Status of V2X in the United States
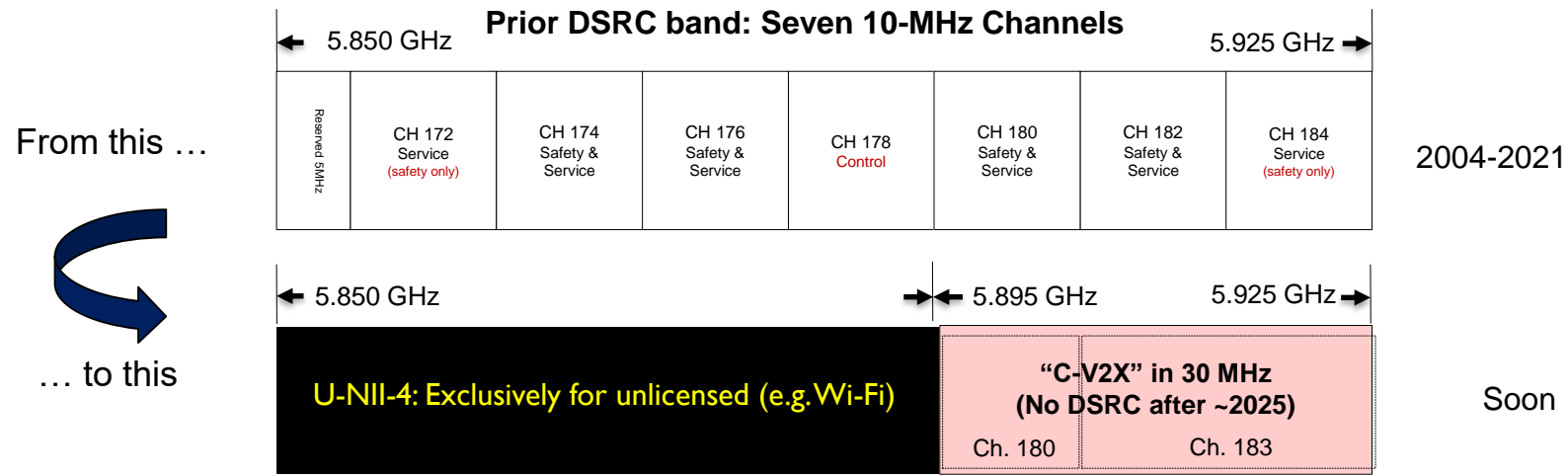
John Kenney

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October 12, 2022

SIP-adus Workshop 2022

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Outline

- Regulation Status

- Standards Status

Spectrum: new 5.9 GHz rules from FCC

Prior DSRC band: Seven 10-MHz Channels

5.850 GHz

| Reserved 5MHz | CH 172 Service (safety only) | CH 174 Safety & Service | CH 176 Safety & Service | CH 178 Control | CH 180 Safety & Service | CH 182 Safety & Service | CH 184 Service (safety only) |

5.925 GHz → 2004-2021

From this …

… to this

5.850 GHz → ← 5.895 GHz — 5.925 GHz →

U-NII-4: Exclusively for unlicensed (e.g. Wi-Fi) | **"C-V2X" in 30 MHz (No DSRC after ~2025)** — Ch. 180 / Ch. 183

Soon

First Report and Order (2021)

- 75 MHz → 30 MHz
- U-NII-4 for use with indoor Access Points
- Very loose out-of-band emissions (OOBE) threaten ITS
- FCC intends to switch from DSRC to "C-V2X" (but not yet)
- Created "streamlined" waiver process to allow early deployment of C-V2X
- 1st R&O took effect July 2021. Wi-Fi deployment started.
- DSRC below 5895 MHz moved or stopped by July 2022

Spectrum (continued)

FNPRM for 2nd Report & Order (2021)

- Propose to define "C-V2X" as Release 14 LTE V2X and establish detailed rules

- Propose transition timeline from DSRC to C-V2X (2 years from 2nd R&O)

- Propose to allow outdoor U-NII-4 (double-edged sword for V2X)

- We do not know when 2nd R&O will be issued

FNPRM = Further Notice of Proposed Rulemaking

Spectrum: Responses to FCC

- Petitions to FCC for reconsideration are unlikely to be granted
- ITSA/AASHTO lawsuit challenging FCC 1st R&O was defeated (Aug. '22)
- Waiver requests
  - "Joint" waiver request (Dec. 2021)
    - Did not use streamlined process
    - Comments collected July/August '22
  - Several states have filed separate waivers
  - We do not know when FCC will decide on waivers.

- Summary: eventually rules for widespread deployment will be in place

Spectrum: what protocols will be permitted?

- FCC proposal: only Release 14 LTE V2X

- 5GAA comments on FNPRM (June 2021) propose to remove Release 14 limitation, would permit any 3GPP release including NR V2X (Releases 16, 17, 18 …)
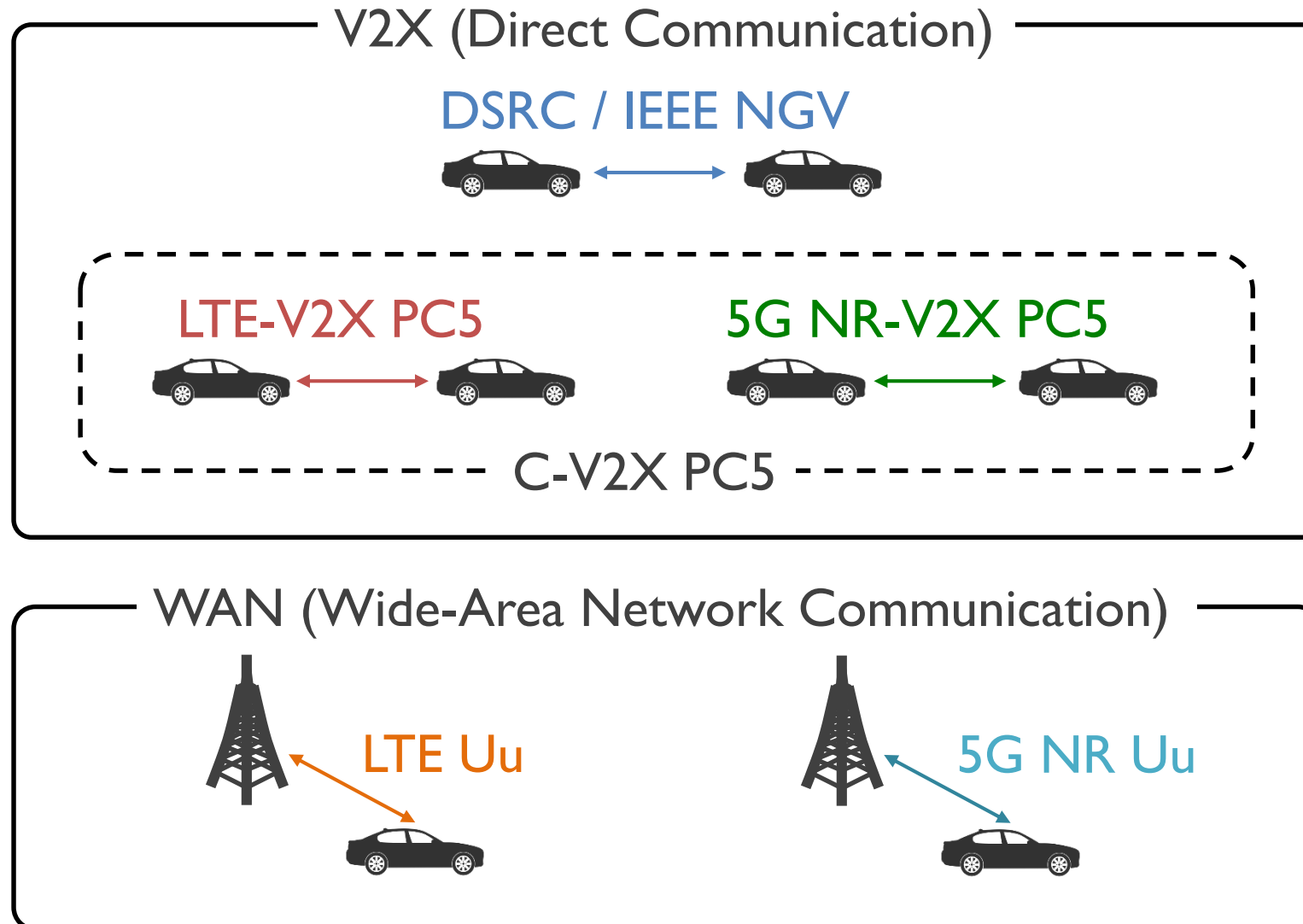
> ## § 90.379 Technical standards for Roadside Units
>
> (1) The 3GPP ~~Release 14,~~ 3rd Generation Partnership Project Technical Specification Group Services and System Aspects ~~(2018). This~~ standards ~~is~~ are available from ATIS, 1200 G Street NW Suite 500, Washington, D.C. 20005, https://www.atis.org/docstore/default.aspx.
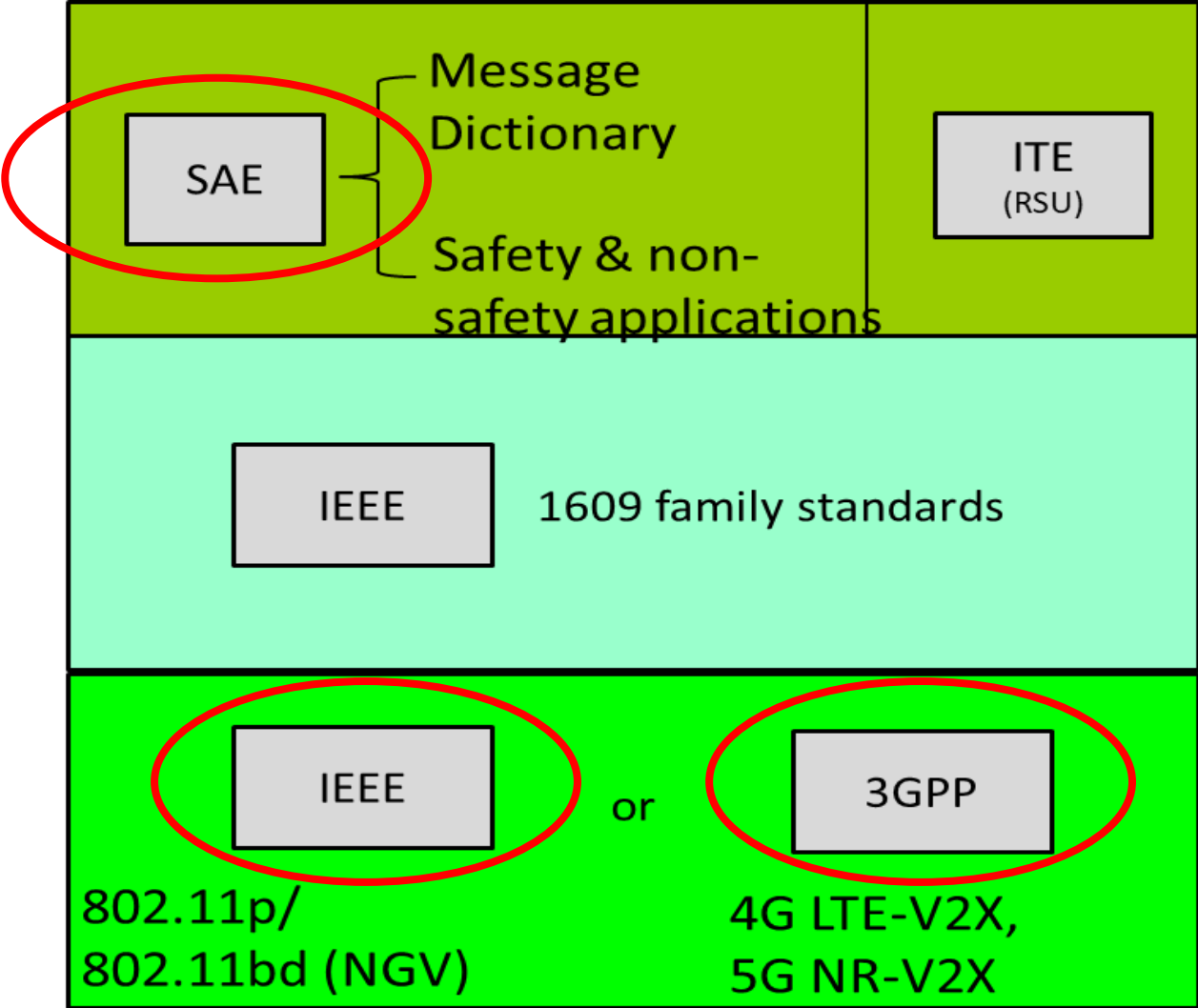
- Autotalks proposal (September 2022): Allocate Channel 180 for 5G NR V2X (Rel. 16 and onward), Channel 183 for LTE V2X (Release 14)

- Toyota comments on FNPRM (June 2021) propose to defer specific protocol limitations until industry consensus emerges

US Department of Transportation

- US DOT Strongly opposed FCC First Report and Order
- V2X Summit August 24-25, 2022 (Washington DC)
  - Strong consensus shown for V2X benefits
  - US DOT (Volpe) presented LTE V2X field test results
    - Focus on Wi-Fi Interference and high vehicle density
  - Funding available for V2X infrastructure
  - Attendees requested USDOT to set a national roadmap toward deployment
- No indication that US DOT/NHTSA will renew V2X mandate initiated in 2017
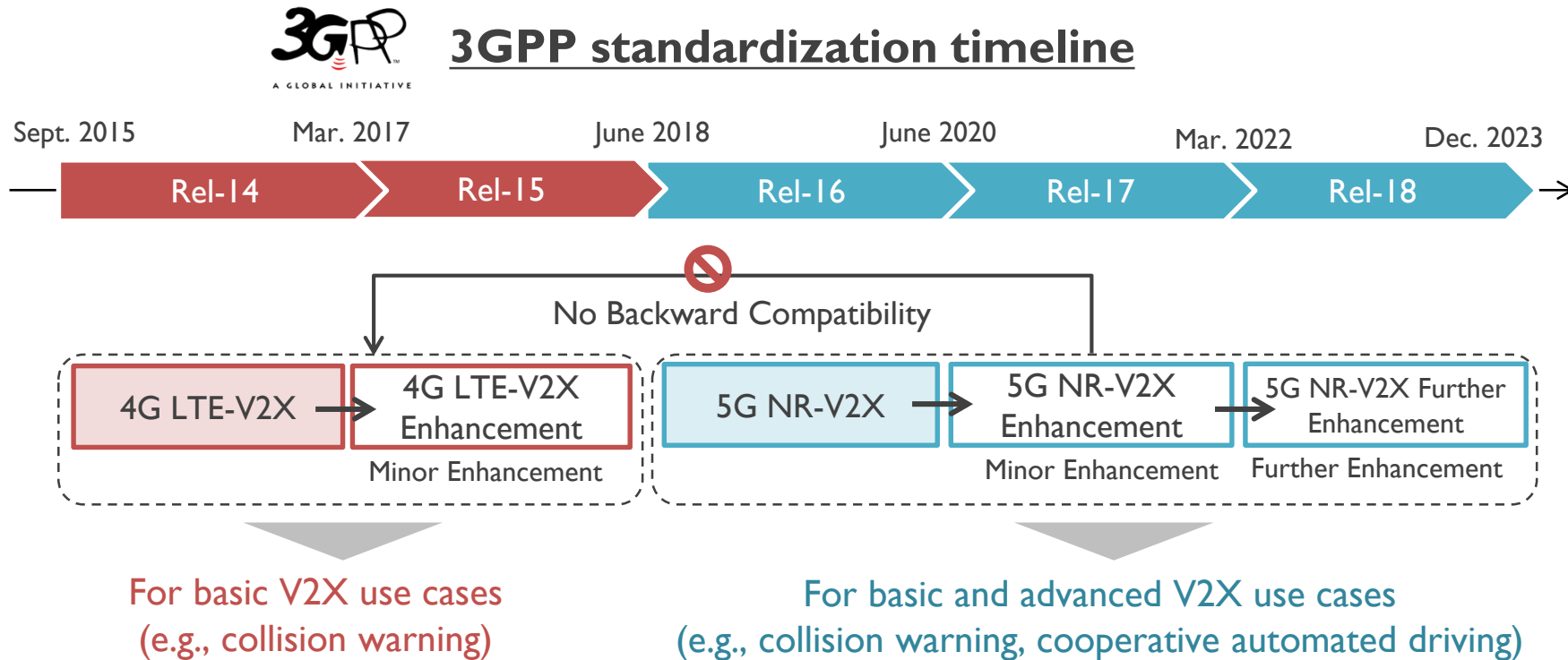
Standards: Taxonomy of V2X Technologies

V2X (Direct Communication)

DSRC / IEEE NGV

LTE-V2X PC5   5G NR-V2X PC5

C-V2X PC5

WAN (Wide-Area Network Communication)

LTE Uu   5G NR Uu

- Most use "V2X" to mean direct V2X communication.
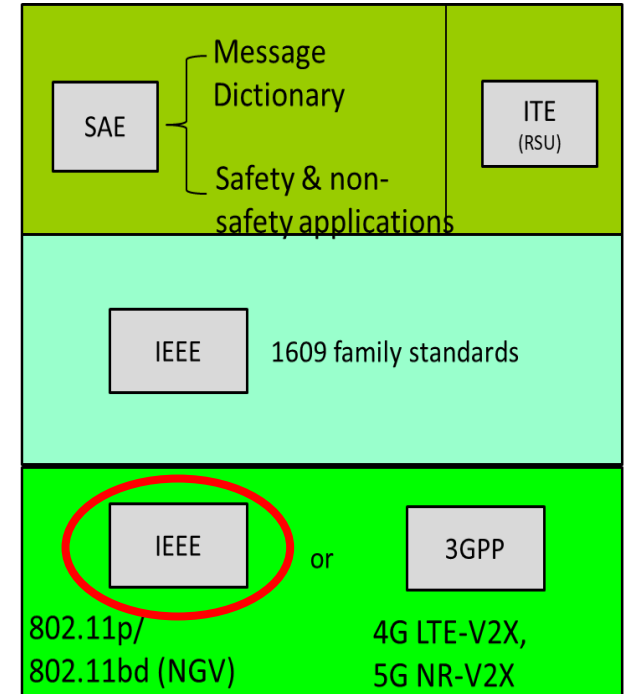- Some use "V2X" more broadly to include indirect V2X communication via base stations.

V2X Standards
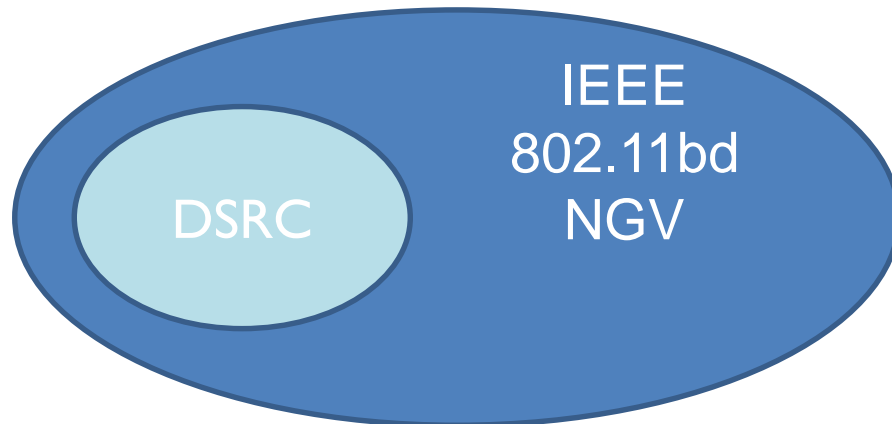
Standards: 3GPP

3GPP is working on Rel-18 5G NR-V2X Further Enhancement.

NR: New Radio

3GPP standardization timeline

Sept. 2015	Mar. 2017	June 2018	June 2020	Mar. 2022	Dec. 2023
Rel-14	Rel-15	Rel-16	Rel-17	Rel-18	

🚫 No Backward Compatibility

4G LTE-V2X	→	4G LTE-V2X Enhancement

Minor Enhancement

5G NR-V2X	→	5G NR-V2X Enhancement	→	5G NR-V2X Further Enhancement

Minor Enhancement   Further Enhancement

For basic V2X use cases
(e.g., collision warning)

For basic and advanced V2X use cases
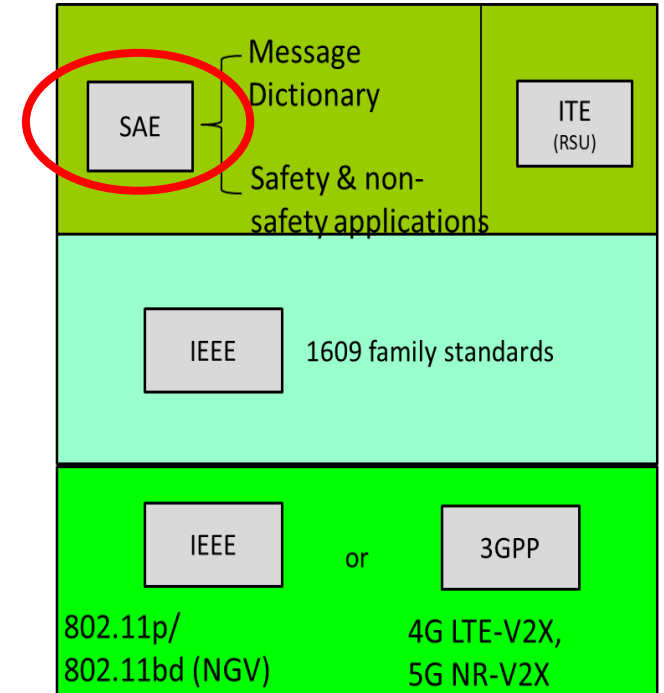(e.g., collision warning, cooperative automated driving)

Standards: IEEE 802.11bd NGV

- NGV = Next Generation V2X = "DSRC+"
- Amendment to IEEE 802.11 standard
- State of the art PHY, higher data rates & reliability
- Will be approved in December 2022
- 802.11bd is a superset of DSRC, so
  - It is same-channel coexistent, backward compatible, and interoperable
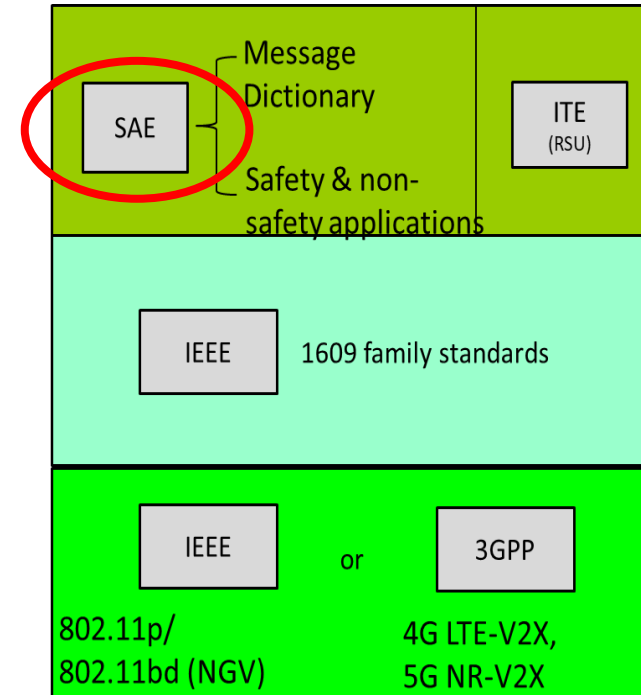 - Seamless evolution for those using DSRC (e.g. JP, EU)

- **J3161/1 and J3161 for Ch. 183**
  - published after some patent owners declined to provide licensing assurances to SAE
- **Others published include:**
  - J2945/3 V2I Weather
  - J2945/5 Security
  - J2945/C Traffic Probe
  - J2735 Message Dictionary (updated)
  - J3224 Sensor Sharing (next slide)
  - J3217 Toll Collection
  - Many others are in progress: V2I Road Safety, Platooning, Signal preemption/priority, …

Standards related to automated driving

- Sensor Sharing Service
  - SAE J3224
  - Sensor Data Sharing Message
  - Analogous to ETSI Collective Perception Message
  - Published August 2022
- Maneuver Sharing and Coordinating Service
  - SAE J3186
  - Currently being developed (publication expected 2023)

Summary:

- V2X Standards are in place, not holding back deployment

Conclusion

- Regulations: FCC 1st R&O (2021) and 2nd R&O (expected soon)
  - Waiver requests to start LTE V2X deployment soon

- Regulations: US DOT V2X Summit (August 2022)
  - Test results LTE V2X
  - V2X Roadmap to be developed jointly with industry

- Standards: 3GPP working on 5G New Radio V2X
  - Release 16 (June 2020), Currently working on Release 18
  - Incompatible with Release 14-15 LTE V2X

- Standards: IEEE 802.11bd Next Generation V2X
  - "DSRC+": backward compatible, coexistent, and interoperable
  - Will be approved December 2022

- Standards: SAE
  - Standards for Channel 183 published
  - Standards for Cooperative Automated Driving (J3224 SSS, J3186 MSCS)

- Regulations (soon) and Standards (now) in place

- Deployment Status: still unclear (will discuss in CV Breakout)