

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Unlicensed Use of the 6 GHz Band)	ET Docket No. 18-295
)	
Expanding Flexible Use in Mid-Band)	GN Docket No. 17-183
Spectrum Between 3.7 and 24 GHz)	

COMMENTS OF 5GAA

I. Introduction and Summary

The 5G Automotive Association (“5GAA”)¹ is pleased to provide the following comments in response to the *Notice of Proposed Rulemaking* (“NPRM”) seeking input on proposed rules that will promote new opportunities for unlicensed use in portions of the 1200 megahertz of spectrum in the 5.925-7.125 GHz band (“6 GHz band”).²

5GAA recently filed a petition for waiver (“Waiver Petition”)³ that would allow for the deployment of Cellular Vehicle-to-Everything technology, better known as C-V2X, in the 5.905-5.925 GHz range of the 5.850-5.925 GHz band (“5.9 GHz band”).⁴ C-V2X is today’s best

¹ 5GAA is a global cross-industry organization of companies from the technology, telecommunications, and automotive industries working together to develop end-to-end connectivity solutions for intelligent transportation, future mobility systems and smart cities. Created in 2016 by eight founding members, 5GAA’s membership has expanded rapidly and now includes over 100 companies from around the world. Today, 5GAA’s members include mobile network operators, telecommunications infrastructure vendors, chipset manufacturers, automotive manufacturers, and tier-1 automotive suppliers. See [Appendix A](#) for a complete list of member companies.

² *Unlicensed Use of the 6 GHz Band*, Notice of Proposed Rulemaking, FCC 18-147 (rel. Oct. 24, 2018) (“NPRM”).

³ See Petition of 5GAA for Waiver, GN Docket No. 18-357 (filed Nov. 21, 2018) (“Waiver Petition”).

⁴ C-V2X is a modern standards-based communications system that represents an evolution in connected vehicle technology and the first step towards leveraging 5G to increase safety on America’s roads. C-V2X enables direct, peer-to-peer mode communications between vehicles themselves (“V2V”), vehicles and vulnerable persons such as pedestrians and cyclists (“V2P”), and vehicles and transportation infrastructure (“V2I”), as well as communications between vehicles and mobile networks (“V2N”). These communications can help enable important improvements in safety, traffic efficiency, mobility, and energy efficiency on America’s roads.

opportunity to implement and further the vision for Intelligent Transportation System (“ITS”) services in the 5.9 GHz band.⁵ As indicated in the Waiver Petition, 5GAA plans to file in the near future a petition for rulemaking requesting that the Commission initiate a proceeding to modify its rules for the 5.9 GHz band to allow for C-V2X operations in a substantial portion of the band. On December 6, 2018, the Office of Engineering and Technology issued a *Public Notice* soliciting comment on 5GAA’s Waiver Petition.⁶ To date, the response to the *Public Notice* reflects substantial support for the prospects for C-V2X in general and, more specifically, the relief sought by 5GAA to allow C-V2X deployments in the United States, initially in the upper 20 MHz of the 5.9 GHz band.⁷

5GAA supports the Commission’s efforts in these proceedings to identify new opportunities for unlicensed use in the 6 GHz band, and believes that the 6 GHz band – and not the 5.9 GHz band – represents the best opportunity for providing for more spectrum for unlicensed uses. However, without proper safeguards in place, out-of-band emissions (“OOBE”) from secondary 6 GHz unlicensed operations will degrade primary licensed vehicle safety communications operations in the 5.9 GHz band. To prevent such an outcome, the Commission should adopt the protection criteria proposed by 5GAA herein.

⁵ See Waiver Petition at 1-2.

⁶ *Office of Engineering and Technology and Wireless Telecommunications Bureau Seek Comment on 5GAA Petition for Waiver to Allow Deployment of Cellular Vehicle-To-Everything (C-V2X) Technology in the 5.9 GHz Band*, Public Notice, DA 18-1231 (rel. Dec. 6, 2018).

⁷ See e.g., Comments of Ford Motor Company, GN Docket No. 18-357, at 1 (filed Jan. 28, 2019) (filed as Nick Baracos) (“Ford not only supports [5GAA’s] waiver but also believes that CV2X will be critical in bettering the roads and cities of the future ...”); Comments of Intel Corporation, GN Docket No. 18-357, at 1 (filed Jan. 24, 2019) (“Intel ... fully supports [5GAA’s] waiver request to enable C-V2X technology deployment in America.”); Comments of T-Mobile USA, Inc., GN Docket No. 18-357, at 1 (filed Jan. 29, 2019) (“T-Mobile USA, Inc. submits these comments in support of [5GAA’s waiver request] seeking authority to deploy Cellular Vehicle to Everything technology ...”); Comments of HAAS Alert, GN Docket No. 18-357, at 3 (filed Jan. 28, 2018), (“C-V2X[,] from a technology, scalability, and cost side[,] supports the needs of not only automotive, but fleets and the public safety agencies that already have deployed C-V2X.”); Comments of Maryland Department of Transportation, GN Docket No. 18-357, at 1 (filed Jan. 28, 2019) (“[Maryland Department of Transportation] believes that C-V2X technology has a promising future, and additional pilot deployments and testing should be encouraged.”).

II. Two Complementary National Goals Can Be Achieved Through These Proceedings: Opening the 6 GHz Band For Near-Term Unlicensed Use and Preserving the 5.9 GHz Band for C-V2X and Other ITS Services

In light of the near-term opportunities for opening an unprecedented amount of unlicensed mid-band spectrum in the 6 GHz band, the limited spectrum available for unlicensed use at 5.9 GHz, and the practical limitations that will have to be imposed on any potential unlicensed operations in the 5.9 GHz band to protect C-V2X, the Commission should focus on the 6 GHz band for additional unlicensed spectrum. Such an approach will achieve the twin goals of freeing up spectrum for unlicensed use and preserving the 5.9 GHz band for C-V2X and other ITS services.

As recognized in the *NPRM*, the 6 GHz band presents the Commission with a unique opportunity to make available 1200 MHz of spectrum for unlicensed use.⁸ By comparison, interest in unlicensed use in the 5.9 GHz band is, at most, focused on just 45 MHz, in the 5850-5895 MHz portion of the band.⁹ The 1200 MHz of spectrum available for unlicensed use in the

⁸ *NPRM* ¶ 1 (“The broad spectrum swaths that we propose making available in this frequency band could promote new technology and services that will advance the Commission’s efforts to make broadband connectivity available to all Americans, especially those in rural and underserved areas.”). *See also id.* Statement of Chairman Ajit Pai (“[W]ith the massive amount of wireless traffic that is off-loaded to Wi-Fi, opening up this wide swath of spectrum for unlicensed use could be a big boost to our nation’s 5G future.”); *id.* Statement of Commissioner Michael O’Rielly (“[The 6 GHz band] is a prime location for unlicensed services for multiple reasons ... today’s Notice takes a giant step to open a large swath of spectrum needed for increased capacity, higher speeds, and lower latency for unlicensed 5G or technologies not yet envisioned”); *id.* Statement of Commissioner Brendan Carr (“[T]oday’s proceeding is so important. It proposes to add 1,200 MHz of prime mid-band spectrum for unlicensed use—that’s five times the spectrum available today in the 2.4 and 5 GHz bands.”); *id.* Statement of Commissioner Jessica Rosenworcel (“[The 6 GHz band is] an ideal place to explore Wi-Fi expansion because it’s close to our existing Wi-Fi bands.”).

⁹ In 2013, the Commission proposed rules that would allow unlicensed devices to share the 5.9 GHz band. *Revision of Part 15 of the Commission’s Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd 1769 (2013). In 2016, the Commission released a public notice announcing, among other things, its plan to conduct, in coordination with the Department of Transportation and the National Telecommunications and Information Administration, a three-phase collaborative testing plan to further explore sharing solutions between unlicensed devices and Dedicated Short-Range Communications operations in the 5.9 GHz band. *See The Commission Seeks to Update and Refresh the Record in the “Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band” Proceeding*, Public Notice, 31 FCC Rcd 6130 (2016). The results of the first phase of testing were released in 2018. *See Office of*

6 GHz band represents 25 times more bandwidth than the 45 MHz in the 5.9 GHz band. With the adoption of the minimally restrictive Part 15 technical rules discussed below, the Commission can expeditiously free a 1.2 GHz-wide swath of 6 GHz spectrum for unlicensed use without jeopardizing the future of C-V2X. Also, significant restrictions on unlicensed use of the 5.9 GHz band (including, perhaps most significantly, restrictions on outdoor use) likely will be required. In short, the Commission can achieve more “bang for the buck” by focusing its efforts to expand unlicensed opportunities on the 6 GHz band, while simultaneously preserving the 5.9 GHz band for ITS services.

III. New 6 GHz Unlicensed Operations Must Protect Future C-V2X and Other ITS Operations in the 5.9 GHz Band

While 5GAA supports the Commission’s efforts to identify new opportunities for unlicensed use in the 6 GHz band, it is critical that any new unlicensed operations in the proposed U-NII-5 band protect future C-V2X and other ITS operations in the 5.9 GHz band.¹⁰

As the Commission emphasizes in the *NPRM*, “[a]ll Part 15 devices/systems operate on a non-interference basis, including devices that will operate under the proposals we make herein.”¹¹ The Commission has recognized in the *NPRM* and elsewhere that while those who deploy unlicensed technology pursuant to Part 15 are obligated to avoid harmful interference to primary services (such as ITS services in the 5.9 GHz band), the inherent nature of unlicensed

Engineering and Technology Requests Comments on Phase I Testing of Prototype U-NII-4 Devices, Public Notice, DA-18-1111 (rel. Oct. 29, 2018).

¹⁰ Indeed, during the field test conducted by some 5GAA members, interference from the adjacent U-NII-3 band was encountered and care was taken to prevent the interference from impacting the testing results. (See 5GAA Petition for Waiver, GN Docket No. 18-357). As we continue to advance C-V2X technologies, we will further examine this type of interference.

¹¹ *NPRM* ¶ 13 (citing 47 C.F.R. § 15.5(b)).

use requires the imposition in Part 15 of technical restrictions that will provide reasonable protection against harmful interference to primary services under predictable use scenarios.¹²

In the *NPRM*, the Commission proposes an OOB limit of -27 dBm/MHz for 6 GHz unlicensed signals, noting that this limit is consistent with the rules that apply for most of the other U-NII bands.¹³ While 5GAA appreciates the Commission's desire to limit OOB by 6 GHz band unlicensed users in a manner similar to the limits imposed in other unlicensed bands,¹⁴ this technical restriction alone will not be sufficient to protect C-V2X services. Indeed, the proposed OOB limit of -27 dBm/MHz for 6 GHz unlicensed signals would allow unwanted signals in the ITS band at a signal strength of -85 dBm/MHz, assuming free-space path loss at a range of 3 meters.¹⁵ This is 15.4 dB above C-V2X receiver sensitivity, and poses a serious threat to the important safety objectives of C-V2X.¹⁶

To protect C-V2X operations in the 5.9 GHz band, the Commission must impose additional limits on certain U-NII-5 operations.¹⁷ Specifically, with the exception of portable

¹² See *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 29 FCC Rcd 6567, 6681 ¶ 259 (2014) (“[Unlicensed devices] are an important part of this nation’s communications capabilities, serving to augment the operations of licensed services and to meet the needs of a wide range of wireless applications. ... The Part 15 rules specify the minimal technical requirements necessary to prevent harmful interference to authorized services.”).

¹³ See 47 C.F.R. § 15.407(b).

¹⁴ See *NPRM* ¶ 82.

¹⁵ Three meters separation is chosen for this example because an unlicensed access point, hotspot or other device could be operating in very close proximity to a roadway or roadside C-V2X unit. The separation distance between an unlicensed device and a C-V2X receiver may be more or less than 3 meters and still cause harmful interference to the C-V2X receiver. For example, if the distance is increased to 5 meters, the resulting signal strength from the unlicensed devices OOB would still be 11 dB above the C-V-2X receiver sensitivity.

¹⁶ See Appendix B (5GAA Technical Response to the FCC 6 GHz *NPRM*) for additional technical analysis.

¹⁷ While an OOB limit of -27 dBm/MHz has the potential to cause harmful interference, 5GAA recognizes that this level of emissions is applied to unlicensed devices in the 5 GHz band. Accordingly, the unlicensed device manufacturing community has used this level in manufacturing viable equipment. In recognition that creating a more stringent limit for the protection of licensed ITS services could result in difficulties for unlicensed device manufacturers, 5GAA deliberately chose not to take such an approach. Instead, it is proposing a reasonable

devices operating as client devices as defined in the *NPRM*,¹⁸ all U-NII-5 operations using a channel with a center frequency below $5925 \text{ MHz} + \text{BW} \times 3/2$, where BW equals the bandwidth of the channel, must be limited to indoor-only operation.¹⁹ To protect C-V2X services against harmful interference from 6 GHz unlicensed OOB, this restriction means that the U-NII-5 transmission device must have a direct connection to an AC power outlet, that the transmission antennae must be located indoors, and that emissions from the antennae must not be directed outside through a window, doorway or other aperture. These limitations on the use of channels with a center frequency less than $5925 \text{ MHz} + \text{BW} \times 3/2$ is consistent with precedent and the Commission's approach in countless other proceedings.²⁰

These proposed restrictions are necessary to protect the integrity of C-V2X operations. If such protective measures are not taken, OOB from outdoor unlicensed operations in the lower portion of the proposed U-NII-5 band will significantly degrade C-V2X safety-of-life operations.

operational limit on outdoor operations in order to promote a viable unlicensed device market while preserving a viable interference environment for ITS operations.

¹⁸ See *NPRM* n.59. To be clear, 5GAA contemplates that if a device, such as a smart phone, is capable of operating as a client device and as a mobile hotspot, the exception would only apply when operating as a client device and the ban on outdoor use of channels with a center frequency of $5925 \text{ MHz} + \text{BW} \times 3/2$ would apply when operating as a hotspot.

¹⁹ This restriction would preclude, for example, the outdoor operation of access points, fixed client devices, and mobile hotspots. A mobile hotspot can only be permitted to operate on a channel with a frequency center below $5925 \text{ MHz} + \text{bw} \times 3/2$ if it is capable of ascertaining when it is indoors and determines that it is indoors.

²⁰ See, e.g., 47 C.F.R. §§ 15.517(a), 15.257(a) (requiring indoor-only devices to be “connected to the AC power lines” and emissions from such devices to “not be intentionally directed outside of the building in which the equipment is located, such as through a window or a doorway.”). See also *NPRM* ¶ 71 (“Previously, we have required that indoor devices have direct connection to a power outlet.”) (citation omitted); *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, 32 FCC Rcd 10988, 11055 ¶ 203 (2017) (“Our rules require that equipment authorized to operate in the 90 GHz band must be AC- powered in order to ensure that they only operate indoors.”) (citation omitted). For avoidance of a doubt, in-vehicle hotspot use would not be considered use “indoors” and thus would be barred from using a channel with a center frequency less than $5925 \text{ MHz} + \text{BW} \times 3/2$.

IV. Conclusion

In light of the advent of C-V2X technology in the 5.9 GHz band and near-term opportunities for unlicensed use in an unprecedented amount of spectrum in the 6 GHz band, the Commission should focus its efforts to identify new mid-band spectrum for unlicensed use on the 6 GHz band. Any new unlicensed operations in the 6 GHz band must protect C-V2X operations in the 5.9 GHz band pursuant to the criteria outlined above.

Respectfully submitted,

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Appendix A - 5GAA Membership

Membership list as of February 5th, 2019:

- Airbus
- Airgain, Inc.
- Alpine Electronics Inc.
- American Tower Corp
- Analog Devices Inc.
- Anritsu A/S
- Applied Information
- AT&T Foundry
- Audi AG
- BAIC Group (Beijing Automotive Group Co., Ltd.)
- Baidu
- Baoneng
- Beijing University of Technology
- Bell Mobility
- BlackBerry UK Limited
- BMW Group (Bayerische Motoren Werke AG)
- Bosch (Robert Bosch GmbH)
- CATT (China Academy of Telecommunication Technology)
- CETECOM GmbH
- China Mobile
- China Transinfo
- China Unicom (China United Network Communications Group Co.,Ltd)
- China Mobile Research Institute
- Clarion Co. Ltd
- Cohda Wireless
- Commsignia Inc.
- Continental Teves AG & Co. oHG
- Daimler AG
- Danlaw Inc.
- Dekra
- DENSO AUTOMOTIVE Deutschland GmbH
- Deutsche Telekom AG
- Dt&C
- Equinix
- Ericsson AB
- Faraday Future
- FarEasTone
- FEV Group GmbH

- Ford
- Fraunhofer Institute
- Geely Auto
- Gemalto SA
- General Motors
- Hirschmann Car Communication GmbH
- Hitachi
- Honda
- Huawei
- Hyundai America Technical Center
- Hyundai Mobis
- iDirect
- Infineon Technologies AG
- Intel
- InterDigital Communications, Inc.
- Jaguar Land Rover Ltd.
- Juniper Networks
- KDDI
- Keysight Technologies UK Limited
- KT R&D Center
- Laird Bochum GmbH
- Latvijas Mobilais Telefons
- Lear
- LG Electronics Inc.
- Magneti Marelli
- Mitsubishi Electronics
- Murata Manufacturing
- NavInfo
- Neusoft
- NIO China
- Nissan
- Nokia
- Noris Network AG
- NTT-DoCoMo
- OKI
- Orange SA
- P3 Group
- Panasonic
- Proximus B.V.
- PSA Groupe
- Qorvo
- Qualcomm Incorporated
- Quectel
- Renault

- Rohde & Schwarz GmbH & Co. KG
- Rohm Semiconductor
- SAIC Motor Corporation Limited
- Samsung Electronics Co., Ltd
- Savari Inc.
- SGS
- Shanghai Gotell Communication Technology Holdings Co., Ltd.
- SIAC (Shanghai Int. Automobile City)
- SK Telecom
- Skyworks
- Smart Mobile Labs
- Softbank Corp.
- Sumitomo Electric
- Swift Navigation
- Telefónica Digital España S.L.
- Telekom Austria Aktiengesellschaft
- Telstra
- TELUS
- Tencent
- Terranet, SE
- TÜV Rheinland AG
- Valeo (peiker acustic GmbH & Co.KG)
- Veniam Inc.
- Verizon
- Viavi
- Vodafone Group Services Ltd
- Volkswagen AG
- Volvo Cars
- VT Direct
- Wistron NeWeb Corp.
- ZF
- ZTE Corporation

Appendix B – 5GAA Technical Response to the FCC 6 GHz NPRM



Technical Response to FCC 6 GHz NPRM (ET Docket 18-295)

February 15, 2019

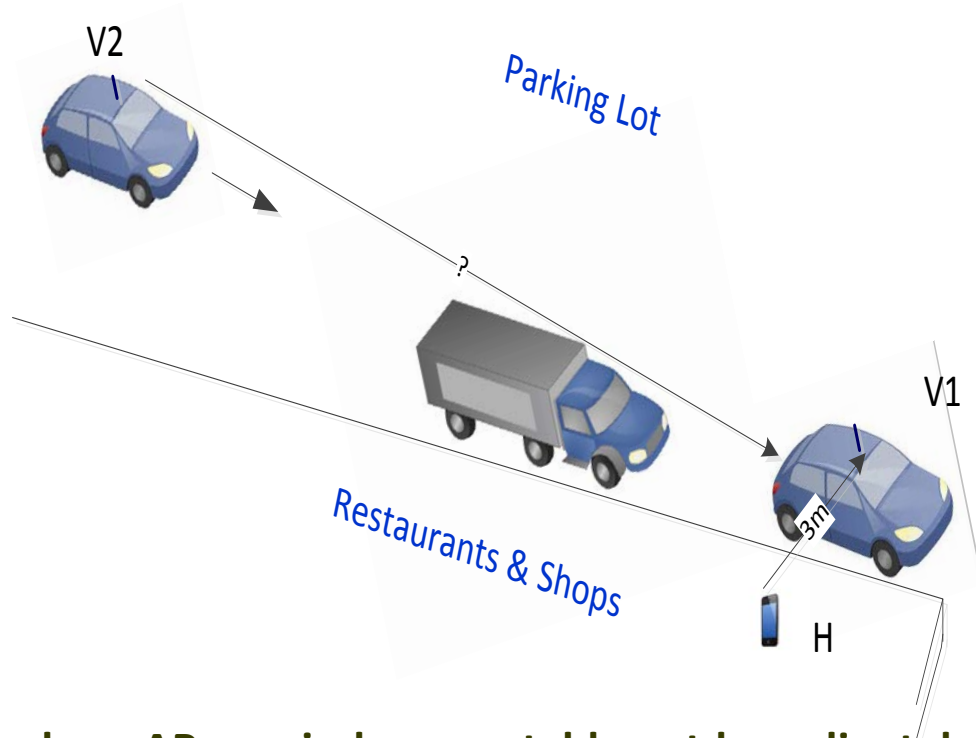
The Need to Protect Licensed ITS 5.9 GHz Band Operations

- The 5.9 GHz licensed ITS band supports safety-of-life vehicle communications
 - Out-of-band emissions from new 6 GHz unlicensed operations must not significantly degrade vehicle safety communications operating in the ITS band
- New 6 GHz unlicensed operations must ensure ITS operations are protected
 - OOB emissions from outdoor unlicensed equipment in the lowermost portion of the proposed U-NII-5 band can significantly degrade 5.9 GHz licensed ITS operations
 - Unlicensed APs mounted on street fixtures, indoor APs serving sidewalk cafes, and mobile APs can be a few meters away from vehicles with active ITS communications
 - Undesired emissions at an ITS receiver using the 5905-5925 MHz band must be below -100.4 dBm/MHz after path losses, building wall penetration, and mitigation techniques to not significantly degrade ITS vehicle safety operations; per 3GPP TS 36.101, minimum required C-V2X receiver sensitivity is -90.4 dBm for 10 MHz BW
 - Undesired signals above this level can cause packet errors and decrease signal range

Restrict New 6 GHz Unlicensed Operations below $5925 \text{ MHz} + \text{BW} \cdot 3/2 \text{ MHz}$ to Protect ITS Safety Operations

- FCC proposed OOB limit of -27 dBm/MHz for 6 GHz unlicensed signals would create unwanted signals in the ITS band at a signal strength of -85 dBm/MHz , assuming free-space path loss at a range of 3 m, which is 15.4dB above sensitivity
 - This can occur with fixed outdoor Access Points (APs), mobile APs, or with APs in a vehicle
 - Restricting unlicensed operations in the lowermost portion of U-NII-5 to indoor use allows building wall attenuation to reduce interference by at least 20 dB
 - A portable outdoor client device communicating with an indoor AP may cause interference but it can be managed (see next slide)
- Limit outdoor operations for certain types of unlicensed equipment using channels with $f_c < 5925 \text{ MHz} + \text{BW} \cdot 3/2$, where f_c is the center frequency of the unlicensed channel of operation and BW is the unlicensed channel bandwidth
 - Fixed outdoor APs
 - Fixed outdoor client devices
 - Mobile hotspots operating outdoors
- Mobile hotspots, such as an in-vehicle hotspot, could cause significantly more interference to 5.9 GHz ITS operations, so mobile hotspots also should not be allowed to operate outdoors or in vehicles below $5925 \text{ MHz} + \text{BW} \cdot 3/2$

U-NII-5 Interference to 5.9 GHz ITS Operations



- **Even where APs are indoor, portable outdoor client devices can cause interference to ITS safety operations**
- **Scenarios where portable outdoor client devices in U-NII-5 interfere with ITS operations are usually where vehicles are not moving at highway speeds – lower communications range can be better tolerated at reduced speeds**

- V2 drives towards V1 in the outer lane in front of a shopping plaza at a low speed below 30 km/hr
- Transmissions of U-NII-5 device (H) interferes with the communications from V2 to V1.
- Assume V2 chooses MCS ≤ 9 w/o HARQ or MCS ≤ 17 w/ HARQ (This is an aggressive choice for typical C-V2X deployments)
- U-NII-5 signal seen by V1 (LOS): $-27 \text{ dBm/MHz} - 58 = -85 \text{ dBm/MHz}$, assuming free space LOS at 3 m
- V2 signal strength received by V1 must be greater than -78 dBm/MHz
 - For BSM messages, assume 20 RB or 4 MHz BW and 14 dBm/MHz EIRP power (20 dBm EIRP total), PL $< 92 \text{ dB}$
- Using the three slope path loss model in ECC report 228, PL of 92 dB is about 105 m for urban and 150 m for suburban.
 - These distances correspond to more than 12 s and 18 s, respectively, for a vehicle travelling at 30 km/hr
- What if the truck blocks the line?
 - V1 will experience less interference from the U-NII-5 interferer once it starts to move

Conclusions

- To protect ITS safety operations in the 5.9 GHz ITS band, U-NII-5 operations should be limited as follows:
 - OOB limit in 5850-5925 MHz from new 6 GHz unlicensed operations should be no greater than -27 dBm/MHz
 - Indoor only operation for lowest channel in the 6 GHz band plan, *i.e.*, channel center frequency $f_c < 5925 \text{ MHz} + \text{BW} \times 3/2 \text{ MHz}$ for fixed outdoor APs, fixed outdoor client devices, and mobile hotspots

BW (MHz)	Lowest Outdoor Center Frequency (MHz)
20	5955
40	5985
80	6045
160	6165
320	6405