kapsch
challenging limits

Penn State Transportation Engineering and Safety Conference

Operational Considerations for Connected Vehicle Services Case Studies

John Estrada

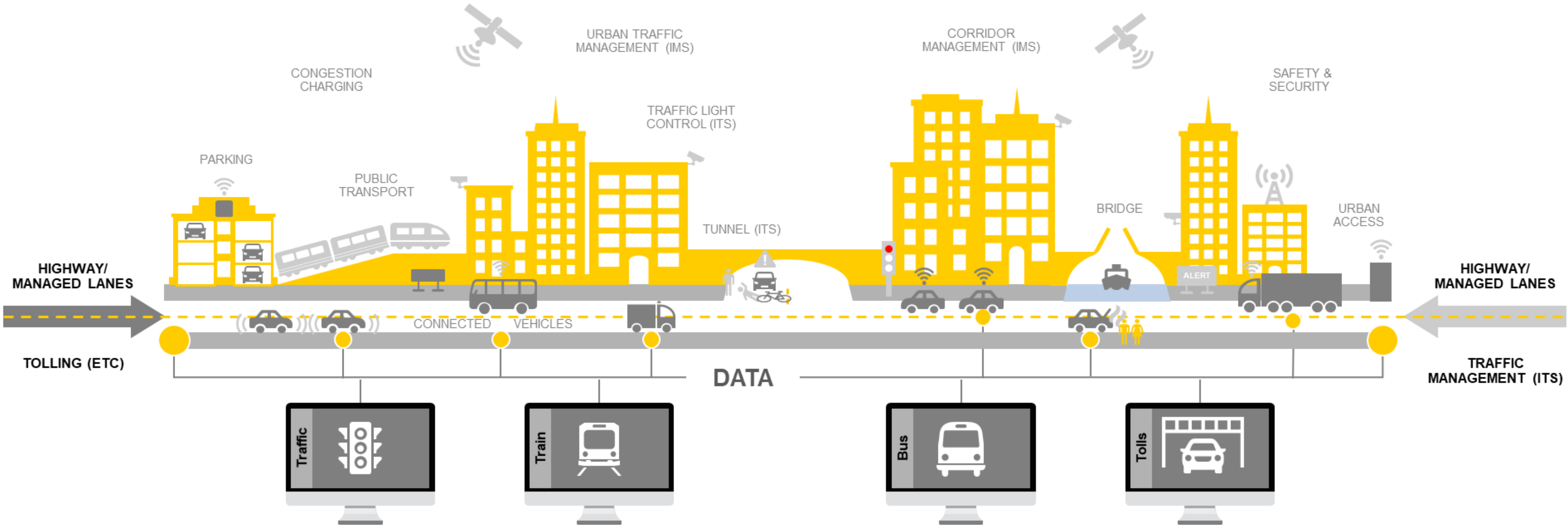
December 4, 2018

Agenda

1. **Connected Vehicle: The Enabling Technology**
2. CV and AV, Need Both?
3. Validate Your Installation
4. Monitor and Manage Your Installation
5. Questions

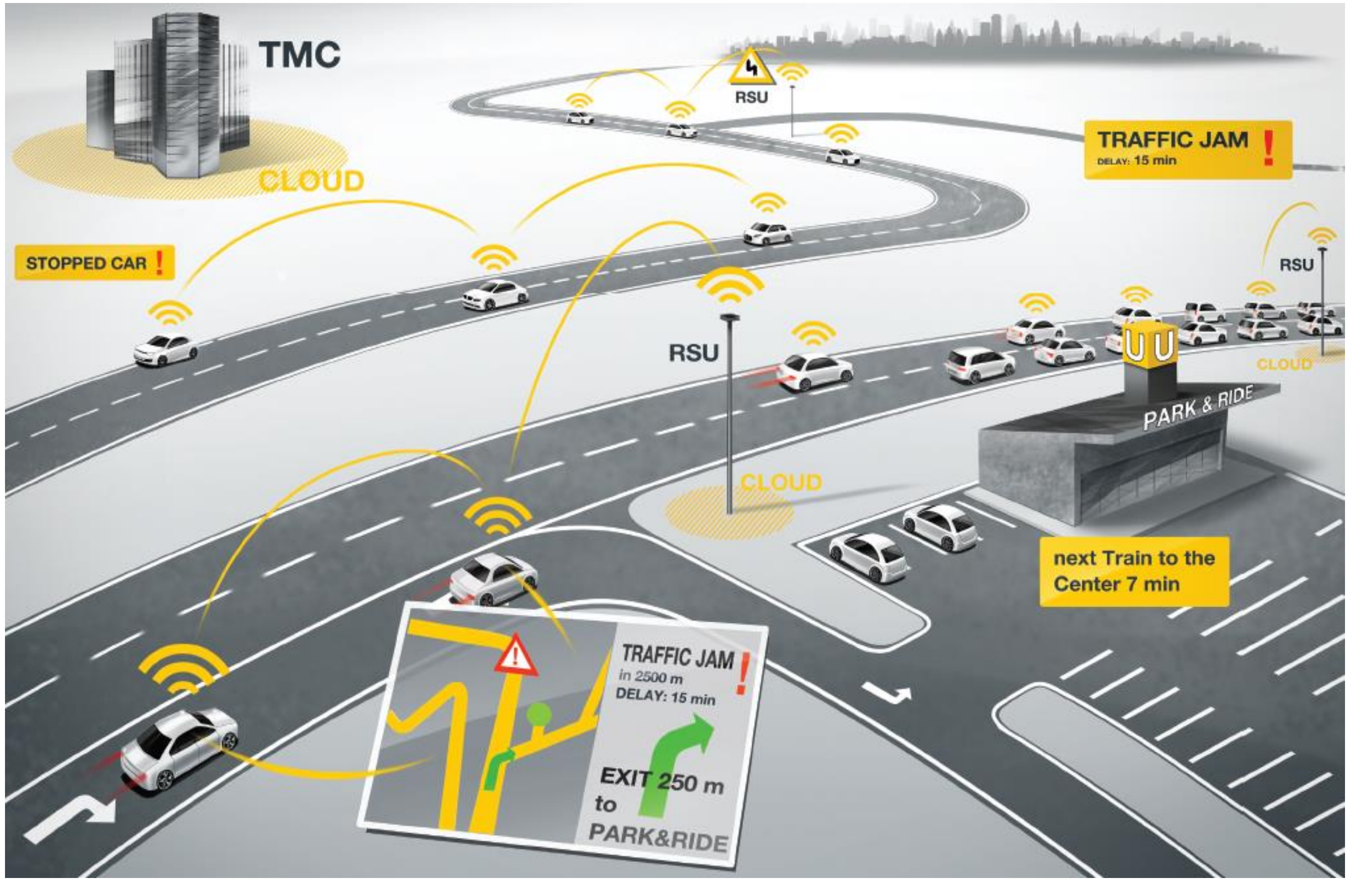
Connected Vehicle: the Enabling Technology

> From Highways to Cities.



CV Services

- Foundational services
  - Travel Times, Traveler Information, Work Zone Warnings
- Operational Services
  - Transit Signal Priority
  - Predictive travel times
  - Work Zone Notifications
  - Corridor Data Warehouse and Analytics Platform
  - Performance measurements/metrics
- Safety
  - CV driven incident awareness
  - End of Queue Warning
  - Corridor condition warnings



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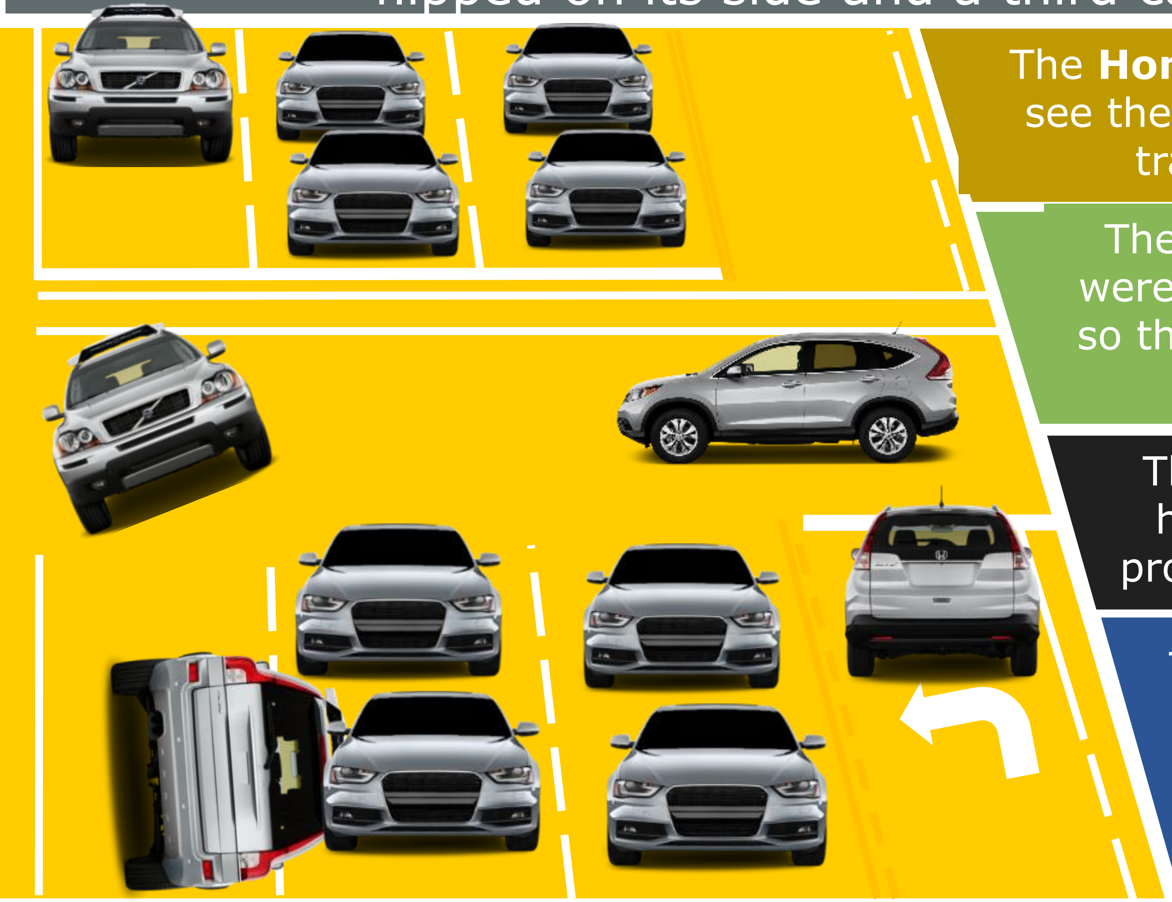
Plan for Technology and CAV Convergence

Source: USDOT

Uber Arizona Case

March 24, 2017

"Tempe police cited a driver for making an illegal left turn and hitting one of Uber's test Volvos while it was in self-driving mode. The **Uber SUV**, occupied by a test driver and an engineer in the passenger seat, flipped on its side and a third car was struck".



The **Honda** was turning left and did not see the oncoming **Uber** vehicle due to traffic in the other direction

The vehicles in the left most lanes were stopped but not blocking traffic so the **Honda** proceeded with its left turn.

The **Uber** was going 38 miles per hour, didn't see the **Honda,** and proceeded through the intersection.

The **Honda** hit the **Uber**, which proceed forward into a pole, flipped over and ran into two other cars.

Uber Arizona Case – with CV Technology

DSRC allows vehicles to communicate information, such as speed, bearing, and direction to nearby vehicles, even if not in the line of site.

The **Honda** would have still wanted to turn left

However, with V2V it would have been notified that the **Uber** was coming even though it couldn't see it.

Also, the Uber would have been notified about the Honda and would have known to slow down, giving the Honda more time

The accident could have been avoided, other cars would have been safe and the Uber could proceed on its way

Let’s Do The Math

(Don’t worry there’s no Quiz at the end)

- The V2V application Intersection Movement Assist would have provided enough information to each of the vehicles to warn the driver or software of the other vehicle
- DSRC will provide information for at least 150 meters (longer in many intersections)
- The Uber Vehicle was traveling 38 miles per hour and the Honda was going about 10 mph, so they would have begun to get warnings 6.7 seconds before hitting each other
    - Uber 38 mph = 63.3 kph = 17.5 m/s
    - Honda 10 mph = 16.7 kph = 4.7 m/s
    - Total is 22.2 m/s (total speed heading toward each other)
    - It takes 6.7 seconds to traverse 150m at 22.2 m/s
- 6.7 Seconds would be more than enough time for both vehicles to react, slow down and avoid each other.

Emergency Braking

Without V2V technology if the front car slams on its brakes, the last car will not know that this has happened if the middle car isn't paying attention. This can cause a multi-car pile up. Traditional ADAS/AV Sensors (Camera, Lidar, Radar) can't see through cars.

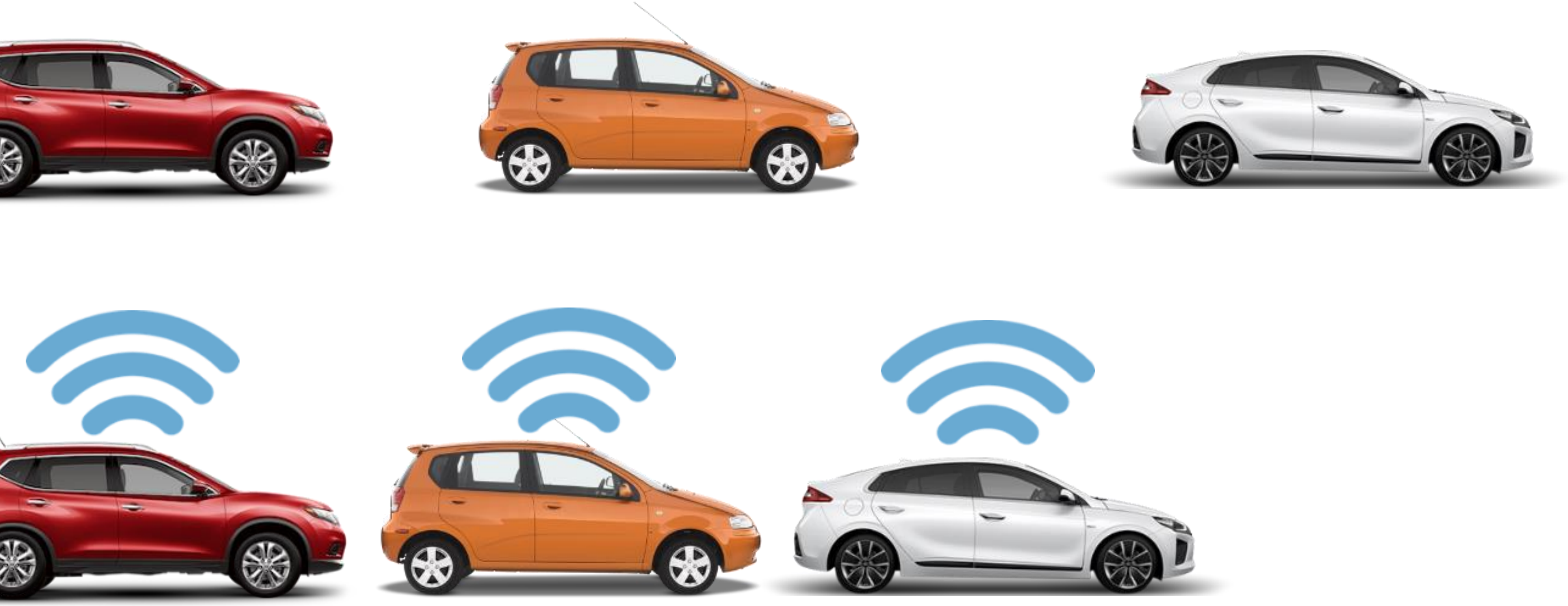
Emergency braking is best handled through V2V technology. As the front car quickly slows down this is announced via DSRC communication and then the last car can easily stop in time.

An option for trucks is to have video in the truck provide information to the car behind. A camera on the front of the truck streams video to the car behind so that that driver/AV system can "see through" the truck to see what is happening in front. When that front car brakes, the rear car will be notified. This has the advantage of not requiring DSRC in the front car.

V2V Platooning

Without V2X even autonomous vehicles will have to keep greater distance between vehicles. This takes up more road space and limits the speed at which the vehicles can travel

With V2X the vehicles can stay closer together thus saving fuel and allowing more vehicles on an individual stretch of road which is increasingly important as the number vehicles increases.



Platooning Advantages

Without V2X even autonomous vehicles will have to wait and detect movement from the vehicle in front before moving forward once the light changes

With V2X the light can signal it is going to change, the vehicles can confirm they received the message and then proceed all at once saving time, fuel and road space.

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Panasonic V2X Program

Connected Vehicles

- B2B V2X RSU Development Program supporting Panasonic Smart City Initiatives
- Panasonic under MSA with Colorado DOT to provide a statewide V2X ecosystem
- State plans expanding to 1000 miles of V2X Corridor and 10,000 equipped vehicles beyond initial program

- Multi-Phase 12 mo Program
  - Base RSU Development Program
  - 100 unit I-70 90 mile V2X corridor deployment
  - C-V2X Pilot initiative in cooperation with Panasonic and Qualcomm completed by end of 2018

$1.6M Budget

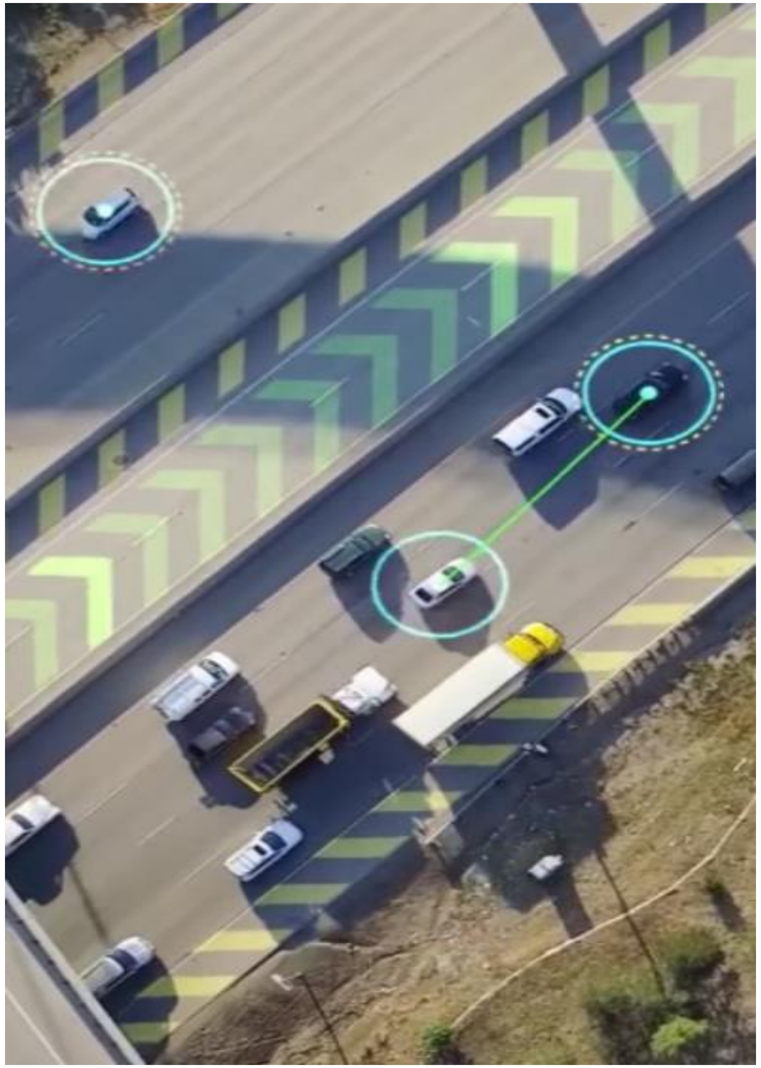
Establishes industry partnership

2018-2019

100+ unit deployment

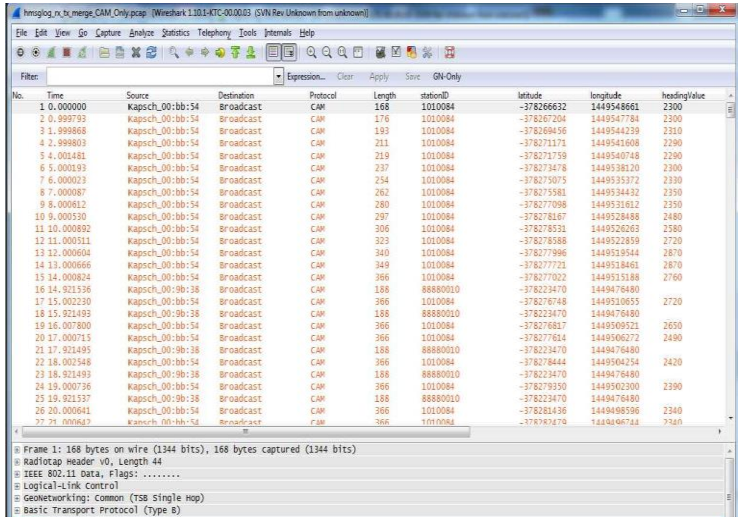
I-70 90 mile V2X corridor

Participation in automotive industry



Modeling and Coverage Testing

- Software virtualization models signal coverage for new construction such as tunnels and overpasses
- Coverage Testing
  - Identifies optimal RSU placement
  - C470 project average distance has been 500m-700m, greatest distance was 900m



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2	1,000	Kapsch_00:bb:54	Broadcast	CAM	176	1010084	-378267204	1449547784	2300		144.9547784,-37.8267204,0
3	2,000	Kapsch_00:bb:54	Broadcast	CAM	193	1010084	-378269456	1449544239	2310		144.9544239,-37.8269456,0
4	3,000	Kapsch_00:bb:54	Broadcast	CAM	211	1010084	-378271171	1449541608	2290		144.9541608,-37.8271171,0
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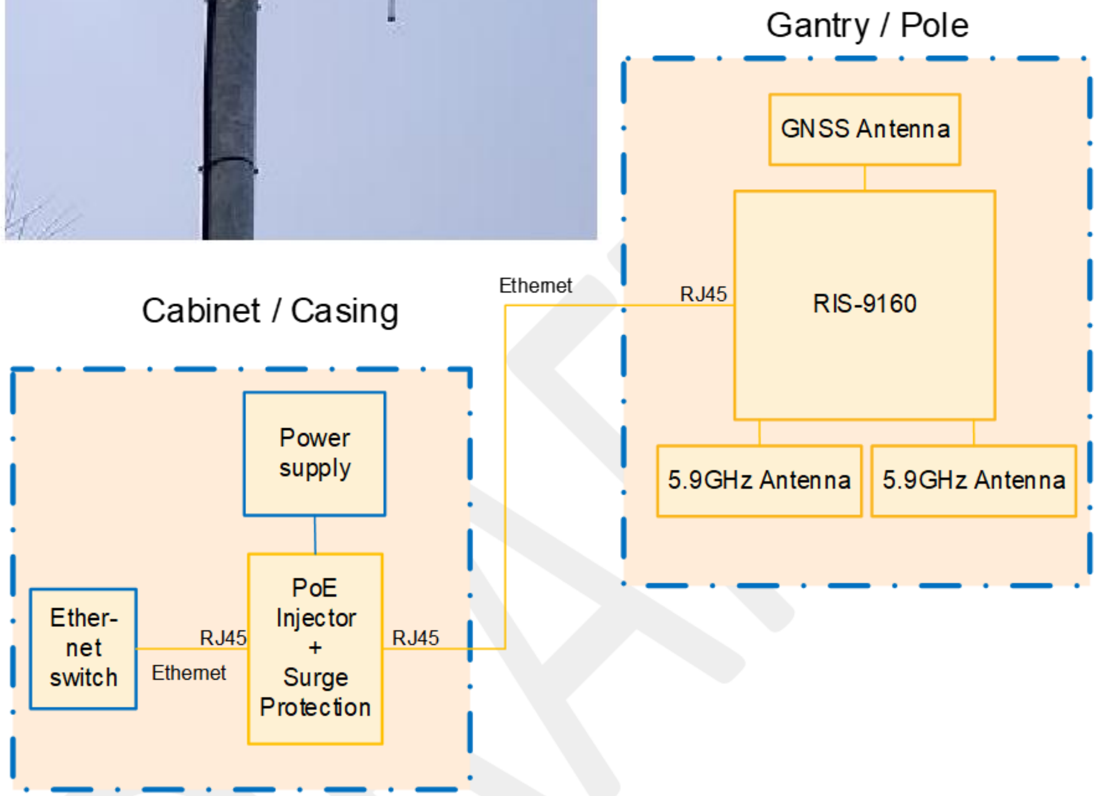
Mounting and Installation

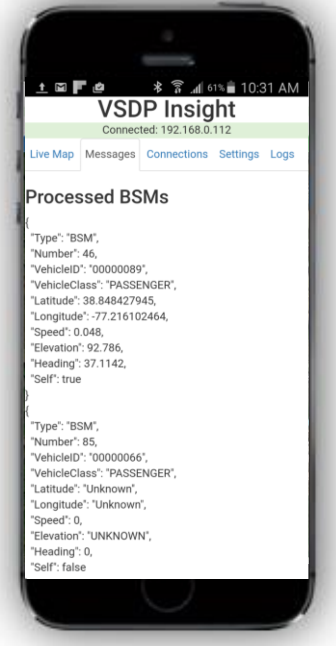
- Simplistic mounting approach / Custom or Proprietary
- PoE per USDOT RSU 4.1 Spec standards
- O&M packages should be considered such as data storage



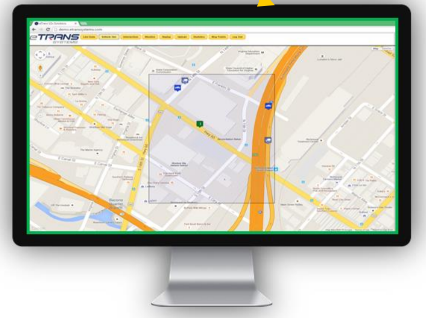
CV Validation Tools

RSU attached to a light transmitting SPaT, MAP, RSM and TIM Messages. This is the unit that is being validated.

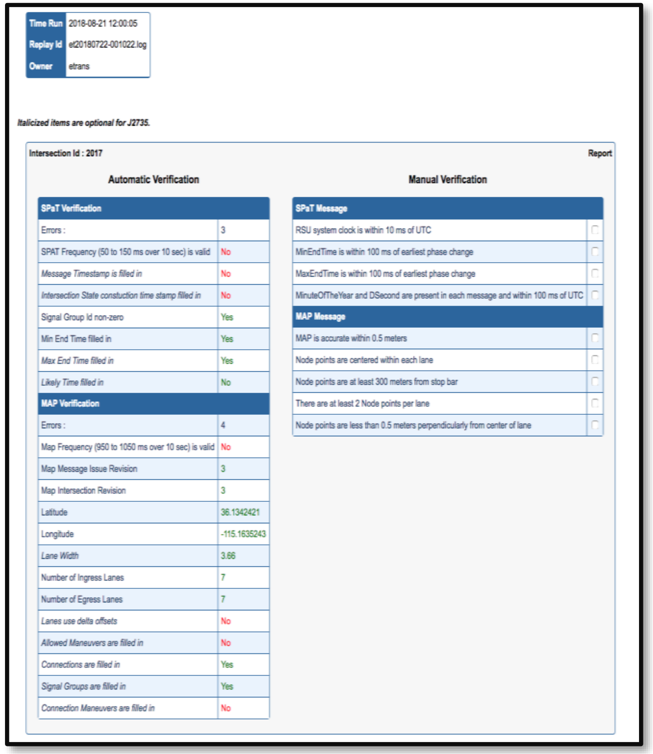
Kapsch OBU plus Bluetooth or Wi-Fi/Cell Modem.



Insight on a tablet or smartphone. Connects to OBU over Wi-Fi or Bluetooth.



Omnisight in the cloud records and plays back recorded data. Verifies SPaT and MAP data.



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Cary, NC SPaT Demonstration

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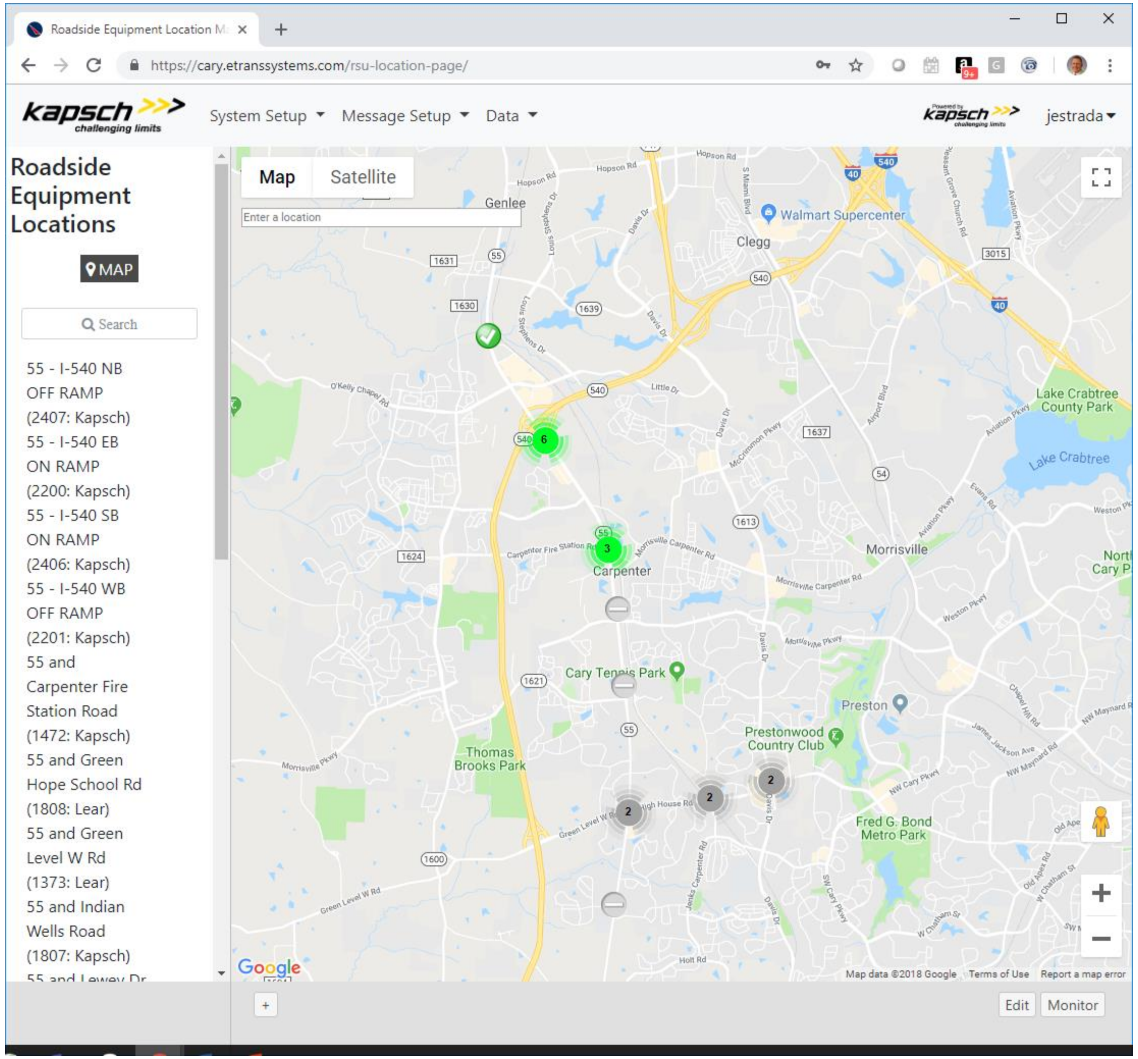
- Cary and NC DOT Collaborative Corridor
- Supports FHWA SPaT Challenge Initiative
- Multi-vendor RSU and OBU Interoperability
- Intersection Safety Focus
  - Red Light Warning
  - eWalk Pedestrian Safety
  - Curve Speed Warning
  - Speed Zone Warning



Fiscally Sound

Establishes industry partnership

2018-2019

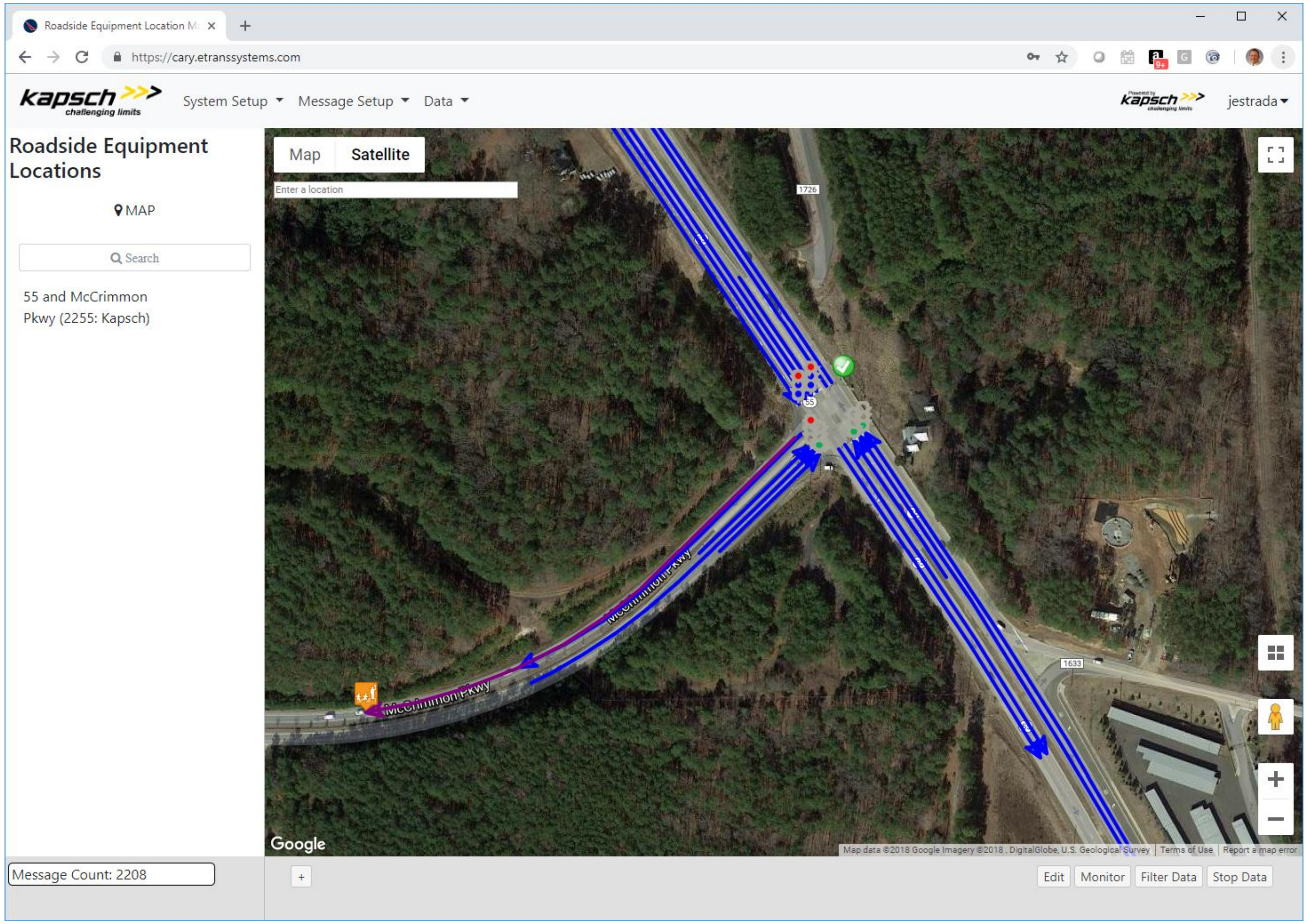
Revealing user and agency benefits

20 intersection V2X corridor

Collaboration with multiple vendors and Transportation agencies

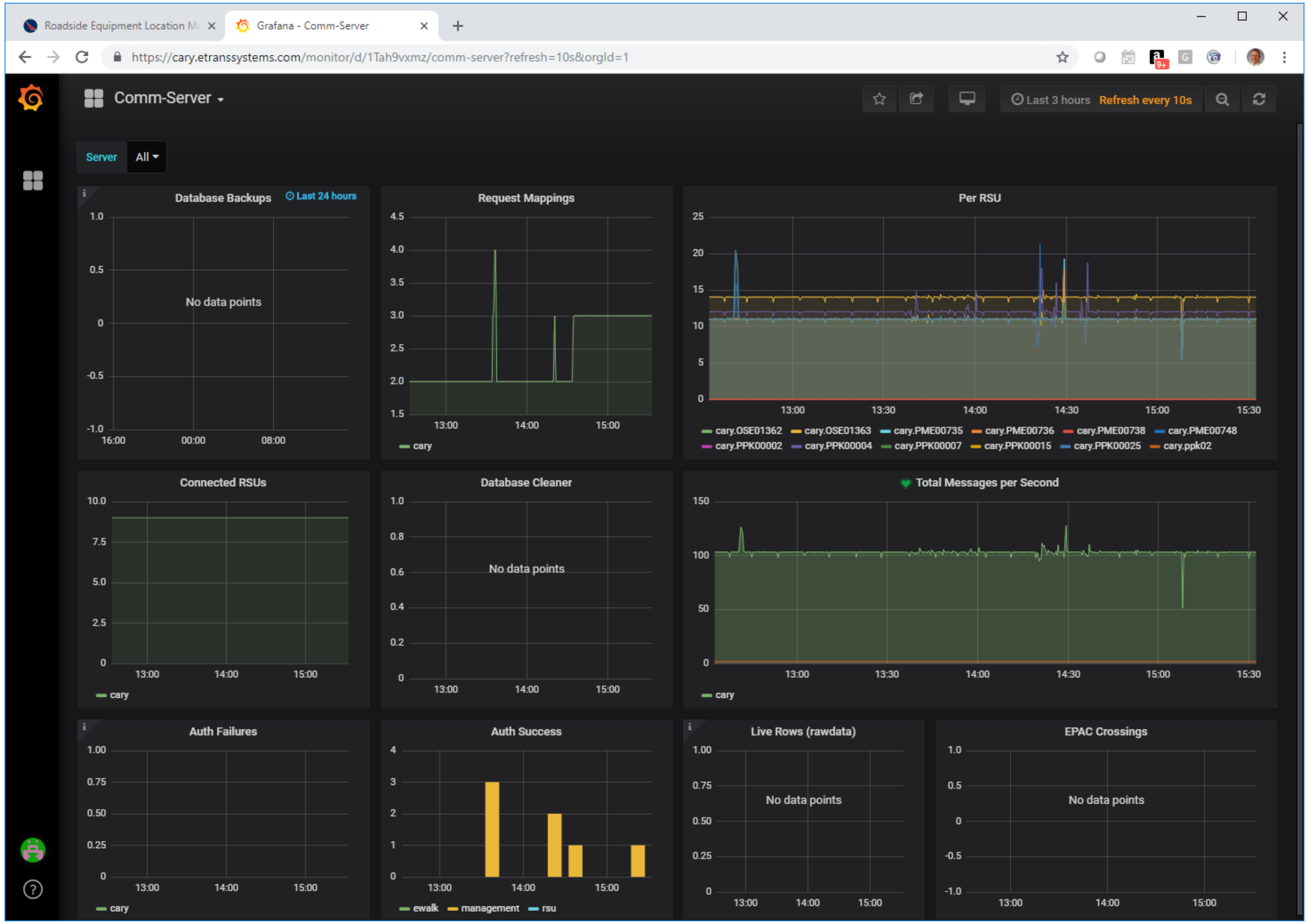
Corridor Management

- Manage and Configure
  - Locations
  - RSUs
  - MAP Messages
- Receive and Process Real Time Alerts
- Monitor Real-Time Message Traffic
  - MAP Information (Blue & Green Lines)
  - Traffic Lights
  - Vehicles
  - Pedestrians



Data Management

- Monitor Data Being Processed
  - From RSUs
  - From OBUs
  - Other Sources
- Receive and Process Real Time Alerts
- Analytics for Gaining Future Value



Questions?

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