Combined Responses to Motorola and Multiband OFDM Alliance[1] Comments:

1. *Motorola stated several times that a small number of emitters were improbably hovering in the air in front of the earth station antenna, with no allowance for a building to contain them[2].*

It was clearly stated in the report that no UWB emitters were placed in the mainbeam region in the front of the earth station antenna[3]. In addition, allowances were made in the model for loss due to structures and foliage and that includes buildings[4]. In the case of the small number of emitters that were elevated above ground level, and had a line-of-sight attributed to them[5], this is intended to simulate the potential path from an emitter located in a building with a window facing the direction of the earth station. The statement that no allowances were made for buildings to contain emitters[6] also conveniently ignores the cases where UWB emitters were elevated and had 1/r3 and 1/r4 paths attributed to them.

The line-of-sight distance from a ground station located 10 feet above ground level to a 100m high building is 25 miles. Based on this a LOS path between an UWB emitter located in an office building and a ground station antenna is not only possible, but likely.

2. *Motorola states that UWB emitter densities are unrealistically high[7].*

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1 Members of the Multiband OFDM Alliance include: Alereon, Broadcom Corp., femto Devices, FOCUS Enhancements, General Atomics Corp., Hewlett-Packard Company, Intel Corp., Institute for Infocomm Research, Panasonic/Matsushita Electric Corp. of America, Philips, Samsung Electronics, Staccato Communications, STMicroelectronics, Texas Instruments, TRDA Inc., TDK Corp., TZero Technologies, WiQuest Communications, Inc., Wisair, Ltd.

2 Motorola, Inc letter, filed 9 April, 2004 ("Motorola ET Docket No. 98-153, Ex Parte Communication") cover letter, and Pgs. 4, and 5.

3 Evaluation of UWB and Lower Adjacent Band Interference to C-Band Earth Station Receivers, Alion Science & Technology, 11 February, 2004 (Alion Study) at Pg. 3-9, ("Note that all UWB devices were precluded from off-boresight angles of less than 3 degrees.").

4 Ibid at Pg. 3-4 ("A mix of $1/r^2$, $1/r^3$, $1/r^4$ fall-off was used for propagation path loss: $1/r^2$ corresponds to free-space path loss; $1/r^3$ fall-off represents propagation through foliage; $1/r^4$ represents losses through walls, obstacles, etc.").

5 Motorola Ex Parte at Pg. 6, ("Figures 4 and 5 show the positions of the 10 UWB emitters with the strongest signal power at the C-Band receiver for a typical simulation run.").

6 Ibid at Pg 5, ("…UWB devices placed high in the air, close to the receiver were often assumed to have simply free-space path loss – there were no allowances for obstructions and blockage due to the buildings that must have contained the devices.").

7 Ibid at Pg. 2 of cover letter ("Assumptions of UWB emitter density are unrealistically high.").

The conclusions documented in the report show the density at which a C-Band ground station will experience interference in terms of antenna elevation angle and UWB emitter density[8]. Examples were then provided of potential densities of UWB devices based on historical data on the penetration rates of other popular electronic devices. Based on projections by UWB proponents themselves, these estimates appear to be conservative.

Other postulated applications, such as wireless USB connections to personal computers proposed by developer Alereon,[9] will likely result in extremely high densities in residential and office settings. For example, if every PC utilizes 6 wireless connections to replace current wired peripherals such as mouse, keyboard, speakers, printer, network connections and miscellaneous connections for PDAs and cameras, this will result in very high densities of devices often located on desks near windows.

3. *Motorola stated that "the simulations assume all UWB emitters are transmitting simultaneously, 100% of the time".*[10]

This is incorrect. The simulation assumed that 20% of the emitters in the environment would be transmitting at any time[11].

4. *The OFDM Alliance stated that "the Alion Study does not seem to account for an activity factor, which results in only a few UWB devices operating simultaneously in realistic deployment scenarios".*[12]

This is incorrect. The simulation assumed that 20% of the emitters in the environment would be transmitting at any time. There are applications such as wireless USB that have low duty cycles, and there are other applications such as video distribution that have 100% duty cycles. A duty cycle of 20% averaged over a 24-hour period was selected as a reasonable compromise for a fully deployed environment of as yet unknown devices in the future. It should also be recognized that during peak time periods such as early evening, the effective duty cycle will be much higher than 20%, possibly approaching 100%.

5. OFDM Alliance applied an additional 10 dB of loss to 90% of UWB emitters that were elevated above ground level[13]. In the analysis conducted by Alion, this was

[8] Alion Study at Pgs. 6-1 (Summary of Conclusions) and 6-8 (Figure 6-7).

[9] Alereon Press Release, http://www.alereon.com/news/040218.asp. See Coalition Ex Parte.

[10] Motorola Ex Parte at Pg. 2 of cover letter ("The simulations assume all UWB emitters are all transmitting simultaneously 100% of the time – a practical impossibility.").

[11] Alion Study at Pg. 3-12 ("…a steady-state condition exists after about 20 ns with approximately 200 UWBs transmitting at any given time.").

[12] OFDM Alliance Ex Parte at Pg. ii.

[13] Ibid at Pgs. 8 and 18.

already accounted for in the propagation factors attributed to each path. The few paths that were elevated above ground level and had a line-of-sight path (1/r2) attributed to them were intended to simulate the path from an UWB emitter located in a building with a window facing the direction of the earth station. There is no need to add an additional loss to any of these paths.

6. The OFDM Alliance took issue with the use of the FCC peak sidelobe antenna mask in the simulation, and selected one example of a commercial antenna to base their analysis on[14]. The antenna selected by the OFDM Alliance exceeds the minimum performance mandated by the Commission, and there is no statement whether this was selected solely because it exceeds the mask or if it was intended to be representative of all ground station antennas in use. In addition, just because this antenna's specifications exceed the mask on paper doesn't mean it will when installed, or will continue to do so after a period of time in an outdoor environment. The performance of all antennas degrades over time due to rain, snow and wind effects, dirt, and maintenance issues. Also, utilizing an antenna sample size of one that happens to exceed the mask is unrealistic at best.

General Comments

- Motorola and the OFDM Alliance both reproduced the simulation conducted by Alion, and were able to achieve the same predicted levels of aggregate interference power when the same assumptions were applied to the UWB emitters[15]. This serves to independently confirm the simulation methodology and results. They then re-ran the simulation utilizing their set of modified assumptions. As explained above, we believe that the OFDM Alliance assumptions overly simplify the potential impacts of UWB emissions by not considering future growth and applications of UWB, and are contrary to projections of OFDM Alliance members. They base their assumptions on current applications and devices. Consideration must be given to any reasonable growth area and associated density and duty cycles since there will be no recourse if the UWB projections are too low.

- The OFDM Alliance states that the Alion model is predominantly a line of sight model, and that there is no explicit modeling of building penetration loss[16].

As explained in Paragraph 1 above, the Alion simulation is not a line of sight model. It is an area model that utilizes three different propagation factors that are weighted and applied according to distance from the UWB emitter to the victim receiver. While, line-of-sight paths result in the most significant contributions to the aggregate interference power, all modeled propagation modes are actually considered and calculated. Accordingly, this does not make it a line-of-sight model.

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14 Ibid at Pgs. ii and 8.

15 Motorola Ex Parte at Pg. 6, OFDM Alliance Ex Parte at Pg.3.

16 OFDM Alliance Ex Parte at Pg. 2 (Section II).

- The OFDM Alliance stated that a 5-degree ground station main beam elevation angle was used for the study[17]. The appropriateness of that angle was questioned based on the Galaxy series of satellites[18].

In fact, results for a range of ground station antenna elevation angles from 5 to 15 degrees were presented in the report[19]. This covers operation of all available satellites, not just the Galaxy series, from the northeast US (including NYC, Boston, and Portland), Alaska, and Hawaii. This includes AMC – 3, -7, -8, and -10 that are heavily used by broadcast and cable networks to distribute programming.

- The OFDM Alliance goes through an extensive description of propagation coefficients to make a case for a higher loss factor associated with foliage and building loss[20].

While this information is interesting, it is of little practical use in this case because the dominant emitters that contribute to the aggregate interference power are associated with line-of-sight paths. Due to this, changing the loss factors attributed to other paths will not contribute significantly to the results.

The bottom line is determining the potential for line-of-sight paths from emitters in commercial office buildings, high-density housing, and multilane roadways in the vicinity of an earth station at the present, and at any time in the future, and ensuring that these figures are never exceeded.

- Motorola showed data depicting the aggregate power contribution of the top 10 UWB emitters with respect to the C-Band ground station antenna[21]. These 10 emitters were located between approximately 150m and 2800m from the earth station, are elevated between 18 and 98m AGL, and lay within +/-5 degrees of the beam centerline axis[22]. Considering that there are approximately 83 emitters within +/- 5 degrees of the beam centerline out to 3000m assuming a uniform distribution (10/360 * 3000), 10 emitters with LOS attributes is less than 1/8 of all potential paths in this region and less than 0.5% of all emitters out to 3000m.

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17 Ibid at Pg. 13 ("Alion uses an earth station main beam elevation angle of 5°").

18 Ibid, at Pg 13 ("We obtained the following elevation angles necessary to receive the Galaxy series of satellites from Boston, Ma, and Seattle, Wa").

19 Alion Study at Pg. 6-1 ("At antenna elevation angles of 7.5°, 10°, 12.5°, and 15° the critical densities in a uniform UWB environment are 1.9, 4.7, 7.4, and 9.3 devices per acre respectively.").

20 OFDM Alliance Ex Parte at Pgs. 15-18 .

21 Motorola Ex Parte at Pgs. 6-11.

22 Ibid, at Pg. 9 (Figure 4).

- Motorola stated that a density of 795 devices/km2 is possible in their example "high density" wireless network deployment, and that this is in rough agreement with NTIA's estimate of 1000 active devices/km2[23]. These figures result in densities of approximately 3.2 - 4 UWB devices/acre. The density figure arrived at by Motorola was based on a wireless network self-interference limitation of 20m separation distances. This was apparently calculated using free-space propagation loss and assumes that the networks are all operating at maximum range. In reality a significant number of UWB network connections will be at less than maximum range which would increase the available S/I margin, and the attenuation between networks will be much greater than free-space due to walls and other obstructions between devices (offices). Both of these effects will increase the immunity to self-interference, and this will have the effect of allowing an effective UWB density of more than 4 devices/acre for this application.

Conclusions

- Motorola and the OFDM Alliance both reproduced the simulation conducted by Alion, and were able to achieve the same predicted levels of aggregate interference power when the same assumptions were applied to the UWB emitters. This serves to independently confirm the simulation methodology and results.

- UWB emitters were not located in the C-Band ground station mainbeam, and the so-called elevated hovering emitters were modeled as being near building windows. This is a realistic assumption based on the configuration of office and apartment buildings, and the sight distances possible.

- A UWB transmitting duty cycle of 20% was used for the analysis, as a bound to any future known or unknown applications.

- Density values for consumer UWB devices were postulated based on historical information on the introduction of similar consumer electronic devices.

- UWB emitter density values of a minimum of 4 devices/acre are shown to be possible by Motorola using a currently postulated application. The maximum or ultimate density of usable devices in the future will likely be related to the type of application (unknown or as yet undeveloped) and the related duty cycle, S/I, and shielding, but densities much higher than 4/acre are possible. The density in an urban area would probably have to be greater than 4/acre just to be economically viable to produce UWB devices as consumer items.

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23 Ibid, at Pgs. 2-3 ("The implied bound on active UWB device density is therefore about one active device in a circle of 20 meters radius, or somewhat less than 1000 devices per km. This number is in rough agreement with previous figures estimated by NTIA, where analyses assumed 200-1000 active devices per km^2.").

- Motorola results generally agree with our results that UWB devices with LOS paths to the ground station antenna sidelobes are the driving factor in determining the aggregate interference power. The fact that these emitters are in elevated locations with LOS paths is reasonable and possible given the achievable sight distances and configurations of office and apartment buildings.