United States V2X Status: Spectrum and Technology

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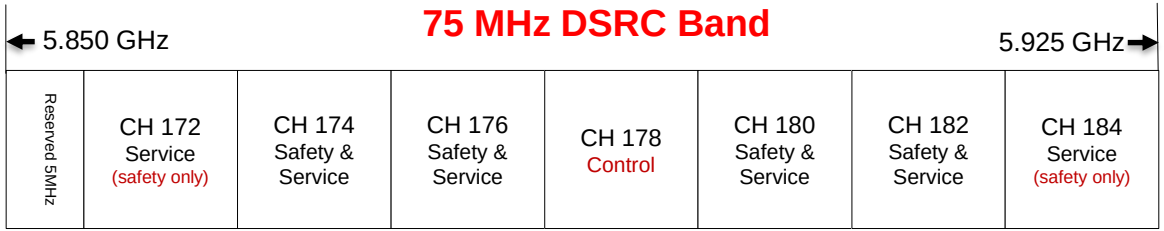
SIP-adus Workshop, November 2020

Outline

- FCC Proposal for US Spectrum and Technology
- IEEE DSRC+ standard (IEEE 802.11bd)
- V2X technology comparison

Current US V2X Spectrum Regulation

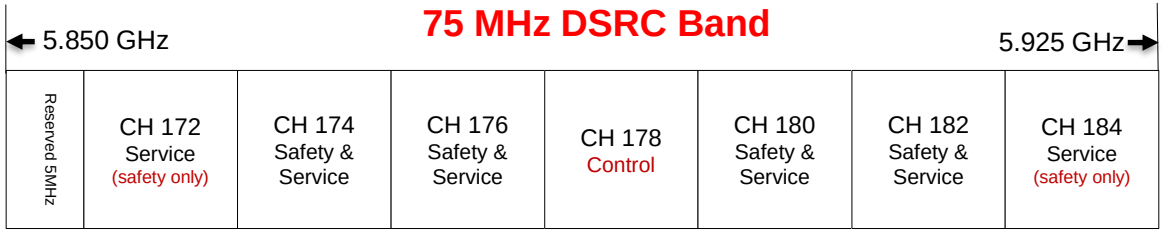


- Only DSRC technology is permitted
- Seven channels
  - Ch. 172 dedicated to V2V/V2I safety
  - Ch. 184 dedicated to Public safety (for example, signal preemption/priority)
  - Ch. 178 designated Control Channel (service announcements)

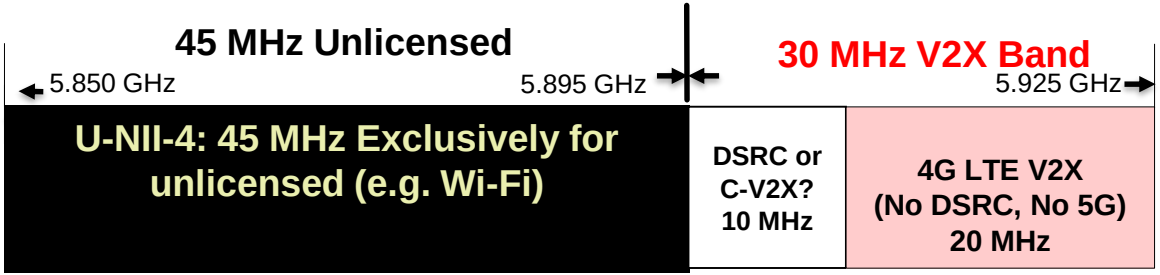
- Most US deployments use Ch. 172, and many use multiple channels

FCC Proposed changes to V2X spectrum

Current:



Proposed:



- 45 MHz Removed from V2X band.
- 30 MHz remaining V2X band
  - 10 MHz could be allocated to DSRC or to LTE V2X. FCC final rule will specify.
  - 20 MHz would be allowed exclusively to LTE V2X.
- This proposal has three major problems

First problem with FCC Proposal:
Reduced V2X Capacity

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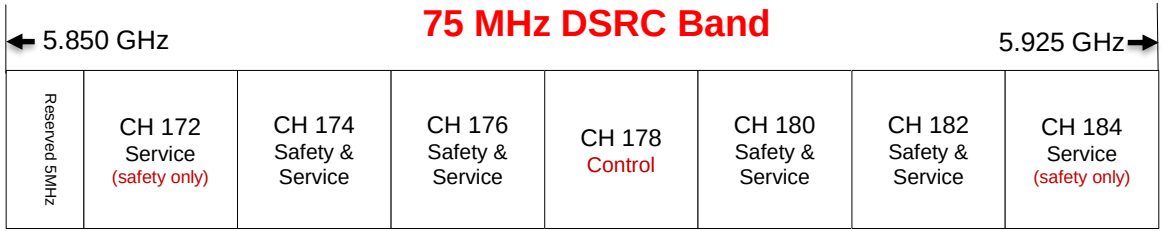
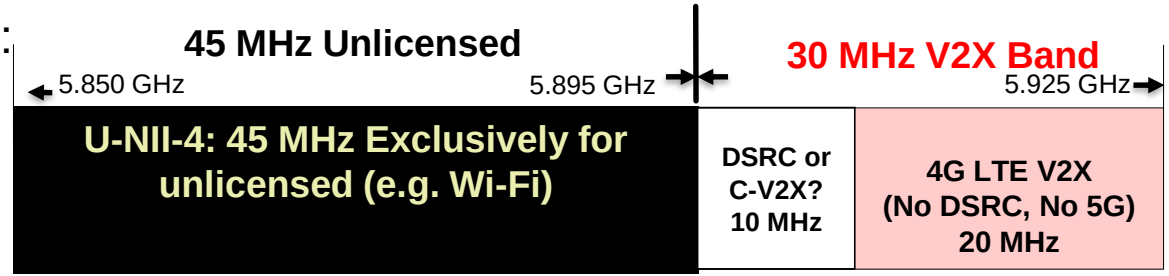
Current:



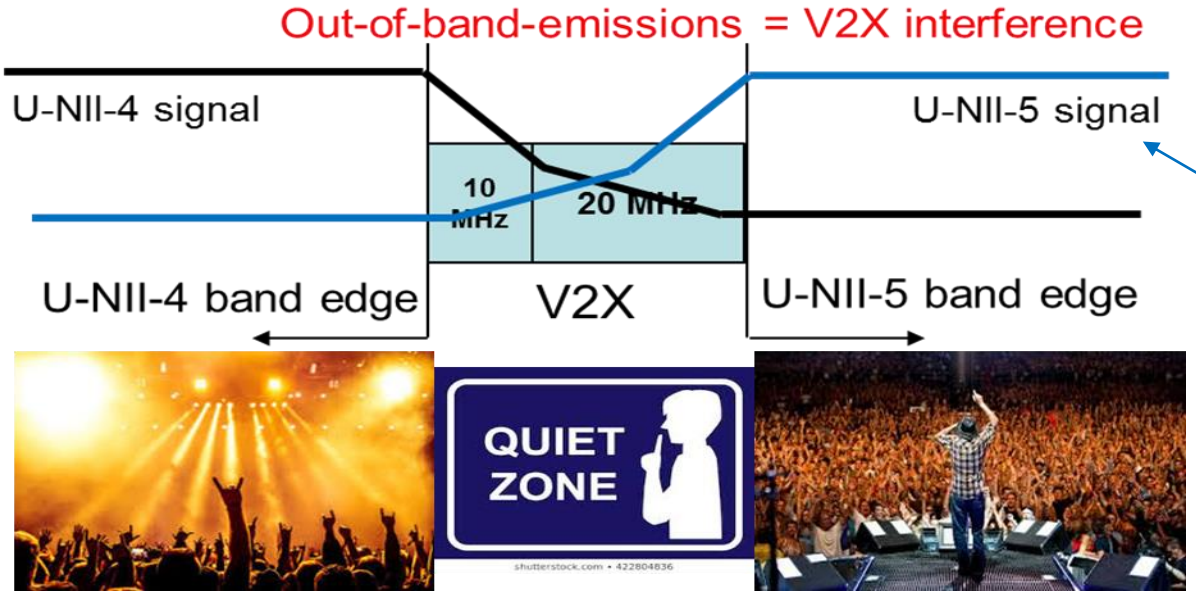
Proposed:



US is only global region ***reducing*** V2X spectrum

- Proposal removes 60% of V2X band
- This reduces V2X capacity by 60%. Reduces V2X society benefits by 60%
- Which applications can be implemented in 30 MHz?
  - Depends on whether DSRC and LTE V2X channels duplicate or complement each other
- **Pedestrian Safety, Platooning, and Cooperative Automated Driving apps likely will NOT fit**

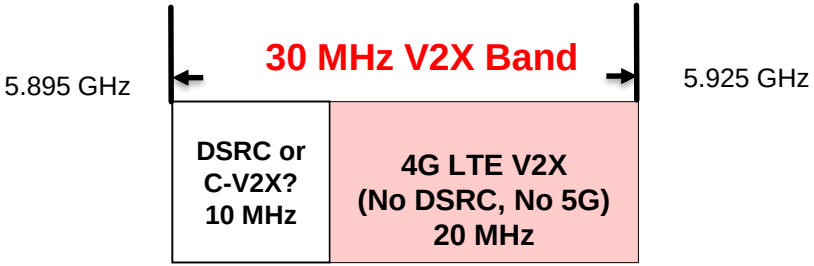
Second problem with FCC Proposal:
Wi-Fi Interference



Approved by FCC in April 2020

- V2X band has Wi-Fi interference on both sides
- U-NII-4 Wi-Fi will be immediately adjacent to V2X band (no guard band)
- It is like permitting rock concerts on both sides of a Hospital Quiet Zone
- **Risk: Interference might prevent ANY safe use of V2X spectrum**

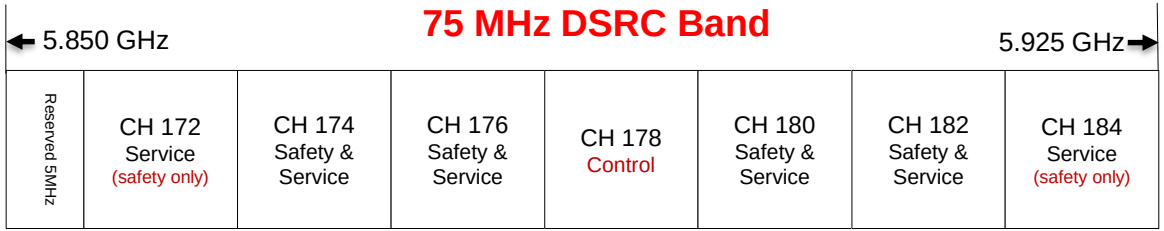
Third problem with FCC Proposal:
Split Technologies



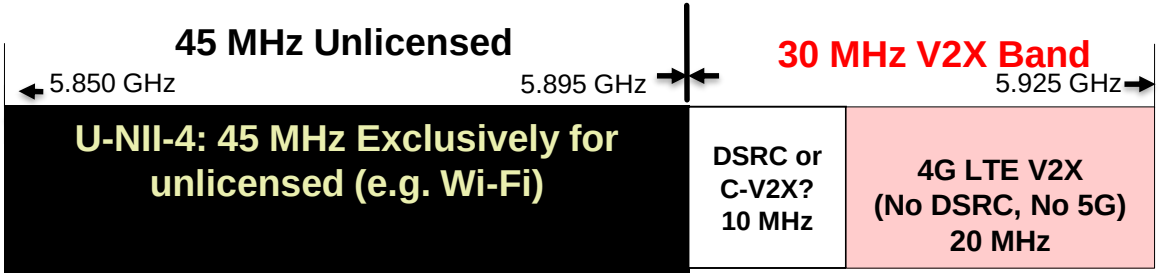
- FCC originally agreed to DSRC-only rule at request of US industry and USDOT
- Ensures interoperability
- Promotes deployment
- **Risk: Incompatible technologies will**
  - **remove interoperability**
  - **discourage mass deployment**

When Will FCC Announce 5.9 GHz Rule?

Current:



Proposed:



- FCC has monthly meetings
- 5.9 GHz Decision mostly likely in November or December 2020 meeting
- Two of Five FCC Commissioners may be replaced in early 2021

https://www.fcc.gov/news-events/events/open-commission-meetings

DSRC and DSRC+: Next Generation DSRC
(also called IEEE 802.11bd)

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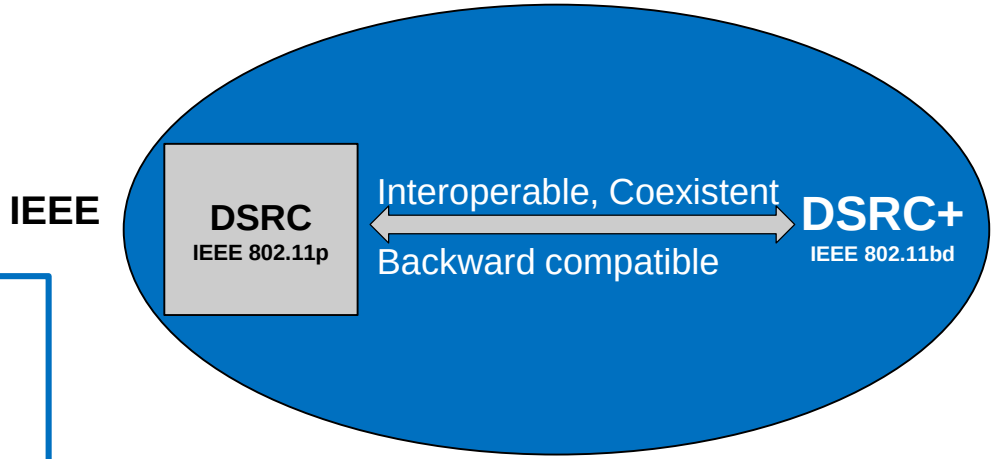
DSRC attributes:

- Proven high performance to save lives *(see NHTSA V2V NPRM)*
- Tens of thousands already deployed in United States
- Supports all V2X applications, not just Day 1
- Seamless evolution path DSRC → DSRC+ and beyond
- Efficient: key safety applications fit in 10 MHz



DSRC+ (802.11bd):

- First ballot Nov. 2020
- Expected completion June 2022
- Higher bit rates and more reliability

3 Candidate V2X Technologies

DSRC and DSRC+

4G LTE-V2X

5G New Radio V2X

- DSRC/DSRC+ is specified in IEEE 802.11p/IEEE 802.11bd
- 4G LTE-V2X PC5 is specified in 3GPP Release 14/15
- 5G NR V2X PC5 is specified in 3GPP Release 16/17

3 Candidate V2X Technologies: **Maturity**

DSRC and DSRC+

- **Proven** in deployment
- Field Trial ~3000 vehicles
- Congestion tested ~2000 vehicles on track

4G LTE-V2X

- No commercial deployment
- No large Field Trial
- Congestion tested ~260 vehicles on track

5G New Radio V2X

- First standard completed
- No implementation or testing

DSRC is mature and in deployment.

3 Candidate V2X Technologies: **Evolution**

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DSRC and DSRC+

4G LTE-V2X

5G New Radio V2X

DSRC has a seamless evolution path to DSRC+

DSRC has same-channel coexistence with DSRC+

- 4G LTE V2X has no same-channel evolution path to 5G NR V2X (or to anything else)
- 4G LTE V2X cannot coexist well in same channel with 5G NR V2X

Only DSRC has a same-channel evolution

3 Candidate V2X Technologies: **Efficiency**

DSRC and DSRC+

- **DSRC/DSRC+ is spectrally efficient**

4G LTE-V2X

- 4G LTE-V2X requires sending every packet twice
- Spectrally inefficient

5G New Radio V2X

- Not clear yet

4G LTE-V2X requires 20 MHz to support the applications that DSRC can support in 10 MHz

Final Thoughts

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- V2X is too important to give up on
- We need to find a way to work together better
  - Develop new V2X technology consensus
  - Decide what applications to deploy in 30 MHz
- DSRC is proven, efficient, and has seamless evolution