Today’s Presentation Goals

• Define Connected & Automated Vehicles

• Describe the Wireless Comms Network to enable

• Where are we now?

• Where are we headed?

• Lots of questions, some answers
Definitions
Definition: Automated Vehicle

- Driver assistance technologies in today’s motor vehicles are already helping to save lives and prevent injuries.
- A number of today’s new motor vehicles have technology that helps drivers avoid drifting into adjacent lanes or making unsafe lane changes, or that warns drivers of other vehicles behind them when they are backing up, or that brakes automatically if a vehicle ahead of them stops or slows suddenly, among other things. These and other safety technologies use a combination of hardware (sensors, cameras, and radar) and software to help vehicles identify certain safety risks so they can warn the driver to act to avoid a crash.
- The continuing evolution of automotive technology aims to deliver even greater safety benefits and – one day – deliver Automated Driving Systems (ADS) that can handle the whole task of driving when we don’t want to or can’t do it ourselves.

A Note on Terminology

Clear and consistent definition and use of terminology is critical to advancing the discussion around automation. To date, a variety of terms (e.g., self-driving, autonomous, driverless, highly automated) have been used by industry, government, and observers to describe various forms of automation in surface transportation. While no terminology is correct or incorrect, this document uses “automation” and “automated vehicles” as general terms to broadly describe the topic, with more specific language, such as “Automated Driving System” or “ADS” used when appropriate. A full glossary is in the Appendix.
**Definition:**

**Connected Vehicles**

*Connected vehicles* are *vehicles* that use any of a number of different communication technologies to communicate with the driver, other cars on the road (vehicle-to-vehicle [V2V]), roadside infrastructure (vehicle-to-infrastructure [V2I]), and the “Cloud” [V2C]. This technology can be used to not only improve vehicle safety, but also to improve vehicle efficiency and commute times.
New York City

Key Facts
- 10,000 city-owned vehicles + Peds/Bikes equipped to test V2V and V2I technology throughout Midtown Manhattan
- Controller and RSE upgrades to support V2I at a number of intersections
- NYCDOT and Transcore are primary leads

Mobility and Safety Issues Goals
- Reduction in spot speeding
- Reduction in accidents in high incident intersections
- Improve Ped safety and reduce bus related accident rate
- Improve safety of disabled Peds using V2P
- Reduce accidents/delays involving low bridges
- Enforce truck route restrictions
- Improve Work Zone Safety
- Balance mobility in congested areas
- Reduce crashes, injuries and delays

https://youtu.be/Bxu29Qbs-zI?list=PL48fn16R8Rdy6aRkSEA328ZgXtYPRntWj
Interstate 80 (I-80) runs 402 miles along the southern edge of Wyoming and is a vital east-west connector for freight and passenger travel in the country. The corridor averages more than 32 million tons of goods per year (at 16 tons per truck). The truck volume is 30 to 55 percent of the total annual traffic stream and comprises as much as 70 percent of the seasonal traffic stream.

Several high-profile crashes, affecting both commercial vehicles and private vehicles, have occurred along I-80 in Wyoming that resulted in fatalities, extended closures, and significant economic loss. One such incident occurred in April 2015, during which icy roads and low visibility from blizzard conditions contributed to a “domino” style chain reaction pileup with more than 65 vehicles. Wyoming’s notorious winds result in some of the nation’s most severe blowing-snow events and greatest concentrations of vehicle blow overs. In the 10-year period from 2006 to 2016, there were 1,237 reported blow overs, with more than 30 this past year.

From October 2015 to September 2016, there were more than 1,600 crashes on I-80, resulting in 18 fatalities and 271 injuries. During this same time, roads were closed to all vehicles for over 1,500 hours. The societal impact of these crashes topped $865 million.

https://youtu.be/9TPluh2dm20

Wyoming DOT
V2X Classification
Connected Vehicle ITS Architecture

Econolite’s Centracs Suite of ATMS Software Systems

- Econolite’s Cabinets, Controllers, Battery Back up
- Econolite’s Signals and Third Party Detectors
Where did we come from?
On May 19, 1997, the Intelligent Transportation Society of America ("ITS America") filed a Petition for Rulemaking ("Petition") requesting that the Commission allocate 75 megahertz of spectrum in the 5.850-5.925 GHz band on a co-primary basis for DSRC-based ITS services.

We note that on June 9, 1998, the President signed the Transportation Equity Act for the 21st Century. The Act shall consider, in consultation with the Secretary, spectrum needs for the operation of intelligent transportation systems, including spectrum for the dedicated short-range vehicle-to-wayside wireless standard. Not later than January 1, 2000, the Federal Communications Commission shall have completed a rulemaking considering the allocation of spectrum for intelligent transportation systems.

June 11, 1998 Amendment of Parts 2 and 90 of the Commission’s Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services.
FCC Grant October 21, 1999

- In a Report and Order adopted today, the FCC decided to use the 5.850-5.925 GHz band for a variety of Dedicated Short Range Communications (DSRC) uses, such as traffic light control, traffic monitoring, travelers' alerts, automatic toll collection, traffic congestion detection, emergency vehicle signal preemption of traffic lights, and electronic inspection of moving trucks through data transmissions with roadside inspection facilities.

- The FCC said that the record indicates that the spectral environment and propagation characteristics of the 5.9 GHz band are appropriate for short range DSRC applications and would enable sufficient signal coverage and considerable frequency reuse.

- The 75 megahertz allocation for DSRC could foster global research, technological innovations, and industry standards-setting activities that are expected to result in the production of affordable DSRC equipment. Further, it is hoped that a significant DSRC allocation will encourage wide-area

- The Commission was originally petitioned by the Intelligent Transportation Society of America, which proposed this allocation for ITS services to increase the safety and efficiency of the Nation's transportation.
Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems — 5-GHz Band Dedicated Short-Range Communications (DSRC), Medium Access Control (MAC), and Physical Layer (PHY) Specifications

- This specification describes a medium access control (MAC) and physical layer (PHY) specification for wireless connectivity using dedicated short-range communications (DSRC) services. This standard is based on and refers to IEEE Standards 802.11, Wireless LAN Medium Access Control and Physical Layer Specifications, and 802.11a, Wireless LAN Medium Access Control and Physical Layer Specifications High-Speed Physical Layer in the 5 GHz Band, with permission from the IEEE society.

- This specification is meant to be an extension of IEEE 802.11 technology into the high-speed vehicle environment. The difference between IEEE 802.11 and IEEE 802.11a operating parameters required to implement a mostly high-speed data transfer service in the 5.9-GHz Intelligent Transportation Systems Radio Service (ITS-RS) Band is explained. Potential operations within the Unlicensed National Information Infrastructure (UNII) Band are also addressed, as appropriate.

- The purpose of this specification is to provide wireless communications over short distances between information sources and transactions stations on the roadside and mobile radio units, between mobile units, and between portable units and mobile units. The communications generally occur over line-of-sight distances of less than 1000 m between roadside units and mostly high-speed, but occasionally stopped and slow-moving, vehicles or between high-speed vehicles. This specification also offers regulatory bodies a means of standardizing access to the 5.9-GHz frequency band for the purpose of interoperable communications to and between vehicles at line-of-sight distances on the roadway.
In August 2008, the European Telecommunications Standards Institute (ETSI) allocated 30 MHz of spectrum in the 5.9 GHz band for ITS.

2003 CEN - EN 12795 Road transport and traffic telematics - Dedicated Short Range Communication (DSRC) - DSRC data link layer: medium access and logical link control

EN 12795 Road transport and traffic telematics - Dedicated Short Range Communication (DSRC) - DSRC data link layer: medium access and logical link control - This European Standard: - defines the Data Link Layer of DSRC; - is positioned with respect to other related standards by the layers defined in OSI Basic Reference Model [EN ISO/IEC 7498-1] as adopted for DSRC; - supports broadcast and half-duplex transmission modes; - supports a variety of fixed equipment configurations. It supports configurations where one fixed equipment communicates with one mobile equipment unit, as well as configurations where one fixed equipment can communicate with several mobile equipment units; - takes into account that the mobile equipment communicates with the fixed equipment while passing through a limited communication zone; - defines neither any specific configuration nor the layout of the communication zone; - does not define to what extent different instances of fixed equipment, operating in the vicinity of each other, need to be synchronised with each other; - defines parameters to be used in negotiation procedures taking place between fixed equipment and mobile equipment.

(C-ITS G5)Intelligent Transport Systems (ITS) include telematics and all types of communications in vehicles, between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure).

The following important topics related to automotive ITS are being addressed:

Cooperative-ITS (C-ITS) and its evolution to support full autonomous driving including wireless short range communications (ITS-G5) dedicated to automotive ITS and Road Transport and Traffic Telematics (RTTT). C-ITS provides connectivity between road participants and infrastructure.

Automotive ITS Security
This includes trust and privacy management and certificate formats.

Automotive radar

Dedicated Short-Range Communications (DSRC)
DSRC provides communications between the vehicle and the roadside in specific locations (for example toll plazas). Applications such as Electronic Fee Collection (EFC) operates over DSRC.
IEEE 802.11p is an approved amendment to the IEEE 802.11 standard to add wireless access in vehicular environments (WAVE), a Vehicular Communications System. It defines enhancements to 802.11 required to support Intelligent Transportation Systems (ITS) applications. This includes data exchange between high-speed vehicles and between the vehicles and the roadside infrastructure, so called V2X communication, in the licensed ITS band of 5.9 GHz (5.85-5.925 GHz).

IEEE1690 is a higher layer standard based on the IEEE 802.11p. It is also the basis of a European standard for vehicular communication known as ETSI ITS G5.

Because the communication link between the vehicles and the roadside infrastructure might exist for only a short time interval, the IEEE 802.11p amendment defines a method to exchange data through that link without the need to establish a basic service set (BSS).

Without the need to wait on the association and authentication procedures to complete prior to exchanging data, for that purpose, IEEE 802.11p-enabled stations use the wildcard BSSID in the header of the frames they exchange, and may start sending and receiving data frames as soon as they arrive on the communication channel.

IEEE 802.11p standard typically uses channels of 10 MHz bandwidth in the 5.9 GHz band (5.850-5.925 GHz). This is half the bandwidth, or double the transmission time for a specific data symbol, as used in 802.11a. This allows the receiver to better cope with the characteristics of the radio channel in vehicular communications environments, e.g. the signal echoes reflected from other cars or houses.

PISCATAWAY, NJ, 05 June 2018 - IEEE, the world’s largest technical professional organization dedicated to advancing technology for humanity, and the IEEE Standards Association (IEEE-SA), today announced the formation of two new study groups focused on advancing the technology and deployment of the IEEE 802.11 standard, commonly referred to as “Wi-Fi®”, in two specific areas: vehicular environments and broadcast services. Both study groups are in their initial stage, currently encouraging stakeholder participation to define the scope of IEEE 802.11 standard amendments that address each group’s respective field of expertise.
• **SAE J2735 201603**—Dedicated Short Range Communications (DSRC) Message Set Dictionary—is the fifth edition of the message set dictionary and specifies a message set, and its data frames and data elements specifically for use by safety applications intended to utilize 5.9 GHz Dedicated Short Range Communications for Wireless Access in Vehicular Environments (DSRC/WAVE).

• **SAE J2945/1 201603**—On-Board System Requirements for V2V Safety Communications—is the first edition of on-board system requirements for V2V safety communications and specifies the parameters for a system to transmit and receive the SAE J2735-defined safety messages over a Dedicated Short Range Communications (DSRC) wireless communications link.

  It also ensures that the exchange of safety messages in V2V safety communications provides the desired interoperability and data integrity to support the performance of the envisioned safety applications and provides the information necessary to build interoperable systems that support select safety applications.
TC204 Intelligent Transportation Systems

- Standardization of information, communication and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects thereof, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services in the intelligent transport systems (ITS) field.
- Excluded: in-vehicle transport information and control systems (ISO / TC 22).
- ISO / TC 204 is responsible for the overall system aspects and infrastructure aspects of intelligent transport systems (ITS), as well as the coordination of the overall ISO work programme in this field including the schedule for standards development, taking into account the work of existing international standardization bodies.
Where are we now?
OEM’s

Top 15 Global OEM’s 2016 per Wiki

<table>
<thead>
<tr>
<th>Rank</th>
<th>Group</th>
<th>Country</th>
<th>Vehicles</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Volkswagen Group</td>
<td>Germany</td>
<td>10,405,092</td>
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<tr>
<td>2</td>
<td>Toyota</td>
<td>Japan</td>
<td>10,213,486</td>
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<td>3</td>
<td>Hyundai</td>
<td>South Korea</td>
<td>7,889,538</td>
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<tr>
<td>4</td>
<td>General Motors</td>
<td>United States</td>
<td>7,793,066</td>
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<tr>
<td>5</td>
<td>Ford</td>
<td>United States</td>
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<td>6</td>
<td>Nissan</td>
<td>Japan</td>
<td>5,556,241</td>
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<tr>
<td>7</td>
<td>Honda</td>
<td>Japan</td>
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<td>8</td>
<td>Fiat Chrysler Automobiles</td>
<td>Italy / United States</td>
<td>4,681,457</td>
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<td>9</td>
<td>Renault</td>
<td>France</td>
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<td>PSA</td>
<td>France</td>
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<td>11</td>
<td>Suzuki</td>
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<td>12</td>
<td>SAIC</td>
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<td>Daimler</td>
<td>Germany</td>
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<td>14</td>
<td>BMW</td>
<td>Germany</td>
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<td>15</td>
<td>Changan</td>
<td>China</td>
<td>1,715,871</td>
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</table>

Top 10 Global OEM’s 2017 per Focus 2 Move

Worldwide Car Sales 2013 to 2017

Car sales in the major car markets of the world were as follows in recent years:

<table>
<thead>
<tr>
<th>Region</th>
<th>2017</th>
<th>2016</th>
<th>2015</th>
<th>2014</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe (EU+GFTA)</td>
<td>20,611,709</td>
<td>19,211,700</td>
<td>18,791,900</td>
<td>18,306,500</td>
<td>17,893,500</td>
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<tr>
<td>Russia*</td>
<td>1,795,700</td>
<td>1,701,500</td>
<td>1,637,300</td>
<td>1,581,200</td>
<td>1,525,100</td>
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<tr>
<td>USA*</td>
<td>8,476,400</td>
<td>8,886,500</td>
<td>8,937,600</td>
<td>8,937,600</td>
<td>8,937,600</td>
</tr>
<tr>
<td>Japan</td>
<td>4,999,400</td>
<td>4,371,600</td>
<td>3,915,600</td>
<td>3,529,400</td>
<td>3,295,200</td>
</tr>
<tr>
<td>Brazil*</td>
<td>2,315,900</td>
<td>1,988,500</td>
<td>1,826,400</td>
<td>1,649,300</td>
<td>1,465,200</td>
</tr>
<tr>
<td>India</td>
<td>2,150,900</td>
<td>1,895,700</td>
<td>1,693,200</td>
<td>1,529,100</td>
<td>1,395,000</td>
</tr>
<tr>
<td>China</td>
<td>41,274,300</td>
<td>37,887,200</td>
<td>34,347,200</td>
<td>31,897,100</td>
<td>29,457,000</td>
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<tr>
<td>Combined</td>
<td>59,216,100</td>
<td>54,548,900</td>
<td>50,125,300</td>
<td>47,643,800</td>
<td>45,309,200</td>
</tr>
</tbody>
</table>

*Light vehicles

Strong Car Sales in China in 2017

China remained by far the world’s largest single-country car market in 2017. Car sales in China increased by 2% to 24,171,400 cars – German luxury carmakers generally increased sales by higher margins.

Ultimately the top 10 OEM’s and Top 3 Governments for OEM sales will likely drive the decision on which wireless technologies are used for V2X vital safety.
Current Wireless Status

• Dedicate Safety Spectrum
• Specified IEEE 802.11P
• ITS Services including CAV

2 differing proposals for sharing
Required test devices
Tiger team formed
Test complete rule making still open

Is LTE Technology not 5G
LTE PC5 Can use the 3GPP Ran as a repeater
LTE PC5 Can use direct V2V communications
LTE-Uu V2X message is Unicast to V2X Application Server and back out to Vehicle either Broadcast or Unicast

Propose to repurpose the lower 45 megahertz of the band unlicensed
Propose that unlicensed device operations in the 5.850-5.895 GHz band be subject to all of the general Part 15
Propose to continue to dedicate spectrum in the upper 30
Wi Fi Spectrum Sharing

DSRC Band Plan

The DSRC spectrum at 5.850-5.925 GHz consists of seven 10 megahertz wide channels and a 5 megahertz segment of spectrum reserved to accommodate future, unforeseen developments. The FCC rules designate two of the seven 10 megahertz channels (5.855-5.865 GHz and 5.915-5.925 GHz) for safety of life and property applications and one of the 10 megahertz channels (5.885-5.895 GHz) is designated as a control channel. Two sets of the 10 megahertz channels may be combined to create a two 20 megahertz channel (5.865-5.885 GHz and 5.895-5.915 GHz). The bandplan is shown below:
3GPP Release 14

- Is LTE Technology not 5G
- LTE PC5 Can use the 3GPP Ran as a repeater
- LTE PC5 Can use direct V2V communications
- LTE-Uu V2X message is Unicast to V2X Application Server and back out to Vehicle either Broadcast or Unicast
- Utilizes Sidelink Communications for V2X
- Focused on RAN functionality and Core
3GPP Release 16

- Updated July 16, 2018 (Source: ETSI Work Programme report)

- Release 16 is a major release for the project, not least because it will bring our IMT-2020 submission for an initial full 3GPP 5G system to its completion (see details below).

- In addition to that formal process, work has started on around 25 Release 16 studies, on a variety of topics: Multimedia Priority Service, Vehicle-to-everything (V2X) application layer services, 5G satellite access, Local Area Network support in 5G, wireless and wireline convergence for 5G, terminal positioning and location, communications in vertical domains and network automation and novel radio techniques. Further items being studied include security, codecs and streaming services, Local Area Network interworking, network slicing and the IoT.

- Technical Reports (the result of the study phase) are also being developed on broadening the applicability of 3GPP technology to non-terrestrial radio access (initially satellites, but airborne base stations are also to be considered) and to maritime aspects (intra-ship, ship-to-shore and ship-to-ship). Work also progresses on new PMR functionality for LTE, enhancing the railway-oriented services originally developed using GSM radio technology that is now nearing end of life.

- As part of Release 16, MC services will be extended to address a wider business sector than the initial rather narrow public security and civil defence services for which they had originally been developed. If the same or similar standards can be used for commercial applications (from taxi dispatching to railway traffic management, and other vertical sector scenarios currently being investigated), this would bring enhanced reliability to those MC services through wider deployment, and reduced deployment costs due to economies of scale – to the benefit of all users.

- 3GPP Release 16 will be finalised at the end of 2019.
US DOT is very active right now

- Automated Driving Systems 2.0
- Roundtable on Data for Automated Vehicle Safety
- Public Listening Summit on Automated Vehicle Policy
- Modal RFI and RFC Releases
- FHWA National Dialogue on Highway Automation Series
- FMCSA and NHTSA Listening
- OMNIBUS 2018
- Preparing for the Future of Transportation: Automated Vehicles 3.0
AASHTO, ITE & ITS-A
Cooperative Automated Transportation (CAT) Coalition

CAT Executive Committee

Policy, Legislative and Regulatory Working Group
Planning Working Group
Infrastructure Industry Working Group
IOO/OEM Forum
Strategic Initiatives Working Group
Technical Resources Working Group
Peer Exchange & Outreach Working Group

CAV-ELT – Phase 2
• Collaboration of IOOs, OEMs, Technology and Service Providers, IOT & Suppliers
• Focus on Connected and Automated Vehicle policies and their convergence.
• Address future business models, data and information systems, organizational and workforce requirements
• Scenario planning
• To be further discussed and modified at the Executive Committee.

V2I Deployment Coalition - Phase 2
• Collaboration of public, private, & academic groups
• Focus on V2I systems to assist drivers and Automated Driving Systems (ADS)
• Communications “medium agnostic” - focus on support for deployable technologies
• Emphasis areas such as, but not limited to: Intersection safety (SPaT Challenge), Work Zones, and Eco Arrival/Departure, Freight, transformational technologies and others
AASHTO SPaT and Connected Fleet Challenge

- Connected vehicles are being tested nationwide
- USDOT supports “Connected Automation” for self-driving cars
- New Security Credential Management System is operational
- USDOT proves connected vehicles are interoperable
- Free connected vehicle data is available to the public
Terabytes of Data, yes but

Data That Connected Cars Collect

Vehicle Sensors
- Lane departure system
- Night vision
- Front object CCD camera
- Front airbag sensors
- ASCD
- Nighttime pedestrian warning
- Drowsiness sensors
- Front object laser radar
- Nighttime pedestrian warning LIDAR sensor
- Active park assist
- Tire pressure sensor

Rear object monitor
- CCD camera
- Rear camera
- Side curtain sensor
- Blind spot detection
- Cross traffic alert
- Central computer
- Rear object laser radar
- Wheel speed sensor
- Tire pressure sensor
- Collision sensor
- Side airbag SRS
- Adaptive cruise control
- Steering Angle sensor
- Automatic brake actuator
- Wheel speed sensor
In-vehicle Ethernet convergence

- High speed – Scales with Ethernet Industry
- Legacy Interoperability, Ethernet-2-CAN/FlexRay
- Routing, Switching, Multicast, Virtualization, VLAN
- Comprehensive Security Strategy
Announced Deployment Timeline
Automated Driving Systems (SAE J3016 Level 4 unless otherwise noted)

Notes:
1) Waymo has suspended regular level 4 operation until further notice. 2) Volvo's DriveME Pilot started in December 2017 with two level-2 consumer-available vehicles. 3) Audi claims regulations prevent consumer availability. 4) Nuro has demonstrated unmanned operation of a low-speed delivery vehicle, but only with a dedicated chase vehicle; it is not entirely clear if operators in the chase vehicle are exercising any real-time remote control.

The CAV Convergence

First Quarter Century

CV
- Pilots
- Rule & Infrastructure
- V2V & V2I

AV
- Trials & Automated Features
- Smart Cities & OEM Agreements
- Mobility Services; AV & V2X

2025

CAV Convergence

Connected Automation
- Shared, Automated Mobility Services;
  Broad Ownership of Driverless Vehicles

Second Quarter Century
Why Certification for Trusted Device Communications?

• Independent accredited laboratory testing & test report
• Conformance & Verification per Test Cases of Standards & Specifications
• Provides Consistency for Device Applications
• Ensures Interoperability among Devices
• Access to Security Credentials to Known Devices
• Minimizes Product Variations & Change Requests in Control Releases
• Qualified Device List for Agency Procurement
• Environment Control & Inspection (Surveillance)
Since 2012, OmniAir® has offered certification for RFID tolling tags and readers.

OmniAir Certified™ devices conform with industry standards, are interoperable, and perform according to requirements established by user groups.

Since 2017, OmniAir® has offered certification for DSRC-V2X devices for connected vehicles, including OBU's and RSU's.

OmniAir Certified™ devices successfully completed OmniAir's Connected Vehicle Conformity Assessment (CVCA) program, and demonstrate minimum levels of performance, security, and interoperability.
Connected Vehicles: Dedicated Short Range Communications (DSRC)

- Based on 802.11p Wi-Fi Technology
- 75 MHz of Spectrum 5.9 GHz Band (5850-5925 MHz)
- Low-latency communications in selectable 10 MHz Channels
- Basic Safety Message every 10 seconds
- Non-line-of-sight transmissions up to 1000 meters that can “see” around corners
- WAVE Standards (SAE J2945/1 & IEEE 1609) in North America & Korea and ETSI Standards (ITS G5) in Europe
- Security Credential Management System (PKI Security & IEEE 1609/2)
- Established Testing & Certification Program
- Long History of Pilots and Operational Deployments worldwide
  - North America
  - Europe
  - Japan, Korea, Australia, Singapore

• AVAILABLE NOW
Connected Vehicles: 5G C-V2X (PC5, 3GPP Revision 14)

What is C-V2X?

Summary: It’s a more modern radio operating under the existing stacks

- C-V2X is based on 3GPP release 14 PC5 “Sidelink” (direct device to device)
  - It doesn’t need a SIM, carrier access, or licensed spectrum
  - Doesn’t require infrastructure - but can communicate V2V or V2I
  - PC5 Modem can be integrated into telematics for cost savings
  - Radio access based on scheduled, deterministic reservations - no CSMA/CA
  - PHY picks best (lowest energy) resources available for the reservation
  - Superior performance compared to 11p, especially in NLOS
    - Longer range/more robust at the same range
    - Fewer RSU’s needed for coverage

- Layers above the PHY/MAC are almost identical to DSRC
  - Uses IEEE 1609.2 security
  - Uses SAE J2735 message set
  - Uses modified version of SAE J2945/1 (J3161) - only changes in radio layer and congestion control
  - Many OmniAir test cases can be used as is
    - Some aren’t needed (MCO - IEEE 1609.4, IEEE 802.11p)
    - Some may need slight changes - work will be done in subcommittee of CVTWG
V2X Safety Applications

**Vehicle-to-Infrastructure**

- Red Light Violation Warning
- Stop Sign Violation Warning
- Stop Sign Gap Assist
- Pedestrian in Signalized Crosswalk Warning
- Curve Speed Warning
- Spot Weather Impact Warning
- Reduced Speed/Work Zone Warning

**Vehicle-to-Vehicle**

- Forward Collision Warning
- Emergency Electronic Break Light
- Left Turn Assist
- Do Not Pass Warning
- Blind Spot Lane Change

**Vehicle-to-Pedestrian**

- Mobile Accessible Pedestrian Signal System
- Pedestrian Signalized Crosswalk
- Intelligent Pedestrian Traffic Signal
- Intelligent Pedestrian Protectors
DSRC & ITS-G5 Deployments

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Policy Challenges for V2X

- Market choice vs. regulatory mandate
- Wireless spectrum availability
- Cybersecurity & privacy
- Shift in research funding priorities to AV
Since 2012, OmniAir® has offered certification for RFID tolling tags and readers. OmniAir Certified™ devices conform with industry standards, are interoperable, and perform according to requirements established by user groups.

Since 2017, OmniAir® has offered certification for DSRC-V2X devices for connected vehicles, including OBU's and RSUs. OmniAir Certified™ devices successfully completed OmniAir's Connected Vehicle Conformity Assessment (CVCA) program, and demonstrate minimum levels of performance, security, and interoperability.
The Econolite Ecosphere
Key Take Away’s

- CAV’s have reached a tipping point
- Connected Vehicles benefit may delay the need for Automated
- OEM’s are moving forward with Connected
- Every government is behind, some less than others
- The tech industry sees our mobility as one of the top 3 targets for IoT
- The impact will take longer than anticipated and will be larger than thought of today
Questions?