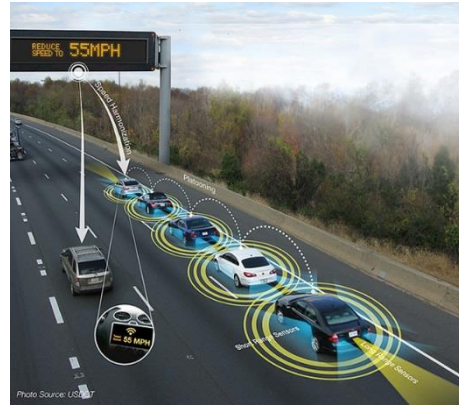


Vehicle-To-Everything Communications

General Overview

June 2019



Communication with the Vehicle

- Not a New Concept
 - OnStar, Sync, UConnect, and others have been around for several years
- Transportation Advancements using Existing Cellular Service
 - Audi traffic light information, enhanced navigation with real-time traffic conditions, safety/convenience information (gas, lodging, etc)
- Transportation Advancements using New Mediums
 - Enable a transition from driver warning systems to advanced driver assist technologies – taking over portions (or all) of the driving task
 - e.g., lane departure warning vs lane keeping assist

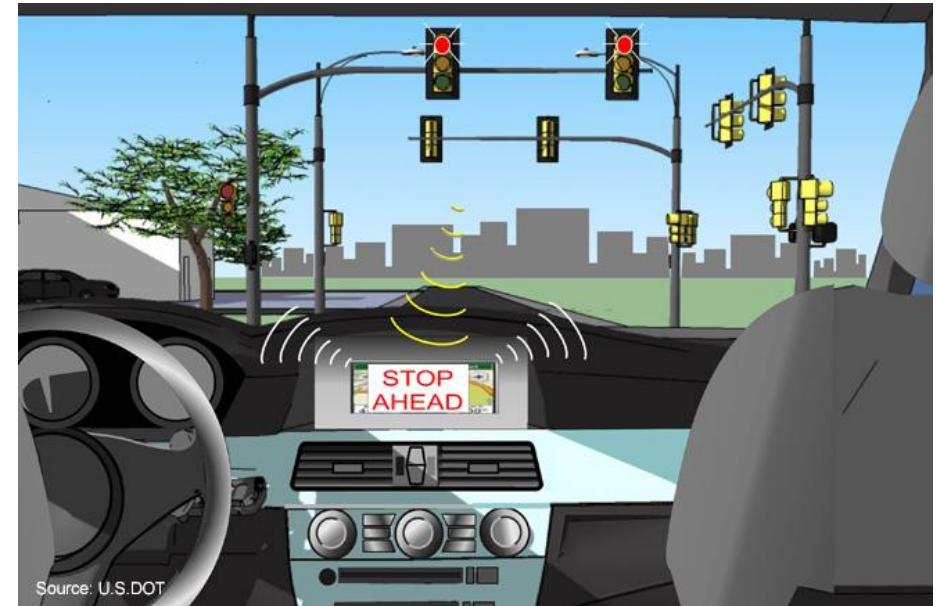
Key Terms in Advanced Communications

- **Latency** - the time it takes for a source to send a packet of data to a receiver
- **Bandwidth** - the capacity of a wireless communications link to transmit the maximum amount of data from one point to another
- **Reliability/Accessibility** – is a wireless connection available, and will it remain connected while the data exchange takes place?



Key Terms in Advanced Communications

- **Latency** – extremely fast data exchange is needed if we are relying on the vehicle to make a decision to avoid a collision (e.g., 10 times a second)
- **Bandwidth** – can't have a safety application fail to function because the "data pipe" wasn't big enough
- **Reliability/Accessibility** – need ubiquitous coverage that won't drop a signal in the middle of a safety-related data exchange, regardless of how fast the vehicle is traveling or how many others are nearby



Advanced Communication Methods

Dedicated Short Range Communications (DSRC)

- Based on WiFi technology (802.11)
- Testing began in the early 2000's, and large scale tests as far back as 2008
- International standards have been adopted
- Next generation of DSRC currently being developed
- Bandwidth is free, but infrastructure costs are not

Cellular Vehicle-to-Everything (C-V2X)

- Based on Cellular technology
- Testing began in 2017, large scale tests are in the process of being conducted
- International standards have been adopted (partially)
- Next generation C-V2X will be based around 5G deployment
- Bandwidth owned by wireless providers
- Business plan for infrastructure costs still uncertain

Common Perception Issues...

- This is not a DSRC vs 5G debate - Yet
 - DSRC is a current technology, 5G could enable future C-V2X when available
 - Once ubiquitous, 5G could enable V2Cloud, possibly reducing roadside installs
- No country has gone “all in” for one or the other
 - Japan and EU leaning toward DSRC while China leaning toward C-V2X
- The auto industry has not decided on one or the other
 - Toyota, GM, Hyundai, and VW have indicated a preference for DSRC
 - Ford and Audi have indicated a preference for C-V2X
- In the US, the FCC has reserved 5.9 GHz spectrum for V2X
 - Currently only for DSRC, but there are petitions to open it up to C-V2X

Common Questions from DOTs...

- Should we wait for the automakers or federal government to “pick a winner” before we engage?
- Is it true that the FCC could help or hinder progress?
- How do we keep up with technology changes?
- What are other State and Local DOTs doing in the face of uncertainty?

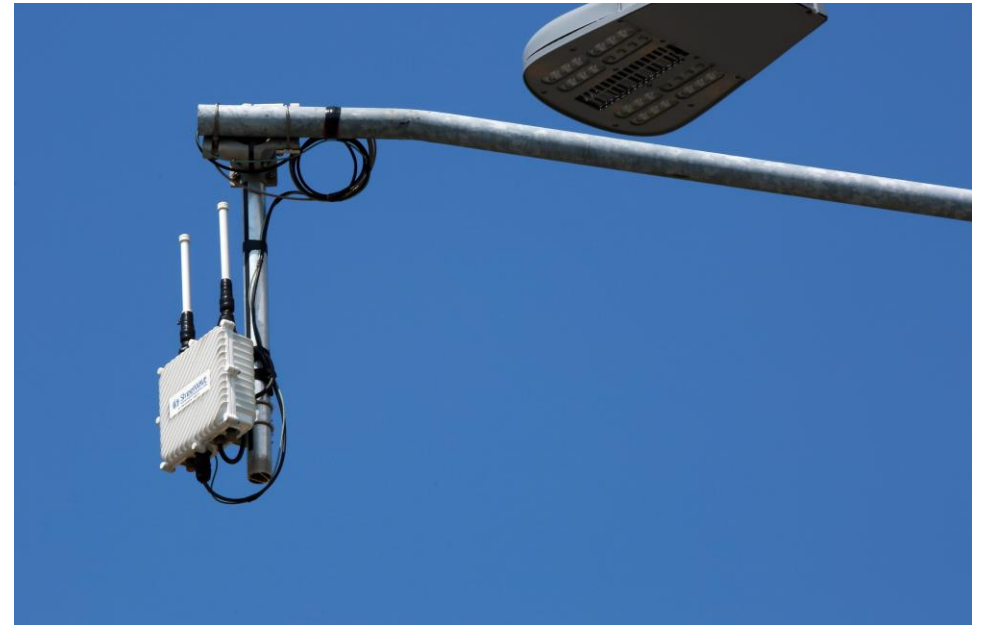


Key Takeaway #1 – Save the Spectrum

- Be vocal, don't let the FCC share the 5.9 GHz spectrum with unlicensed WiFi devices or non-transportation purposes
 - Initial testing in controlled conditions, we don't know if it compromises safety
- If the FCC decides to allow C-V2X to share the 5.9 GHz spectrum there should be a common-sense spectrum sharing plan
 - Encourage some attempt at functional interoperability so that both technologies aren't diminished in capability
- Demonstrate support for the 5.9 GHz spectrum through deployments
 - Take away the false argument that "it's not being used"

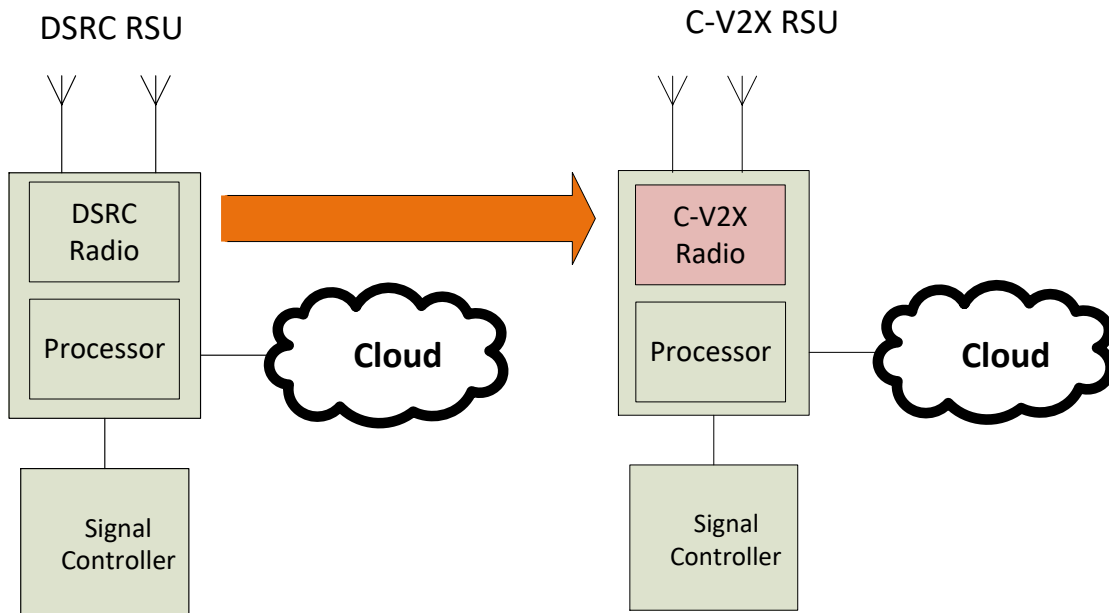
Key Takeaway #2 – Don't Wait to Pilot Test

- Pilot deployments blaze new trails in your network architecture, workforce skills, communication backbone, data management, and procurement
- Applications will evolve much quicker than your infrastructure, and the opportunity to save lives is realistic
- Much of the connected vehicle ecosystem remains usable if the radio technology evolves.

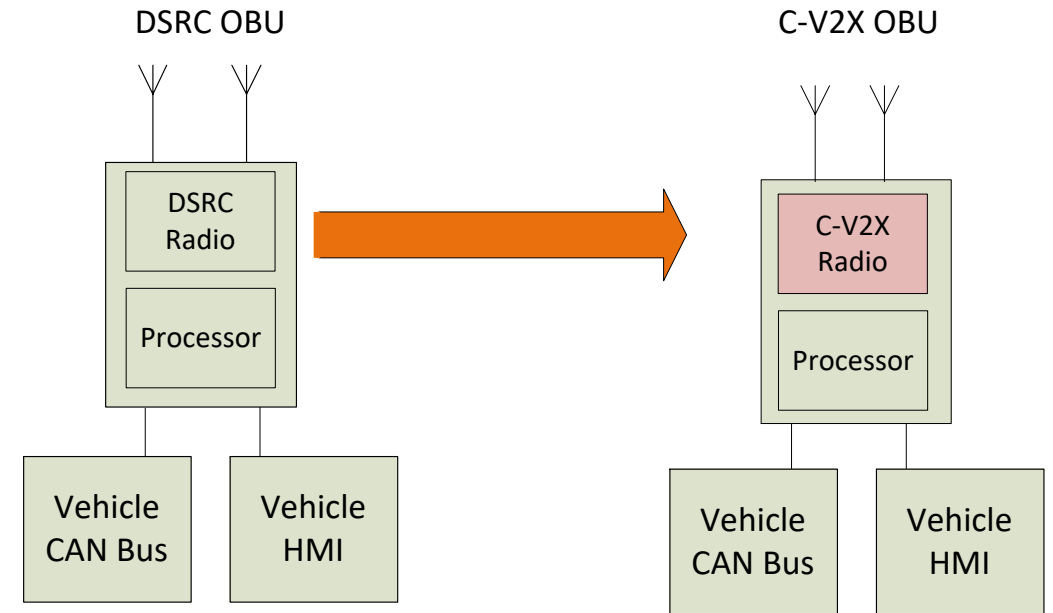


Scenario: DSRC Now, C-V2X Later

RSU



OBU




Key Takeaway #3 – Hurry Up and Wait



- Nothing happens fast – ignore the hype
- Infrastructure procurement and deployment won't be quick
- New car installations won't be immediately ubiquitous, existing fleet/retrofit
- Next generation 5G (ultra low latency) won't be immediately available
- Technology changes rapidly (iPhone?)
- Independent of FCC action, Congress could act
- Lawyers could get involved...

Ready - Fire - Aim

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