

Before the  
**Federal Communications Commission**  
Washington DC 20554

In the Matter of

Spectrum Policy Task Force Seeks Public  
Comment on Issues Related to  
Commission's Spectrum Policies

ET Docket No. 02-135

**Comments of XtremeSpectrum, Inc.**

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Mitchell Lazarus  
FLETCHER, HEALD & HILDRETH, P.L.C.  
1300 North 17th Street, 11th Floor  
Arlington, VA 22209  
703-812-0440  
Counsel for XtremeSpectrum, Inc.

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XtremeSpectrum, Inc. files these Comments in response to the Commission's Public Notice in the above-captioned inquiry.<sup>1</sup>

**A. Summary**

Ultra-wideband is not only a communications and radar technology, but also provides a paradigm for thinking about unlicensed spectrum issues.

In some respects, ultra-wideband marks a return to the earliest model of unlicensed operation. Before the appearance of "Part 15 bands," unlicensed devices had to share spectrum with other services at extremely low power. Ultra-wideband reverts to that approach, yet achieves throughput and reliability that formerly required dedicated spectrum.

The ultra-wideband proceeding (among others) exposed the uncertainties in the Commission's definition of "harmful interference." We recommend an alternative, three-step approach: (1) assess how much degradation or interruption a service can reasonably be expected to tolerate; (2) translate that into permissible levels of received interference; and (3) translate that in turn into maximum permissible emissions levels from the secondary or unlicensed device.

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<sup>1</sup> *Spectrum Policy Task Force Seeks Public Comment on Issues Related to Commission's Spectrum Policies*, ET Docket No. 02-135, Public Notice, DA 02-1311 (released June 6, 2002). XtremeSpectrum manufactures ultra-wideband communications systems as its sole business. XtremeSpectrum takes no position on ultra-wideband radar applications.

This approach will maximize use of the spectrum, giving needed protection to licensed services while allowing unlicensed devices the maximum practical flexibility. Although working out the details may generate some controversy, we think the benefits will justify the trouble.

Ultra-wideband also calls for reassessing how we measure spectrum efficiency. The conventional test -- bits per bandwidth -- fails to capture the very high efficiencies that ultra-wideband (and other low power technologies) can attain by operating many units over a small area. An additional layer of spectrum efficiency results from ultra-wideband's capability of adding services to spectrum that was otherwise fully occupied.

Finally, stepping outside the scope of the Public Notice, we ask the Commission to provide for improved transparency in spectrum proceedings that involve the Federal Government.

## **B. Introduction**

Spectrum is a finite resource subject to growing demand. Only a small number of options are available to meet that demand:

- exploit spectrum not presently used;<sup>2</sup>
- promote minimum standards of information per unit of radio bandwidth;<sup>3</sup>

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<sup>2</sup> *E.g., Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands*, WT Docket No. 02-146, Notice of Proposed Rule Making, FCC 02-180 (released June 28, 2002) (millimeter-wave frequencies).

<sup>3</sup> *E.g., 47 C.F.R. Secs. 90.203(j)(3), (5)* (bits/sec/Hz requirements for certain mobile radios), 101.141 (same for certain fixed microwave).

- keep power limits low, for reuse of the same frequencies at nearby locations;<sup>4</sup> or
- add non-interfering services to frequencies already in use.<sup>5</sup>

Ultra-wideband is a dramatic example of the last category.<sup>6</sup> Developing new frequencies is inherently expensive; and increasing conventional spectrum efficiency and re-use offer incremental gains at best. Ultra-wideband, in contrast, opens spectrum for tens of millions of new wireless devices, at consumer-friendly costs, with negligible effect on existing services, and without requiring an allocation of dedicated frequencies.

From the perspective of an ultra-wideband developer, XtremeSpectrum comments on Items 5, 7, and 19-20 of the Public Notice: spectrum for unlicensed devices, criteria for "harmful interference," and spectrum efficiency. We also add another issue: transparency of spectrum proceedings that involve the federal government.

### **C. Item 5: Spectrum for Unlicensed Devices**

The Commission's Rules have long allowed non-interfering, low-power, unlicensed operation on the same frequencies as licensed services. Instances date back to 1938, just three years after the Commission was founded.<sup>7</sup> Originally, unlicensed operation shared spectrum with

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<sup>4</sup> *E.g.*, 47 C.F.R. Sec. 24.232(b) (automatic implementation of minimum necessary power for PCS communications).

<sup>5</sup> *E.g.*, 47 C.F.R. Sec. 15.501 *et seq.* (ultra-wideband).

<sup>6</sup> Other examples include spread spectrum on Amateur frequencies, 47 C.F.R. Sec. 15.247, and telemetry on UHF mobile voice frequencies. 47 C.F.R. Sec. 90.238(e).

<sup>7</sup> *Operation of Radio Frequency Devices Without an Individual License*, 2 FCC Rcd 6135 at para. 2 (1987).

a variety of other services. This type of operation remains permissible under the Rules today.<sup>8</sup> It can use any frequencies except those in the "restricted bands," such as radio navigation, search and rescue, and satellite downlink bands.<sup>9</sup> Until recently, however, this type of operation has been relatively unpopular because the low power limitations result in a very short range and poor performance.

Over the past thirty years or so, the Commission has added a second approach to unlicensed operation: confining specified types of unlicensed devices to certain bands, but permitting them substantially higher powers. Examples include spread spectrum at 915 MHz and 2.4 and 5.8 GHz, and point-to-point operations in the 24 GHz and 60 GHz bands.<sup>10</sup> All of these bands are allocated to ISM and Government radar, and all but one to the Amateur Radio Service as well.<sup>11</sup> But Part 15 is rapidly becoming their dominant use -- so much so that they are often called "Part 15 bands." This partial set-aside for unlicensed operations has helped to spur innovation, investment, and standardization. A flourishing multi-billion-dollar industry is the result.

Ultra-wideband marks a return to the earlier concept of unlicensed operation: the shared use of otherwise occupied bands at power levels low enough to eliminate any realistic risk of

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<sup>8</sup> 47 C.F.R. Sec. 15.209.

<sup>9</sup> 47 C.F.R. Sec. 15.205.

<sup>10</sup> 47 C.F.R. Secs. 15.247, 15.249, 15.255. Moreover, the Commission recently permitted non-spread-spectrum "digital modulations" under the spread spectrum rules. *Spread Spectrum Devices*, ET Docket No. 99-231, Second Report and Order, FCC 02-151 (released May 30, 2002).

<sup>11</sup> The band at 902-928 MHz also accommodates the Location and Monitoring Service.

interference. The permitted powers are typically about 13,000,000 times lower than those in the "Part 15 bands."<sup>12</sup> Ultra-wideband operates at the same (or lower) powers as traditional Part 15 shared operation. Unlike earlier shared operation, however, ultra-wideband spreads its low-power signal across a very wide range of frequencies. Indeed, ultra-wideband is a fundamentally novel way of making spectrum available. Where allocations divide up frequencies, ultra-wideband divides up signal levels across many frequencies. Even so, ultra-wideband would not have needed separate rules at all, except that it cannot completely avoid the restricted bands.<sup>13</sup>

Both the "Part 15 band" approach and "shared spectrum" technologies, such as ultra-wideband, have useful applications. But the applications tend to be different. Devices in the Part 15 bands use tens or hundreds of milliwatts, with ranges from tens of meters to tens of kilometers. Shared-spectrum devices, on the other hand, are limited to nanowatts or microwatts, with typical ranges of 10 meters or less. But today there is a growing need for "personal area" networks and devices that cover a room or two at most, at the multi-megabit data rates needed for video. Shared technologies such as ultra-wideband can fill that need.

In short, although XtremeSpectrum supports allocating spectrum for unlicensed applications, we remind the Commission that allocations are not the only way to promote unlicensed use. Equally valuable -- more so, for some applications -- is a regulatory scheme that welcomes low-power, non-interfering devices in spectrum already allocated for other purposes.

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<sup>12</sup> For example, a "digital modulation" or spread spectrum transmitter can use 1 watt, while most shared operation is limited to 75 nanowatts (0.000000075 watts). *Compare* 47 C.F.R. Sec. 15.247(b) *and* 47 C.F.R. Sec. 15.209(a).

<sup>13</sup> *Ultra-Wideband Transmission Systems*, 15 FCC Rcd 12086 at para. 4 (2000) (Notice of Proposed Rule Making). Ultra-wideband also requires somewhat different procedures for certification testing. *Id.*

**D: Item 7: Definition of "Harmful Interference"**

Effective sharing of spectrum requires some way to avoid interference among services. By definition, the band's primary user is entitled to operation free of harmful interference. In addition, however, the secondary (or unlicensed) user should be entitled to objective, predictable technical rules which, if complied with, bestow at least a presumption of non-interference.

The current regulatory scheme for unlicensed devices falls short of these standards. The rules embody three principles. First, an unlicensed device must not cause "harmful interference" (and must accept any interference received).<sup>14</sup> Second, "harmful interference" is defined as interference "which endangers the functioning of a [safety service] or *seriously degrades, obstructs, or repeatedly interrupts* a radiocommunication service . . . ."<sup>15</sup> Third, the device must comply with technical rules that seek to minimize interference to other services while maintaining flexibility for unlicensed operation.

The problem with this regime is its high level of uncertainty at every stage. Even a device that complies with the technical rules can be required to shut down if it causes harmful interference. Yet the definition of harmful interference -- that which "seriously degrades, obstructs, or repeatedly interrupts" communications -- is largely subjective. Indeed, disagreement over the application of this phrase, as applied to one service or another, accounted for much of the controversy that attended the ultra-wideband proceeding. Some service providers insisted that *any* hypothetical possibility of interference qualified as "harmful," while ultra-wideband proponents argued the Commission need only protect against any realistic

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<sup>14</sup> 47 C.F.R. Sec. 15.5(b).

<sup>15</sup> 47 C.F.R. Sec. 2.1 (italics added).

possibility of interference. The text of the "harmful interference" definition offered little guidance.

A better approach would be to implement quantitative measures of harmful interference for each service entitled to protection. We foresee three steps.

The first step is functional: The Commission would determine how much degradation or interruption a given service can reasonably be expected to tolerate. That properly depends on both the importance of the service and its overall performance. For example, a fixed microwave service carrying telephone traffic with "five-nines" reliability (averaging 5 minutes outage per year) might be asked to tolerate no more than several additional seconds of interruption per year due to interference. At another extreme, the Citizens Band channels, used mostly for casual communications with extremely poor reliability, would be entitled to little protection, because even significant interference could not make the transmissions perceptibly worse. Only a critical safety-of-life service that operates with near-perfect reliability would qualify for protection against *any* degradation or interruption.<sup>16</sup>

The second step translates these functional degrees of obstruction into permissible received interference levels. Here, again, there are complications. A microwave link, for example, has a margin of capacity available to accommodate "fading conditions," such as those caused by weather. How much of that margin can the link be expected to give up for countering interference? Similarly, a mobile phone at the outermost fringe of its service area will be more

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<sup>16</sup> A question likely to arise is whether spectrum purchased at auction is, for that reason, entitled to a higher degree of protection. We think the answer must be no. The present Part 15 rules were in place before the first spectrum auction. Licensees knowingly purchased their spectrum subject to Part 15 use, and so can be asked to accept whatever level or likelihood of Part 15 interference is appropriate for that service.

susceptible to interference than one closer to a base station. Should the standard for interfering signal levels be set for the phone at the fringe, where the service is unreliable anyway?

Moreover, a licensee may challenge emissions levels based on interference into its current equipment, on the ground that future improvements may yield devices capable of operating reliably at lower signal levels. All such considerations will have to be evaluated for realistic significance.

The third step translates these received levels into maximum permissible emissions levels from the secondary (or unlicensed) device. This process requires reasonable assumptions about several factors: *e.g.*, signal propagation, aggregation of interfering devices, and other sources of interference into the victim receiver. The details of these assumptions are critical. Again, in the ultra-wideband proceeding, the parties generally concurred on the appropriate techniques for predicting interference, but differed greatly on what assumptions to use -- and consequently differed on whether interference would or would not occur in practice.

Finally, a device operating in compliance with these interference-derived limits should enjoy a presumption that it is not a source of harmful interference.<sup>17</sup>

We acknowledge that deriving emissions limits in this way might become a contentious process. But it need be done only once for each service to be protected. And the benefits would be substantial. Licensed services would have better assurance of interference-free communications in the presence of unlicensed devices. Those who design and invest in unlicensed technologies could do so in an environment of certainty and predictability, and hence

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<sup>17</sup> By way of precedent, *see, e.g.*, 47 C.F.R. Sec. 90.361 (Part 15 devices operating under specified conditions are not considered to be causing harmful interference to certain licensed systems).

bring new products and services to market in reasonably short lead times. And the Commission would know it is extracting maximum use of the spectrum under a rational scheme for minimizing interference.

**E. Items 19 and 20: Technologies and Measurements for Spectrum Efficiency**

XtremeSpectrum urges a broad view of how to quantify spectrum efficiency, and of the technologies that can promote it.

Historically the Commission has assessed spectrum efficiency on a per-device basis, in terms of bits/second/Hertz -- the most direct measure of how much data a device transmits per unit of radio bandwidth.<sup>18</sup> Yet this value can be misleading. Devices with individually low bits/sec/Hz values may nonetheless achieve high efficiencies in combination, where many such units share the same spectrum over a given area. For example, radios used for remote reading of utility meters typically transmit only a few hundred bits per day -- very low efficiency, by ordinary standards. But a quarter-million of these devices installed over a few square miles add up to a combined use of the spectrum that is far more efficient than ordinary radios. Indeed, the Commission grants exceptions to the bits/sec/Hz requirement for certain radios if the applicant can show they will be used in close proximity, so as to yield a high usage per Hertz *per area*.<sup>19</sup> We submit the "bit/sec/Hz/area" measure is a more appropriate measure of spectrum usage by low-powered devices.

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<sup>18</sup> See note 3, above.

<sup>19</sup> *Private Land Mobile Radio Refarming Proceeding*, 11 FCC Rcd 17676 at paras. 21-22 (1996) (Memorandum Opinion and Order), providing for exception to 47 C.F.R. Secs. 90.203(j)(3), (5) (4800 bits/sec per 6.25 kHz radio bandwidth for VHF and UHF land mobile radios).

By this test, ultra-wideband is highly spectrum-efficient. XtremeSpectrum, for example, achieves 100 Mbps over about 5 GHz of bandwidth. This works out to 0.02 bits/sec/Hz -- admittedly unimpressive, for one unit. But the power is so low, and the resistance to interference so high, that full frequency re-use is practical just a few meters away. This enables very dense deployment, resulting in very high efficiencies overall.

Ultra-wideband contributes to spectrum efficiency in another way as well, by extracting value from spectrum that is not otherwise available. Because it can share fully-occupied spectrum without causing interference, ultra-wideband exploits spectrum capacity that would otherwise go unused.

We urge the Commission to consider spectrum efficiency from a functional viewpoint, and specifically to acknowledge that even inefficient transmitters may nonetheless produce highly efficient use of the spectrum in combination.

**F. Other Matters: Transparency of Spectrum Proceedings that Involve the Federal Government**

The Commission's Rules require the parties to a rulemaking to publicly disclose their communications with Commission staff.<sup>20</sup> Exempt from this mandatory disclosure, however, is a

presentation [] to or from an agency or branch of the Federal Government or its staff and involv[ing] a matter over which that agency or branch and the Commission share jurisdiction . . .<sup>21</sup>

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<sup>20</sup> 47 C.F.R. Sec. 1.1206.

<sup>21</sup> 47 C.F.R. Sec. 1.1204(a)(5). The provision continues: ". . . provided that, any new factual information obtained through such a presentation that is relied on by the Commission in its decision-making process will, if not otherwise submitted for the record, be disclosed by the Commission no later than at the time of the release of the Commission's decision[.]"

In practical terms, this means that NTIA (and possibly other government agencies) need not disclose their communications to the FCC that relate to spectrum issues.

The federal agencies, led by NTIA, played a critical role in the ultra-wideband proceeding. Although the issues centered on Part 15 unlicensed devices at extremely low power, the affected spectrum included bands important to Government users. NTIA examined possible interference to Government systems, and filed its studies with the Commission for public comment. As the Commission approached its decision, however, it became clear from press reports that government agencies were making multiple communications to the Commission that did not contemporaneously appear in the docket.

Shared spectrum usage by Government and commercial interests will likely grow as the Commission, NTIA, and other agencies continue to address the increasingly complex challenges of managing spectrum efficiently, both providing for new technologies and assuring that national security and public safety uses are protected from harmful interference. It will remain critical for the Commission and other Government agencies to continue communicating on an ongoing basis. In particular, NTIA and the Commission must work together to ensure a fair and fact-based evaluation of new technologies in terms of both incumbent commercial and Government users. On the other hand, this process must not subject entrepreneurial companies to multi-year proceedings that outlive the patience of capital markets, on which new entrants depend.

In summary, XtremeSpectrum believes that the American public can best be served when interested parties have the opportunity to review and respond to agencies' views or concerns on

the record. An optimal result in future proceedings depends on open debate and discussion among all parties, both Government and private sector.<sup>22</sup>

XtremeSpectrum is encouraged by the strong commitments expressed by Chairman Powell, the other Commissioners, Assistant Secretary Victory, and Deputy Assistant Secretary Gallagher to work together on the challenges of spectrum management. We urge the Commission to consult with NTIA and other Government agencies toward amending the rules to make future rulemakings that involve both government and commercial interests transparent to all participants.

### **CONCLUSION**

The mounting pressure on spectrum will keep engineers searching for new ways to squeeze in more services.<sup>23</sup> Some of those innovations may require the Commission to rethink fundamental assumptions. Among other lessons, the recent experience of the ultra-wideband proceeding has taught us all that a willingness to question long-held truths of the past will be essential to exploiting the developments of the future.

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<sup>22</sup> Where issues of national security are involved, of course, some level of confidentiality may be necessary. But we believe the public interest is best served when these instances are kept to a minimum.

<sup>23</sup> We recognize that engineers at the FCC and other government agencies face increased pressures as new technologies continue to evolve at a faster pace. The ultra-wideband proceeding, in particular, required Herculean efforts on the part of OET engineers and their counterparts at NTIA. Highly qualified engineers are the key to the agencies' ability to continue providing sophisticated technical analysis in regulatory proceedings involving new technologies. We believe it would directly serve the public interest for the Commission to give high priority to supplementing existing engineering resources as necessary.

XtremeSpectrum appreciates the opportunity to participate in this proceeding, and remains available to assist the Commission in any way possible.

Respectfully submitted,

Mitchell Lazarus  
FLETCHER, HEALD & HILDRETH, P.L.C.  
1300 North 17th Street, 11th Floor  
Arlington, VA 22209  
703-812-0440  
Counsel for XtremeSpectrum, Inc.

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## SERVICE LIST

Chairman Michael Powell  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Commissioner Michael J. Copps  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Commissioner Kathleen Q. Abernathy  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Commissioner Kevin J. Martin  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Edmund J. Thomas  
Chief  
Office of Engineering and Technology  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Paul Kolodzy  
Senior Spectrum Policy Advisor  
Office of Engineering and Technology  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Lauren M. Van Wazer  
Special Counsel to the Office Chief  
Office of Engineering and Technology  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W., Room 7-C257  
Washington, D.C. 20554

Michael J. Marcus  
Associate Chief  
Office of Engineering and Technology  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Bruce A. Franca  
Deputy Chief, Technology  
Office of Engineering and Technology  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Julius P. Knapp  
Deputy Chief  
Office of Engineering and Technology  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Bruce A. Romano  
Associate Chief (Legal)  
Office of Engineering and Technology  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W.  
Washington, D.C. 20554

Office of Media Relations  
Reference Operations Division  
Federal Communications Commission  
445 12<sup>th</sup> Street, S.W., Room CY-A257  
Washington, D.C. 20554

Qualex International  
445 12<sup>th</sup> Street, SW, Room CY-B402  
Washington, DC 20554