WILTSHIRE & GRANNIS LLP

January 30, 2014

Ex Parte

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: GN Docket No. 12-268

Dear Ms. Dortch:

On January 28, 2013, in a series of meetings, Austin Schlick, Aparna Sridhar, Alan Norman (via telephone), and Andy Lee (via telephone) of Google Inc.; Chris Szymanski and Ron Porat of Broadcom Corporation; and I discussed the above-referenced proceeding with FCC staff. We met with Louis Peraertz, Legal Advisor to Commissioner Clyburn; Jeffrey Neumann, Legal Advisor to Commissioner Pai; Erin McGrath, Legal Advisor to Commissioner O'Rielly; Gary Epstein, AJ Glusman, and Edward Smith of the Incentive Auction Task Force; Roger Sherman, Madelaine Maior, Chris Helzer, Jennifer Tomchin, and John Leibovitz of the Wireless Telecommunications Bureau; and Geraldine Matise, Matthew Hussey, Robert Weller, Ira Keltz, Hugh Van Tuyl, Paul Murray, Alan Stillwell, and Uri Livnat of the Office of Engineering and Technology. We discussed that material contained in the attached presentations.

Pursuant to the Commission's rules, a copy of this notice is being filed electronically in the above-referenced docket. If you require any additional information please contact the undersigned.

Sincerely,

Paul Margie
Counsel to Google Inc.

cc: meeting participants

Guard Band Maps

for Major Metros

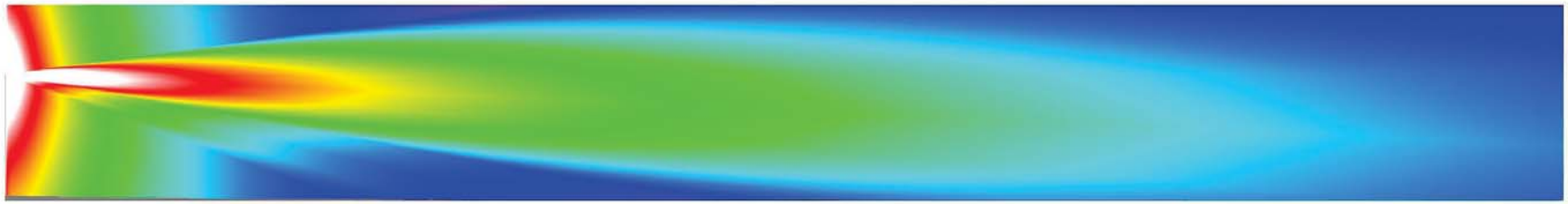
Google

Modeling Overview

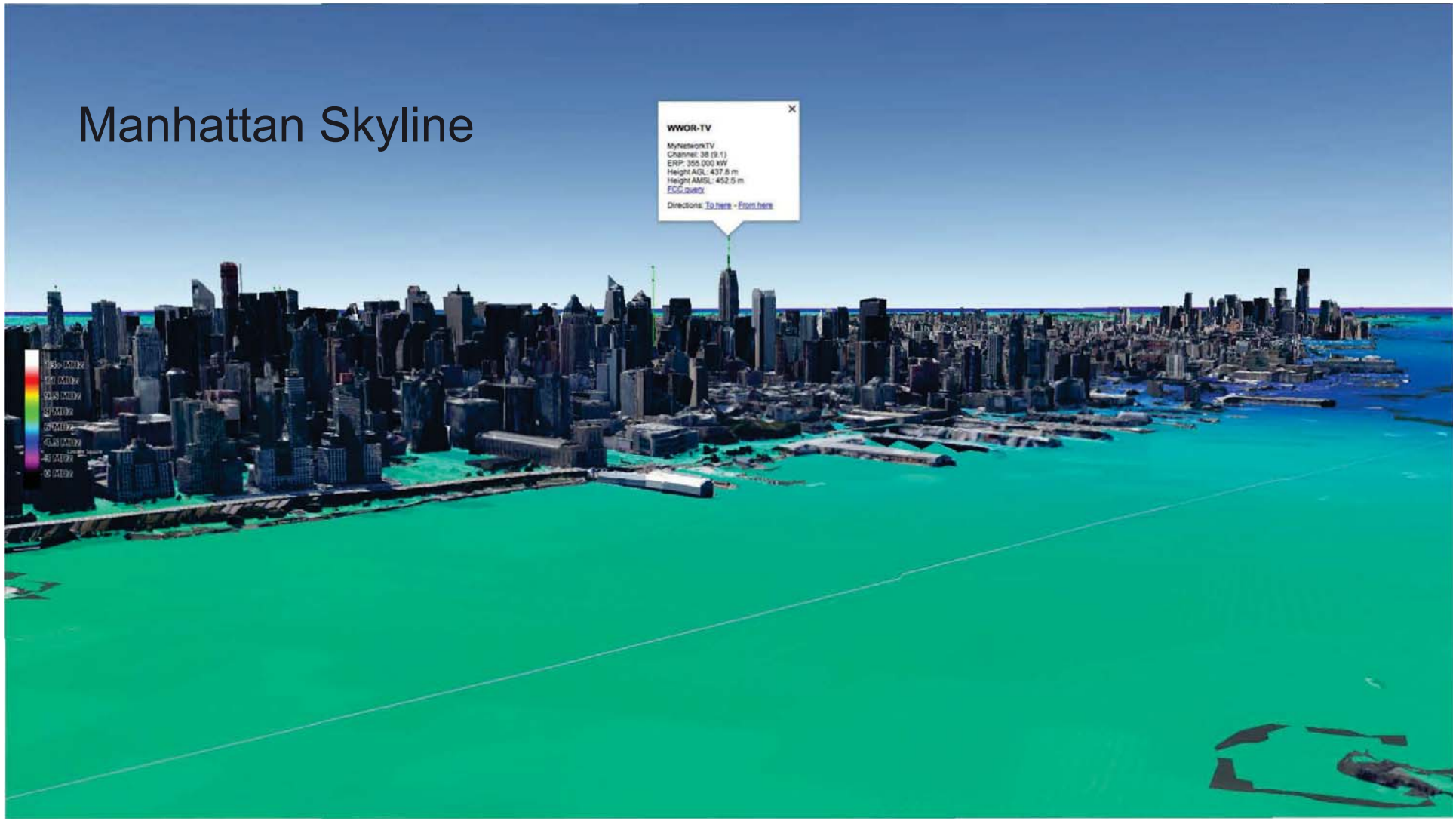
- Based on OET Bulletin No. 69 principles
- Mapping TV signal power to required LTE guard band size

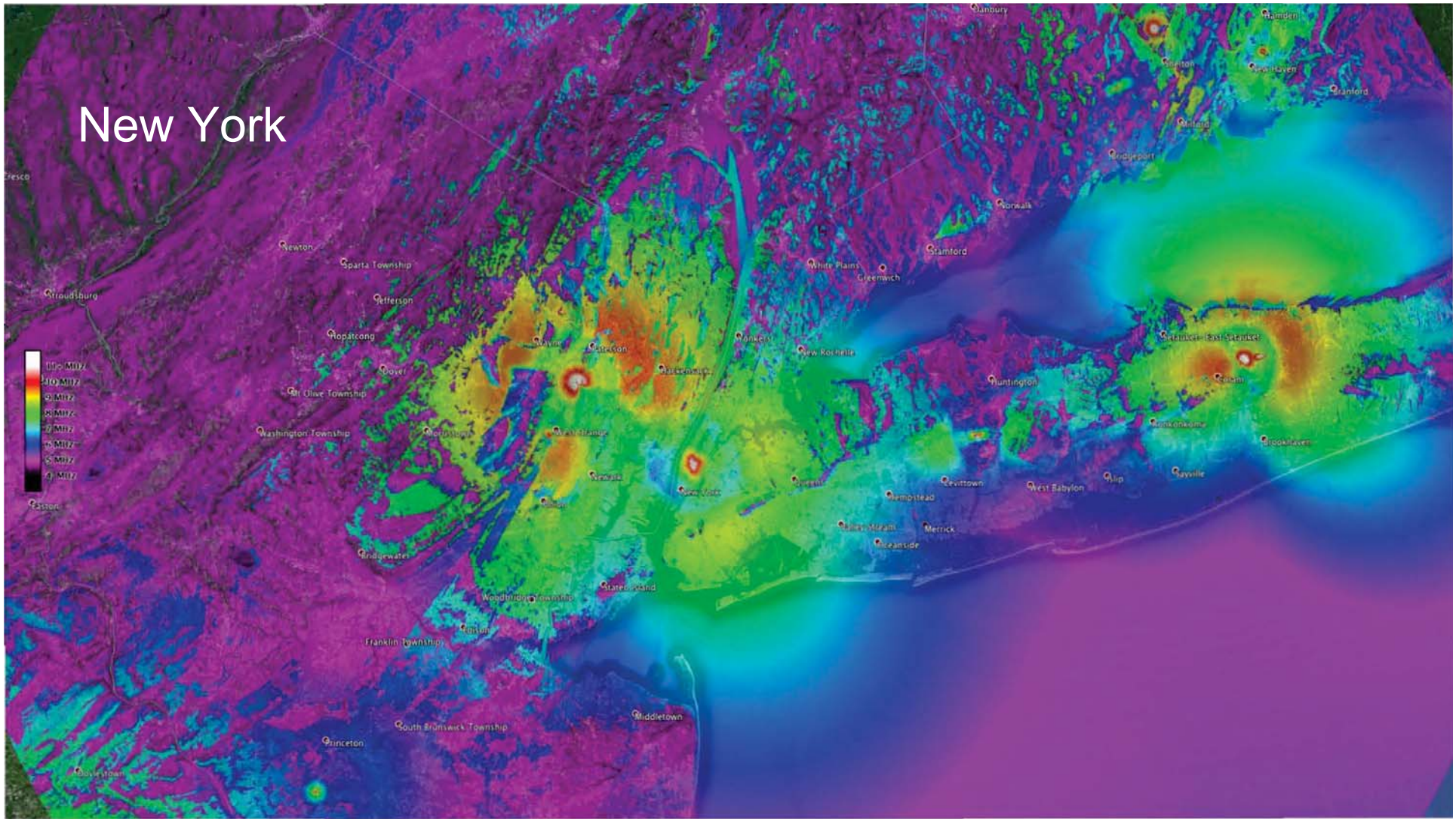
TV Signal Strength	Guard Band Size
-7 dBm	12 MHz
-11 dBm	11 MHz
-15 dBm	10 MHz
-19 dBm	9 MHz
-23 dBm	8 MHz
-27 dBm	7 MHz

Vertical Antenna Pattern from OET-69



Manhattan Skyline

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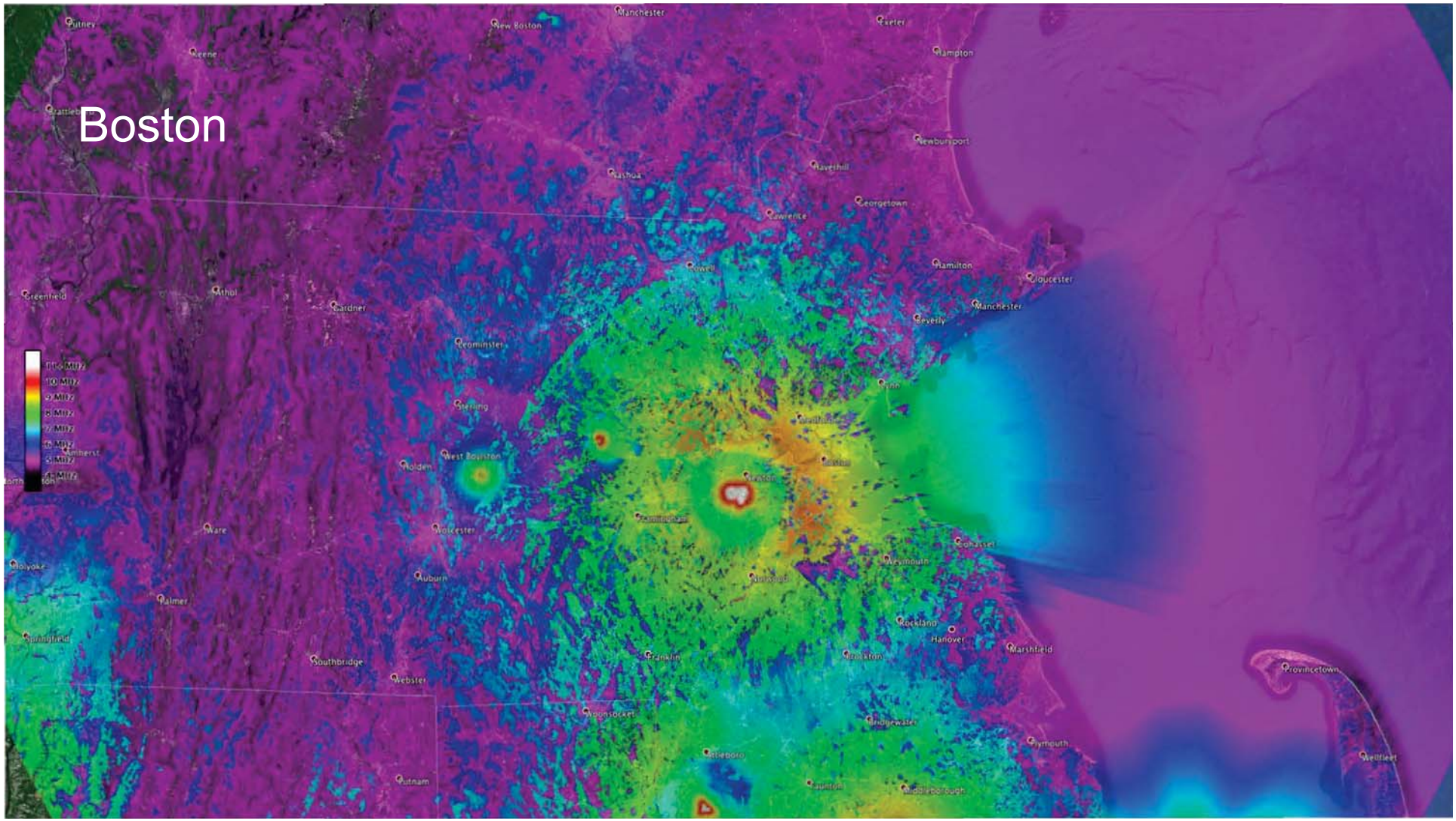
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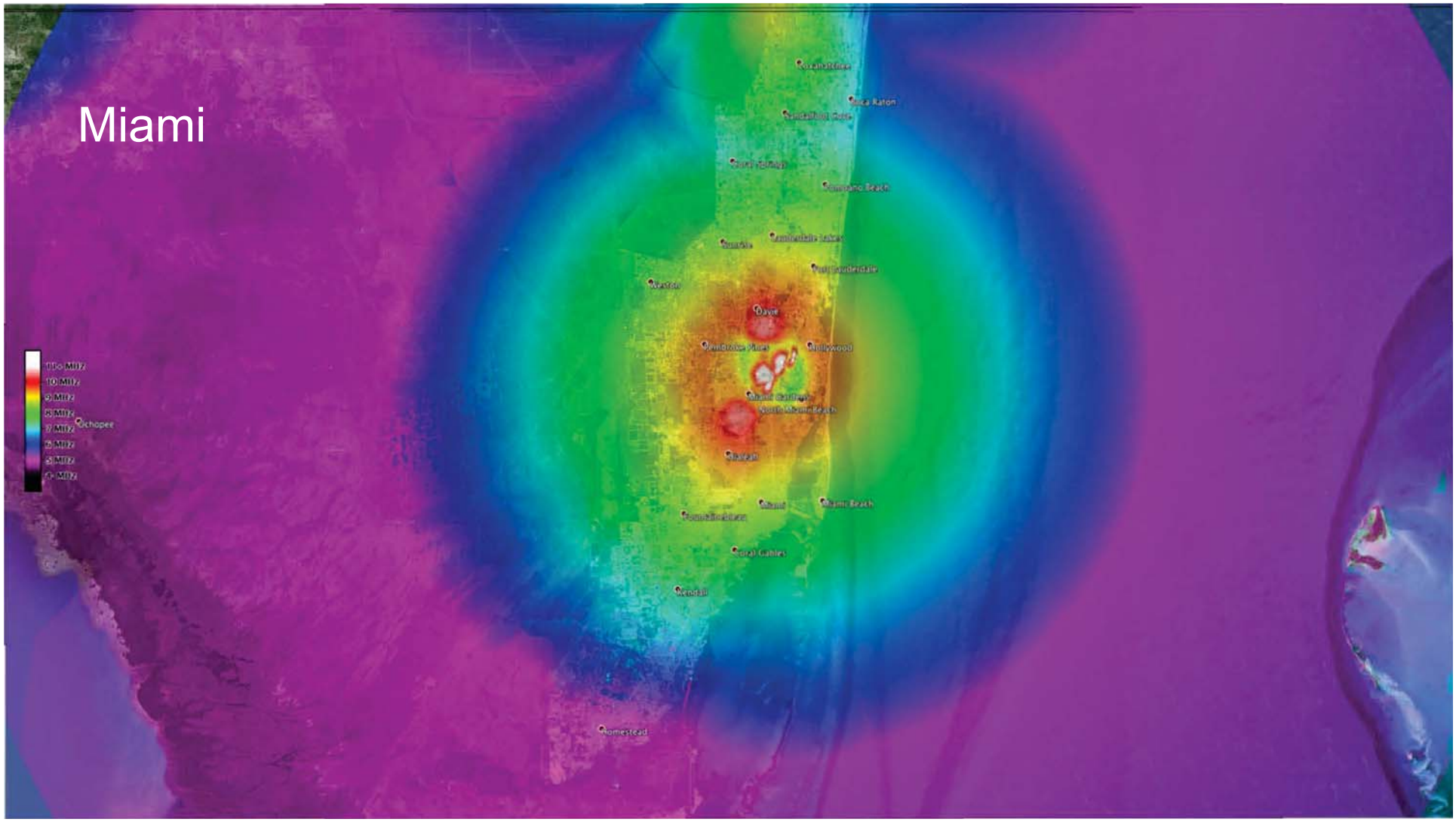
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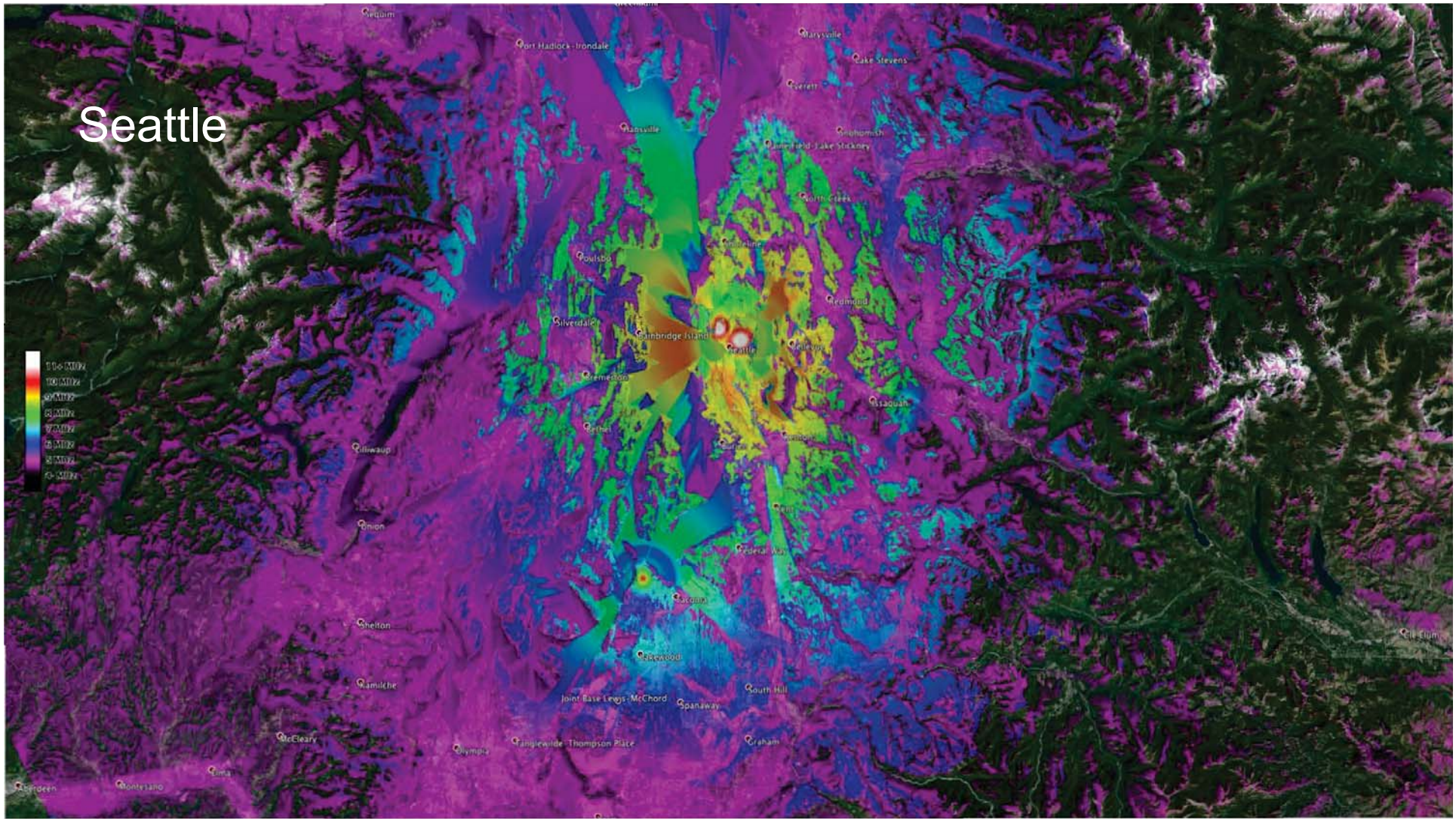
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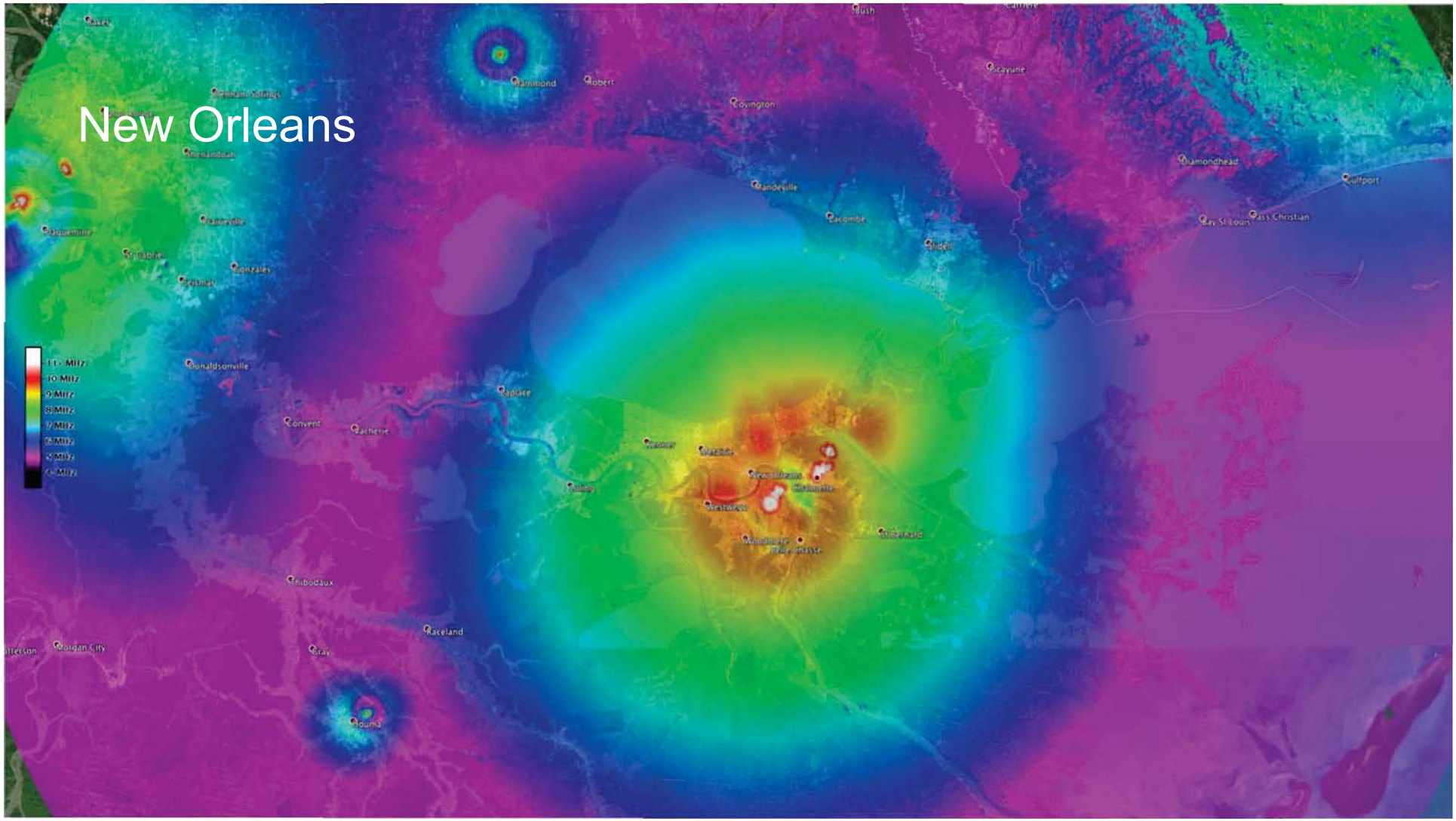
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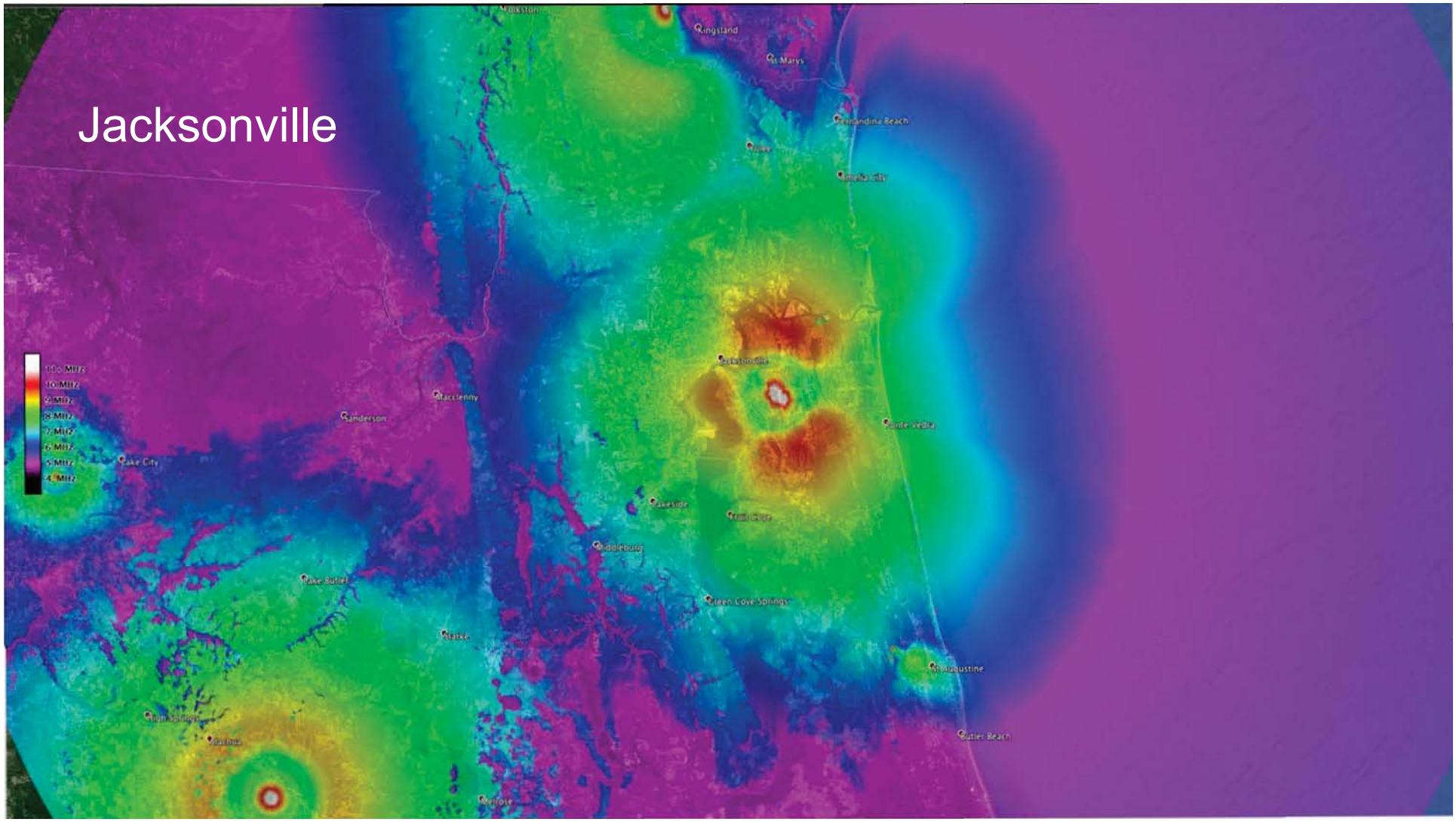
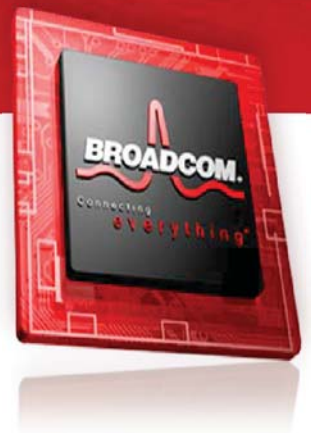
7 MHz
6 MHz
5 MHz
4 MHz

Jacksonville



BROADCOM CORPORATION CHANNEL 37 ANALYSIS



January 28, 2014

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WIFI OPERATION IN CHANNEL 37

- **We analyzed GE Healthcare filing link budget analysis on TVBD co-channel operation as described in Table 5, Scenario 3 of GEHC's Technical Appendix filed on January 25, 2013.**
- **The following table summarizes our reasonable assumptions and the resulting separation distance between a portable 40mW TVBD and a hospital.**

Scenario	Portable 40mW TVBD	
EIRP (dBm/10KHz)	-11.4	
Building penetration loss (as in GE)	20dB	
Number of dominant transmitters	1	
WMTS noise floor (dBm/10KHz) (as in GE)	-110	
I/N Ratio	3dB	-6dB
Maximum allowed interference power (dBm/10KHz)	-107	-116
Required path loss (Winner+, UMi combined LOS/NLOS)	75.6dB	84.6dB
Required TVBD to WMTS distance [m]	57	83

- **The separation distance is more than an order of magnitude shorter than the number shown in GE filing under that scenario (3.3km) due to the following factors:**
  - Winner plus (*) path loss models were used for TV frequencies, which are also used in LTE.
  - In particular the Urban Micro combined LOS/NLOS model was used, which assumes a base station at or below rooftop level – we equate this to a WMTS device on a high floor of a hospital.
  - The ground floor devices are expected to experience higher path loss.

(*) D5.3 Winner+ Final Channel Models – section 4.1.1.

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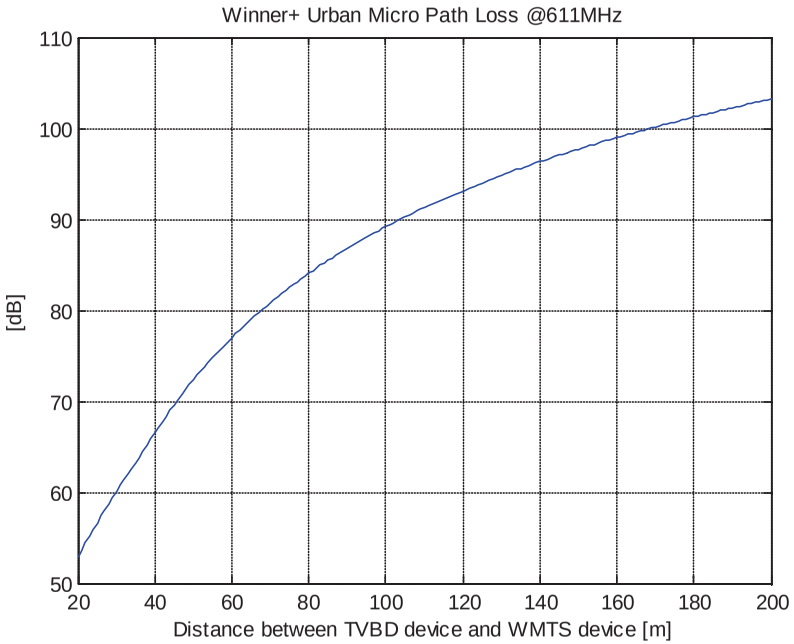
ANALYSIS CONTINUED

- **We agree with the assumption in scenario #3 of one interferer**
  - WiFi devices defer when they hear other devices; and
  - At that range, a given side of a hospital may not hear two devices transmitting at the same time.
  - Note the Winner path loss assumed is for outdoor TVBD devices and indoor devices will have further wall penetration.
- **We do not understand the explanation that the WMTS system aggregates interference from 10 antennas <u>without</u> also aggregating the desired signal. If that is the case we propose that the algorithm is changed to only take the strongest antenna signal and in doing so removing the 10dB interference penalty assumed in the table**
- **We also assume 4dB lower transmit power than is assumed in scenario #3**
- **Lastly we provide two options for the allowed I/N – the assumption made appears strict, but we have included it in our table as well.**



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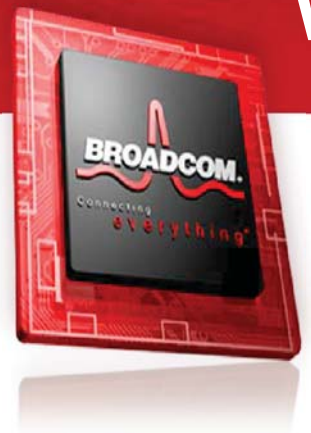
BROADCOM CORPORATION
WIFI-LTE INTERFERENCE ANALYSIS



January 28, 2014

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ANALYSIS OF WIFI OPERATION ADJACENT TO LTE DL

- **Our feasibility analysis of WiFi transmissions adjacent to LTE DL considered the following two factors to determine the allowed transmit power:**
  - WiFi out of band emissions (OOBE); and
  - LTE adjacent channel rejection.
- **To assess real world performance we studied the adjacent channel rejection performance of an LTE product and the OOBE of a WiFi design conforming to FCC TVWS regulations (supporting at least 55dB attenuation at the first 100KHz outside the 6MHz channel occupying WiFi signal).**
  - Note that FCC regulations for OOBE in the TVWS are a minimum requirements. Products are expected to naturally have adjacent channel spectrum roll-off with increasing frequency separation.
- **After analyzing both factors, we concluded that a LTE receiver becomes impacted first by in-band noise due to OOBE before being impacted by the adjacent channel signal power.**
- **Accordingly, our analysis of OOBE provides the allowed transmit WiFi EIRP as a function of the gap (in frequency and distance) to an LTE receiver.**
  - Note that in the analysis 0MHz means the gap between a 6MHz WiFi channel and a 5MHz LTE channel (actual gap between signals is around 800KHz, LTE signal is 4.5MHz in a 5MHz channel and WiFi signal is 4.875MHz in a 6MHz channel).

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ASSUMPTIONS

- **The following table summarizes our assumptions for the total propagation loss, allowed level of I/N and the resulting total (integrated) allowed in-band noise level into an LTE band.**

Frequency	665MHz	
LTE device to WiFi device distance	2m	3m
Free space loss	35dB	38.5dB
Body loss*	3dB	
Antenna polarization mismatch*	2dB	
Shadowing*	3dB	
LTE antenna Gain	-5dB	
Total propagation Loss	48dB	51.5dB
LTE noise level	-101.5dBm	
Interference level 3dB higher	-98.5dBm	
Allowed WiFi noise level into LTE band	-50.5dBm	-47dBm

- **Comparing the allowed WiFi noise level into the LTE band with the out of band noise of a 40mW TVWS device meeting the required FCC level of -56.8dBm/100KHz (or -40.3dBm/4.5MHz) we see a 7dB stricter requirement (for 3m distance).**
- **Finally, the OOBE expected from a TVWS product is used to arrive at the allowed EIRP.**

*** Conservatively based on OET report on advanced wireless service interference tests results and analysis . FCC precedent supports up to 6dB for body loss.**

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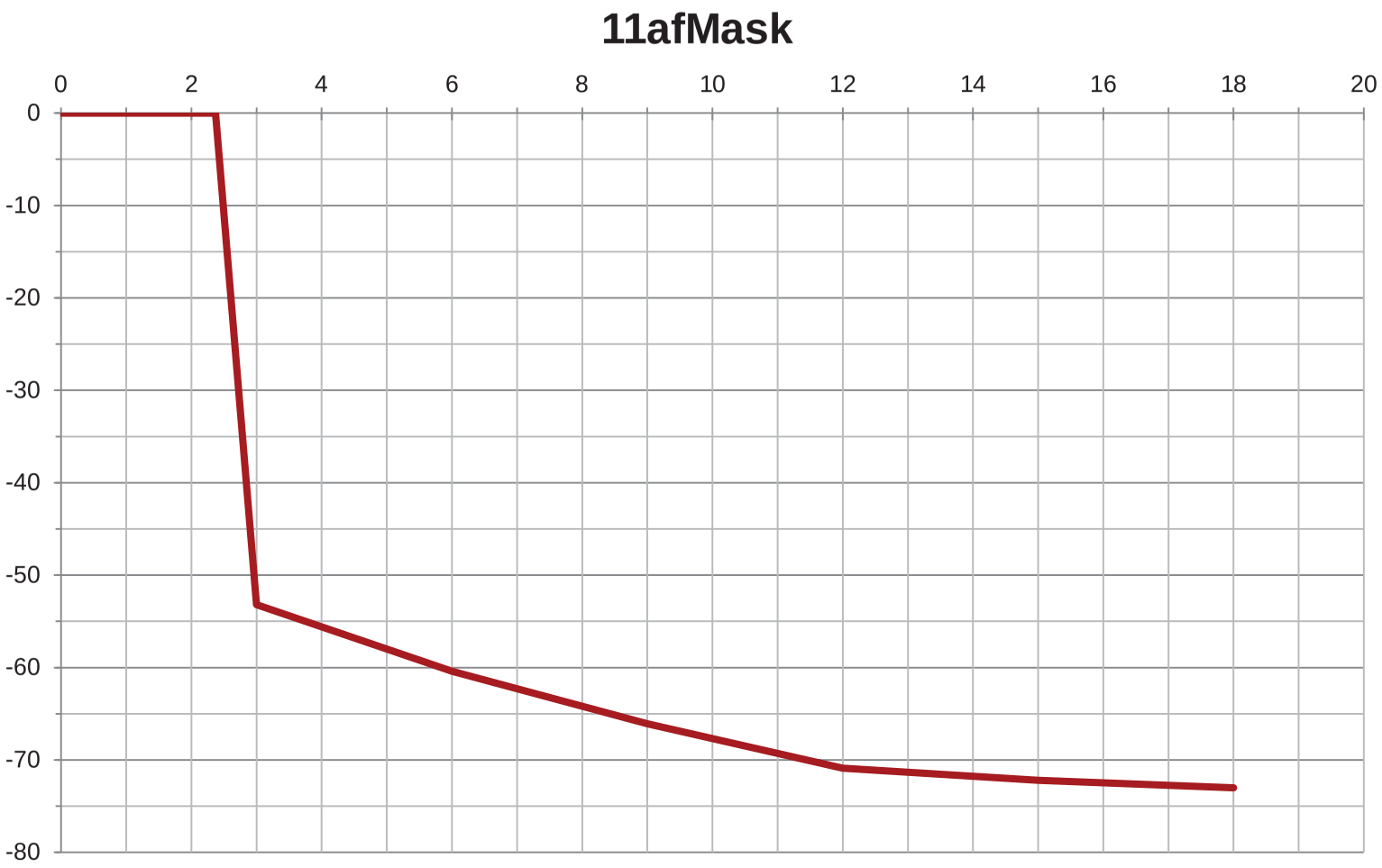
TVWS OOBE

- **The plot below provides an example spectral mask of a TVWS device where about 10dB extra roll-off is achieved at 6MHz gap to the TVWS channel edge.**



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CONCLUSION

Integrated OOBE into LTE 4.5MHz BW and resulting allowed WiFi EIRP			
LTE device to WiFi device distance		2m	3m
WiFi 6MHz to LTE 5MHz channels Gap	Integrated WiFi OOBE into LTE	Maximum WiFi EIRP	
0MHz	-58.2dBr	7.6dBm	11.1dBm
1MHz	-60.2dBr	9.6dBm	13.1dBm
2MHz	-62.5dBr	11.9dBm	15.4dBm
3MHz	-64.3dBr	13.7dBm	17.2dBm
4MHz	-65.9dBr	15.3dBm	18.8dBm
6MHz	-69.2dBr	18.6dBm	22.1dBm

- **At 2m separation, 4MHz gap enables transmit power similar to that allowed under current FCC rules 16dBm (40mW) and operation adjacent to LTE is possible at 7-8dB reduced power.**
- **With 3m separation the gap shrinks conservatively to 3MHz.**
- **Conclusion**
  - WiFi transmission at 3-4MHz gap from LTE DL is feasible at 40mW for devices having lower OOBE emission than is currently required by TVWS regulations.
  - WiFi transmission at 0MHz gap from LTE DL is feasible at 5-10mW for devices having lower OOBE emission than is currently required by TVWS regulations.

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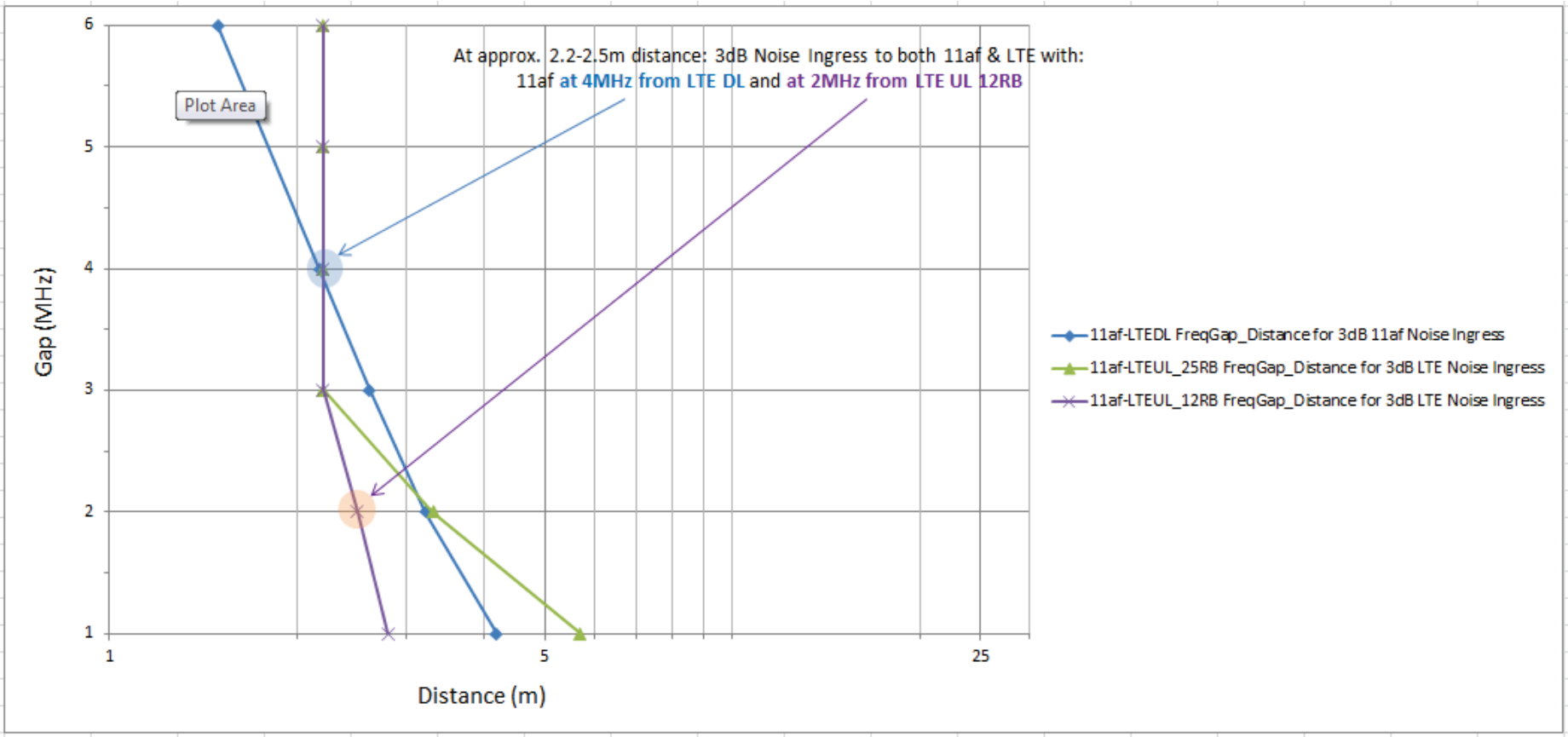
ANALYSIS OF LTE UL INTERFERENCE INTO WIFI

- **Similar to the previous analysis, we reviewed WiFi blocking performance and LTE UL OOBE and provide an overall summary of the required gap and distances in the plot below.**
- **The same assumptions from Slide 3 continue to apply, except that here we:**
  - Assume LTE UL transmissions at 23dBm (and WiFi at 16dBm) as the input to the analysis;
  - Look at the separation distance and gap to achieve the same 3dB noise ingress to WiFi; and
  - Note that LTE UL may use a portion of the BW (especially cell edge devices) and we observed reduced OOBE in this case



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RECOMMENDATIONS

- **WiFi operation in the guard band or duplex gap should be enabled by:**
  - Keeping the current TVWS in-band power rules for portable devices; and
  - Keeping the current TVWS out-of-band emission rules for portable devices; and
  - Requiring a lower OOBE threshold (e.g. -47dBm integrated over 4.5MHz) into the nearest 4.5MHz LTE band.

- **A duplex gap size of 12MHz is preferable and would allow for a 6MHz TVWS channel to be optimally positioned 4MHz away from LTE DL and 2MHz away from LTE UL, which would enable LTE DL, WiFi and LTE UL to operate with minimum interference at similar distances from each other.**

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