January 24, 2020

Via Electronic Filing

Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

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

The following ex parte notification is being provided in the above-referenced proceedings in accordance with Section 1.1206 of the Commission's Rules. On January 22, 2020, Emily Fisher and Richard Ward from the Edison Electric Institute ("EEI"), Brett Kilbourne and Rob Thormeyer from the Utilities Technology Council ("UTC"), Corry Marshall from American Public Power Association ("APPA"), Ken Zdunek from Roberson and Associates, LLC ("Roberson"), Craig Gilley of Venable LLP, Christina Baworowsky from Alliant Energy, and Ben Portis of Entergy met with the Office of Engineering and Technology. Additional electric power and gas industry representatives and Alan Wilson and Paul Erickson from Roberson and Associates also attended by telephone conference bridge. A complete list of all the participants in that meeting is attached.

During the meeting the discussions focused on the utility participants' most recent filing (January 13, 2020) in the above-listed dockets and the attached technical presentation entitled the "Impact of Proposed Wi-Fi Operations on 6 GHz Microwave Links."[1] The participants emphasized the importance of protecting incumbent critical infrastructure industries' ("CII") use of the 6 GHz band. Electric, gas, and water utilities, oil and gas companies, railroads, wireless carriers, as well as public safety and law enforcement officials, all require strenuous protections against harmful interference to microwave communications systems in the band on a continuous (24/7), low latency, uninterrupted basis to ensure the capability to operate key facilities and equipment, and to maintain the backbone of their communications networks during emergencies

[1] *See* Letter from Emily Fisher, General Counsel and Corporate Secretary, Edison Electric Institute; Brian O'Hara, Senior Director Regulatory Issues --Telecommunications & Broadband, National Rural Electric Cooperative Association; Matthew Agen, Assistant General Counsel, American Gas Association; Brett Kilbourne, Vice President Policy & General Counsel, Utilities Technology Council; Desmarie Waterhouse, Vice President, Government Relations, and Counsel, American Public Power Association; Jennifer Uhle, Vice President Generation and Suppliers Nuclear Energy Institute; and Kevin Morley, Vice President Generation and Suppliers, Nuclear Energy Institute to Marlene H. Dortch, Secretary, Federal Communications Commission in ET Docket No. 18-295 and GN Docket No. 17-183 (Jan. 13, 2020). *See also* Roberson and Associates, LLC, "Impact of Proposed Wi-Fi Operations on Microwave Links at 6 GHz" in WT Docket No. 18-295 and GN Docket No. 17-183 (filed Jan. 13, 2013)("CII User Study"), *available at* https://ecfsapi.fcc.gov/file/1011370444952/Impact_RLANs_Houston_v1.4(10-Jan-2020)%20roberson.pdf.

and disasters. Without sufficient interference protection to these microwave communications systems, the safety of our nation's infrastructure is placed at risk.

At the outset, the participants explained that to the extent the Commission permits unlicensed operations to share the 6 GHz band, it is critical that the Commission's new rules are structured to prevent interference before it occurs, rather than to correct it after it occurs. For any unlicensed operations in the band, and especially for outdoor operations, Automated Frequency Coordination ("AFC") and other interference mitigation safeguards are vital. *Post hoc* remedies will be far too little too late to correct the failure of mission-critical communications systems. Ultimately, any 6GHz AFC system adopted here, and all interference coordination/mitigation methodologies and algorithms for that matter, must ensure that our systems can operate as designed without interruption.

Based on the findings of the CII User Study, the need for AFC– at a minimum -- for indoor as well as outdoor devices is clear. Specifically, the CII User Study found that allowing unlicensed operations to share the 6 GHz band would cause widespread and significant interference to microwave systems. This is not a matter of isolated interference in a few corner cases or worst-case modelling. The CII User Study found that within 94% of the Houston MSA, indoor or outdoor RLAN devices (assumed to be operating on a 4% duty cycle) could cause harmful interference to at least one of the 2325 microwave receivers in the Study. The findings could have been worse due to varying propagation scenarios and RLAN densities. Given these facts and the need to protect CII microwave systems -- which must meet extremely high standards for reliability -- it is clear that further study is needed before unlicensed operations may be permitted to share the 6 GHz band.

The industry participants also urged the Commission to pursue consensus-based solutions to sharing the 6 GHz band. In addition to further real-world testing, the participants suggested that the Commission convene a multi-stakeholder technical conference to develop solutions that will permit unlicensed devices to operate in the band (or parts of it) in furtherance of the deployment of 5G technologies while simultaneously avoiding harmful and potentially disastrous interference to incumbent CII and public safety microwave communications systems. The participants also committed to submit further recommendations for improvements to the Commission's proposed rules that would help to protect incumbent CII and public safety systems in the 6 GHz band.

We look forward to working with the Commission and other stakeholders to ensure that this issue is resolved properly.

Respectfully submitted,

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Dated: January 24, 2020

cc: Office of Engineering and Technology

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Impact of Proposed Wi-Fi Operations on 6 GHz Microwave Links

OET Discussion

22-Jan-2020

Roberson and Associates, LLC
Technology and Management Consultants ®

Summary

- **Analyzed impact of Wi-Fi deployment on 2325 CII point-point links in Nine County Houston MSA**
  - Used actual point-point receiver antenna locations, heights, gains
  - Included aggregate interference of indoor, outdoor RLANs
  - RLAN deployment density based on population density
  - RLAN characteristics based on emerging Wi-Fi use cases
  - Assessed Houston MSA “off-limits” to RLANs if point-point receivers are to be protected at -6 dB I/N
  - **Results:**
    - Point-point receivers in Houston Metro area will be degraded significantly beyond -6 dB I/N for unrestricted indoor or outdoor deployment
    - To protect all receivers at – 6 dB I/N, 94% of the nine-county area needs to be excluded from RLAN deployment

- **Analyzed impact of Wi-Fi interference scenarios in Central Houston**
  - Considered interference backscatter; receiving antenna main-, side- and back-lobes
  - Analyzed Wi-Fi channel availability in Central Houston to avoid interference with point-to-point
  - **Results**
    - To protect point-to-point receivers in central Houston, RLAN deployment needs to excluded within 1 km of receivers
    - Based on the point-to-point receiver frequencies, if receivers are to be protected, no Wi-Fi channels should be used indoors in central Houston within 1 km radius

- **Analyzed Very Low Power (VLP) Proposal**
  - Practical and likely VLP scenarios exist causing I/N in excess of -6 dB
  - Further analysis is required

Impact of 6 GHz Wi-Fi Operations in Nine County Houston MSA

- Analyzed 2325 Critical Infrastructure Industries (CII) point-to-point receivers in Houston MSA
  - Antenna locations, heights and gains from FCC license database
- Considered Aggregate Emissions from Population of Wi-Fi Access Points (Radio LANs)
  - Uniform geographic density of RLANS based on population density
  - Indoor (250 mWatt EIRP) and outdoor (4 W EIRP) deployment
    - Co-channel with point-to-point
    - Adjacent channel to point-to-point
  - Wi-Fi use case: emerging high-throughput applications (streaming video; gaming)
- Analysis Approach
  - Computed aggregate transmitted area power spectral density (APSD)
  - Applied APSD to fixed receivers in nine-county area
    - Computed received I/N distribution for 2325 receivers (indoor, outdoor)
    - Assessed per-cent of nine-county area off-limits to RLANs in order to protect all fixed receivers at -6 dB I/N

Nine-County Houston MSA Study Area

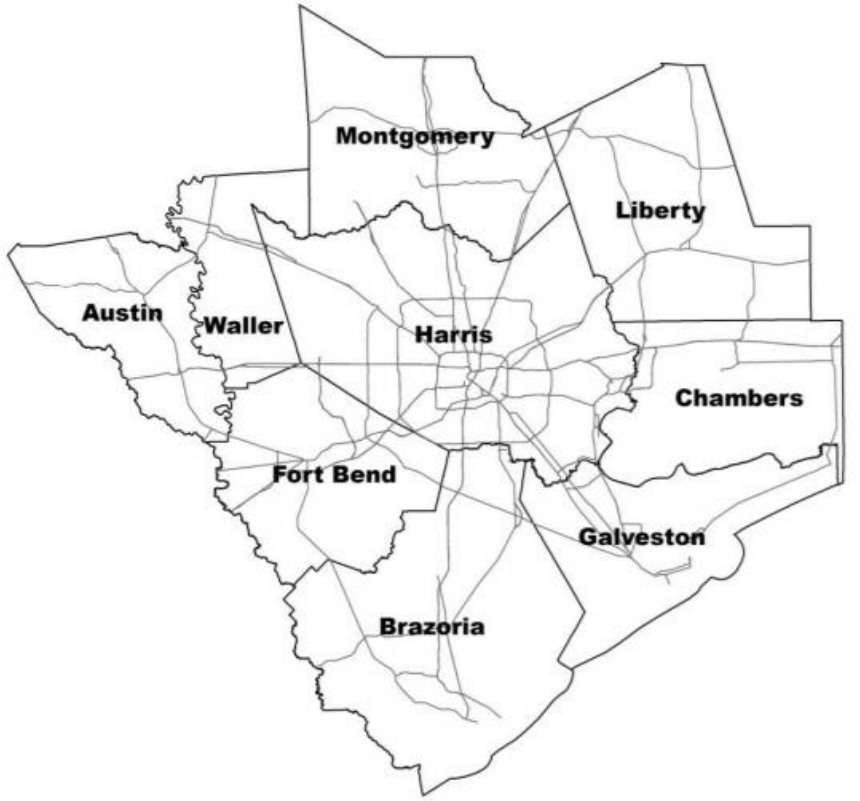


Figure 3

2325 point-to-point paths in Houston MSA

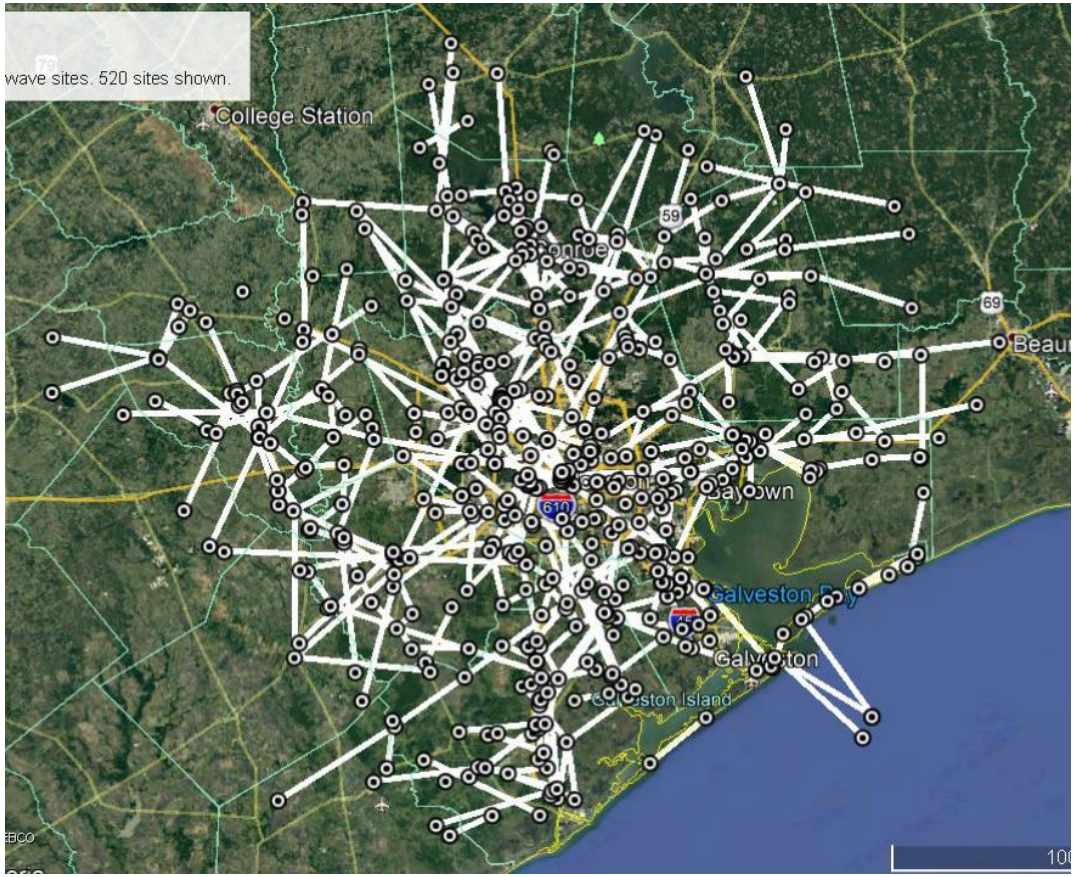


Figure 4

6 GHz Interference Scenario: Spectrum View

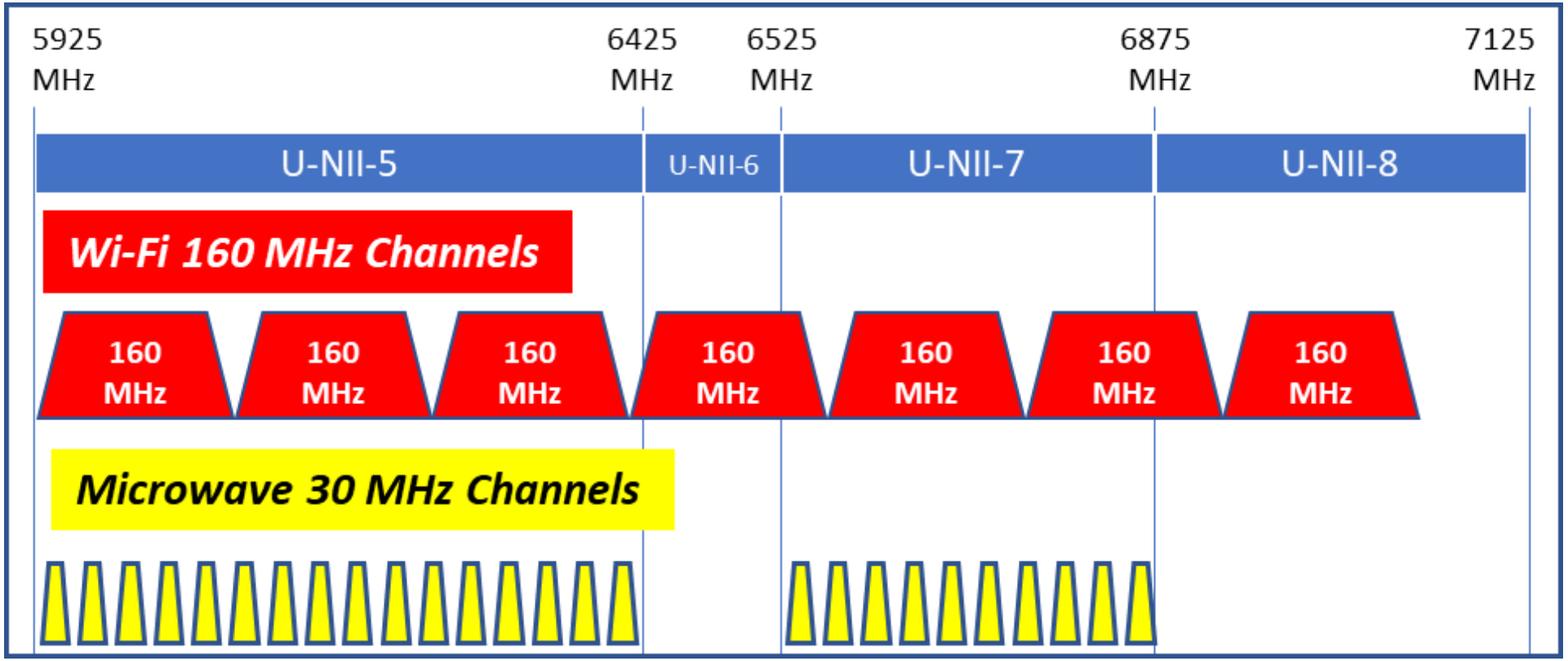


Figure 1

Aggregate Interference Scenario

- Point-Point Receiver Parameters
  - Antenna height / gain per FCC ULS database. 2325 victim receivers.
- RLAN Parameters
  - Power: 250 mW EIRP (indoor); 4 W EIRP (outdoor)
  - Antenna Height 2 m.
  - Uniform frequency distribution across U-NII-1, 3, 5, 6, 7, 8 bands (1425 MHz in total).
  - Transmitted Interference Power Spectral Area Density: 45.6 mW/MHz-km^2
  - 4% transmit duty cycle
  - 1 AP/pop indoor RLAN density in Houston metro area
    - Pop. Density 260 pop/km^2
  - 1% AP/pop outdoor RLAN density
- Propagation model
  - free space for 1 km, then based on Urban Macro NLOS model from ITU-R Rep. M.2135.
- Interference Limit
  - - 6 dB I /N (ref)
  - Based in requirement to maintain high availability of links supporting critical infrastructure

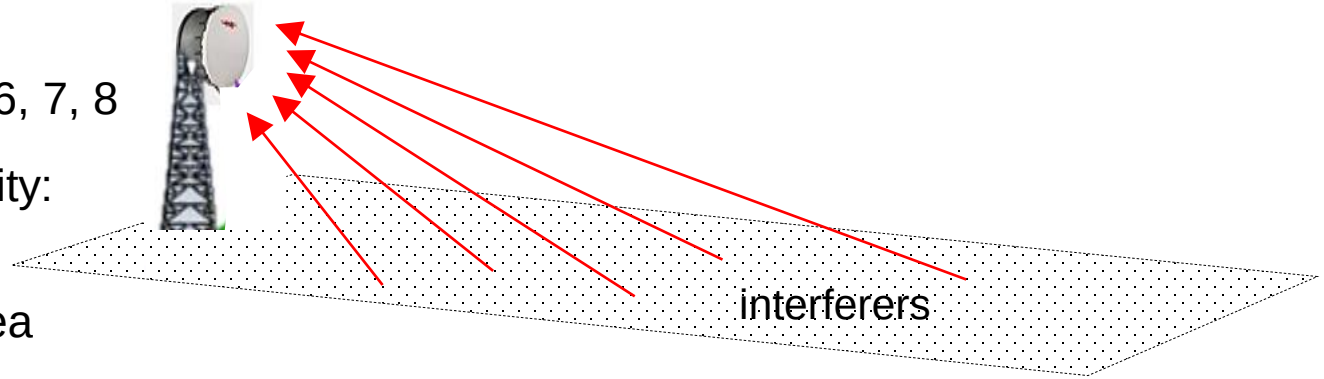
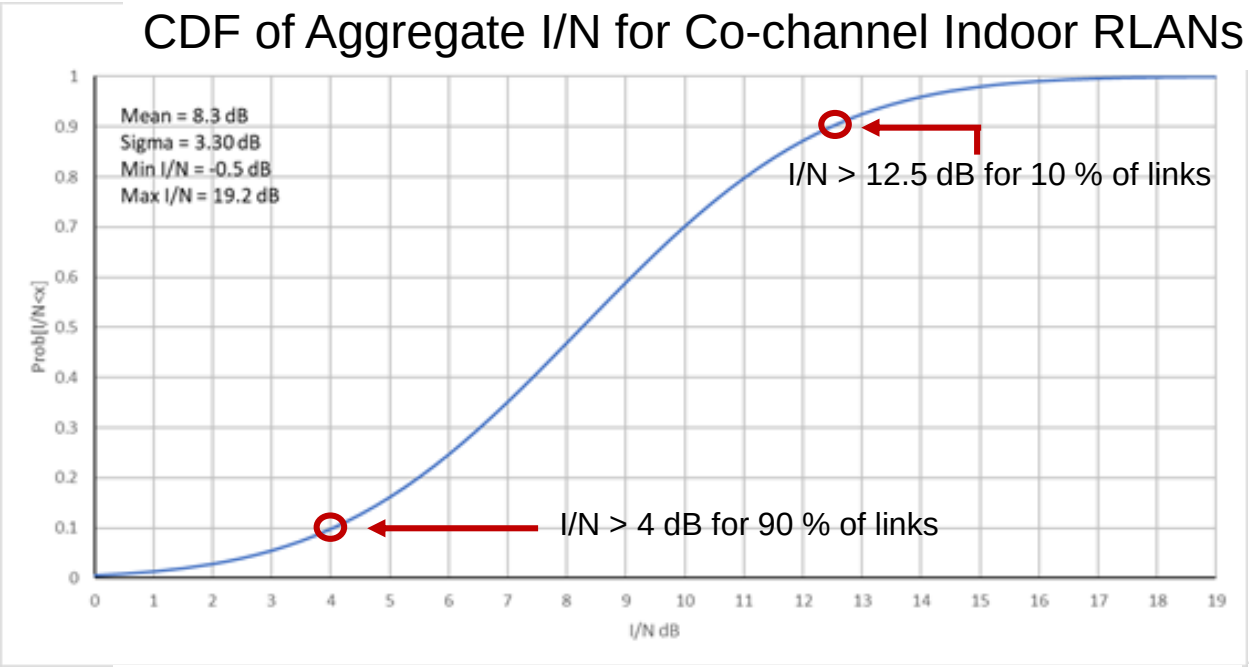


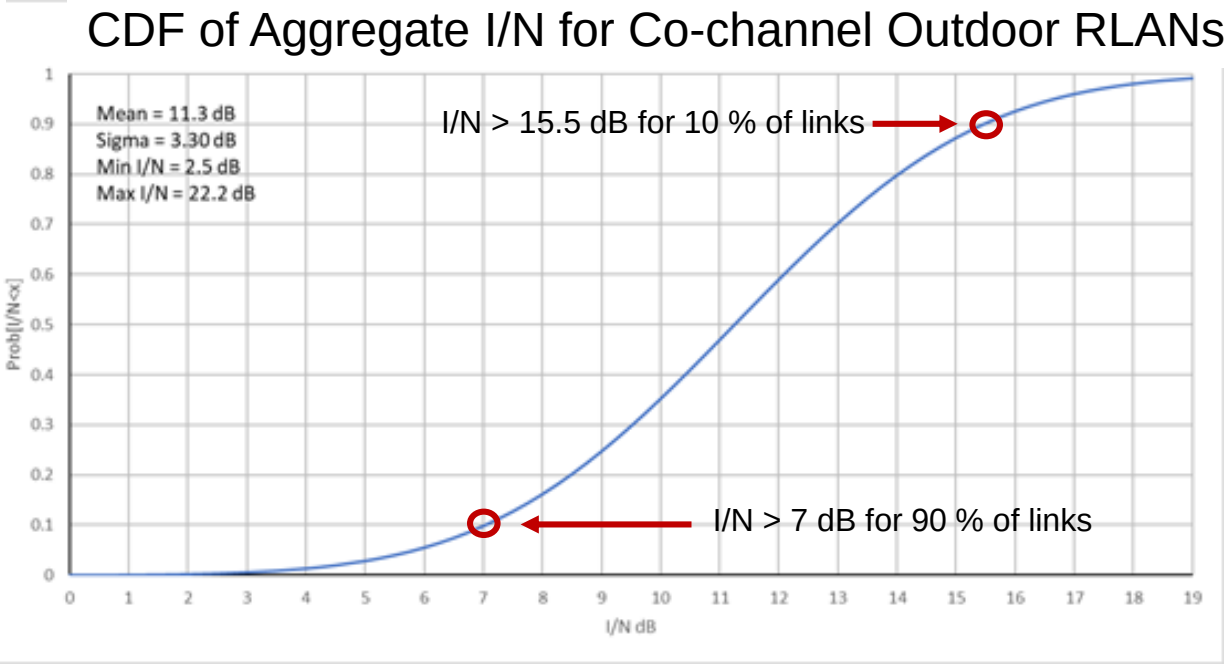
Figure 2

Nine County Houston MSA: Results for 2325 Point-to-Point Links

CDF of Aggregate I/N for Co-channel Indoor RLANs



CDF of Aggregate I/N for Co-channel Outdoor RLANs



Condition	Prob	I/N	Exceed Limit	Ratio
Indoor Co-Channel	Min	-0.54 dB	5.46 dB	3.5
	50%	8.26 dB	14.26 dB	27
	90%	12.50 dB	18.50 dB	71
	Max	19.24 dB	25.24 dB	334
Outdoor Co-Channel	Min	2.46 dB	8.46 dB	7.0
	50%	11.26 dB	17.26 dB	53
	90%	15.50 dB	21.50 dB	141
	Max	22.24 dB	28.24 dB	667
Indoor Adjacent Ch.	Max	-5.45 dB	0.55 dB	1.14
Outdoor Adjacent Ch.	99%	-5.55 dB	0.45 dB	1.11
	Max	-2.45 dB	3.55 dB	2.26

Indoor Co-channel RLANs

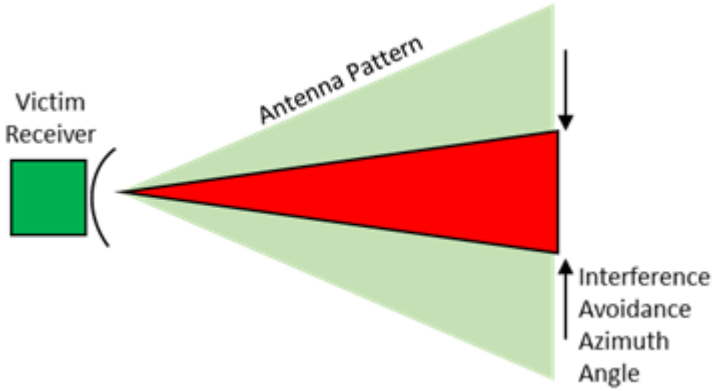
- -6 dB I/N for 90% of links exceeded by 10 dB
- Link with best (min) I/N exceeds -6 dB by 5.4 dB

Outdoor Co-channel RLANs

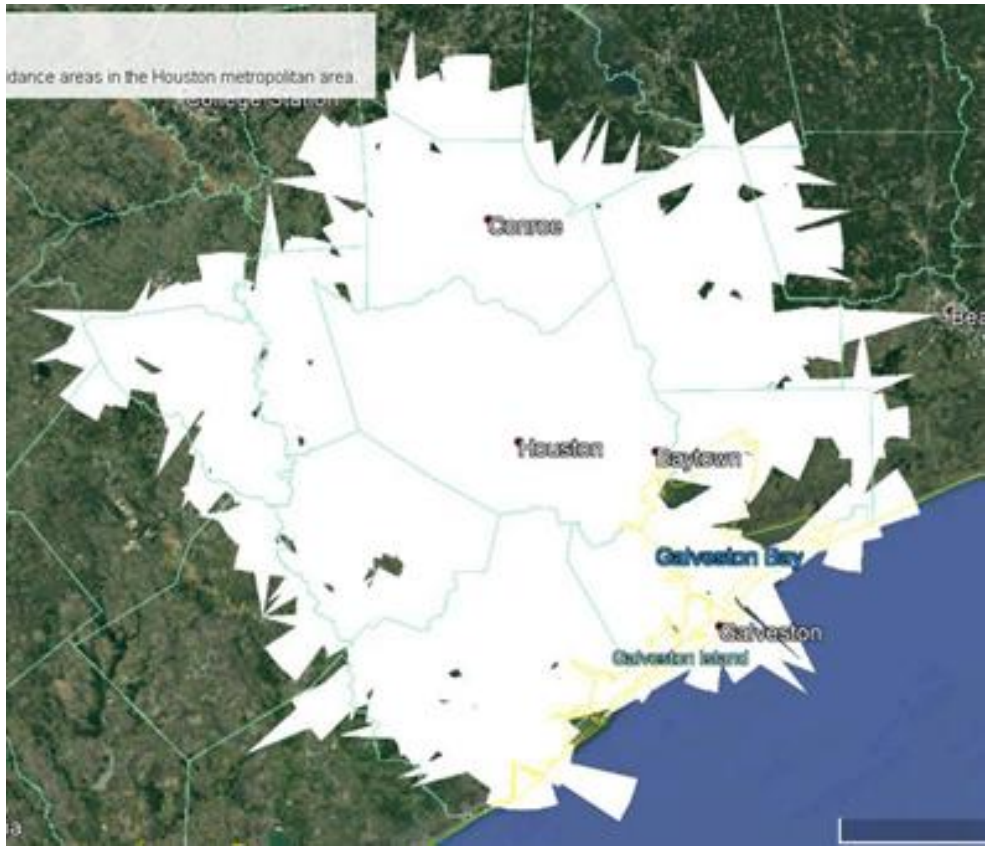
- - 6 dB I/N for 90% of links exceeded by 13 dB
- Link with best (min) I/N exceeds -6 dB by 8.4 dB

Houston RLAN Deployment Area Contributing to Excess I/N

Analysis: Interference Avoidance Azimuth Angle (IAAA) Increased Until 100% of Point-Point Links Protected at – 6 dB I/N



IAAA	Prob[I/N < -6 dB]	Prob[I/N > -6 dB]
0°	0%	100%
5°	17.2%	82.8%
10°	97.3%	2.7%
15°	99.9%	0.1%
20°	100%	0%



- Area within +/- 10^{o} of fixed receiver boresight should be clear of RLANs in order to protect all receivers
- This eliminates approximately 94% of Houston MSA from 6 GHz RLAN operations

Interference Analysis in Central Houston

Impact of 6 GHz Wi-Fi Operations in Central Houston (Section 7.4)

- Point-to-point receivers in 1 km radius of central Houston (7.4.1)
  - Interference Scenarios for 250 mW indoor RLAN, distributed over all U-NII channels
    - Backscatter aggregate interference into close-in antenna sidelobe (26 dBi @ -4^{o} ; 14 dB building loss
      - Result: I/N criteria exceeded by 9.4 dB (Table 6)
      - Conclusion: indoor RLAN operation must be avoided within 1-2 km of receiver.
    - Direct radiation into far-antenna sidelobe (-13 dBi @60^{o}); single RLAN; 0 dB building loss.
      - Result: I/N criteria exceeded by 14.8 dB (Table 7)
      - Conclusion: (single) indoor RLAN operation must be avoided within 200 m. of receiver
    - Direct radiation into antenna backlobe (- 30 dBi; single RLAN; 0 dB building loss)
      - Result: I/N criteria exceeded by 6 dB (Table 8)
      - Conclusion: indoor RLAN must be avoided within 50 m, all directions around receiver)
- Point-to-point transmitters in central Houston (far-receivers)
  - Interference Scenario for aggregate interference from RLANs in central Houston visible to Far point-to-point receivers -- all U-NII channels used (7.4.2.1)
    - Result: I/N criteria just met for far interferers; I/N criteria exceeded when RLANs close to receivers included
    - Conclusion: The aggregate RLAN interference from distant high-density RLAN deployments must be taken into account to protect receivers
  - RLAN operation on one Wi-Fi channel (impact of limited frequencies) (7.4.2.2)
    - Result: I/N criteria exceeded by 8.7 dB.

Results of Central Houston Analysis

Scenario	I/N	Exceed Spec (dB)	Ratio
Backscatter	3.48	9.48	8.9
Side lobe	8.91	14.91	31.0
Back lobe	0.43	6.43	4.4
Far-Side	-5.98	0*	4.0
Limited Frequencies	2.69	8.69	7.4

Conclusion: Additional interference effects that increase I/N need to be considered.

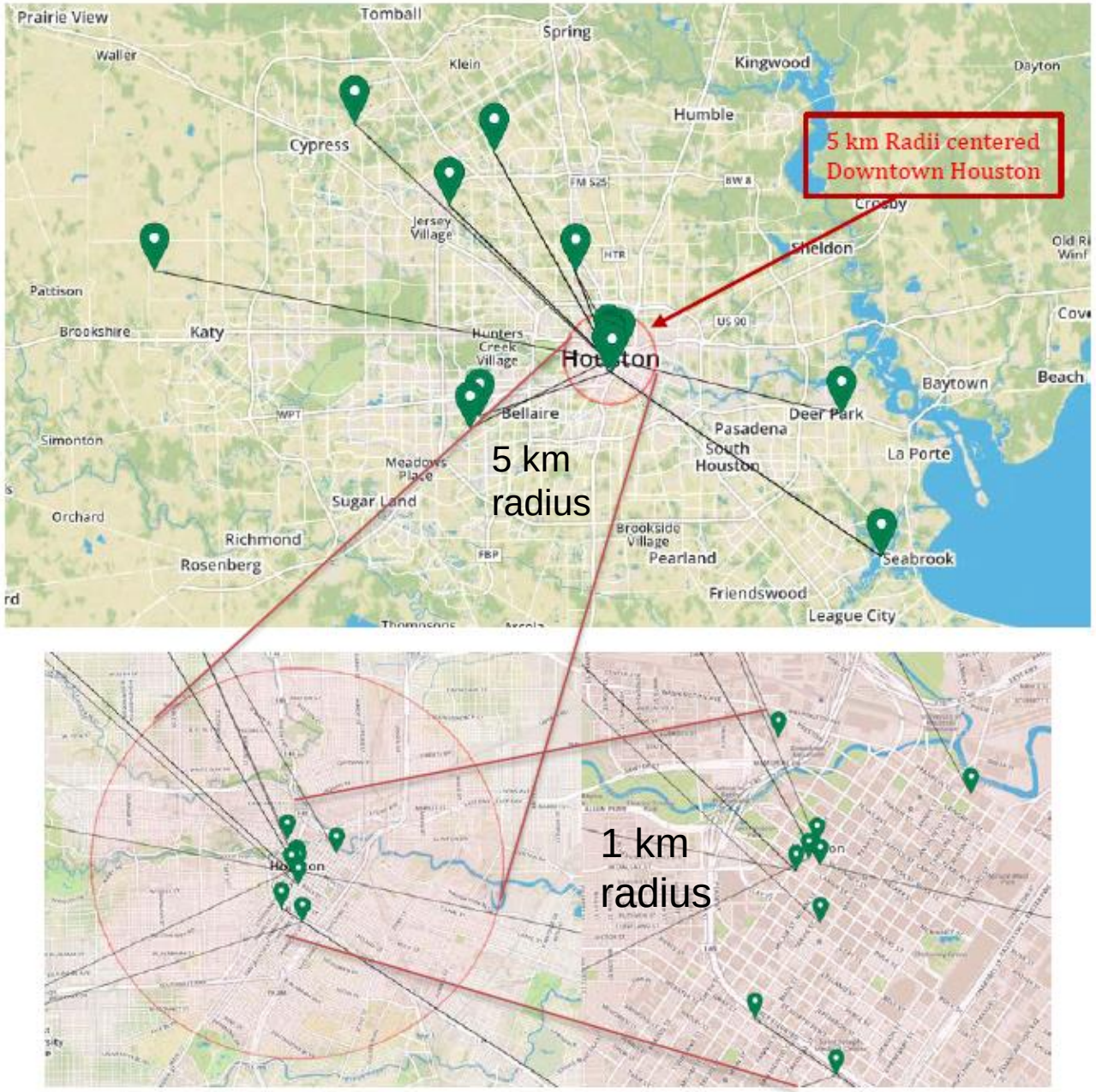
*exceeds –6 dB I/N spec if near-in interferences sources included

Availability of Wi-Fi Channels in Central Houston

- 34 point-point receivers in 1 km radius
  - Preceding analysis indicates RLANs cannot operate within 1 km of receiver

- Conclusion
  - To avoid interference to receivers in central Houston, no overlapping Wi-Fi channels can be used

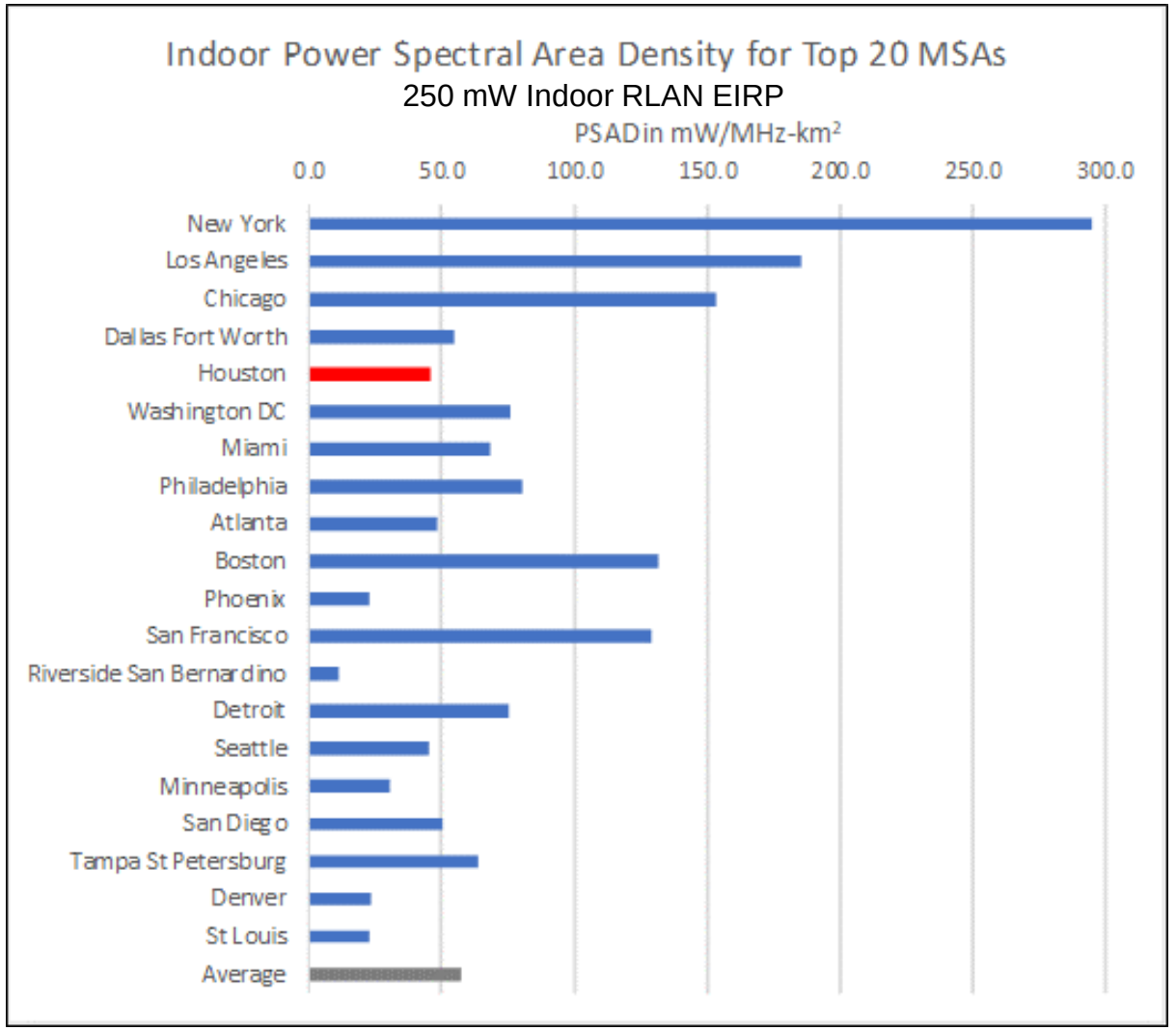
RLAN Channel Number	Number of Microwave Receivers in this channel	Number of Microwave Transmistters in this channel	Number of Microwave Radios - Rx or Tx in this channel
1	3	8	11
2	4	7	11
3	8	1	9
4	2	2	4
5	1	3	4
6	3	0	3
7	0	0	0



Top 20 Metropolitan Statistical Areas and Expected Aggregate Interference Power Spectral Area Density (PSAD)

- Houston exhibits a lower expected PSAD than most of the top metros

- Other top metros are expected to have higher aggregate interference levels into point-point receivers based on population



Proposed Very Low Power Outdoor Operation

VLP Interference Analysis* and Revision

	Parameter	Previous Filing		Revised	Comment
A	RLAN Bandwidth	160	MHz	160	But I/N would increase 6 dB for 80 MHz BW (not shown in Total I/N)
B	Maximum RLAN EIRP	14	dBm	20	Revised for aggregate power of 4 devices
C	Body Loss /Transmit Power Control	-18	dB	-15, -12	Revised for +3, +6 dB above minimum power
D	Effective RLAN EIRP	-4	dBm	+5, +8	Revised EIRP is 9 dB or 12 dB greater
E	Feeder/System Loss	-2	dB	-2	No justification provided for this value
F	Polarization Mismatch	-3	dB	-2	No justification provided for this value
G	Antenna Mismatch	-3	dB	-3	No justification provided for this value
H	FS-RLAN Distance (horiz)	100	m.	100	Should use multiple actual distances
I	FS Gain (@9.37 degrees)	4.86	dB	4.86	Should use actual gains vs angle
J	Prop Loss (FSPL)	88	dB	88	Should calculate for multiple interferers
K	Total I/N	-8.2	dB	+0.8, +3.8	Revised interference exceeds -6 dB I/N by 6.8 or 9.8 dB

Likely Interference scenario

I/N's in excess of -6 dB

Result: Practical and likely VLP scenarios exist resulting in I/N in excess of -6 dB

Conclusion: More study is required

* cf: Ex parte filing, Harris, Wiltshire, and Grannis, December 9, 2019, Re: *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295; *Expanding Flexible Use in Mid-Band Spectrum between 3.7 and 24 GHz*, GN Docket No. 17-183.

Conclusions

- For Nine County Houston MSA
  - Unrestricted indoor or outdoor RLAN deployment will significantly impair CII point-to-point links
  - I/N ratios between 5.4 and 25.2 dB in excess of -6 dB I/N occur for indoor RLANs
  - I/N ratios between 8.4 and 28.2 dB in excess of -6 dB I/N occur for outdoor RLANs
  - RLAN deployment in 94% of Houston MSA would need to be prevented in order to protect all point-to-point links at -6 dB I/N
  - Indoor or outdoor RLANs cannot be deployed without AFC to protect licensed fixed microwave
  - AFC needs to take into account both aggregate interference from RLANs to the 2325 individual point-to-point links, and the interference scenarios for each link.

- For Central Houston
  - Analysis of actual interference scenarios (interference backscatter; receiver main-, side- and back-lobes) with high-rise RLAN deployment indicates RLANs should not operate within 1 km of point-to-point receiver
  - If fixed receivers are to be protected, analysis of actual frequencies of operation of fixed receivers in Central Houston reveals there are no 160 MHz Wi-Fi channels available for use in central Houston

- For Very Low Power Outdoor Operation
  - Practical and likely VLP scenarios exist causing I/N in excess of -6 dB
  - Further analysis is required