Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
Modification of Parts 2 and 15 of the Commission's Rules for unlicensed devices and equipment approval.	)	ET Docket No. 03-201

POST-REPLY COMMENTS OF BANDSPEED, INC.

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As the Commission is aware, Bandspeed is a Texas-based technology vendor that helps operators increase the capability of their 802.11 wireless local area networks by providing antenna and software solutions that bring switching architecture to such networks.[1] Bandspeed markets a switched, sector antenna technology that is more efficient than the hub-based architecture usually used in 802.11 networks.

In its original comments, Bandspeed – like most other commenters – strongly supported the Commission's conclusion that "it is in the public interest to accommodate efficiently configured sector and phased array antenna technologies."[2] Indeed, two rounds of comments reflect a broad industry consensus that the Commission should quickly adopt rules permitting the routine deployment of advanced antenna technologies.

But Bandspeed – like several others – cautioned that the Commission must take care to avoid drafting its rules either too tightly (thus needlessly foreclosing or disadvantaging some advanced antenna technologies) or too loosely (thus needlessly permitting harmful interference to neighboring systems). Given the record in the proceeding, however, Bandspeed believes the Commission can draft balanced rules for advanced antenna technologies that will be sufficiently flexible to accommodate competitive technologies yet limit harmful interference. Such rules would eschew the proposed aggregate antenna beam width limitation in favor of per beam and aggregate EIRP limits, while prohibiting beam overlap.

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[1] Most WLAN access points use a hub architecture where all users share the same bandwidth. As more users attempt to access the same bandwidth, the system can suffer a bandwidth constraint. Bandspeed's solution solves this problem by using a single access point to support up to six Basic Service Sets (BSS) while a conventional, omnidirectional access point can support only one BSS. In other words, the Bandspeed solution can provide up to six times the bandwidth of a conventional access point. *See Bandspeed, Solutions Brief* (http://www.bandspeed.com/technology/SB1001DR1.pdf).

[2] NPRM at ¶10.

DISCUSSION

The Commission should adopt advanced antenna technology rules that accommodate all technology implementations, but that do not materially increase interference potential. As the comments in this proceeding demonstrate, this means the Commission must resolve issues regarding aggregate antenna beam width limitations, power levels and antenna beam overlap in a balanced and technology neutral way.[3]

I. THE COMMISSION SHOULD NOT ATTEMPT TO LIMIT INTERFERENCE BY ADOPTING AN AGGREGATE ANTENNA BEAM WIDTH LIMITATION

Despite the enormous support for the Commission's goals in this proceeding, the large majority of commenters developing or using advanced antenna technology opposed the imposition of limits on aggregate antenna beam width.[4] This is because an aggregate antenna beam width limitation would foreclose a variety of advanced antenna technologies while providing no commensurate interference "benefit." Such a limitation would, for example, prohibit deployment of Bandspeed's sectorized switching technology. And, Navini Networks, Inc. (Navini)[5] pointed out, the proposed limitation was "incompatible with adaptive systems that form dozens of simultaneous beams."[6] Others, such as Vivato, Inc., simply noted that the bandwidth limitation could reduce

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[3] Bandspeed also joins the majority of parties in supporting device compliance testing based on the operational conditions of the device. Further elaboration is provided later. In addition, Bandspeed again urges the Commission to codify its prior conclusion that in certain cases fixed sector systems can be classified as a point-to-point system. *See* https://gullfoss2.fcc.gov/prod/oet/cf/ri/FccEasRi.cfm, Interpretations Database Full Text Search, "Date/Ctrl# Search" no. 20000711-001. *See also* Bandspeed Comments at 8-9.

[4] For example, s*ee generally* comments of Information Technology Information Council, YDI Wireless Inc., Motorola, Cisco, Hewlett Packard, Sky Pilot Network, Intel, Atheros, Navini Networks, Inc. and Vivato. While a handful of trade associations suggested that the Commission's proposed bandwidth limitation was "reasonable," the comments appeared to be made in passing with little or no analysis.

[5] Navini uses phased array antenna technology.

[6] Reply Comments of Navini Networks, Inc. at 3.

efficiency and argued that the Commission's rules should be flexible enough to allow antenna beam width to be optimized for a system's intended deployment.[7]

Another reason the Commission's aggregate beam width proposal found so little support is that for Part 15 devices, which do not require coordination, an aggregate antenna beam width limitation is ineffectual for reducing interference potential. While the 120° aggregate antenna beam width limitation seems as though it should lower the incidence of interference, in fact its effectiveness depends entirely on the location of "victim" systems in relation to the area illuminated by the interferer's antenna beam. In other words, since the Commission (properly) does not specify where Part 15 devices can be deployed, any interference reduction benefit is random – depending on the location of the "interfering" and "victim" systems.

Moreover, the proposed 120° beam width limitation is not likely to be effective in limiting interference because it would not prevent several unrelated 120° beam width systems from operating in the general vicinity of a victim receiver.[8] Put another way, any interference benefit derived by limiting the aggregate beam width of a single system is lost when multiple systems are operating in the same geographic area. Consequently, if a bandwidth limitation were imposed, any reduction in interference potential would be essentially accidental.

Thus while it is important to limit the interference potential of advanced antenna technologies, a limitation on aggregate bandwidth is not the best approach. Instead, the

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[7] *See* Comments of Vivato Inc.

[8] No rule would prohibit, for example, three strangers from co-locating their respective 120° beam width systems – with main beams spaced 120° apart – and operating on the same frequency.

Commission should limit interference potential through limits on per beam EIRP and aggregate system EIRP.

II. THE COMMISSION SHOULD ADOPT PER BEAM AND AGGREGATE EIRP LIMITS TO CONTROL POTENTIAL INTERFERENCE FROM ADVANCED ANTENNAS

As Bandspeed argued in its initial comments, the most effective way to enable new antenna technologies while preventing undue interference is to specify a maximum per beam EIRP limit, a maximum aggregate system EIRP limit and a maximum EIRP density limit for systems intended to communicate with mobile systems.[9] Most importantly, the Commission's new rules must not permit base stations operating at point-to-point (or even higher) power levels to communicate with mobile transceivers. Were they to do so, it would create an enormous risk that excessively high-powered beams would routinely sweep across numerous victim receivers – interfering with them all. It is to address this risk that Bandspeed proposes a per beam EIRP limit.

Bandspeed notes that one party – Navini – suggests that the Commission "impose no EIRP per beam" limit, but allow a "9 dB power allowance."[10] Navini claims that for phased array systems where antenna gain is self-limiting, there is no need for per beam EIRP limits.[11] While it may be true that antenna gain is self-limiting in a phased array system, it is also true that phased array systems are capable of allocating total system power to a variety of beam configurations, including multiple beams or even a single, narrow beam. The Commission cannot allow a situation where, for example, all available power is dynamically allocated to a single, high-powered and very narrow beam. Though

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[9] Bandspeed Comments at 5. Bandspeed also proposed that to avoid a functionally high-power omnidirectional system the Commission should adopt a rule preventing use of a single frequency over 360° of azimuth.

[10] Navini Reply Comments at 4.

[11] Navini Comments at 5.

for this beam type the "interference area"[12] may be minimal in horizontal azimuth, victim receivers that happen to be illuminated will surely experience harmful interference.[13] Regardless, Bandspeed continues to believe that the best way to guard against potentially harmful interference – while affording the flexibility needed to promote competitive technologies – is to impose a per beam EIRP limit and an aggregate EIRP limit.

III. ADOPTING PER BEAM EIRP AND AGGREGATE EIRP LIMITS WILL NOT DISADVANTAGE ADAPTIVE ANTENNA SYSTEMS

Bandspeed, as noted above, believes that the Commission's new advanced antenna technology rules should avoid unnecessarily foreclosing – or disadvantaging – any form of advanced antenna technology. And, despite Navini's opposition to per beam limits, Bandspeed does not believe it's proposed per beam and aggregate EIRP limits will disproportionately disadvantage adaptive antenna systems.[14]

In a digital beam forming system, arrays of antenna elements are used to form beam patterns by varying the relative phase and amplitude of the signal fed to the individual elements. Bandspeed's proposed per beam EIRP limits would not apply to the individual "elemental" antenna beams, and there is no reason why Bandspeed's proposed limits could not fairly be applied to a composite beam or beams.[15] According to Navini, in a digital beam forming system, maximum available power is constant. As coverage requirements demand additional beams to be formed, the maximum system power is

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[12] The Commission's aggregate beam width limit seems to be aimed at limiting the "area" covered by antenna beam operating above the current power levels.

[13] And if the beam itself is moving to remain focused on a mobile receiver, the "interference area" will also be moving.

[14] Of course per beam EIRP limits would also apply to sector systems for the same basic reason -- to avoid excessive power levels from one system that could destroy the use of the relevant band for other systems.

[15] By "composite" beam, Bandspeed means the completely formed beam(s) intended to serve a user or group of users.

shared among those beams, causing the per beam power to decrease.[16] Since such a system is already configured to operate with beams operating at various power levels, there is no reason why Bandspeed's proposed maximum peak aggregate EIRP limit of 40 dBm and peak per beam EIRP limit of 36 dBm cannot be applied to such a system.[17] As long as the aggregate (all beams, all frequencies) system EIRP does not exceed 40 dBm, and – at any moment in time – no individual beam exceeds an EIRP of 36 dBm, the adaptive system should still be able to allocate system power and beam power in any way it desires while meeting these limits and with no disadvantage relative to other technologies.[18]

IV. THE COMMISSION MUST LIMIT OVERLAPPED ANTENNA BEAMS

Overlapped antenna beams can be extremely destructive to non-system receivers. When overlapped beams add constructively, incident energy to a victim receiver increases, thus increasing the noise floor at the receiver. This makes it difficult for a victim receiver to find and move to a different, usable channel. In addition, current technology 802.11-based networks do not have a bandpass filter in the RF chain. Consequently, excessive received energy from overlapped beams causes significant degradation in the receiver's performance.

Bandspeed understands the concern raised by some adaptive antenna proponents that antenna beam overlap restrictions might harm adaptive antenna technologies.

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16 Navini Comments at 4.

17 *See* Bandspeed Comments at 7. Bandspeed's suggested per beam EIRP limit simply ensures that an excessively high-powered dynamic beam cannot be generated and directed toward potential victim receivers.

18 Indeed, Navini hints at limitation that – depending on what value is chosen – could be effectively equivalent. See Navini Comments at 5. There is also no reason why the Commission could not do compliance testing for such limits on an adaptive system. To check whether an adaptive system meets EIRP limits even though beams may be constantly changing, the Commission might have a could use the system algorithm to run "worst case" scenarios of beam forming vs.EIRP.

However, Bandspeed believes that the Commission can address the concern about overlapping beams without disadvantaging adaptive antenna technologies. One way to do this would be to specify a beam overlap rule whereby as the adaptive system's antenna beams move and potentially overlap, the resultant antenna gain of the composite beam at any instant in time can never exceed 36 dBm. Thus, no matter how the adaptive system antenna beams are behaving, their EIRP "envelope" would never exceed that which is permitted sector systems.

For sector systems, Bandspeed continues to believe that overlapped antenna beams should be prohibited. As stated before, overlapped beams in a sector system have the potential to create interference in adjacent sectors and would likely decrease spectrum efficiency.[19] For this purpose, it is sufficient to define overlapped antenna beams in a sector system as beams that overlap at their 3 dB power beam widths or above.[20] However, regardless of how the Commission crafts its beam overlap prohibition, it must prevent beam overlap that results in constructive adding of signals and, therefore, excessively high, uncontrolled power. Any system – whether adaptive or sector – should be designed in a way to avoid this phenomenon.

CONCLUSION

Bandspeed applauds the Commission's efforts to liberalize its Part 15 rules to accommodate advanced antenna technologies. Done correctly, this will spur development of new, more spectrum efficient Part 15 devices. And this can happen with no material increase in the potential interference environment. Though there is overwhelming support for new rules to allow advanced antenna technologies in

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[19] Bandspeed Comments at 8.

[20] Bandspeed Comments at 8, fn. 14.

unlicensed bands, several parties to this proceeding identify a number of adjustments to the Commission's proposals to reflect the fact that sector and adaptive systems operate differently. From its review of the record, Bandspeed realizes that it may not be possible to develop common rule *text* to fit both sector and adaptive systems comfortably. However, Bandspeed does believe that the numerical limits it proposes are applicable to either adaptive or sector systems and should be adopted. What the Commission must ensure is that the rules it does adopt do not foreclose any viable technology and at the same time do not permit excessively high power levels. Bandspeed is prepared to provide further assistance to the Commission to craft final rules.

Respectfully submitted,

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