TAMPA-HILLSBOROUGH EXPRESSWAY AUTHORITY

Connected Vehicle and BIG DATA

May xx, 2016

That future is NOW!

Connected Vehicles (CVs) – Enable safe, wireless, networked communications among:

- Vehicles
- Roadway infrastructure
- Personal communication devices

Applying technology to transform surface transportation and make it safer, smarter and greener.

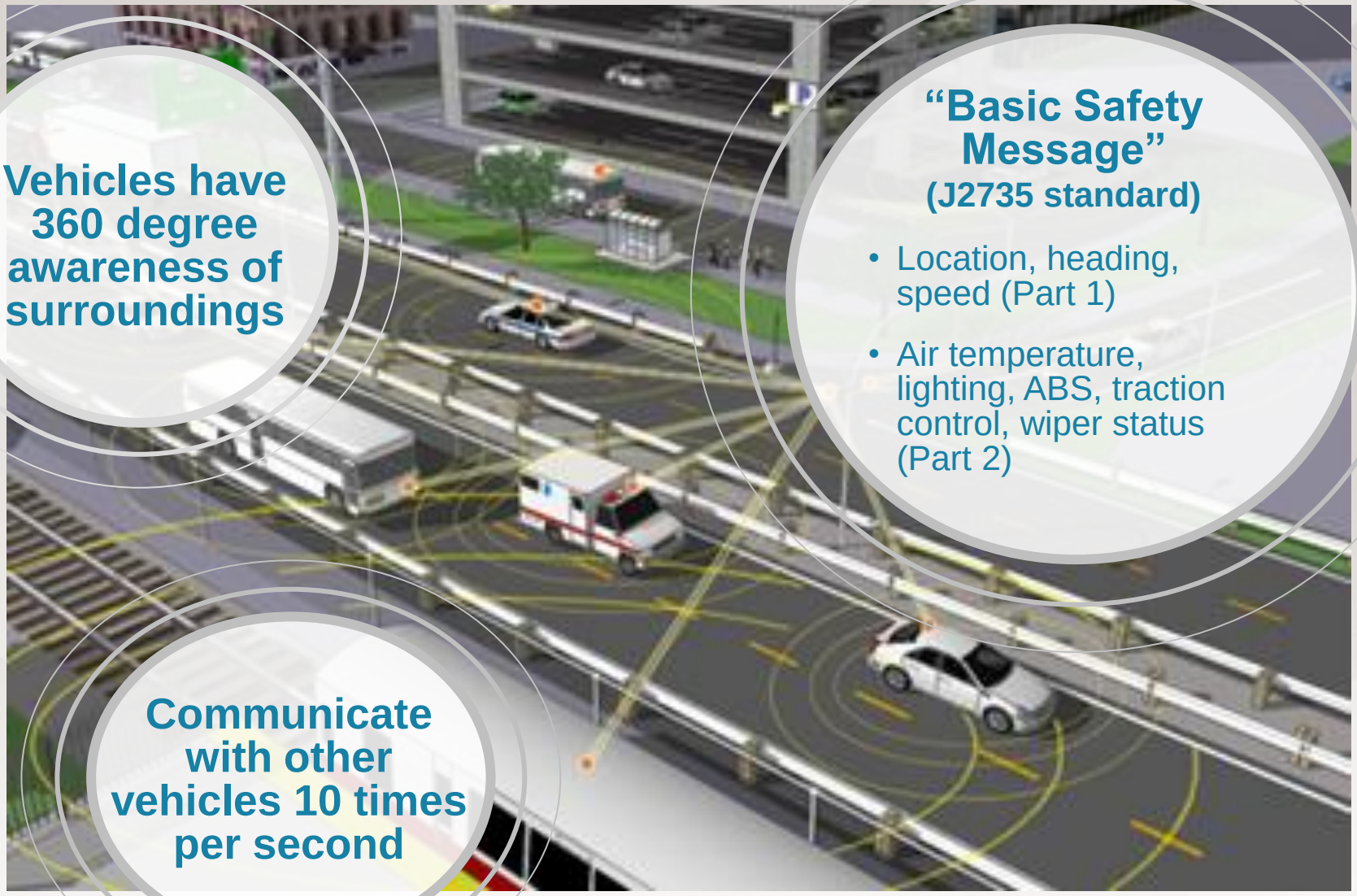
Connected Vehicle Technology

- Ultimately, connected vehicle technology could be the game-changer envisioned by U.S. DOT and the automakers more than a decade ago
- Integration of connected vehicle technology into the existing operations environment will be challenging
- Engineering and operational concepts, performance measures, algorithms, the transportation workforce, and traffic control systems will be transformed

The book is being rewritten.

GAME CHANGER

Connected Vehicle Communication



Vehicles have 360 degree awareness of surroundings

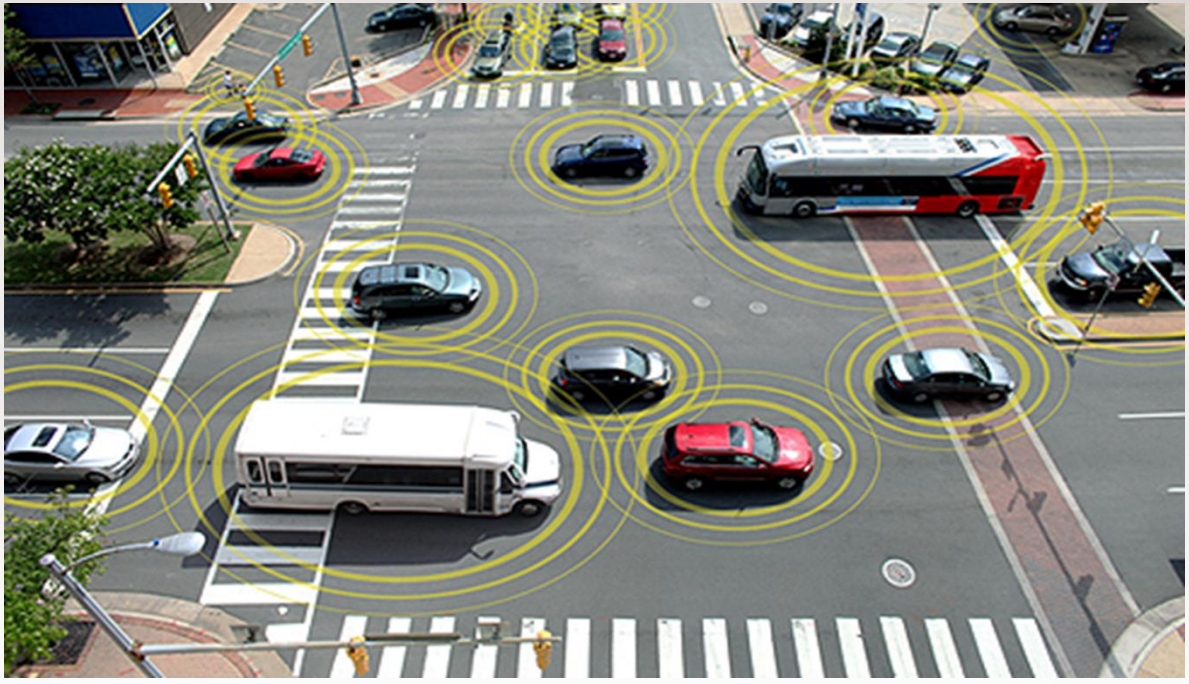
"Basic Safety Message"
(J2735 standard)

- Location, heading, speed (Part 1)
- Air temperature, lighting, ABS, traction control, wiper status (Part 2)

Communicate with other vehicles 10 times per second

Connected Vehicles: Current State

- Advance notice of proposed rulemaking on August 18, 2014
- Final rule on V2V expected this year
- AASHTO “Footprint Analysis” for infrastructure applications
- GM announced they would offer connected vehicles in the 2017 model year (later this year)
- Connected Vehicle Pilot Deployment program



Connected Vehicle Benefits

- Connected vehicle technology could address **more than 80% of vehicular crash scenarios** involving unimpaired drivers

- However, many challenges must be overcome to realize the benefits of this promising technology

Connected Vehicle Challenges

- Challenges for public agencies:
  - Application Support
  - Network / Data Management
  - Security Management
  - Integration and Testing
  - Data Analytics
  - Performance Management and Decision Support
- Continuing concerns
  - Maturity of the technology
  - Stability of the environment
  - Operational considerations
  - Spectrum issues
  - Cybersecurity

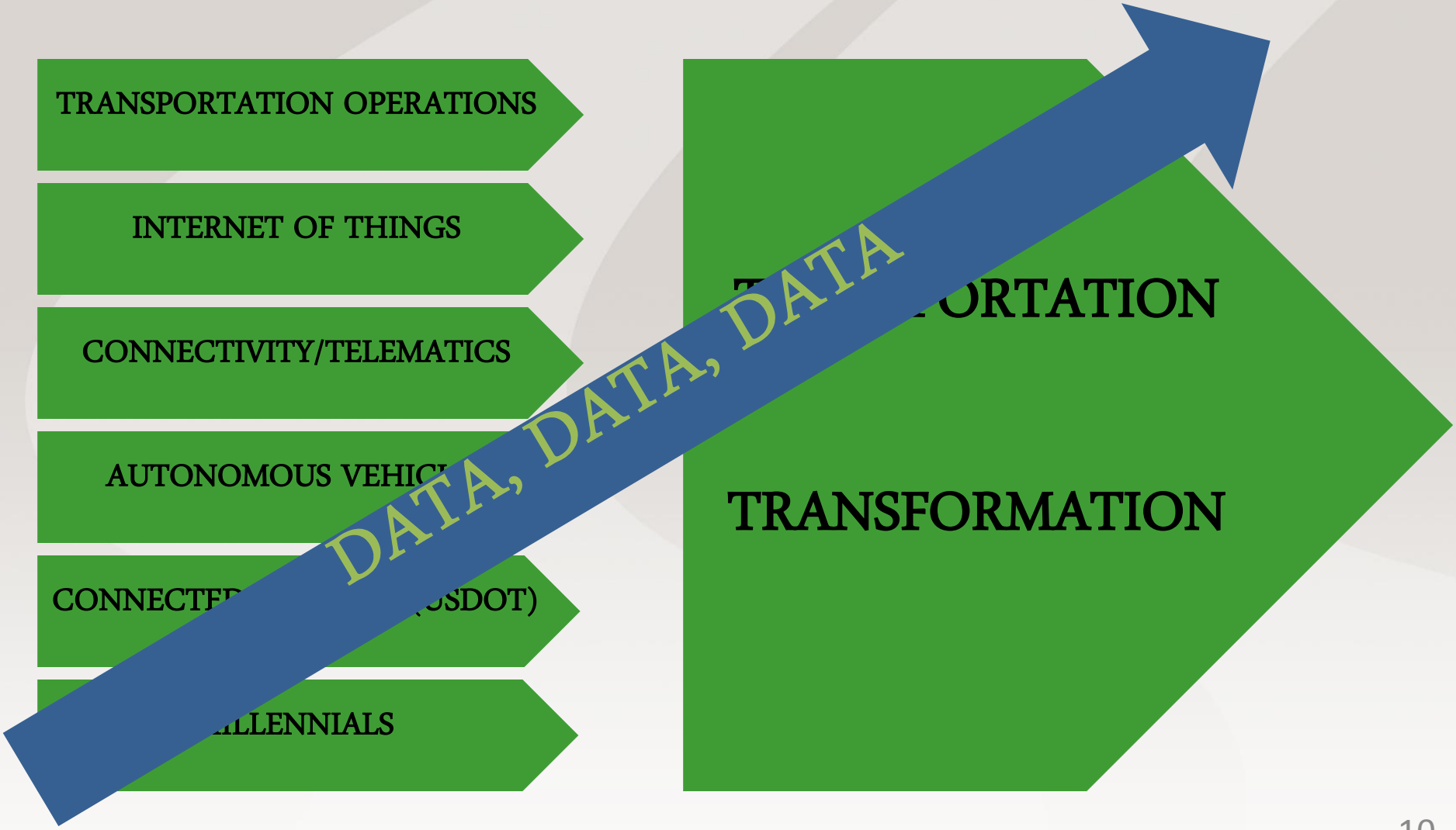
Big Data, Big Challenges, Big Changes

USDOT Safety Pilot Data

SPaT	• Expected: Total for 8 RSUs = 6,912,000 messages per day • Actual: Total for 8 RSUs = 28,821,437 messages per day
MAP	• Expected: Total for 7 RSUs = 691,200 messages per day • Actual: Total for 7 RSUs = 2,510,384 messages per day
TIM	• Expected: Total for 3 RSUs =259,200 messages per day • Actual: Total for 3 RSUs = 227,766 messages per day
BSM	• Expected: Total for 26 RSUs = 6,516,458 messages per day • Actual: Total for 26 RSUs = 16,740,785 messages per day

Storage Size (total file storage + database size per month)		
Files **4.6 TB**	**Database** **13.8 TB**	**Total** **18.4 TB**

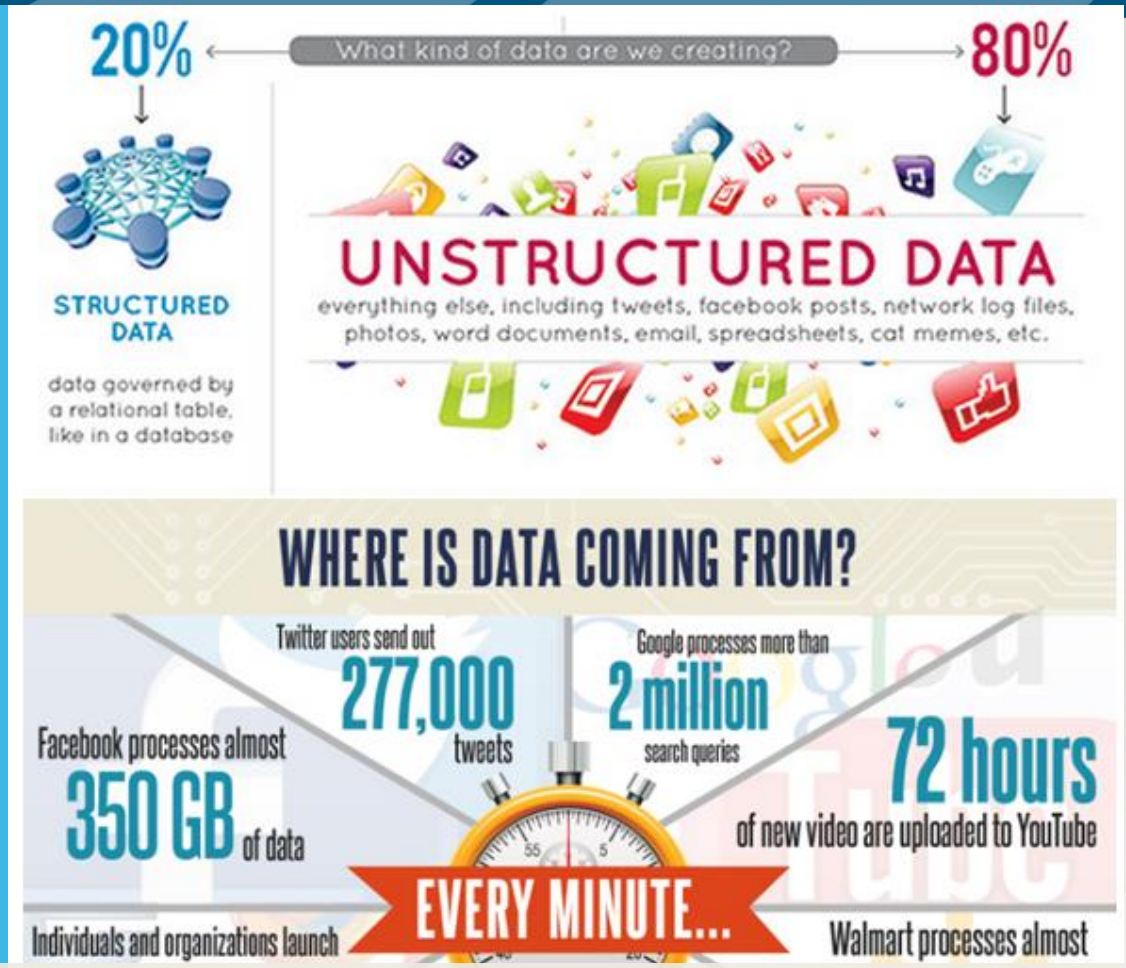
Confluence of Trends



How Much Data???

Big Data

- 70B
  connected devices (2050)
- 2.8T
  sensors by 2019
- Autonomous Vehicles (L2)
  80+ processors;
  200+ sensors;
  100M+ lines of code (GM)



2,500,000,000,000,000,000

2.5 Quintillion bytes EVERY DAY

Big Challenges

- Privacy and Security
- Value
- Organizational
  - New Roles, New Leaders
  - Understanding & connecting to your customer

Computer World 2014

Big Changes

- Connected and Autonomous Vehicles
- More ICM
- More Toll Roads; Toll Lanes; RUC
- Active Travel Demand Management

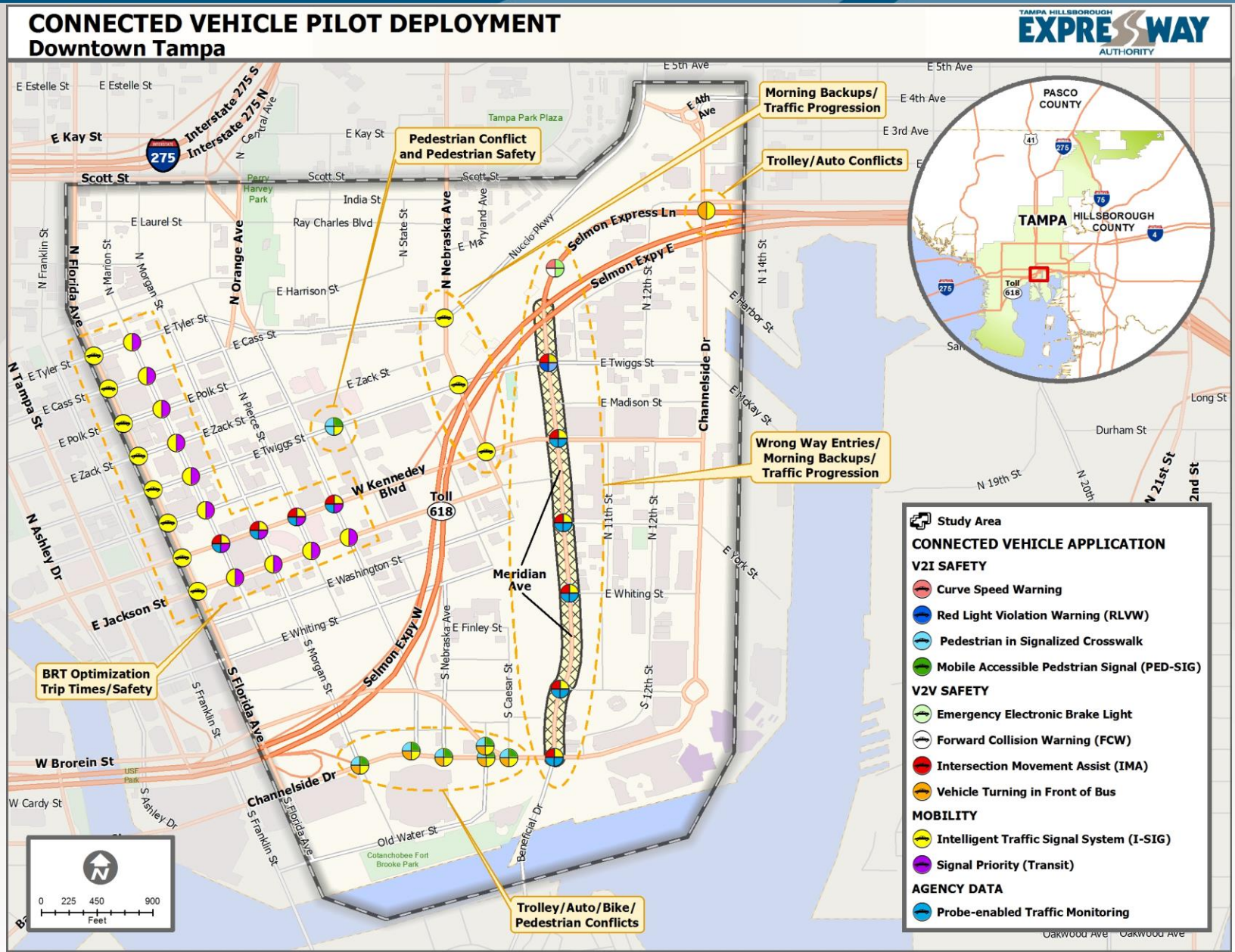
Connected Vehicle Pilot Program

- USDOT selected 3 initial pilot sites
  - Tampa-Hillsborough Expressway Authority
  - New York City
  - Wyoming

THEA Connected Vehicle Pilot

- THEA's CV 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

CV Applications/Concepts Being Explored



CV Pilot Use Cases

- UC1 – Morning Peak Hour Queues
- UC2 – Wrong-Way Entries
- UC3 – Pedestrian Safety
- UC4 - Bus Rapid Transit Signal Priority Optimization, Trip Times and Safety
- UC5 - TECO Line Streetcar Trolley Conflicts
- UC6 - Enhanced Signal Coordination and Traffic Progression

The Result

Rich sets of data about our transportation system that can be aggregated, analyzed and assembled into meaningful outcomes will help us solve tomorrow's transportation challenges.

UC1 – Morning Peak Hour Queues

- Normalized speed
- Vehicle speed
- Basic Safety Messages (BSMs)
- Signal timing updates
- Emergency Electronic Brake Light (EEBL) warnings
- Forward Collision Warnings (FCW)

UC2 – Wrong-Way Entries

- Vehicle BSMs
- Wrong way entry warnings
- Wrong way driver warnings

UC3 – Pedestrian Safety

- Pedestrian BSMs
- GPS corrected pedestrian BSMs
- Vehicle BSMs
- Pedestrian warnings
- Driver warnings

UC4 - Bus Rapid Transit Signal Priority Optimization, Trip Times and Safety

- Bus location
- Bus movement
- Bus number
- Bus route
- Bus schedule
- Priority granted
- Priority denied
- Priority granted, then denied

UC5 - TECO Line Streetcar Trolley Conflicts

- Vehicle BSMs
- Trolley BSMs
- Pedestrian BSMs
- GPS corrected Pedestrian BSMs
- Vehicle turning right in front of trolley warnings
- Pedestrian warnings
- Vehicle warnings
- Trolley warnings (to pedestrian only)

UC6 - Enhanced Signal Coordination and Traffic Progression

- Vehicle BSMs

UC1 – Morning Peak Hour Queues

- Mobility
  - Travel Times
  - Travel Time Reliability
  - Queue Length
  - Delay
  - Percent Arrival on Green
- Safety
  - Crash reduction / crash rate
  - Type of conflicts / near misses
  - Severity of conflicts / near misses
  - Approaching speed on REL
  - Percent (%) red light violations
- Emissions
  - Changes in idle speed emissions
  - Changes in running emissions

UC2 – Wrong-Way Entries

- Mobility
  - Travel Times Delay
- Safety
  - Crash reduction / crash rate on East Twiggs Street
  - Type of conflicts / near misses East Twiggs Street
  - Number of wrong way entries and frequency
- Environment
  - Emissions Reduction
  - Excess time spent on idle conditions

UC3 – Pedestrian Safety

- Mobility
  - Travel time
  - Travel time reliability
  - Queue length
  - Vehicle Delay
  - Pedestrian delay
- Safety
  - Crash reduction / crash rates between vehicles and between vehicles and pedestrians
  - Type of conflicts / near misses between vehicles and between vehicles and pedestrians
  - Severity of conflicts / near misses between vehicles and between vehicles and pedestrians
  - Reduction in approach vehicle speed towards crosswalk
- Environment
  - Changes in idle speed emissions
  - Changes in running emissions

UC4 - Bus Rapid Transit Signal Priority Optimization, Trip Times and Safety

- Mobility
  - Bus travel time
  - Bus route travel time reliability
  - Percent (%) arrival on schedule
  - Percent (%) arrival on green
  - Percent (%) red light violation/running
  - Signal Priority:
    - Number of times priority is requested and granted
    - Number of times priority is requested and denied
    - Number of times priority is requested, granted and then denied due to a higher priority
- Environment
  - Changes in idle speed emissions
  - Changes in running emissions

UC5 - TECO Line Streetcar Trolley Conflicts

- Safety
  - Crash reduction / crash rate
  - Type of conflicts / near misses
  - Severity of conflicts / near misses

UC6 - Enhanced Signal Coordination and Traffic Progression

- Mobility
  - Travel time
  - Travel time reliability
  - Queue length
  - Delay
  - Percent (%) arrival on green
- Safety
  - Crash reduction / crash rate
  - Type of conflicts / near misses
  - Severity of conflicts / near misses
  - Vehicle speed on Meridian Ave through all intersections in study area
  - Percent (%) red light violations
- Environment
  - Changes in idle speed emissions
  - Changes in running emissions

Challenges

- Project in Planning Stage
- Identifying Key Metrics
- Ensure Metrics can be Gathered
- No Personally Identifiable Information

Data Collection Benefits

- Measure Before and After Affect of CV Deployment
- Reconstruction of Events
- Rich Set of Data for Research
- Improved Mobility
- Improved Safety

For More Information

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