25. Feb 2019

Finch Fulton
Deputy Assistant Secretary for Transportation Policy
DEPARTMENT OF TRANSPORTATION
1200 New Jersey Avenue SE.,
Washington, DC 20590
VIA ELECTRONIC DELIVERY

RE: Public Notice, Docket DOT-OST-2018-0210
Department of transportation requests comments for V2X communication

Dear Mr. Fulton:

Autotalks is a leading international designer/manufacturer of connected car technologies. For over a decade, Autotalks developed Automotive-grade chipsets for Dedicated Short Range Communications (DSRC) technology, awarded for mass market deployment. Recently, Autotalks implemented C-V2X, offering configurable dual-mode DSRC/C-V2X chipset[1].

Autotalks thanks USDOT for the excellent questions, and hopes the answers will help USDOT to provide regulatory certainty to stakeholders for untangling the V2X deployment deadlock in US. The desired regulatory guidance would specify a **single technology for V2X services**, and would protect investments by requiring **interoperability and backward compatibility**. China and in Europe[2] have provided such guidance, driving accelerated V2X mass-deployment there, showcasing that the technology isn't the barrier to deployment.

Preliminary estimation indicates 1% decrease in motor vehicle deaths in 2018[3]. Yet, the number of fatalities is still 14% higher than 4 years ago. Saving lives on US roads is a prime target, and swift mass-deployment of V2X technology can help to achieve that.

1. Technology evaluation

As a developer of both technologies, Autotalks is well familiar with the strengths, weaknesses and usability of DSRC and C-V2X. The performance of the two technologies is roughly equivalent, with some advantages and disadvantages for each. Both technologies can serve all V2X requirements.

Recently, a test report comparing C-V2X and DSRC was submitted to FCC. The test measured a low-performing DSRC unit, having 10dB lower performance than production-grade DSRC (7dB lower sensitivity and no RX diversity gain) and no mobility support. The measurements were taken using non-representative fixed short packets, low transmission power (11dBm instead of 21dBm) and impractical antennas location (two antennas at the center of the roof). The measurements should be retested under representative scenarios. In addition, results of essential test scenarios should be measured and published, such as:

- High-speed mobility: vehicles moving in high relative speed
- Urban tests: performance at cities in various intersections
- Scalability: minimal and average communication range in presence of many vehicles
- Realistic variable length V2X packets as generated by V2X stack, with congestion control

[1] https://www.auto-talks.com/technology/global_v2x_dsrc-and-c-v2x/
[2] https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-2592333_en
[3] https://injuryfacts.nsc.org/motor-vehicle/overview/preliminary-estimates/

Autotalks conducted and continues to conduct field tests for DSRC and C-V2X. The tests are performed using the exact same hardware, which can support the two different technologies. The tests don't show a preference for one technology or the other, having immaterial communication range difference between the two. Results fairness is assured as Autotalks DSRC performance is considered to be best-in-class and Autotalks C-V2X performance is on par or better than the industry published results.

IEEE802.11 launched 802.11bd task group to develop the next generation of DSRC[4]. 802.11bd is backward compatible and interoperable with DSRC, and based on latest WiFi generations 802.11ac / 802.11ax. 3GPP has ongoing activity to include the next generation of C-V2X as part of Rel. 16[5], based on 5G cellular radio. C-V2X Rel. 16 requires a dedicated channel allocation on top of the channel needed for Rel. 14/15.

Deployment timeframe is estimated in the following table:

Technology	SOP year	Explanation
IEEE802.11p (DSRC)	**2017**	DSRC is a mature production technology Already deployed in Cadillac since 2017
IEEE802.11bd (DSRC next gen)	**~2025**	Draft is expected by 2020. Devices are expected to be available in 2021, two years of testing can end by 2023, and production can start by 2025.
C-V2X Rel. 14/15	**~2022**	Profile of operation (SAE J3161) and certification test should be finalized. Large scale field tests should be concluded. Aggressive 2-years Automotive development cycle can start afterwards, for starting production in 2022.
C-V2X Rel. 16	**~2025**	Rel. 16 specification will be finalized 3 years after Rel. 14 finalization. Rel. 16 introduction cycle isn't expected to be faster than Rel. 14 due to the high amount of changes from Rel. 14. Therefore, 2025 is a reasonable target.

This estimated deployment timeframe is valid only when a single technology, DSRC or C-V2X, is used. The deployment would be delayed by at least 2 years, if not more, for development and testing of dual-technology operation, concurrent DSRC and C-V2X.

2. Technologies coexistence

Ability of technologies to share same channel with other technology is described in table below.

	DSRC / 802.11bd	**C-V2X Rel. 14, 15, 16**
DSRC / 802.11bd	Supported. By design. DSRC and 802.11bd recognize each other's transmission. 802.11bd transmits as DSRC once detecting legacy DSRC units	Not supported. DSRC and C-V2X have different access layer. Transmission of one technology isn't decodable by the other. DSRC transmissions: DSRC will defer transmission if received C-V2X energy is higher than -62dBm. Neighboring C-V2X vehicles (low tens of meters) will co-exist, but all other C-V2X vehicles not. C-V2X transmissions: Transmission begins at pre-determined time without carrier sense, thus ignoring ongoing DSRC transmission, hence blocking co-existence.
C-V2X Rel. 14, 15, 16	Not supported. See explanation above on right.	Not supported. By design. Access layers of Rel. 14, Rel. 15 and Rel. 16 are all different. Rel. 16 device is expected to additionally include Rel. 14/15 PHY operating in a different channel for basic awareness.

[4] https://standards.ieee.org/project/802_11bd.html
[5] http://www.3gpp.org/release-16

Regardless of technology, DSRC or C-V2X, transmission blinds close receivers even if tuned to another channel in the 5.9GHz band. Status and potential mitigation are described in the table below.

	DSRC / 802.11bd	**C-V2X Rel. 14, Rel. 15**	**C-V2X Rel. 16**
DSRC / 802.11bd	Mitigation is possible Autotalks will show promising results in March 2019 IEEE802.11bd meeting	No mitigation scheme is known C-V2X and DSRC transmissions aren't synchronized. Duration of C-V2X transmission is 1mS, meaning it can harm up to 3 DSRC messages, having a typical duration of 0.5mS.	
C-V2X Rel. 14, Rel. 15	No mitigation scheme is known. See above on right	Only a single C-V2X Rel. 14 / Rel. 15 channel would exist, hence sharing isn't needed	Mitigation would be needed
C-V2X Rel. 16		Mitigation would be needed	A single C-V2X Rel. 16 channel is expected, hence sharing isn't needed
C-V2X Rel. 17 / 18 / …		Future Releases (17 / 18 / etc..) may require additional channels, for example for Pedestrian protection. Mitigation schemes should be developed	

The interference impact depends on the frequency separation between channels. Non-adjacent channels, having separated frequency, will impact only vehicles in close proximity, up to 25 meters. But an adjacent channel interference impact is significant, blocking other channel even beyond 100 meters. Although spectrum is sparsely used today, avoiding adjacent channel usage, that can't be assumed given introduction of future services.

Neither IEEE802.11bd nor 3GPP Rel. 16 consider cross-technology interference mitigation. ETSI (European Telecommunications Standards Institute) is expected to initiate a task group (under ERM TG37) for studying co-channel operation feasibility. The long study till date haven't yield practical solutions for DSRC / C-V2X sharing.

3+4. Interoperability between different technologies and generations

Two different technologies can interoperate if both conditions below are satisfied:

- Co-existence: The two technologies can co-exist in the same channel. For that, each technology should avoid collisions with other technology transmissions.
- Compatibility: The newer technology / generation is required to decode the messages transmitted by old devices, and should transmit as old device once detecting the presence of a device supporting only old technology.

An old device isn't required to decode new technology messages because compatibility is only backward and not forward. Forward compatibility concept, also called mutual-compatibility, is impractical, not applied and cannot be applied in the communication market.

IEEE802.11bd applies co-existence and backward compatibility with DSRC. 802.11bd receives 802.11p messages, and when detecting 802.11p only devices it transmits as one.

C-V2X Rel. 14, Rel. 15 and Rel. 16 aren't interoperable. Rel. 16 device is expected to include either Rel. 14 or Rel. 15 PHY for supporting the Basic Safety Messages (BSM).

Cross-technology interoperability doesn't exist, as co-existence and backward compatibility aren't supported. Since both technologies are satisfying V2X requirements, there is no justification to develop cross-technology interoperability.

5. Usage of different technologies for different use-cases

As explained above, any two channels in 5.9GHz band interfere to each other when co-located in same vehicle or even in vehicles in proximity. One channel transmission blinds the other channel receiver.

Therefore, the usage of different technologies for different use-cases could be made possible only after cross-technology mitigation scheme would exist. Such scheme would be more complicated than using a single technology for all use-cases.

6+8. C-V2X effect on V2I or V2P and Automated vehicles

The different technologies are analyzed ahead in the context of usage inside Smartphone, infrastructure and Autonomous driving.

Smartphone considerations:

V2P may be supported by either DSRC or C-V2X. Deployment base doesn't exist and Interoperability isn't a requirement. Smartphone's WiFi chip can enable DSRC quickly at no additional cost, except the supplemental security elements. Honda demonstrated DSRC Smartphone more than 5 years ago[6]. C-V2X is likely to be more expensive as RFIC and antennas sharing should be added to a Smartphone.

It should be noted that the barrier to V2X usage in Smartphone is positioning accuracy and not the communication technology. Accuracy should be sufficient to determine if pedestrian is on or off the sidewalk. Vehicles should have HD maps to determine the boundary of the sidewalk. Those gaps require further development, hence V2P isn't expected in the near future.

The promise of Smartphone is limited to vehicle-to-pedestrian and protection of two wheelers. Smartphone is unsuitable as vehicle aftermarket safety device. Smartphone is typically placed at the bottom of vehicle's center console. At this location, its GNSS antenna doesn't have line of sight to the sky, thus reducing the positioning accuracy. The Smartphone's V2X antenna is blocked as well because of the low placement, hence failing to meet or assure the target safety communication range.

Infrastructure considerations:

Over 5000 DSRC RSUs are already deployed in US, and more deployments are planned. Therefore, V2I interoperability is a concern since continuity of service would be harmed.

V2I cost is often mistakenly believed to be different between DSRC and C-V2X. V2I involves deployment of new equipment at intersections. Local information is delivered to vehicle about traffic light phase, and optionally and preferably information about other vehicles and road users in the intersection. The cost of direct communication components is similar for DSRC and C-V2X. Consequently, the budget required for V2I installation is identical for both technologies.

Hybrid communication is the most promising communication scheme. Direct real-time link, either DSRC or C-V2X, is used for safety, while cellular network is used for large-area non-safety communication. Cellular network can work with either DSRC or C-V2X without any difference. The usability of cellular network isn't impacted by the direct link, which is completely independent.

[6] https://www.prnewswire.com/news-releases/honda-demonstrates-advanced-vehicle-to-pedestrian-and-vehicle-to-motorcycle-safety-technologies-221495031.html

Automated vehicles considerations:

Platooning communication is similar to V2V awareness use-case (BSM) with a single exception: the communication is controlling the vehicle, and a failure may risk safety of life. The Automotive industry follows ISO26262 to asses the potential risk resulted from a failure. Truck platooning, and other vehicle control use-cases, require ISO26262 ASIL B certification. It is highly doubtful if V2X device integrated with cellular modem, as typically offered for C-V2X, can reach ASIL B.

7. Different technologies impact on security

The two technologies have similar security concepts. Security level differs between implementations; not between technologies having different access layer.

The fundamental rule of security is "lower surface of attack → better security". Non-isolated V2X chipset, as offered by consumer grade cellular modem integrating C-V2X, has high surface of attack and inherently lower security. On the other hand, an isolated V2X chipset offers high security level for both technologies.

9. Deployment assessments of communication needs and technologies

Deployments must not assess communication technologies. The communication needs and technologies should be defined by the regulators. Any deployment should religiously follow the regulatory guidelines.

Additional topics

Autotalks would like to address items which are not part of questionnaire, but are relevant for this discussion. Further elaboration can be found in Autotalks comments to FCC[7].

10. Incremental V2X cost of both technologies is similar, with potential optimization for DSRC

C-V2X and DSRC have similar cost structure.

DSRC has the potential for lowering system cost by sharing the functionality with out-of-vehicle WiFi. Out-of-vehicle WiFi is used by Electrical Vehicles for negotiation with wireless charging station, is used by cellular operators for mobile offload, and for zero data cost Over-the-Air-Update in dealerships and at home.

11. Single language is needed for V2X deployment

A single language is a condition to successful V2X deployment:

- V2X benefits can be achieved only if all vehicles are speaking the same language
- Using two-technologies for a single service is spectrum inefficient
- OEMs require a regulatory certainty to deploy
- Using two-technologies for a single service is cost deficient
- Concurrent dual-technology development would push V2X deployments by several years
- Other geographies selected a single technology
- Both DSRC and C-V2X satisfy V2X requirements

[7] https://ecfsapi.fcc.gov/file/101181977420288/Autotalks%20comments%20on%205GAA%20petition.pdf

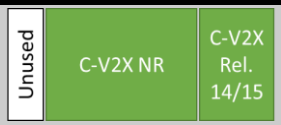
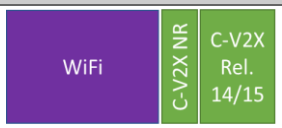
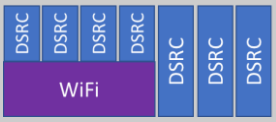
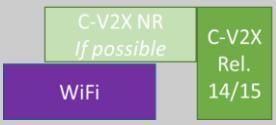
12. WiFi sharing impact on technologies

Autotalks urged FCC to make a single decision about the 5.9GHz allocation, covering WiFi, DSRC or C-V2X.

FCC is reviewing potential sharing solutions between proposed WiFi and DSRC for enabling U-NII-4 band. FCC defined multi-phases test procedure in ET Docket No. 13-49. The outcome of this activity will directly impact the availability of spectrum for V2X and its usability. The testing should expand to include WiFi sharing schemes for C-V2X, if C-V2X is allocated in 5.9GHz band.

Phased decisions, one for C-V2X Rel. 14/15, second for C-V2X NR, and third for WiFi sharing, have the potential to create misalignment. A single decision is needed. Having said that, spectrum may be re-allocated if justified for future V2X services, while maintaining backward compatibility and interoperability with existing V2X services.

Applying the principle of single technology, Autotalks believes that only the allocation options below are applicable:

U-NII-4 policy	Spectrum when DSRC is used	Spectrum when C-V2X is used	Comments
Not sharing with V2X			1. Bandwidth allocation of 50MHz is unlikely for C-V2X NR 2. IEEE802.11bd is backward compatible with DSRC, and doesn't require a different allocation
Re-channelization			C-V2X can't operate in same channel with WiFi. FCC WiFi sharing phase I test report raises doubts about DSRC as well. Overall V2X bandwidth would be limited to 30MHz.
Detect & Vacate			Detect & vacate is likely to enable DSRC sharing with WiFi. C-V2X detect & vacate is less likely due to high cost burden on U-NII-4 WiFi devices.

13. Global harmonization

Worldwide market would remain split between DSRC and C-V2X regardless of US direction. DSRC is selected in Europe because the European Commission sees an urgent need to improve vehicle safety and DSRC is currently the only mature technology. C-V2X is selected in China because of IP registered by Chinese companies.

Global OEM would have to support both technologies, DSRC and C-V2X. Typically, OEMs have a single design for Europe and US, and another design, often performed in China by a local subsidiary, for the Chinese market. The overall development expenses are roughly identical for any technology selected in US, with a potential increase if C-V2X is selected as a 3rd design may be needed: one for US (US C-V2X), second for Europe (DSRC) and third for China (Chinese C-V2X).

Selection of concurrent operation of both technologies will be a major deviation from all other geographies, and would increase the development, testing, certification and deployment expenses needlessly. No other geography selected, or would select, two technologies.

14. Summary

Autotalks believes that a single language is a condition for mass-market V2X deployment. Only single language can assure interoperable deployment.

Both DSRC and C-V2X can address all connectivity use cases, V2V, V2I and V2P, having similar performance and similar cost.

Autotalks urges USDOT to complete selection of a single V2X technology, either DSRC or C-V2X, and continue the process of V2X mandate. Regulatory guidance is essential to untangle V2X deployment deadlock

Yours sincerely
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