Compass 4D, City of Newcastle UK
Fully-realized Connect Vehicle system that fulfills the project Scope

- **Identify** existing real-world safety and mobility issues
- **Measure** the Current Situation: “Before” metrics
- **Apply** existing CV technology as mitigation
- **Measure** the Effect: “After” metrics

**Measures of Success**

- Success = Effective Connected Vehicle technologies are promoted for wider deployment
- Success = Ineffective Connected Vehicle technologies are retired, sunk cost = $ 0
THEA PILOT OVERVIEW

Source: HNTB

Pilot Location

- Tampa Florida metropolitan area
- THEA
  - Owns / operates Selmon Expressway
  - Owns Meridian Ave traffic signals
- West: Residential community of Brandon
- East: MacDill Air Force Base
- Study area
  - Midway of Selmon Expressway
  - Shown in red box
Focused Deployment Area

- Traffic Flow Optimization/Bus Priority
- Pedestrian Safety
- Rush Hour Collision Avoidance
- Wrong-Way Entry Prevention
- Traffic Management
- Traffic Flow Optimization
- Streetcar Safety

www.tampacvpilot.com
STUDY AREAS: EXISTING SAFETY ISSUES

- Transit Signal Priority
- Turning Right in Front of Bus
- Ped in Crosswalk Mobile Accessible
- Intelligent Traffic Signal System
- Intersection Movement Assist
- End of Ramp Deceleration
- Wrong Way Warning Reversible Lanes
- Probe-Enabled Traffic Monitoring
- Emergency Elect. Brake Light
- Forward Collision Warning

Source: Siemens Industry Inc.
NOT ENFORCEMENT: PREDICTIVE ALERTS

Source: FDOT.

Source: USDOT.

Source: FL Legislature
THEA PILOT VEHICLE SYSTEMS

- Specific Warnings - Telltale Indicators and audio
- Bluetooth
- Battery operated

OBU interfaces: Composite video, drivers for telltales, and blue tooth audio

Source: Brand Motion
USE CASES OF APPS AT STUDY LOCATIONS

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>APPLICATION</th>
<th>NEED / USE CASE</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Wrong Way Entry (WWE)</td>
<td>Wrong-Way Entries</td>
<td>REL at Twiggs Street</td>
</tr>
<tr>
<td></td>
<td>Pedestrian in Signalized Crosswalk (PED-X)</td>
<td>Morning Backups</td>
<td>REL at Twiggs Street</td>
</tr>
<tr>
<td></td>
<td>Exit Ramp Deceleration Warning (ERDW)</td>
<td></td>
<td>Channelside Drive</td>
</tr>
<tr>
<td></td>
<td>Intersection Movement Assist (IMA)</td>
<td>Streetcar / Auto / Ped / Bike Conflicts</td>
<td>Bus Rapid Transit - REL to Marion Street</td>
</tr>
<tr>
<td></td>
<td>Emergency Electronic Brake Lights (EEBL)</td>
<td>BRT Optimization / Trip Times / Safety</td>
<td>Twiggs Street at Courthouse</td>
</tr>
<tr>
<td></td>
<td>Forward Collision Warning (FCW)</td>
<td>Pedestrian Conflicts / Pedestrian Safety</td>
<td>MacDill Airforce Base</td>
</tr>
<tr>
<td></td>
<td>Vehicle Turning Right In Front of Transit Vehicle (VTRFTV)</td>
<td>Traffic Progression</td>
<td>Meridian Avenue</td>
</tr>
<tr>
<td>Mobility</td>
<td>Intelligent Traffic Signal System (I-SIG)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transit Signal Priority (TSP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mobile Accessible Pedestrian Signal (PED-SIG)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agency Data</td>
<td>Probe-Enabled Traffic Monitoring (PDETM)</td>
<td></td>
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</tr>
</tbody>
</table>

Source: Siemens Industry Inc.
Participants

- **1,600** Privately Owned Vehicles
- **500+** Pedestrian Smartphones (Android devices only)
- **10** TECO Line Streetcar Trolleys
- **10** Hillsborough Area Regional Transit (HART) buses
## Connected Vehicle Applications

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of Ramp Deceleration Warning (ERDW)</td>
<td>Alerts driver approaching curve with speed safety warning</td>
</tr>
<tr>
<td>Emergency Electronic Brake Light (EEBL)</td>
<td>Enables broadcast to surrounding vehicles of severe braking</td>
</tr>
<tr>
<td>Forward Collision Warning (FCW)</td>
<td>Warns driver of impending collision ahead in same lane</td>
</tr>
<tr>
<td>Intersection Movement Assist (IMA)</td>
<td>Indicates unsafe (i.e., wrong way) entry into an intersection</td>
</tr>
<tr>
<td>Intelligent Traffic Signal System (I-SIG)</td>
<td>Adjusts signal timing for optimal flow along with PED-SIG and TSP</td>
</tr>
<tr>
<td>Probe Date Enabled Traffic Monitoring (PDETM)</td>
<td>Uses vehicles as probes to calculate travel times</td>
</tr>
<tr>
<td>Transit Signal Priority (TSP)</td>
<td>Allows transit vehicle to request and receive priority at a traffic signal</td>
</tr>
<tr>
<td>Vehicle Turning Right in Front of a Transit Vehicle (VTRFTV)</td>
<td>Alerts transit vehicle driver that a car is attempting to turn right in front of the transit vehicle</td>
</tr>
<tr>
<td>Wrong Way Entry</td>
<td>Warns driver of potential and actual Wrong Way travel direction</td>
</tr>
</tbody>
</table>
### Connected Vehicle Applications

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<tr>
<th>APPLICATION</th>
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<tbody>
<tr>
<td>Pedestrian Collision Warning (PCW)</td>
<td>Alerts vehicle to the presence of pedestrian in a crosswalk</td>
</tr>
<tr>
<td>Pedestrian Safety</td>
<td>Single pedestrian application</td>
</tr>
<tr>
<td>Pedestrian in a Crosswalk Vehicle Warning (Ped-X)</td>
<td>Calculates the path trajectory of the pedestrian and approaching vehicles and logs an event if a potential conflict is identified.</td>
</tr>
<tr>
<td>Pedestrian Mobility (PED-SIG)</td>
<td>Gives pedestrians priority with signal phase and timing</td>
</tr>
<tr>
<td>Pedestrian Transit Movement Warning (PTMW)</td>
<td>Provides informational warnings to pedestrians that a bus or streetcar is starting up / stopping at an intersection</td>
</tr>
</tbody>
</table>
Morning Backup

Forward Collision Warning (FCW)
Emergency Electronic Brake Light (EEBL)
End of Ramp Deceleration Warning (ERDWF)
Intelligent Signal Systems (I-SIG)
Wrong-Way Drivers

Wrong-way Entry
Intersection Movement Assist (IMA)
MAP
Signal Phasing and Timing (SPaT)
Pedestrian Safety

Pedestrian in a Signalize Crosswalk Warning (Ped-X)

Pedestrian Collision Warning (PCW)
Transit Signal Priority

I-SIG
Transit Signal Priority (TSP)
IMA
Pedestrian Transit Movement Warning (PTMW)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)
Streetcar Conflicts

Vehicle Turning Right in Front of Transit Vehicle (VTRFTV)

PTMW
Traffic Progression

Probe Data Enabled Traffic Monitoring (PDETM)
Pedestrian Mobility (PED-SIG)
I-SIG
IMA
# THEA PILOT CYBER SECURITY

Realize the Security Management Operational Concept developed during Phase 1

<table>
<thead>
<tr>
<th>Guide</th>
<th>Implement</th>
<th>Assure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oversee</strong> the entire security implementation</td>
<td><strong>Harden</strong> system components</td>
<td><strong>Monitor</strong> component vulnerabilities</td>
</tr>
<tr>
<td><strong>Ensure</strong> security experts are available for consultation for <em>all project participants</em></td>
<td><strong>Integrate</strong> certificate management system</td>
<td><strong>Assess</strong> interactions and subsystems</td>
</tr>
<tr>
<td><strong>Define</strong> security and privacy program</td>
<td><strong>Train</strong> operational personnel</td>
<td><strong>Perform</strong> red / blue team and incident response exercises.</td>
</tr>
</tbody>
</table>

- Ensure the project and system achieve the desired protection level
- Protect individual elements and interactions adequately
- Enable operational confidence with robust testing and validation

*Source: Siemens Corporate Technologies*
BACKUP
**Deployment Approach – Work Flow Diagram**

- Siemens provides systems engineering and design for roadside units, TMC Operations and Personal Safety Devices
- Siemens provides hardware and applications acquisition, installation and testing for RSU and TMC
- Brand Motion provides systems engineering and design for onboard units and vehicle system integration
- Brand Motion provides hardware and applications acquisition, installation and testing for OBU
- Overarching Systems Engineering, Design, integration and Testing is overseen by HNTB, Systems Engineering Lead
**Current Situation:**
- Existing Modern Traffic Management Center
- NEMA TS-2 and ATC 5201 standard controllers
- TMC $\leftrightarrow$ Controllers: NTCIP 1202 v2 standard

**Added Connected Vehicle Interfaces:**
- Controllers $\rightarrow$ RSU: USDOT V2I Hub ICD
- RSU $\rightarrow$ Controllers: NTCIP 1202 v2 standard
- Master Server $\leftrightarrow$ RSU: OCIT (no NTCIP exists)
- RSU $\leftrightarrow$ Smart Phones: Personal Safety Message
- RSU $\rightarrow$ Transit Signal Request Message

Source: Siemens Industry Inc.
## THEA PILOT CYBER SECURITY

**Guide**

Cyber Security: Siemens Corporate Technologies, Princeton NJ
- About **150 IT-Security experts** (all with academic degrees, 33% PhD)
- **Certifications** (CISSP, CISA, CISM, ISO 27000 Lead Auditor, ISACA)
- **Trend scouting** at conferences & communities (e.g., SANS, BlackHat)
- Prior support for DOE hardening of power grid and others

Expert guidance for all stakeholders
- Security program design
  - Vendor / product gap analysis
  - Develop vendor improvement program

**Implement**

<table>
<thead>
<tr>
<th>Hardening Options</th>
<th>Integrate certificate management</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Risk based - implement as many controls as possible</td>
<td>Deliver incident response training</td>
</tr>
<tr>
<td>2. <strong>Golden thread</strong> - implement security controls for a critical “golden thread” in the system</td>
<td>Implement security program for Phase 3</td>
</tr>
<tr>
<td>3. <strong>CV</strong> – implement controls of CV interaction only</td>
<td>In order of Threat ( \div ) Effort within budget</td>
</tr>
</tbody>
</table>

**Assure**

- Automated vulnerability scans: RSU plus three OBU types
- Penetration test
- Red/Blue team exercise
- **Table-top incident response stakeholder training and exercise**

Source: Siemens Corporate Technologies