CONNECTED & AUTOMATED VEHICLES

STATUS…… & THINGS TO CONSIDER!

NYSAMPO Conference
Syracuse, NY
Wednesday, June 21, 2017

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DEFINITIONS

LOTS OF ACTIONS…WITH LOTS OF CONFUSION!

- **Connected, Automated, Autonomous, Driverless, Self-Driving, Fused,…….**
- **Lots of standards – SAE, IEEE, NTCIP, SCMS…….**
- **3 Major Types:**

  '*Connected Vehicles*' - USDOT Program; Driver Warnings, No Automation, Cell/5.9 GHz DSRC

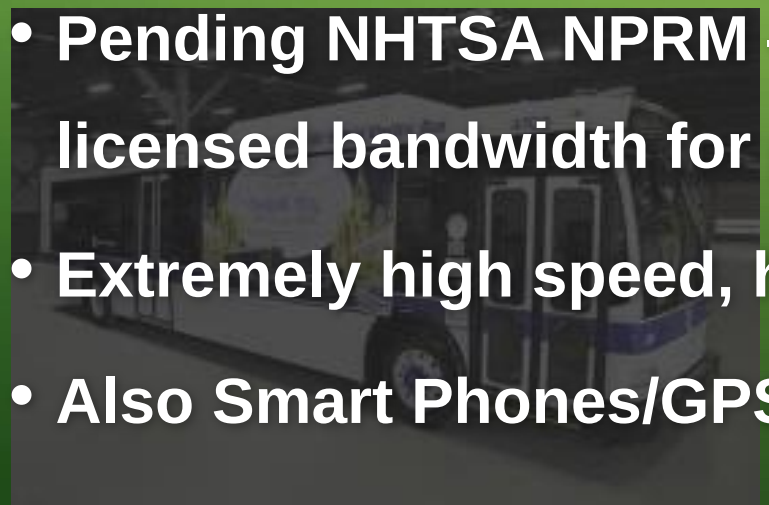
  '*Autonomous Vehicles*' – Not Connected, High Degree of Automation/Driverless

  '*Automated Functions/Vehicles*' – Most Brands, Many Models, Various Degrees/Levels of Automation

CONNECTED VEHICLE TECHNOLOGY

BACKGROUND

- "Smart vehicles, smart highways"
- "Internet" model for the highway/transportation system
- Connected vehicles (USDOT) - Messaging to driver for crash avoidance; no automation
- Pending NHTSA NPRM – V2V Communication (5.9 GHz licensed bandwidth for public transportation/FCC)
- Extremely high speed, high capacity, low latency
- Also Smart Phones/GPS enabled wireless devices



EARLY CONNECTED VEHICLE RESEARCH

AUTOMATED VEHICLE TECHNOLOGIES

BACKGROUND

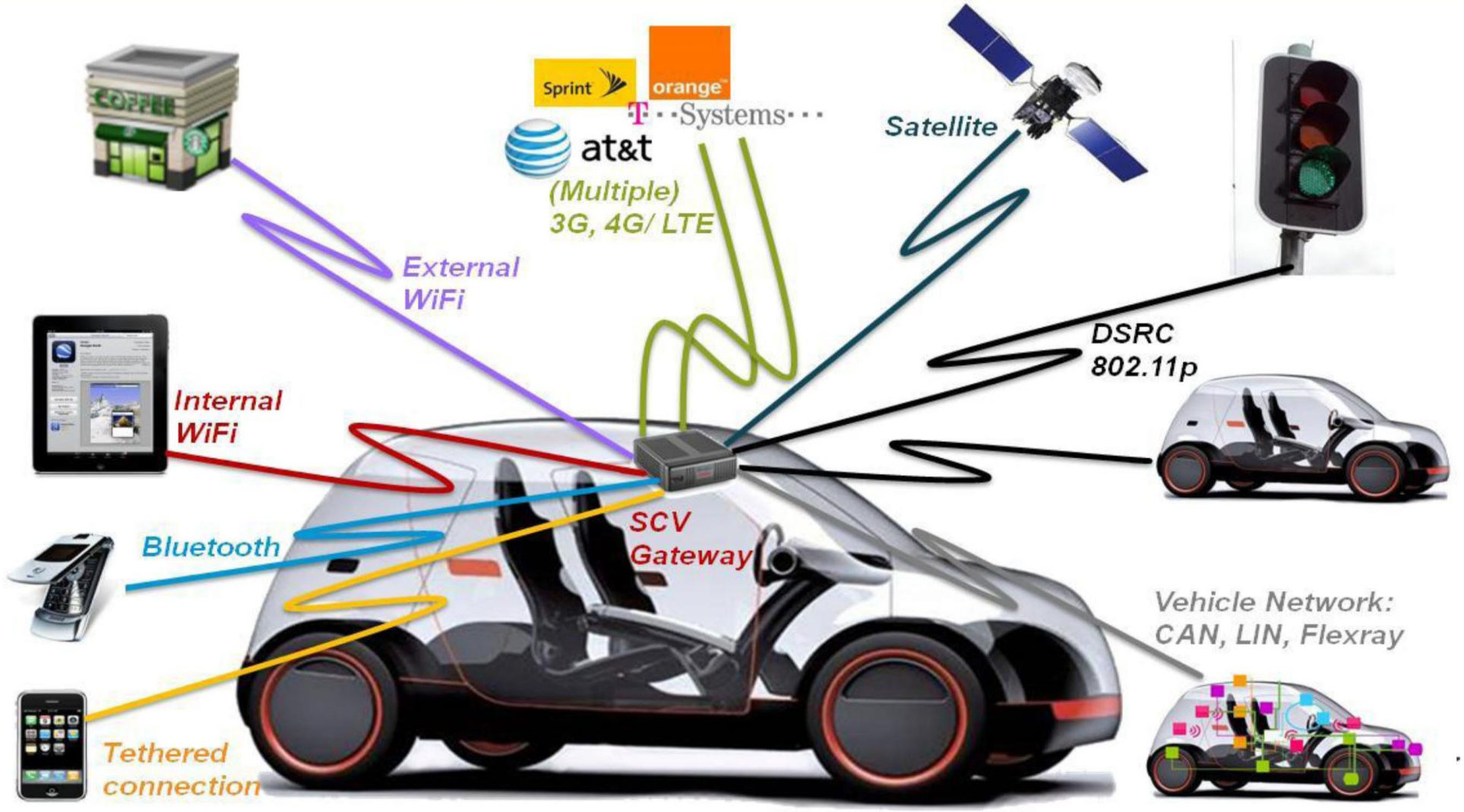
- Systems control the vehicle or intervene when driver does not react or before a driver can react
- Car companies have deployed various automated systems, initially on high end models
- All involve on board, sensor driven “autonomous” operation to determine situational awareness
- Capabilities offered on many models today – many times as an additional “cost”
- Various levels of automation (NHTSA 5 Levels)
- Goes from simple (ABS) systems to totally driverless operation
- Driverless vehicles being tested & operated in many states
- NYS V&T Law requires “hand on the wheel”, temporarily amended 2017

AUTONOMOUS VEHICLE TECHNOLOGIES

BACKGROUND

- Stand alone automated systems, ***not connected!***
- Use sensors including radar, lidar, cameras, etc.
- Generally use onboard highly accurate digital maps
- Color detection for traffic signals; can/do not “read” Signal Phase & Timing (SPAT) broadcasts
- Sensors severely limited in any inclement weather
- California leading the way – state & private sector (Google, Tesla, etc.)

CV as Pathway to IoT



5.9 GHZ CONCEPT OF CONNECTED VEHICLE

OBE

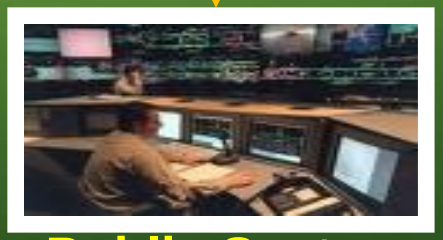
DSRC @ 5.9 GHz

OBE

RSE

DSRC @ 5.9 GHz

Operations Center/Network



Public Sector

Vehicle to Vehicle (V2V)

Carriers, Fleet managers, OEMs, Private Companies, Service & Telematics Providers, etc.

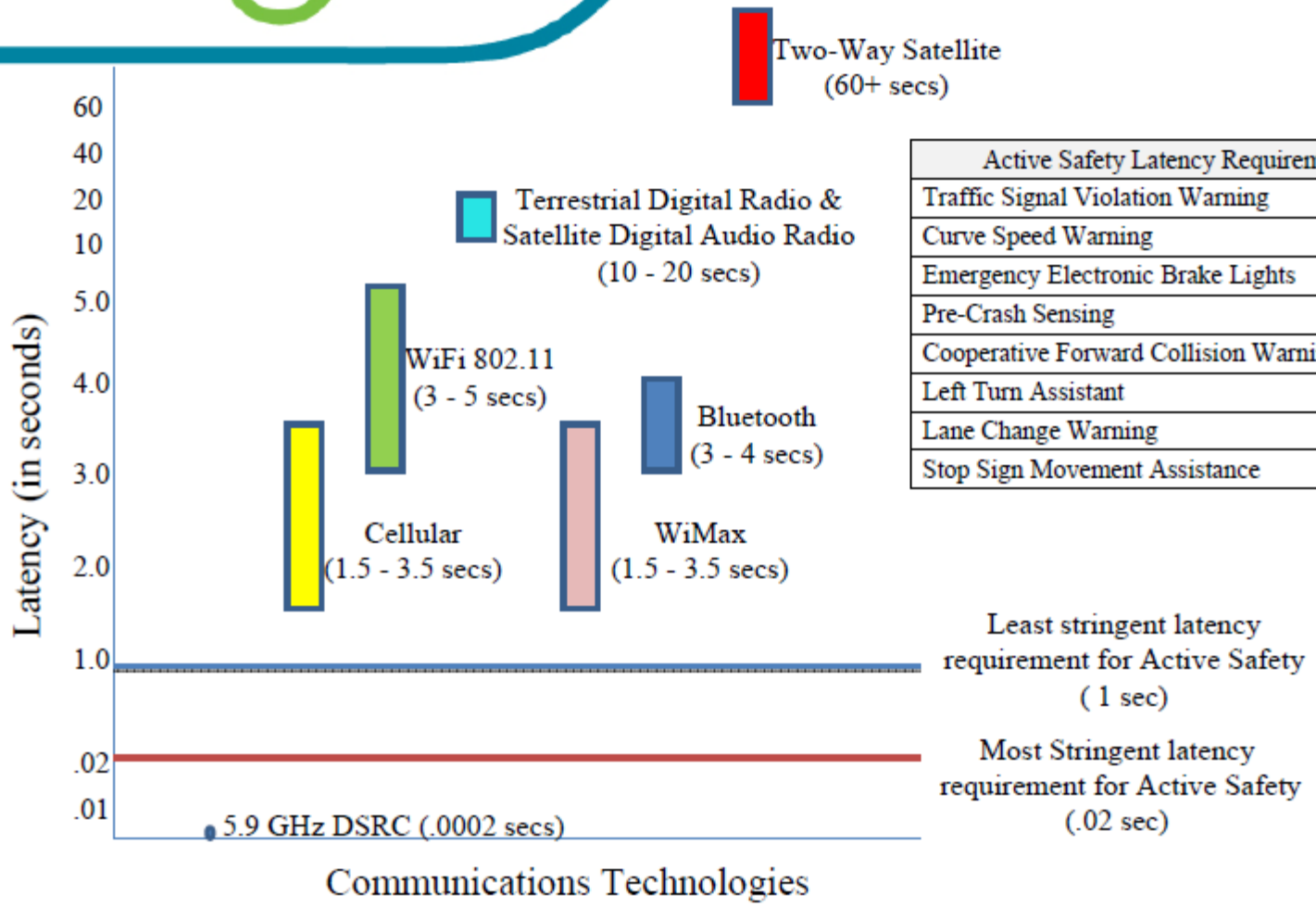
Private Sector

OBE – On Board Equipment

RSE – Road Side Equipment

IntelliDrive℠

Communication Technologies

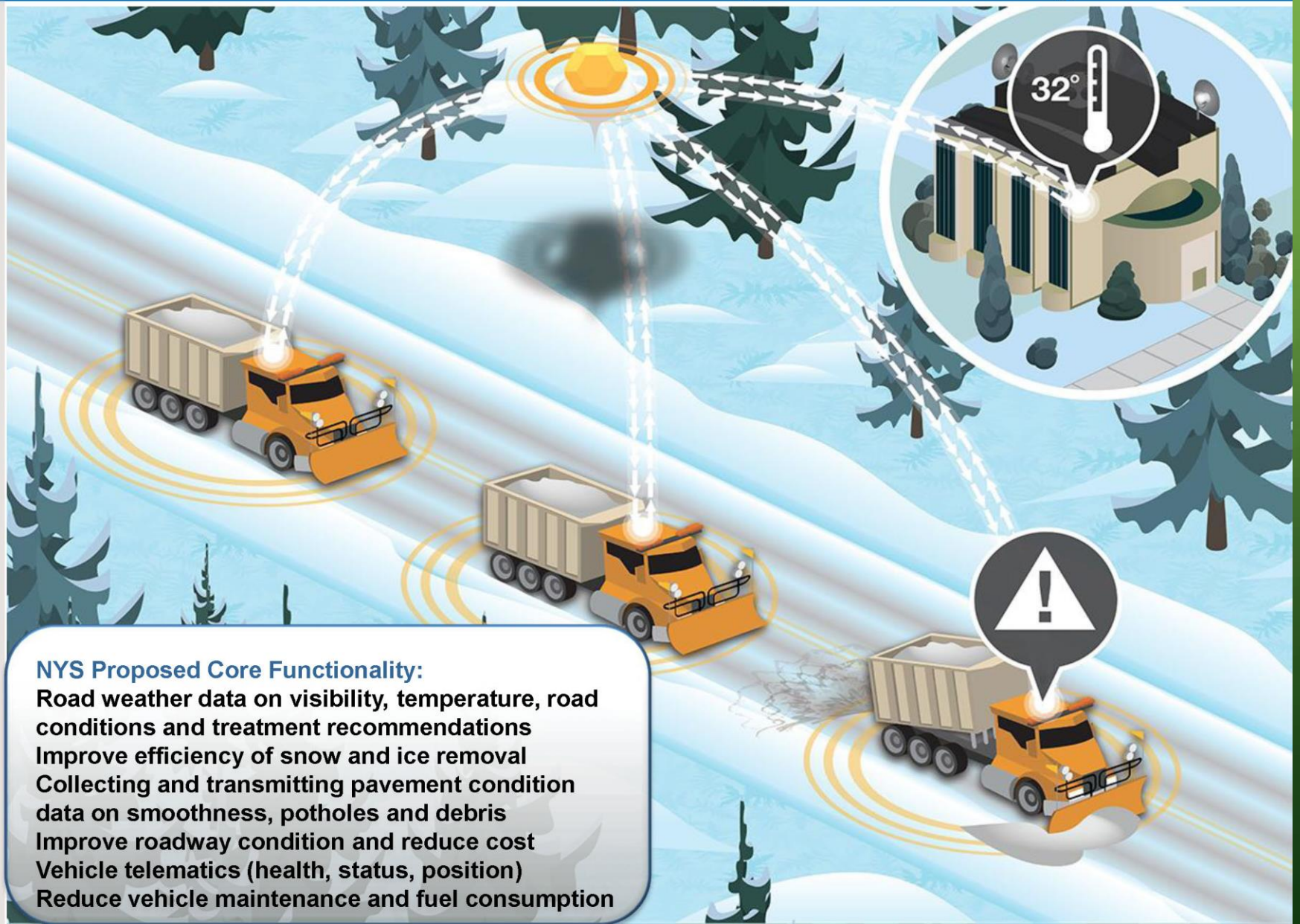


Active Safety Latency Requirements (secs)	
Traffic Signal Violation Warning	0.1
Curve Speed Warning	1.0
Emergency Electronic Brake Lights	0.1
Pre-Crash Sensing	0.02
Cooperative Forward Collision Warning	0.1
Left Turn Assistant	0.1
Lane Change Warning	0.1
Stop Sign Movement Assistance	0.1

CAV Technology

Commercial Vehicle Data Bus

Environment and Agency Efficiency



NYS Proposed Core Functionality:

Road weather data on visibility, temperature, road conditions and treatment recommendations
Improve efficiency of snow and ice removal
Collecting and transmitting pavement condition data on smoothness, potholes and debris
Improve roadway condition and reduce cost
Vehicle telematics (health, status, position)
Reduce vehicle maintenance and fuel consumption

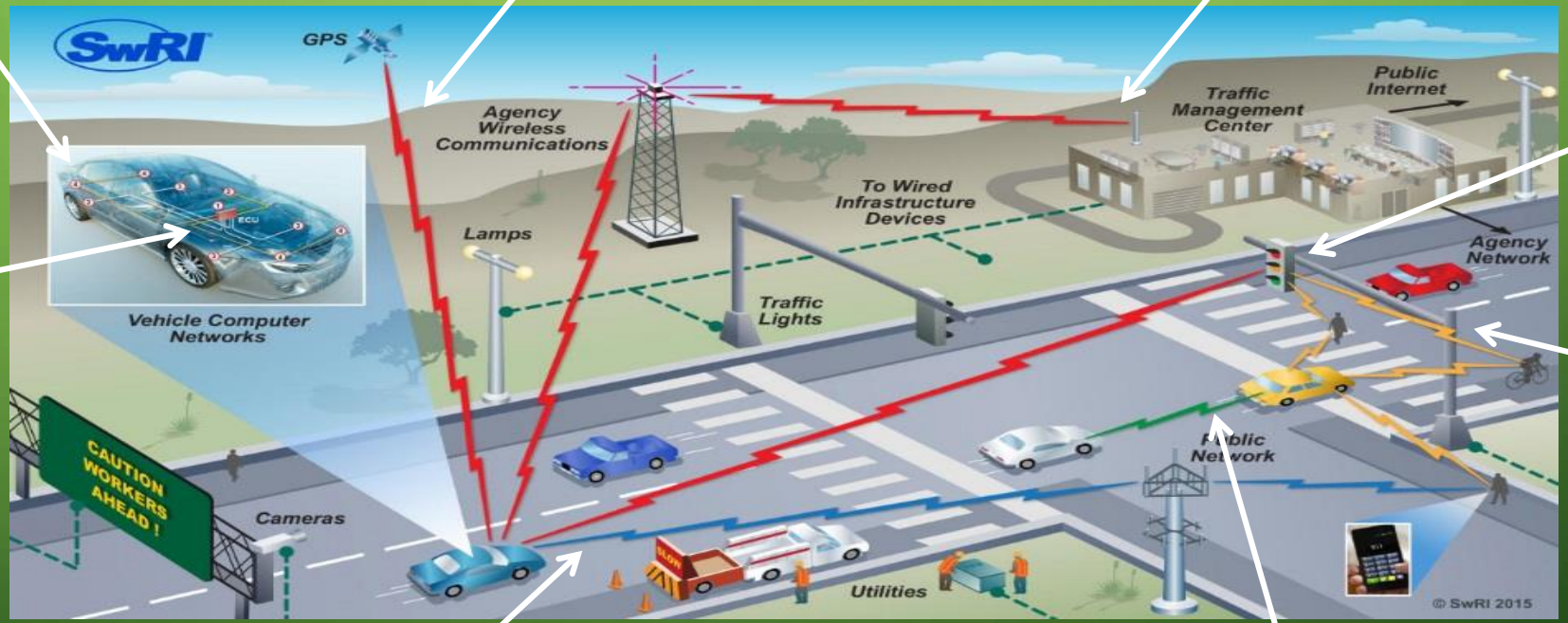
CONNECTED VEHICLE ENVIRONMENT

POTENTIAL ATTACKS

Injecting bad data that is then communicated over trusted comms

Spoofing, jamming, or subtle skew of GPS signal

Use roadway infrastructure to infiltrate TMC network



Hack RSE and alter SPAT/MAP messages

Using comms or physical means to hack vehicle and control it or obtain trusted security credentials

Broadcast incorrect messages to/from Vulnerable Road Users

Flood DSRC safety & control channels

Simulate vehicles that will trigger safety apps. Tough to detect if sensors are occluded

SAFETY – THE COSTS & RISKS

- Deaths per year – approx.40,000!; 1.25 M worldwide
- Leading cause of death for ages 5 – 35 yrs
- NHTSA estimates $871B/yr - $2,800/person (2014)
- 95% are behavior based i.e. **Preventable!**
- Bad news – Things are getting worse! (from National Safety Council Press Release)
- Driving is one of the most dangerous situations normally experienced each day
- We've come to accept carnage on the roads!

SAFETY IS THE KEY!

- Technology is available today to:

  Override the driver and “Perform the correct action”
- Driving is a privilege, not a right
- Driver does not have the right to hurt someone else
- Automation is the answer
- We already accept some of this automated technology…
  - Anti-lock Brakes
  - Electronic Stability Control
  - Cruise Control

NHTSA's full final investigation into Tesla's Autopilot shows 40% crash rate reduction

Posted Jan 19, 2017 by Darrell Etherington (@etherington)

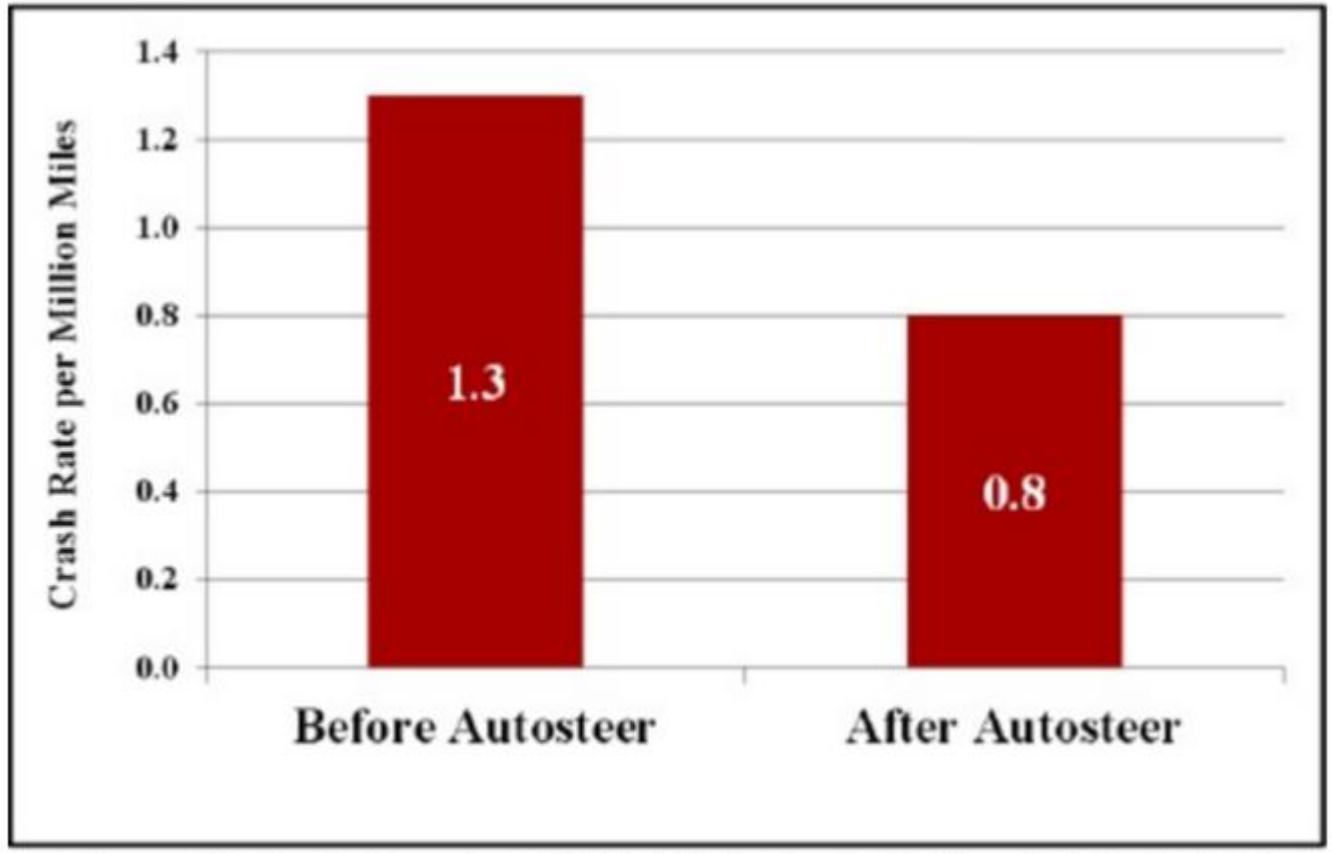


Figure 11. Crash Rates in MY 2014-16 Tesla Model S and 2016 Model X vehicles Before and After Autosteer Installation.

https://techcrunch.com/2017/01/19/nhtsas-full-final-investigation-into-teslas-autopilot-shows-40-crash-rate-reduction/

Table 1
Licensed drivers as a percentage of their age-group population

Age	1983	2008	2011	2014
16	46.2	31.1	27.5	24.5
17	68.9	50.0	45.0	44.9
18	80.4	65.4	60.3	60.1
19	87.3	75.5	69.3	69.0
20-24	91.8	82.0	79.7	76.7
25-29	95.6	86.3	87.5	85.1
30-34	96.5	90.6	89.1	86.6
35-39	94.9	91.7	90.2	87.9
40-44	92.2	91.9	91.6	89.1
45-49	92.5	93.0	91.9	90.5
50-54	91.4	94.2	92.2	91.2
55-59	88.2	94.9	93.2	91.8
60-64	83.8	95.9	92.7	92.1
65-69	79.2	94.0	93.0	91.4
≥70	55.0	78.4	79.2	79.0

University of Michigan Transportation Research Institute: Report# UMTRI – 2016 – 4, January 2016

TABLE 3
CHANGES IN THE PERCENTAGE OF PERSONS WITH A DRIVER'S LICENSE

Age	1983 to 2014	2008 to 2014
16	-47.0%	-21.2%
17	-34.8%	-10.2%
18	-25.2%	-8.1%
19	-21.0%	-8.6%
20-24	-16.4%	-6.5%
25-29	-11.0%	-1.4%
30-34	-10.3%	-4.4%
35-39	-7.4%	-4.1%
40-44	-3.4%	-3.0%
45-49	-2.2%	-2.7%

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CONNECTED & AUTOMATED VEHICLE NATIONAL POOLED FUND STUDY

- **The Connected Vehicle Pooled Fund Study (CV PFS) is a partnership of transportation agencies who have an interest in facilitating the development and evaluation of Connected & Automated Vehicle applications**
- **The program will help prepare state, local, and international transportation agencies for the deployment of Connected & Automated Vehicle technologies**
- **The program has the following outcomes:**
  - Development and demonstration of connected vehicle technology, algorithms, tools and applications
  - Field deployments
  - Development and deployment documentation
  - Lessons learned and identification of challenges from field deployments

CURRENT CV PFS MEMBERSHIP

- **VDOT is lead agency with technical/administrative support from UVA**
- **20 Core Members:**
  New York, California, Delaware (pending), FHWA, Florida, Georgia, Maricopa County, Maryland, Michigan, Minnesota, New Jersey, Ohio, Pennsylvania, Tennessee, Texas, Transport Canada, Utah, Virginia, Washington, and Wisconsin
- **Associate Members:**
  Palm Beach Co, FL; Oakland Co, MI; MTC (Bay Area), San Diego's Regional Planning Agency, Los Angeles County Metropolitan Transportation Authority (Metro), Transport Canada, Arizona DOT, Rijkswaterstaat and North Texas Toll Authority

CONNECTED VEHICLE PFS COMPLETED PROJECTS

- *All the reports can be found on the research page of the CV PFS Website at http://www.cts.virginia.edu/cvpfs_research/*

- CV Traffic Signal Control Algorithm
- Pavement Maintenance Support Algorithm
- Evaluation of Signal Phase and Timing Data
- CV Certification Program
- Aftermarket On-Board Equipment
- Traffic Management Centers in a CV Environment
- 5.9GHz DSRC Vehicle Based Road and Weather Condition Application
- Surveying/Mapping for CV Applications
-

PFS PHASE III PROGRAM
FEBRUARY 2016 – AUGUST 2017
(TO BE EXTENDED TO JUNE 2018)

- **Basic Infrastructure Message Development and Standards Support for Connected Vehicles Applications**
  - Southwest Research Institute, Dec. 2016 – Dec. 2017, $400K
  - To develop a Basic Infrastructure Message (BIM); and
  - To establish a means to collaborate with the relevant standards development organizations

- **5.9 GHz Dedicated Short Range Communication Vehicle Based Road and Weather Condition Application, Phase 2**
  - Synesis Partners, Jun. 2016 – September 2017, $195K
  - Building on work performed in Phase 1, to deploy a DSRC based Road Weather application in New York and Michigan
  - To evaluate and interface with existing back office systems, including New York's INFORM, Michigan's DUAP, and FHWA Weather Data Environment (WxDE)

DYNAMIC MOBILITY APPLICATION
MULTI-MODAL INTELLIGENT TRAFFIC SIGNAL SYSTEM
OCTOBER 2011 – JUNE 2016

- **Objective: Develop and test a system that integrates connected vehicle information and devices into a more effective and safer traffic signal control system for multiple modes of travelers**
- **Funded in part by USDOT to support its Dynamic Mobility Application Program**
- **Phase I – Develop the ConOps, systems requirements and system design**
- **Phase II – Demonstrate and field test the system in two locations**
  - **Maricopa County, Arizona**
  - **El Camino Real, California**
- ***Phase III – Deployment Readiness Enhancement***
  - *June 2017 – December 2018*
  - *$562.5K (FHWA $450K, PFS match $112.5K)*

ADDITIONAL PFS INFORMATION

- **Connected Vehicle Pooled Fund Study Website**
  - Main: http://www.cts.virginia.edu/cvpfs/
  - Research: http://www.cts.virginia.edu/cvpfs_research/

- **Contacts**
  - Virginia Lingham – Virginia.Lingham@VDOT.Virginia.gov
  - Hyungjun Park – hpark@email.virginia.edu

DRIVEWYZE PROGRAM

ONE EXAMPLE OF CONNECTED VEHICLE

- GPS based application utilizing geo-fencing features allowing CV operators to legally bypass designated inspection sites.
  - Drivewyze works on smartphones, tablets, and in-cab devices.
    - A hands-free mobile app that complies with federal and state distracted driving legislation.
    - Does not use transponders, or the systems and equipment used by other bypass services.
  - Motor carriers pay to voluntarily participate in the Drivewyze program on a monthly basis.

DRIVEWYZE PROGRAM

- **Drivewyze operate at designated NYS weigh stations and inspection sites.**
  - 25 Drivewyze locations throughout the State of New York.
    - Currently operates in 36 states.

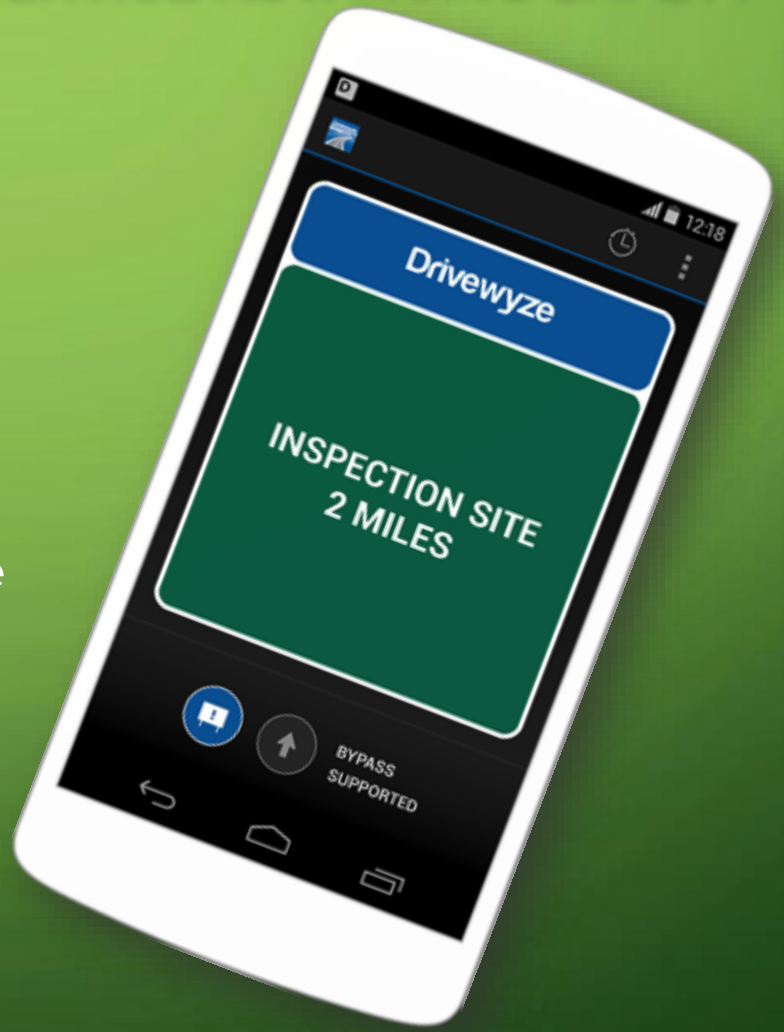
- **NYS has complete control and makes all decision concerning bypass screening rules:**
  - Participating carriers and drivers are granted permission, by NYS, to bypass weigh stations and inspection sites, based on:
    - Federal and state commercial vehicle safety and credential data sources
    - Screening rules that are selected and managed by NYS, including:
      - Safety history
      - IRP/Registration compliance
      - IFTA and NYS tax compliance
      - Other state-based rules including OS/OW permits

Connected Vehicle

EXAMPLE -HEADS UP SERVICE ADVANCING SAFETY

Drivewyze Weigh Station
Heads Up service

- Signals drivers 2 miles away from upcoming weigh stations so they can be prepared
- Available at no cost for mobile and ELD devices
- Works in all 50 states
- Covers 750 sites across the U.S.



DRIVEWYZE PROGRAM

DRIVEWYZE PROGRAM

- Future (near term) Connected Vehicle Applications
  - NYSDOT led an effort with Drivewyze to identify and geofence commercial vehicle rollover and crash hotspot location data in NYS
  - NYSDOT also developed in-vehicle safety message design recommendations and presented to Drivewyze for eventual integration as driver warnings
  - **Like to add geo-located in-vehicle signage and traveler information**

SIGNIFICANT BEHAVIOR CHANGES

- **Smartphones – Gift & a Curse!**
- **Driver's Licenses down!**
- **Transportation as a Service – Pay as you Go (Uber, Lyft, etc.)!**
- **Approximately 2.5 hours a day for average vehicle use**
- **Roughly 10% of day vehicle is used – 90% of time doing nothing but depreciating!**
- **Cars are expensive -** $8,698 a year average cost (15,000 miles)
- **Technology available TODAY to address most crashes**

WHERE ARE WE?

- Private Sector continues a rapid path to developing Automated and Autonomous Vehicle Capabilities (Google, Tesla, Uber, etc.)
- Driver behavior crash causation – 95%!!!!!!
- Connected vehicles alone, without automation, do not adequately address many highway safety situations, particularly at less than full vehicle penetration/deployment
- Need automation to “intervene” in safety critical situations
- V2V, in combination with on-board sensor based systems, with automated capabilities addresses almost all crash scenarios

WHERE ARE WE?

- Sensor based systems good, getting better but have considerable weaknesses
- Real time V2V improves situational awareness
- Fused systems best choice (both on board sensor and V2V)
- NHTSA NPRM for Federal Motor Vehicle Safety Standards – requires all new light vehicles to be capable of V2V communication…predicated on the use of on-board DSRC
- Comments received April 12, 2017
- Need to follow up with Heavy Vehicle NPRM!

WHERE ARE WE? WHERE SHOULD WE GO?

- Legislation/Regulations to allow Automated Vehicle Testing & Operations
- GIS/Mapping Capabilities (Single, Integrated Platform)
- Local collaboration – GIS and Operating Decisions
- Digitized/Geo Data – Inventory Assets (Signs, Clearances, etc.)
- IT/IT/IT/IT/IT……Networks, Connections and IP Addresses Oh My! CV Program based on IPv6
- One place to consider starting - Agency Fleets, V2I/I2V

WHERE ARE WE? WHERE SHOULD WE GO?

Stay abreast of national activities and publications:

- National CAV PFS
- 3 Connected Vehicle Pilot Projects (NYC, Wyoming, Tampa Bay, FL)
- NHTSA NPRM V2V
- NHTSA Federal Automated Vehicles Policy - *Accelerating the Next Revolution In Roadway Safety*
- *Alain's SmartDrivingCars Newsletter*
- *Bernie Wagenblast Transportation Communications Newsletter*

NEW YORK STATE OF OPPORTUNITY. Department of Transportation

THANK YOU.....

& FAREWELL!

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