

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Status of 2360 to 2400 MHz MBANS Proposal to the FCC

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Re: IEEE P802.15-08-0108-01-0006, 15-08-0254-02-006, 15-08-0491-00-0006, 15-08-0537-01-0006

Abstract: This presentation provides an update on the status of the FCC public notice regarding GE Healthcare's proposal to create a new Medical Body Area Network Service

Purpose: To inform TG6 of the FCC's public notice and progress towards a Notice of Proposed Rulemaking.

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Status of 2360 to 2400 MHz Medical Body Area Network Service (MBANS) Proposal to the FCC

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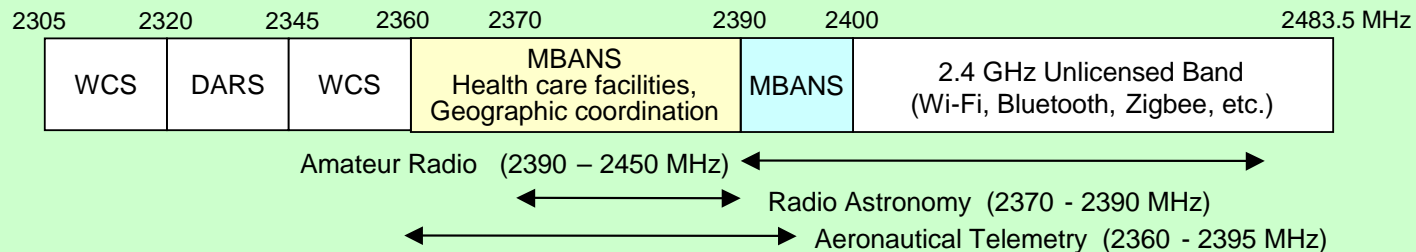
Refined, Proposed Part 95 Rules for Medical Body Area Network Service (MBANS)

Eligibility & Permissible Communications

- Licenses by rule operations by authorized health care professionals and by any other person, if such use is prescribed by a health care professional. Limited to transmission of data (no voice) used for monitoring, diagnosing or treating patients.

Frequencies & Authorized Locations

- **2360-2390 MHz** MBANS operations in the 2360-2390 MHz band limited to health care facilities only. Establish geographic exclusion zones around all 157 aeronautical mobile telemetry receive sites. MBANS operations in the 2360-2390 MHz band would not occur within such geographic exclusion zones.
- **2390-2400 MHz** operations permitted anywhere CB radios may operate.



Technical Parameters

- All stations must employ unrestricted contention-based protocol.
- Maximum emission bandwidth of 1 MHz.
- Maximum EIRP not to exceed the lesser of **1 mW** or $10 \log BW_{20dB \text{ MHz}} \text{ dBm}$.
- Same out-of-band (more than 500 kHz outside of band) field strength limits as apply to MICS.

Reference = http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520184274, Nov 2008

Brief Update on Recent Developments

Based on feedback from the Commission, NTIA, AFTRCC and other interested parties, GEHC proposed several modifications to the MBANS rules:

- Clarified proposed footnote NG186 in the Table of Allocations to state that aeronautical mobile use is prohibited only for MBANS devices and that the status of all currently-allocated services (including AMT) remains unchanged.
- Also modified proposed footnote NG186 to clarify GE Healthcare’s intent that MBANS operations be secondary to all primary services, regardless of frequency band.
- Proposed geographic exclusion zones for MBANS operations in the 2360-2390 MHz band around all AMT receive sites to further reduce the potential for interference while still creating an extremely valuable resource from otherwise fallow spectrum – “belt and suspenders” approach.

Recent supportive / concurring filings in the record:

- Philips
- Draeger-Seimens
- SpaceLabs
- AdvaMed
- Texas Instruments
- Baxter
- Toumaz
- ST+D
- WCA
- Paul Kolodzy

A 9.7 km exclusion radius, which the latest conservative analysis shows to be more than sufficient, would make the entire 2360-2400 MHz band available in over 99.5% of CONUS while one quarter of the band (2390-2400 MHz) would be available everywhere.

GEHC has submitted rigorous new coexistence analysis that clearly demonstrates viability.

**With the remaining issues substantially narrowed,
an NPRM is the appropriate next step.**

Comments Support Clinical / Public Benefits

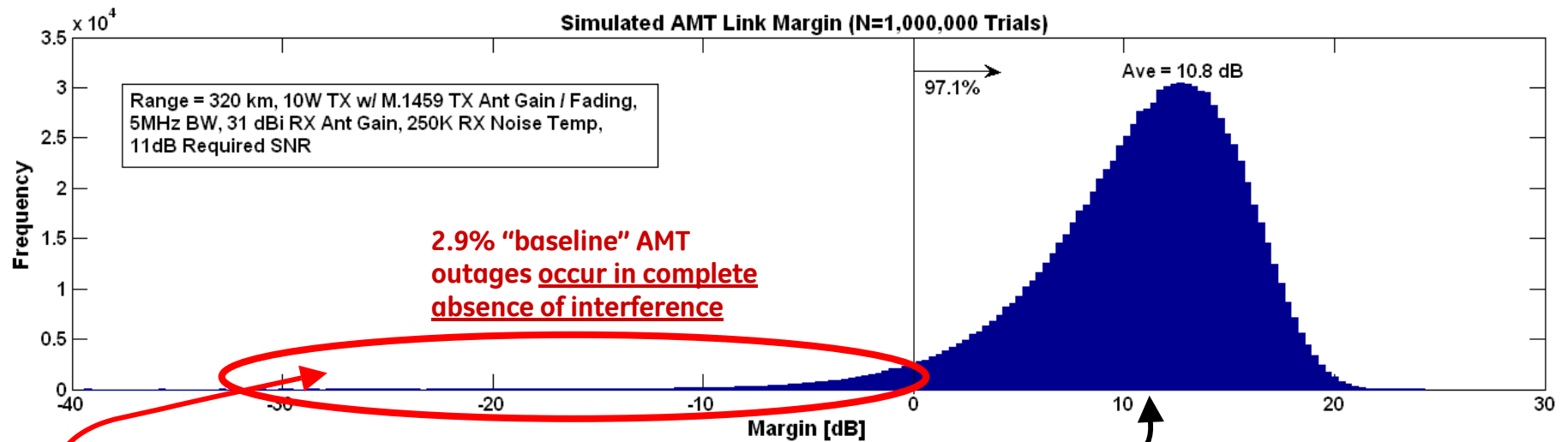
- **Michael Shabot (M.D., VP and Chief Quality Officer, Memorial Hermann Healthcare):** “As a surgeon and critical care intensivist, I strongly support the allocation of bandwidth to support wireless medical Body Sensor Networks. Such a network would free critically ill patients from electrical patient monitoring cables that are inconvenient, obtrusive and even unsafe at times. If these cables could be eliminated with a Body Sensor Network, patients would be more comfortable and physicians and nurses would be able to provide better care.”
- **Kim Bonzheim (Director, Cardiac Services, William Beaumont Hospital):** “[T]he ability to reduce or eliminate wires and cords would be a significant benefit to caregivers.”
- **Marilyn Rantz (RN, PhD, FAAN, Prof., Sinclair School of Nursing, University of Missouri):** “If we are to manage the enormous population of older adults in our society and begin to meet their chronic illness needs, technology must be developed that can be used to support home and community based care as well as traditional long term care services. Dedicated radio spectrum frequencies for the wireless communication of these technological advances are critical to their success. Please support this petition.”
- **Lisa Gaudet (Director, Remote Care Technology, Northeast Health, Troy, NY):** “I support the application for new spectrum allocation for wireless service. This increase will allow us to provide more pervasive monitoring of our patients. This will offer improved quality outcomes, efficient use of resources, and better quality of life for our patients.”
- **David Pugliese (D.O., Geisinger Specialty Clinic, Wilkes-Barre, PA):** “[Wireless monitoring] is definitely a benefit to patient care, [both] with regard to logistics and quality of care.”
- **Anthony Mastroianni (M.D., Schenectady, NY):** This proposal will help health care professionals provide more pervasive monitoring of our patients while mitigating issues of interference and radio co-existence within the hospital environment.
- **Nick Oliver (diabetologist and medical technologist, BSc MBBS MRCP, Clinical Research Fellow, Imperial College):** As hospitals and health care providers move to adopt electronic medical records, we will need to send electronic clinical data on a regular basis to the patient’s chart. The reliability of these patient monitoring systems is critical to safe patient care enhanced by real-time clinical data.

Coexistence Topics Executive Summary

- GEHC has recently completed new much more rigorous analysis that indicates the viability of coexistence between MBANS and AMT.
 - Monte Carlo statistical analysis using industry-accepted tools indicates acceptable SNR levels with modest back-off range
 - Recent ECC draft report 121 supports the viability of the MBANS proposal by determining that aeronautical telemetry and “PWMS” wireless microphones operating in the L-band with 50 mW-per-200 kHz emissions limit can coexist.
 - AFTRCC analysis is based entirely on static MCL calculations of absolute power flux density (ITU M.1459), which is not a *necessary* condition for coexistence
- OOB of legal, FCC certified, and ubiquitously deployed Part 15 devices in the 2400-2483 MHz band already violate AFTRCC’s requested PFD limit in the AMT band without any adverse effects noted
- Learjet Tests provided by AFTRCC are notable in two ways:
 - Used continuous narrowband test signals that were not representative of proposed MBANS devices (e.g., the test signals used much higher power spectral density)
 - The tests did not demonstrate any actual observed harmful interference (outage) effects beyond 0.7 miles separation— consistent with GEHC statistical analysis.
- The evidence is clear that coexistence is possible and readily manageable.

Reference = http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520184274, Nov 2008

Actual Characteristics of Typical AMT Link That Are Not Accounted for in AFTRCC Analysis



- At most points in time, AMT link has copious excess margin.
- AMT outages are driven by long “tail” of fading distribution – outages will be relatively common, even with zero interference.
- Although imperfect, the AMT link is quite robust – outage rate is insensitive to moderate interference.
- For cases where a perfectly-reliable AMT link really is required, it would best be achieved through techniques like coding or diversity, which can exploit the significant excess margin, and not by preserving fractional dBs of SNR by seeking to limit interference to unrealistically low thresholds.

Either: Outage rates of several percent are, in fact, acceptable and are being tolerated already,
Or: The AMT link budget actually has more margin than AFTRCC has acknowledged (e.g. not operating out to full 320 km, using more TX power than claimed, actual fading is less severe than claimed 30 dB, incorporating coding, diversity, or other mitigation techniques, etc.).

AFTRCC Inappropriately Applies M.1459 PFD Limit

- The M.1459 power flux density limit is very stringent in general and is particularly inappropriate for application to the 2360-2395 MHz AMT band, as is done by AFTRCC.
- Unlike other AMT bands, the 2360-2395 MHz band already has significant noise due to fundamental and spurious emissions from a variety of non-AMT sources operating in the same or adjacent bands.
- Applying AFTRCC’s analysis, which is based on the ITU-R M.1459 PFD limit, to permitted emissions from these existing interference sources yields absurd results...

| Interference Source | Separation distance required to satisfy M.1459 PFD limit using n=2.4 propagation exponent |
|--|--|
| Single typical amateur radio transmitter | 10W fundamental emissions: 1,370 km , -50 dBc OOB: 11.3 km , -60 dBc OOB: 4.4 km |
| Single Part 27 WCS device | OOB ¹ : 17.8 km |
| Single Part 18 ISM device | OOB ² : 7.0 km |
| Single 2.4 GHz Part 15 unlicensed device | Ubiquitous, Uncontrolled Devices |
| | 2360-2390 MHz Average OOB ³ : 1.2 km |
| | 2360-2390 MHz Peak OOB ⁴ : 8.1 km |
| | 2390-2395 MHz -20 dBc OOB ⁵ : 162 km |

¹ See 47 CFR 27.53(a); ² See 47 CFR 18.305 and FCC MP-5-1986 Measurement Procedure; ³ See 47 CFR 15.209(a); ⁴ See 47 CFR 15.209(a) and 15.35(b); AFTRCC has suggested that peak, rather than average, emissions should be used in analysis; ⁵ See 47 CFR 15.247(d)

Actual Part 15 OOB will already violate PFD Limit

- Part 15 devices are:
 - Highly uncontrolled
 - Ubiquitous
 - Portable / used outdoors
- A review of compliance data revealed that emissions from many real-world devices are commonly at or near their maximum permissible limits in the AMT band.
- Data shows this to be *the rule, not the exception*, for popular “Wi-Fi” devices.
- Wide array of products (e.g., access points, notebook computers, smartphones, digital music players) from leading manufacturers, including many products designed for portable and/or outdoor use.
- Phenomenon is not limited to any one 802.11 standard, modulation type, data rate, or channel.
- With no assurance of several km separation from AMT sites, the M.1459 PFD limit cited by AFTRCC can be expected to be significantly exceeded today.

Selected examples...

Less than 1 dB margin to limit is common.

| Manufacturer | Device Description | FCC ID | Freq. [MHz] | Emission [dBuV/m@3m] | Test Condition |
|--------------|--|----------------------|-------------|----------------------|--|
| 3Com | AP3150 Wi-Fi Access Point | O9C-AP3150 | 2386.20 | 53.70 Ave | 802.11b, channel 1, antenna 2 |
| | | | 2390.00 | 53.55 Ave | 802.11g, channel 1, antenna 2 |
| | | | 2389.93 | 73.64 Peak | 802.11n, 20MHz channel 1 |
| 3Com | AP3950 802.11n Wi-Fi Access Point | O9C-AP3950 | 2390.00 | 53.57 Ave | 802.11n, 20MHz channel 6 |
| | | | 2390.00 | 53.92 Ave | 802.11n, 40MHz channel 1 |
| | | | 2386.36 | 52.07 Ave | 802.11b, channel 1 |
| | | | 2390.00 | 53.28 Ave | 802.11g, channel 1 |
| Apple | iPod Touch | BCGA1288 | 2390.00 | 53.08 Ave | 802.11g, channel 1, horz pol |
| Aruba | AP-70 802.11b/g Wi-Fi Access Point | Q9DAP70SDR | 2390.00 | 52.28 Ave | 802.11g, channel 1, 6dBi antenna-2 |
| | | | 2390.00 | 73.30 Peak | 802.11b, channel 1, 12dBi antenna-7 |
| | | | 2390.00 | 52.54 Ave | 802.11b, channel 1, integral ant. ART = 17.5 |
| Aruba | AP-120 802.11n Wi-Fi Access Point | Q9D AP120121SDR | 2390.00 | 73.19 Peak | 802.11g, channel 1, integral ant. ART = 13.5 |
| | | | 2390.00 | 73.37 Peak | 802.11n HT-20, channel 1, integral ant. ART = 12 |
| | | | 2390.00 | 53.08 Ave | 802.11n HT-40, channel 1, integral ant. ART = 9.5 |
| | | | 2388.38 | 52.44 Ave | Mode 4: 802.11n(20M) (2412MHz) (Ant A), horz pol |
| Asustek | R1E Notebook PC with integrated 802.11n Wi-Fi | MSQR1E | 2389.87 | 53.95 Ave | 802.11g, channel 1, 18 dBi, vert pol |
| Broadcom | Wi-Fi module for notebook PCs (e.g. Dell D620) | QDS-BRCM1020 | 2386.60 | 53.44 Ave | 2412 MHz, 11 Mbps, Legacy CCK, Dual Paths |
| Cisco | AIR-AP1141 / 1142 802.11n Access Points | LDK102069, LDK102070 | 2390.00 | 54.00 Ave | 2412 MHz, 54 Mbps, Non HT-20, Single Transmit Paths |
| | | | 2390.00 | 53.61 Ave | 2412/2432 MHz, 54 Mbps, Non HT-20 Beam Forming |
| | | | 2389.20 | 73.58 Peak | 2412/2432 MHz, 54 Mbps, Non HT-40 Dupl, Dual Paths |
| Cisco | Aironet LAP1510 802.11b/g outdoor Access Point | LDK102058 | 2385.90 | 53.35 Ave | 802.11b, channel 1, 5.5 dBi antenna |
| | | | 2390.00 | 53.89 Ave | 802.11g, channel 1, 5.5 dBi antenna |
| D-Link | DIR 825 802.11n Wi-Fi Router | KA2DIR825A1 | 2390.00 | 72.88 Peak | 802.11n (20 MHz), channel 1, vert pol |
| | | | 2382.00 | 52.74 Ave | 802.11n (40 MHz), channel 1, vert pol |
| Dell | Notebook PC | E2K24GBRL | 2390 | 52.54 Ave | 802.11g, channel 1, vert pol |
| | | | 2385.2 | 52.87 Ave | 802.11b, channel 1, horz pol |
| IBM | ThinkPad G40 2387, 2388, 2389 notebook PCs | ANO 20020306A1L | 2368.00 | 53.10 Ave | 802.11g, channel 6, horz pol |
| | | | 23900000 | 53.92 Ave | 802.11g, 2417MHz, pwr setting 0x33xx, vert pol |
| Linksys | WRT600N 802.11n Wi-Fi Access Point | WRT600NV11 | 23900000 | 53.84Ave | 802.11 SISO, 2427MHz, pwr setting 0x41xx, vert pol |
| | | | 2389.6 | 53.8 Ave | 802.11n 40MHz, 2422MHz, pwr setting 0x3f3d, vert pol |
| | | | 2388.6 | 53.92 Ave | 802.11n 20MHz, 2412MHz, pwr setting 0x433e, vert pol |
| | | | 2386.00 | 53.25 Ave | 802.11b, channel 1 |
| Meru | AP-150 802.11b/g Wi-Fi Access Point | RE7-AP150R2 | 2390.00 | 53.82 Ave | 802.11g, channel 1 |
| | | | 2390.00 | 53.70 Ave | 802.11g Turbo, channel 6 |
| | | | 2385.60 | 53.67 Ave | 802.11b channel 1, antenna 5 |
| Meru | OAP-180 802.11b/g Outdoor Wi-Fi Access Point | RE7-OAP180 | 2390.00 | 53.42 Ave | 802.11g channel 1, antenna 5 |
| | | | 2390.00 | 53.84 Ave | 802.11g turbo channel 6, antenna 5 |
| | | | 2390.00 | 53.84 Ave | 802.11g turbo channel 6, antenna 5 |
| Nokia | E61 RM-89 Wi-Fi Enabled smartphone | PYARM-89 | 2390.00 | 71.32 Peak | 802.11g, 48 Mbps symbol rate, channel 1 |
| Palm | Treo Pro Wi-Fi Enabled smartphone | O8F-SKYG | 2389.99 | 52.43 Ave | 802.11b, channel 1, horz pol |
| | | | 2390.00 | 72.44 Peak | 802.11g, channel 1, horz pol |
| Proxim | ORINOCO AP-700 802.11b/g Access Point | HZB-AP700 | 2390.00 | 52.40 Ave | 802.11b, channel 1, antenna 4, vert pol |
| | | | 2390.00 | 52.30 Ave | 802.11b, channel 6, antenna 5, vert pol |
| | | | 2360.00 | 52.80 Ave | 802.11b, channel 11, antenna 5, vert pol |
| | | | 2378.00 | 53.20 Ave | 802.11b, channel 11, antenna 5, vert pol |
| RIM | BlackBerry 8820 | L6ARBG40GW, | 2390.00 | 51.20 Ave | 802.11b/g, channel 1, vert pol |
| Samsung | Q1 Ultra Mobile PC | A3L-NP-Q1 | 2369.60 | 53.59 Ave | 802.11b, channel 1, foxconn ant, horz pol. |
| | | | 2390.00 | 53.57 Ave | 802.11g, channel 1, foxconn ant, horz pol. |
| | | | 2390.00 | 53.09 Ave | 802.11g, channel 1, foxconn ant, vert pol. |
| | | | 2368.80 | 53.29 Ave | 802.11b, channel 1, KAE ant, horz pol. |
| | | | 2369.20 | 53.94 Ave | 802.11b, channel 1, KAE ant, vert pol. |
| | | | 2364.40 | 53.45 Ave | 802.11g, channel 1, KAE ant, horz pol. |
| Sony | VAIO notebook PC with integrated 802.11g Wi-Fi | AK8PCG6J1L | 2389.58 | 51.28 Ave | 802.11g, channel 1 |
| | | | 2386.36 | 52.07 Ave | 802.11b, channel 1 |
| Trapeze | Model 430 802.11n Wi-Fi Access Point | QZE303 | 2390.00 | 53.28 Ave | 802.11g, channel 1 |
| | | | 2389.93 | 52.40 Ave | 802.11n, 20MHz channel 1 |
| | | | 2389.84 | 72.93 Peak | 802.11n, 20MHz channel 6 |
| | | | 2390.00 | 53.92 Ave | 802.11n, 40MHz channel 3 |
| | | | 2390.00 | 53.39 Ave | 802.11n, 40MHz channel 6 |

Reference: http://fjiaffoss.fcc.gov/prod/lects/retrieve.cgi?native_or_pdf=pdf&id_document=6520183249, 30 Oct 2008

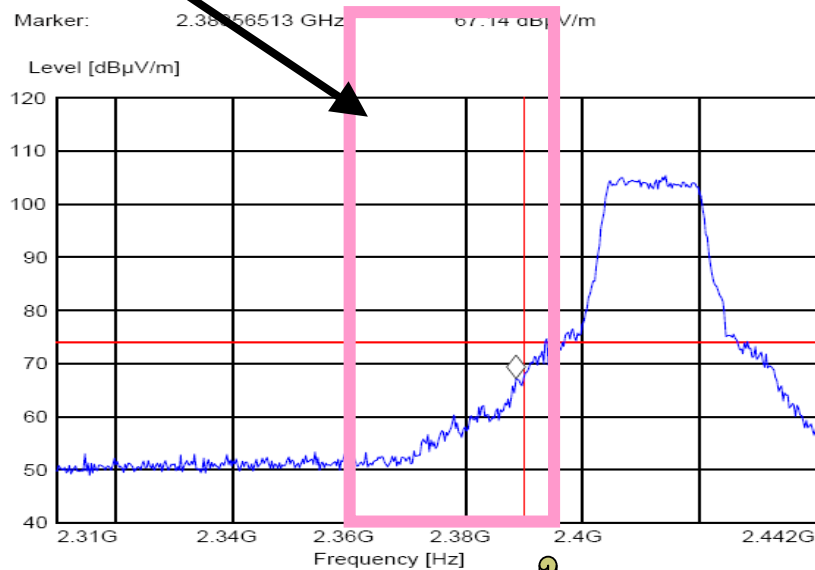
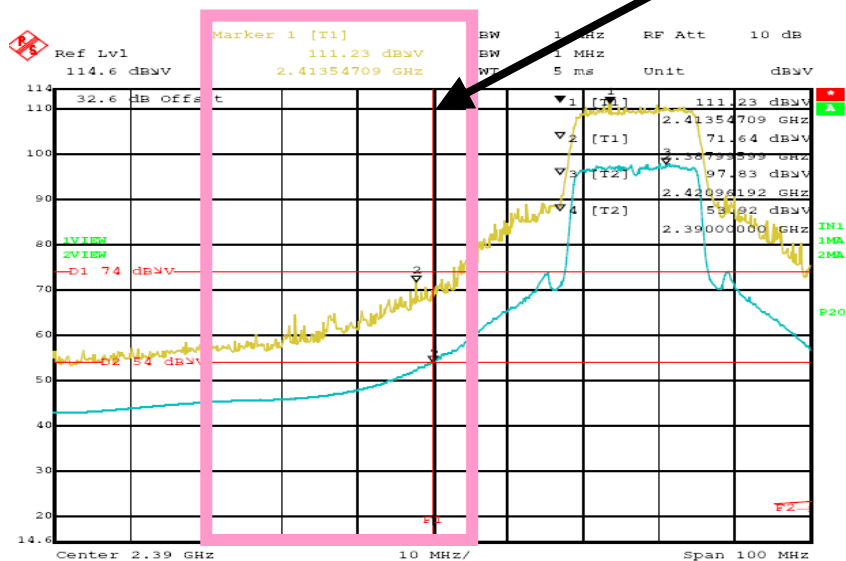
Actual Part 15 Device Emission Examples

Linksys WRT600N 802.11n Access Point¹

Apple iPhone²



2360-2395 MHz
portion of
proposed band
used by AMT



Significant OOB occur with multiple Wi-Fi standards, but especially with the newer 802.11g and 802.11n that employ OFDM.

¹ See https://gulfoss2.fcc.gov/prod/oe/forms/blobs/retrieve.cg?attachment_id=789037&native_or_pdf=pdf
² See https://gulfoss2.fcc.gov/prod/oe/forms/blobs/retrieve.cg?attachment_id=767386&native_or_pdf=pdf

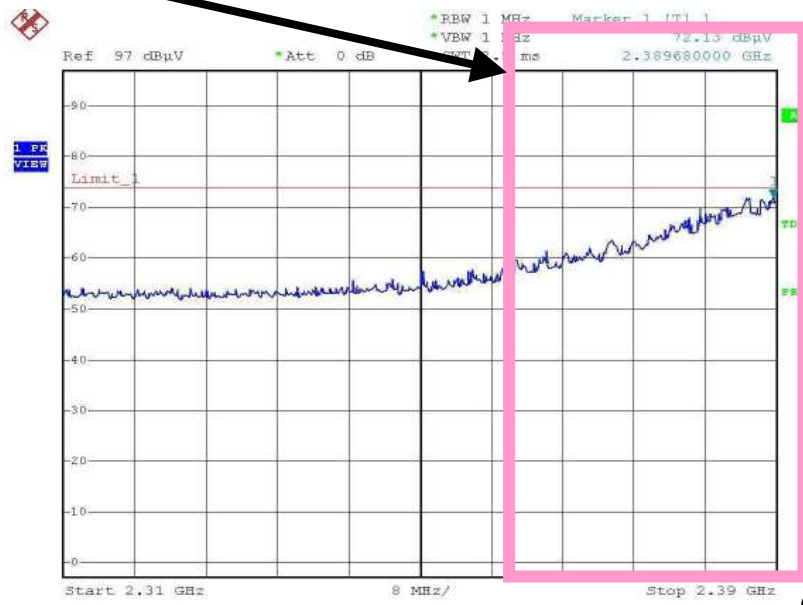
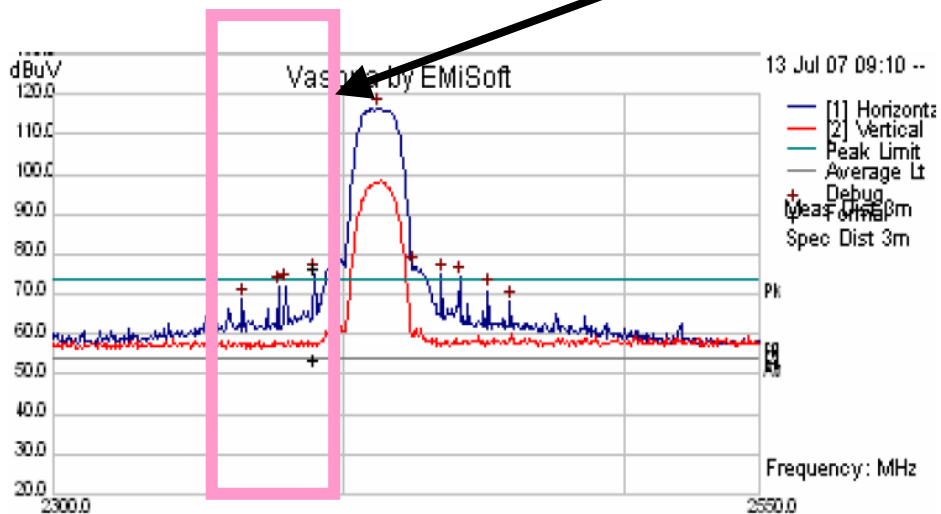
Actual Part 15 Device Emission Examples

Aruba AP-70 802.11b/g Wi-Fi Access Point¹

Linksys WRT350N 802.11n Access Point²



2360-2395 MHz
portion of
proposed band
used by AMT



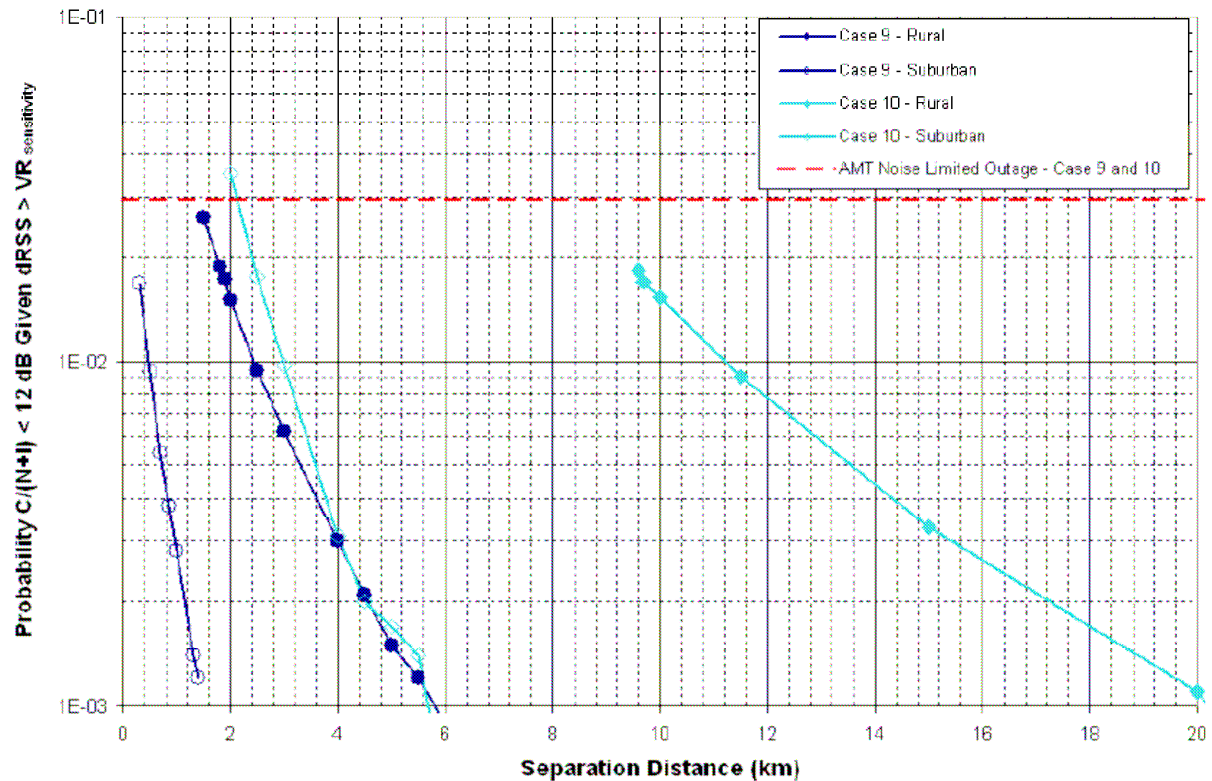
Significant OOB/E occur throughout AMT band, not just at upper end.

¹ See https://gulfoss2.fcc.gov/prod/oe/forms/blobs/retrieve.cgi?attachment_id=820101&native_or_pdf=pdf
² See https://gulfoss2.fcc.gov/prod/oe/forms/blobs/retrieve.cgi?attachment_id=711130&native_or_pdf=pdf

Monte Carlo Analysis Confirms MBANS / AMT Coexistence With Modest Separation Distances

Simulated conservative, worst-case scenario:

- 50 interference-contributing MBANS systems in the main beam of an AMT receive antenna.
- Range of AMT transmitter to receiver was fixed at the worst-case of 320 km.
- AMT Propagation model with Rayleigh-like fading from ITU-R M.1459
- MBANS propagation did not include body loss or antenna mismatch



Resulting upper bounds on sufficient separation:

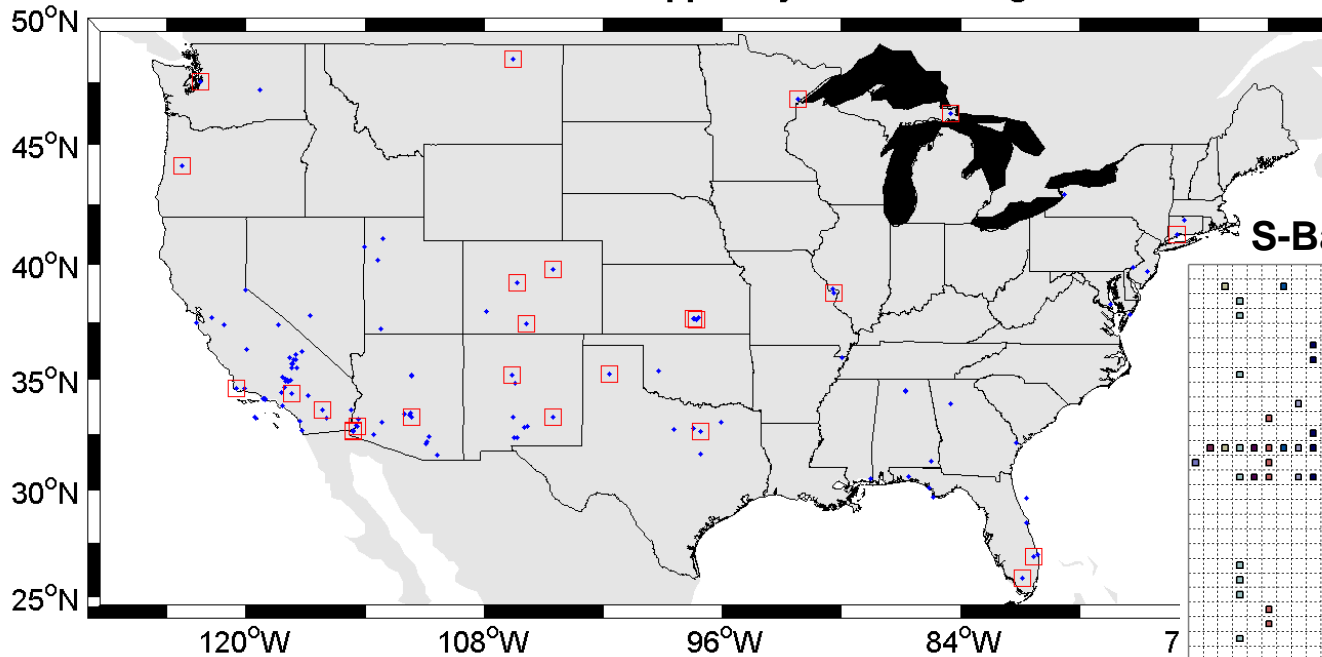
≤3.3 km for suburban propagation.

9.7 km for rural propagation with typical 31 dBi (8' diameter) AMT antenna.

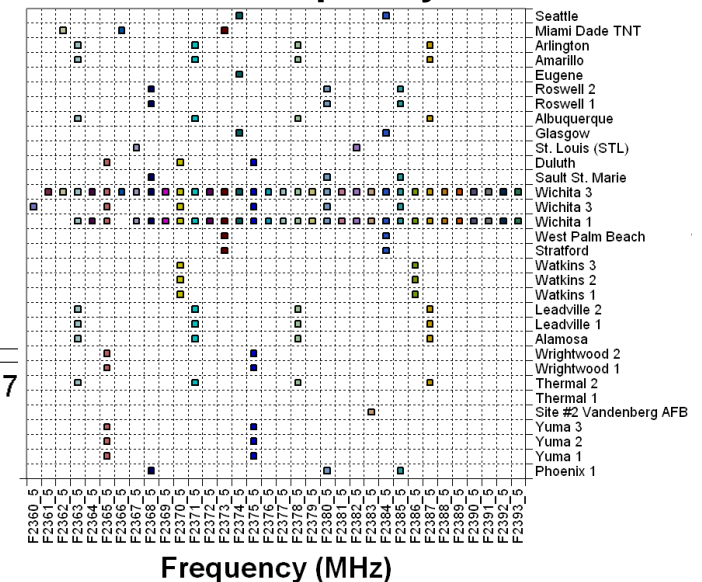
Compare to AFTRCC's claim that 62 km required for a single 1 mW MBANS device.

AMT Receive Operations are Very Sparsely Distributed in Space, Frequency and Time.

157 AFTRCC Sites Mapped By Latitude/Longitude



S-Band Frequency Licenses



- Only 32 of 157 AMT sites have an S-band license.
- 30 AMT sites use 4 or fewer channels out of 34.
- Fight test operations are inherently non-continuous and sporadic in nature.

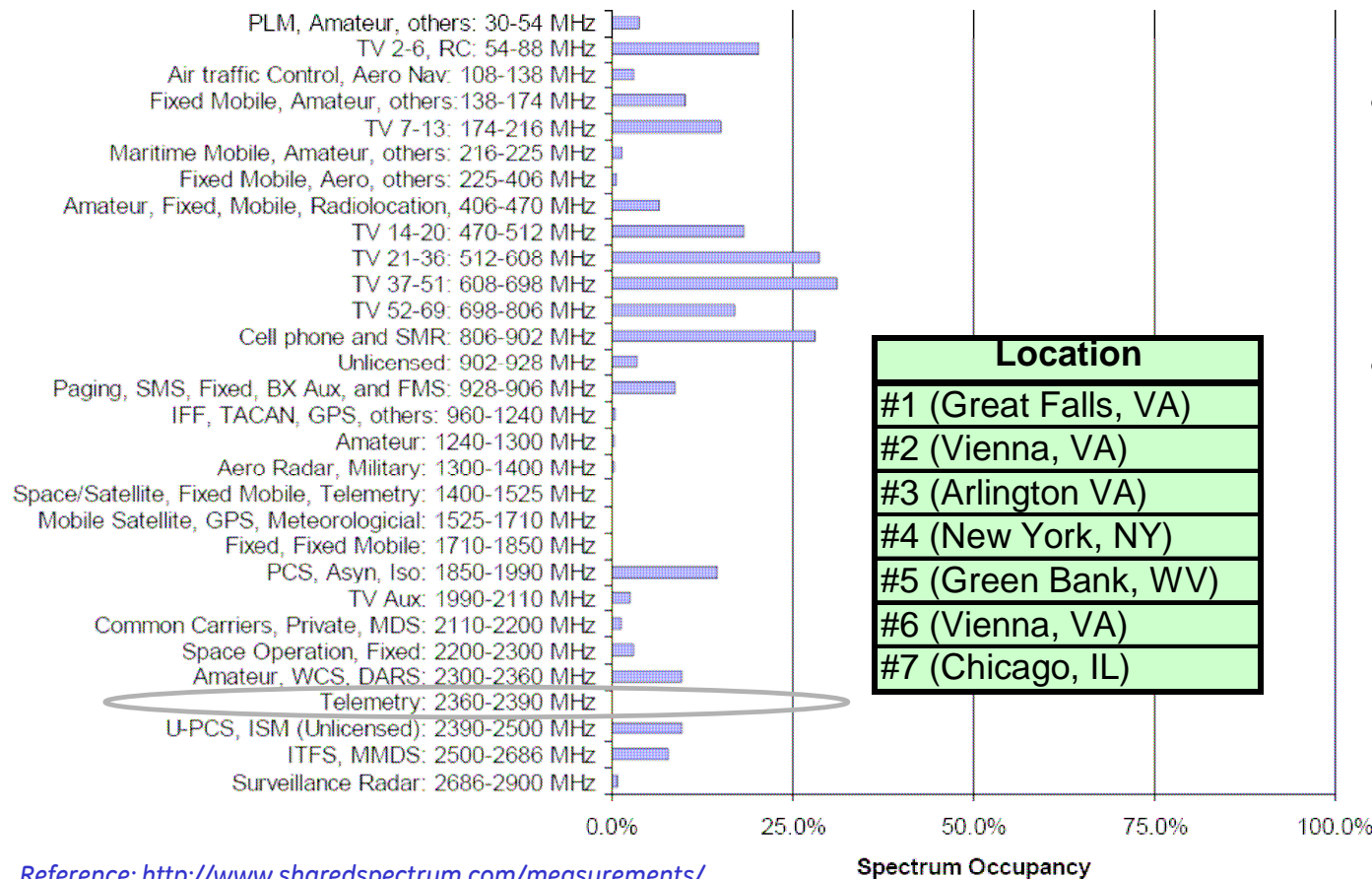
MBANS rules would protect *all 157 sites* with 2360-2390 MHz exclusion zones

Measurements Confirm Sparse Utilization

Spectrum utilization measurements from NSF's NRNRT research



Measured Spectrum Occupancy Averaged over Seven Locations



- *E.g., utilization of AMT band only 0.021% in Chicago during 46 hours of observation.*
- AMT usage was not present or, at worst, was below detectable levels proving MBANS devices would be able to operate without receiving interference as AFTRCC has suggested.

Reference: <http://www.sharedspectrum.com/measurements/>

Conclusion

- BANs and BSNs hold significant promise for health care quality and efficiency.
- FCC's consideration of MBANS proposal represents opportunity for TG6 to achieve coexistence and noninterference for medical BSNs
 - The incumbent services in the proposed band are well suited to coexistence with low-power short range BSNs.
 - The proposed band has many other desirable properties (e.g. proximity to 2.4 GHz Part 15 band).
 - The proposed band is, by any objective measure, sparsely utilized over most of the USA at any instant in time.
- Support of MBANS proposal required via filing of *ex parte* comments with FCC still needed to show benefit and feasibility

With the remaining issues substantially narrowed, an NPRM is the appropriate next step.