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

Date Submitted: November 10, 2008

Source: David Davenport, GE Global Research

Address 1 Research Circle, Niskayuna, NY 12309, USA

Voice: +1 518-387-5041, FAX: +1 518-387-7592, E-Mail: davenport@research.ge.com

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.

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

David Davenport
GE Global Research
RF and Photonics Laboratory

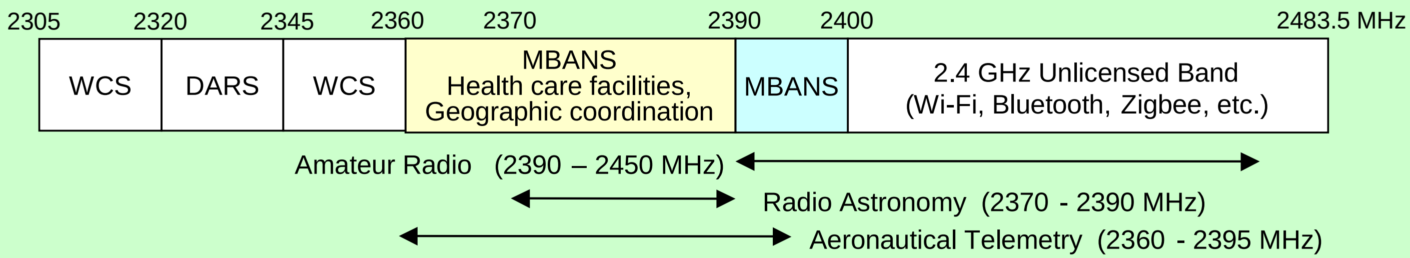
Refined, Proposed Part 95 Rules for Medical Body Area Network Service (MBANS)

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 $BW_{20dB\ MHz}$ 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.

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.

Recent supportive / concurring filings in the record:

- IEEE 802
- Philips
- Draeger-Seimens
- SpaceLabs
- Toumaz
- Baxter
- ST+D
- AdvaMed
- WCA
- Paul Kolodzy
- Texas Instruments

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

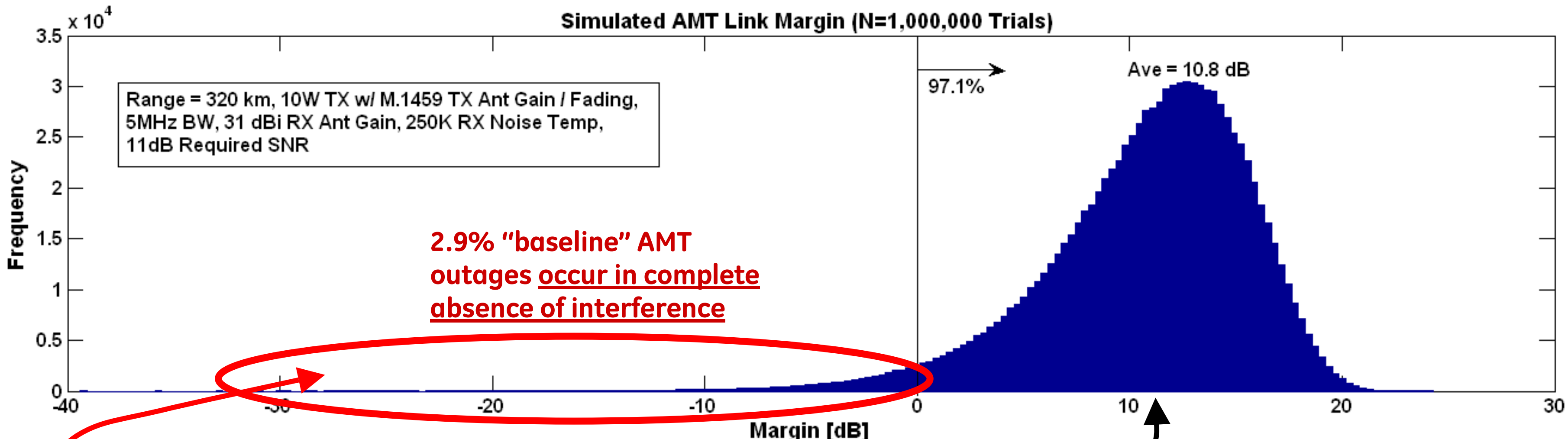
- **Michael Shabot (M.D., VP and Chief Quality Officer, Memorial Hermann Healthcare):** "As a surgeon and critical care intensivist, I strongly support the allocation of bandwidth to support wireless medical Body Sensor Networks. Such a network would free critically ill patients from electrical patient 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
- OOBE 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 OOBE: **11.3 km,** -60 dBc OOBE: **4.4 km**
Single Part 27 WCS device	OOBE[1]: **17.8 km**
Single Part 18 ISM device	OOBE[2]: **7.0 km**
Single 2.4 GHz Part 15 unlicensed device	2360-2390 MHz Average OOBE[3]: **1.2 km**
	2360-2390 MHz Peak OOBE[4]: **8.1 km**
	2390-2395 MHz -20 dBc OOBE[5]: **162 km**

Ubiquitous, Uncontrolled Devices

[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 OOBE 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, <u>the M.1459 PFD limit cited by AFTRCC can be expected to be significantly exceeded *today*.</u>

Selected examples…

Less than 1 dB margin to limit is <u>common.</u>

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
3Com	AP3950 802.11n Wi-Fi Access Point	O9C-AP3950	2389.93	73.64 Peak	802.11n, 20MHz channel 1
			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
Aruba	AP-120 802.11n Wi-Fi Access Point	Q9D AP120121SDR	2390.00	52.54 Ave	802.11b, channel 1, integral ant, ART = 17.5
			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
Asustek	R1E Notebook PC with integrated 802.11n Wi-Fi	MSQR1E	2388.38	52.44 Ave	Mode 4: 802.11n(20M) (2412MHz) (Ant A), horz pol
Broadcom	Wi-Fi module for notebook PCs (e.g. Dell D620)	QDS-BRCM1020	2389.87	53.95 Ave	802.11g, channel 1, 18 dBm, vert pol
Cisco	AIR-AP1141 / 1142 802.11n Access Points	LDK102069, LDK102070	2386.60	53.44 Ave	2412 MHz, 11 Mbps, Legacy CCK, Dual Paths
			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
Linksys	WRT600N 802.11n Wi-Fi Access Point	WRT600NV11	2390000	53.92 Ave	802.11g, 2417MHz, pwr setting 0x33xx, vert pol
			2390000	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
Meru	AP-150 802.11b/g Wi-Fi Access Point	RE7-AP150R2	2386.00	53.25 Ave	802.11b, channel 1
			2390.00	53.82 Ave	802.11g, channel 1
			2390.00	53.70 Ave	802.11g Turbo, channel 6
Meru	OAP-180 802.11b/g Outdoor Wi-Fi Access Point	RE7-OAP180	2385.60	53.67 Ave	802.11b channel 1, antenna 5
			2390.00	53.42 Ave	802.11g channel 1, 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	53.49 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
Trapeze	Model 430 802.11n Wi-Fi Access Point	QZE303	2386.36	52.07 Ave	802.11b, channel 1
			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

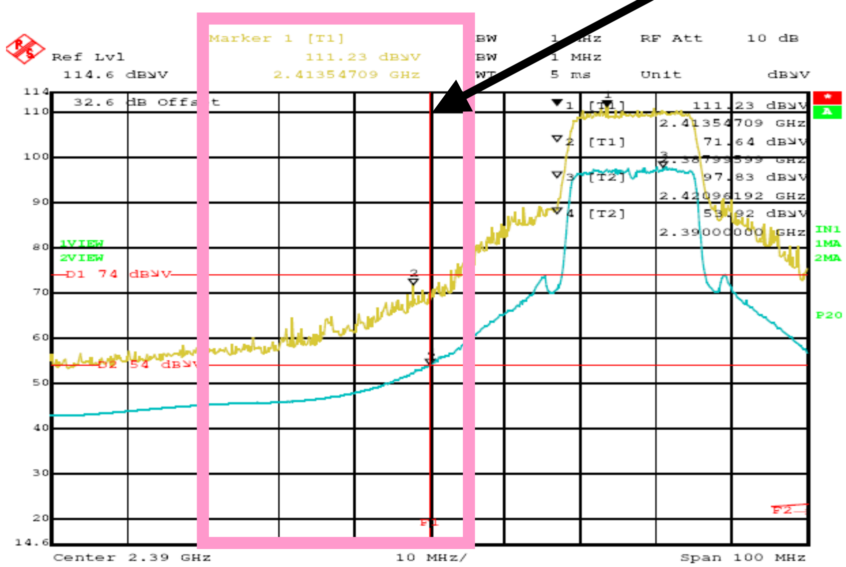
Reference: http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520183249, 30 Oct 2008

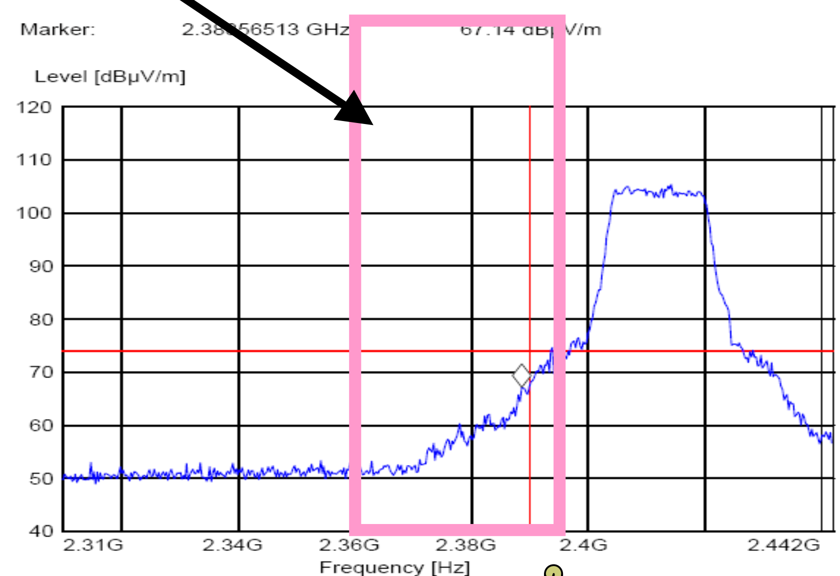
Actual Part 15 Device Emission Examples

Linksys WRT600N 802.11n Access Point[1]

Apple iPhone[2]

2360-2395 MHz portion of proposed band used by AMT





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

[1] See https://gullfoss2.fcc.gov/prod/oet/forms/blobs/retrieve.cgi?attachment_id=789037&native_or_pdf=pdf

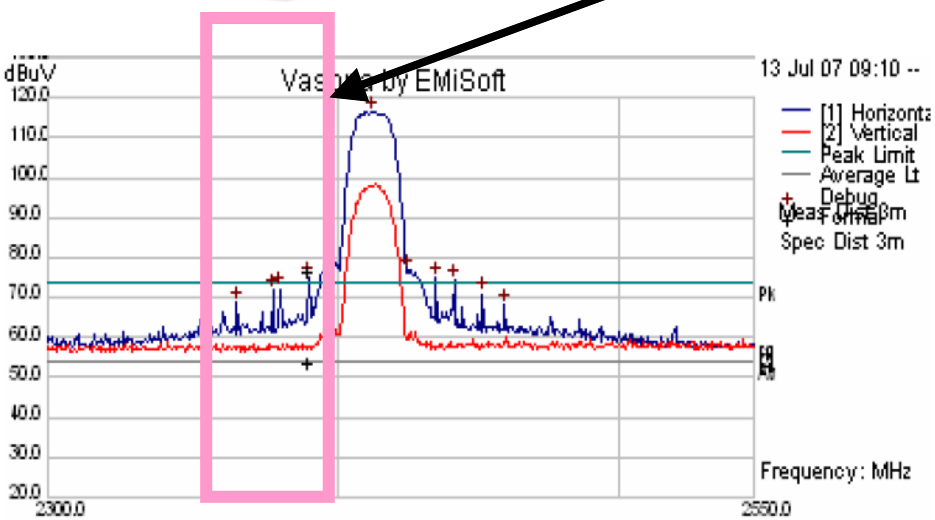
[2] See https://gullfoss2.fcc.gov/prod/oet/forms/blobs/retrieve.cgi?attachment_id=767386&native_or_pdf=pdf

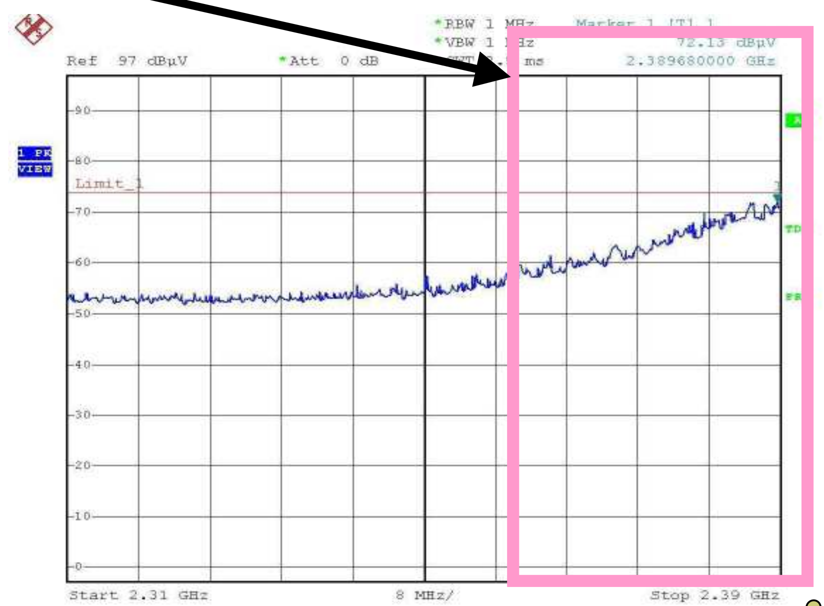
Actual Part 15 Device Emission Examples

Aruba AP-70 802.11b/g Wi-Fi Access Point[1]

Linksys WRT350N 802.11n Access Point[2]

2360-2395 MHz portion of proposed band used by AMT





Significant OOBE occur throughout AMT band, not just at upper end.

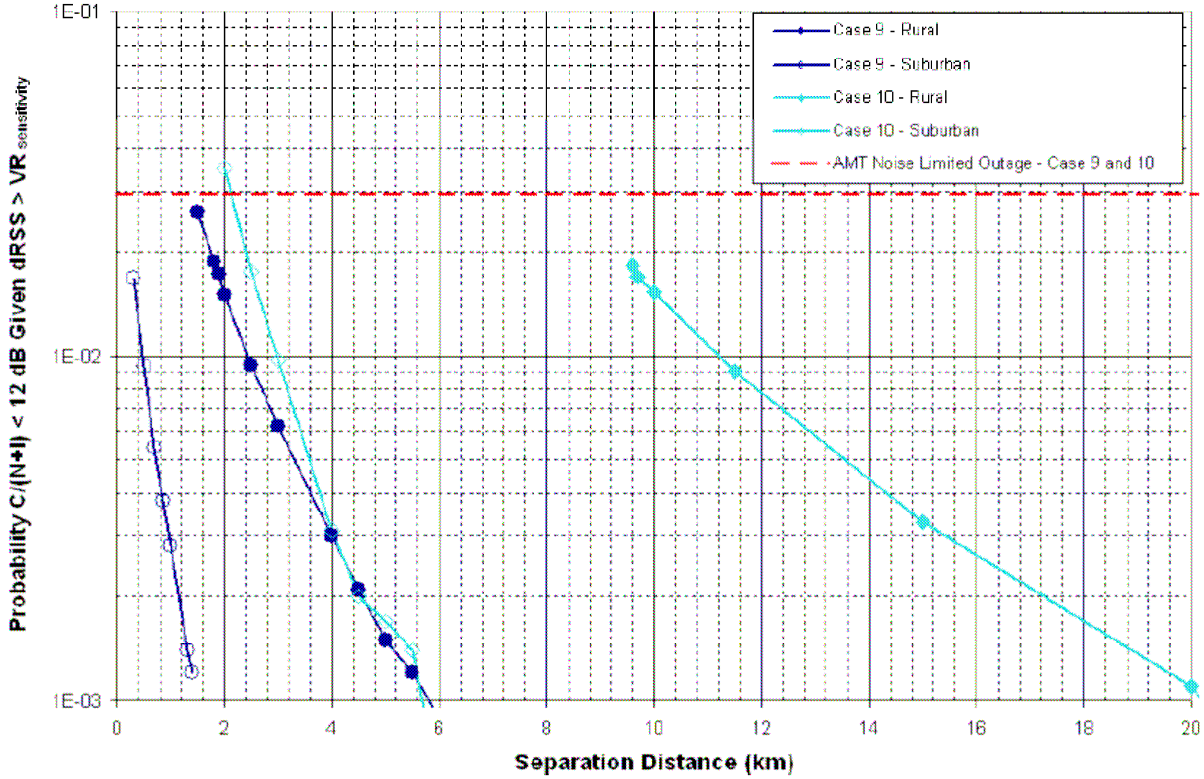
[1] See https://gullfoss2.fcc.gov/prod/oet/forms/blobs/retrieve.cgi?attachment_id=820101&native_or_pdf=pdf

[2] See https://gullfoss2.fcc.gov/prod/oet/forms/blobs/retrieve.cgi?attachment_id=711130&native_or_pdf=pdf

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

Simulated <u>conservative, worst-case scenario</u>:

- 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.

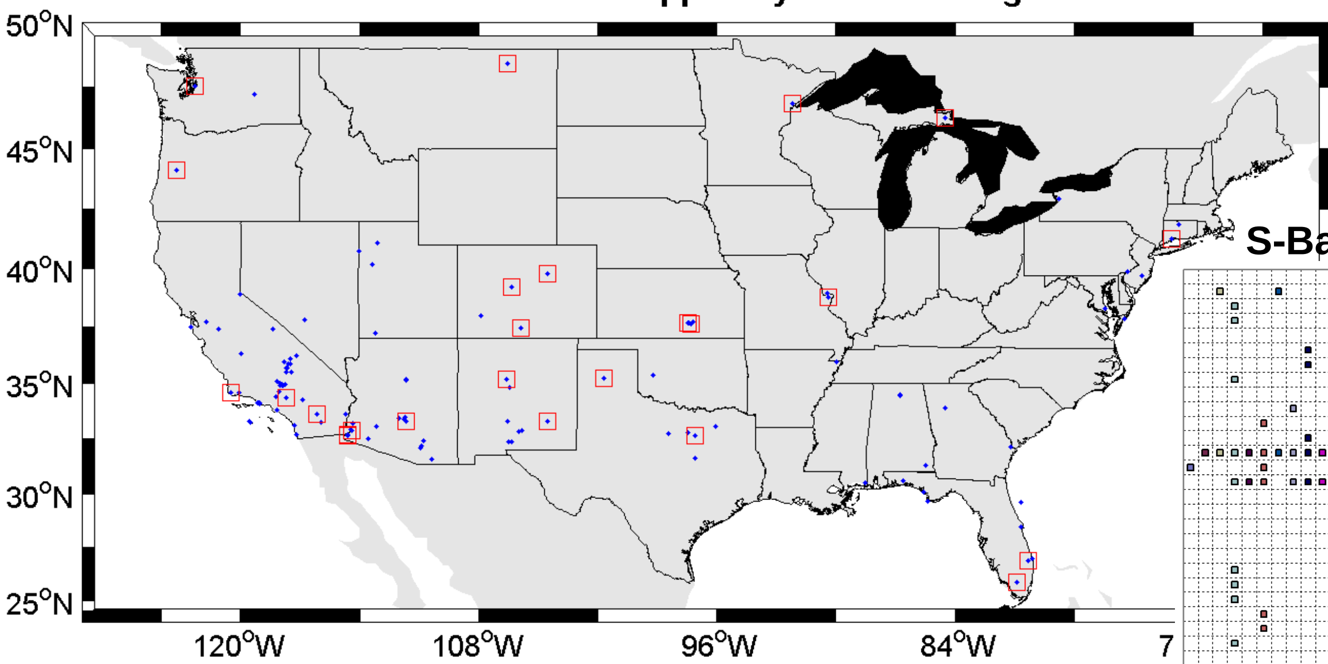
9.7 km for rural propagation with typical 31 dBi (8' diameter) AMT antenna.

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

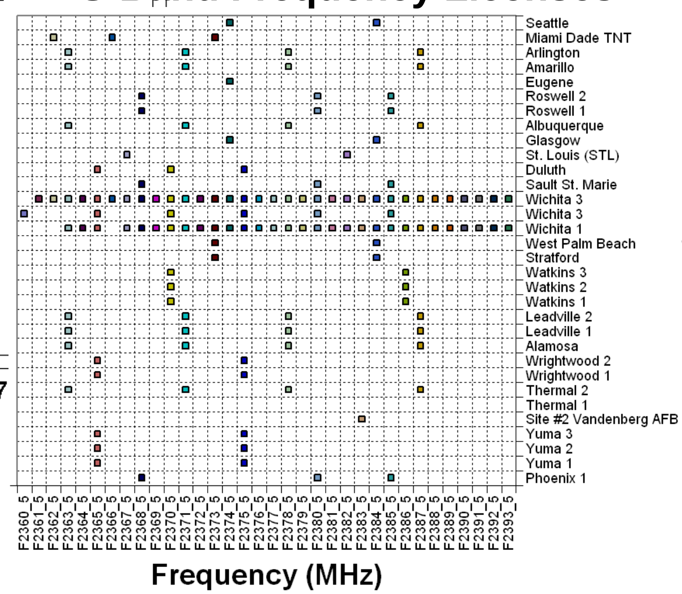
Reference: http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520169190

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

157 AFTRCC Sites Mapped By Latitude/Longitude



S-Band Frequency Licenses

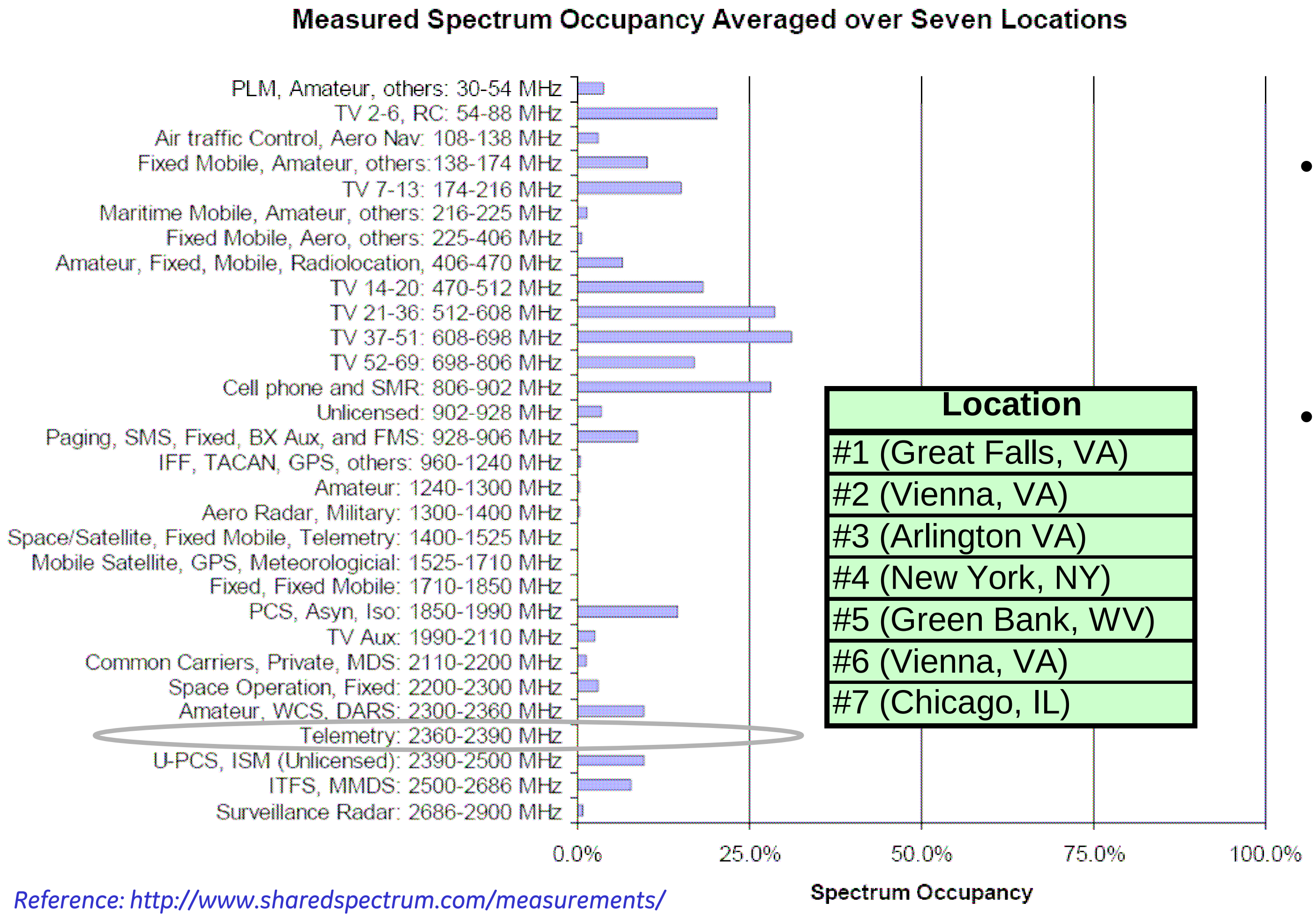


- Only 32 of 157 AMT sites have an S-band license.
- 30 AMT sites use 4 or fewer channels out of 34.
- Fight test operations are inherently non-continuous and sporadic in nature.

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



Location
#1 (Great Falls, VA)
#2 (Vienna, VA)
#3 (Arlington VA)
#4 (New York, NY)
#5 (Green Bank, WV)
#6 (Vienna, VA)
#7 (Chicago, IL)

- *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.