

Before the Federal Communications Commission Washington, D.C. 20554

In the Matter of

Revision of Part 15 of the Commissions's
Rules Regarding Ultra-Wideband
Transmission Systems

ET Docket No. 98-153

Reply Comments by Timothy J. Shepard, Ph.D.

Wide-band radio technology holds much promise. Excitement about the development of this technology is evident in the comments filed. The great importance of this proceeding has already been noted by other filers.

I hope that the FCC will proceed with rule making that will allow rapid development of UWB systems without any requirements that UWB systems filter out intentional radiation in any particular bands.

Regarding concerns about interference with existing systems, concern is appropriate, but the concerns expressed in the comments filed (in particular, by the FAA and the U.S. GPS Industry Council) have been overstated. I believe that it is appropriate to allow intentional radiation in the restricted bands under the same regulations that govern unintentional radiation in these bands. If we must have regulations restricting the amount of radiation in certain protected bands, then there is no clear reason why these regulations need to hold sources of intentional radiation to a higher standard than sources of unintentional radiation.

Regarding the comments filed by the FAA

The FAA in its filed comments (letter dated 20 October 1998) stated that it is opposed to any authorization of licensed or unlicensed UWB systems to intentionally radiate in the restricted bands. While the FAA should be opposed to any change that would allow emissions that degrades the performance of critical aircraft navigation systems, it should not be opposed to changes that allow emissions at a level which do not degrade performance of such systems.

The FAA goes on to state that the FAA has documented cases of radio frequency interference caused by non-licensed low-power devices such as television antenna amplifiers, baby monitors, personal computers, and UWB operations. But the FAA failed to state in its letter that the documented interference was from devices which were radiating at levels below any particular level (regulatory or otherwise). That malfunctioning devices can radiate at levels which can cause harmful interference to a receiver is no surprise. That malfunctioning devices have caused harmful interference in the past should not be used as an argument that no appropriate level of emissions can be allowed from any devices in the future.

The FAA says that it "could agree with an appropriate licensing procedure if the manufacturers of UWB systems could demonstrate how radiation from UWB systems could be inhibited/filtered-out in those restricted bands, in Part 15, that are designated for aeronautical safety systems." Here the FAA is seeking to place all of the burden on the manufacturers while declining to take on any responsibility the FAA should have to participate and clarify exactly what levels of emissions would actually cause harmful interference.

Surely there is some level of emissions (intentional or otherwise) that can be allowed in the restricted bands without causing harmful interference to the protected systems. We should endeavor to set the regulatory limits on intentional emissions in these bands at the appropriate level, neither too low nor too high. Whether or not the source of emissions is or is not intentional is irrelevant. A receiver does not experience interference differently depending on the intent of the source. The same regulations should apply to both intentional and unintentional sources. The regulations should set the allowed level of emissions at the level appropriate to adequately protect those systems that must be protected, but not any lower.

Regarding comments filed by the U.S. GPS Industry Council

The U.S. GPS Industry Council filed comments similar to the FAA, claiming that any increase in the noise floor would be intolerable. My reply comments to the FAA (above) are appropriate in reply to these comments as well. But also, the U.S. GPS Industry Council argues that the GPS system architecture is unchangable (true) and that because of this a designer of a GPS receiver has no options to design a receiver that would be less susceptible to in-band interference. This is clearly not true.

There are many options available to the designer of a GPS receiver to make it more robust against all sorts of in-band interference. These would include (1) better signal processing and time & position solution-finding algorithms which better combine the available information (including recent as well as current observations), and (2) improved antennas which limit the sensitivity to low-angle sources of in-band signals which are already commonly used to improve a GPS receiver's robustness against multipath interference (which comes from reflections of the GPS signal off of nearby objects on the ground).

In particular, there is an obvious approach that can be used to protect a GPS receiver (for example, on an airplane) from ground-based sources of in-band interference. Phased-array directional receiving antennas could track each satellite with a tight beam, providing many decibels of gain over any ground-based sources of interference. Even today, upward-looking GPS receiver antennas surely have some directional gain (compared to an isotropic antenna) that would overcome some level of interference from ground-based UWB sources.

The FAA wanted no allowed intentional emissions in the protected bands. The U.S. GPS Industry Council did state its desires in a somewhat more useful manner by saying that it wants "no increase in the noise floor in the GPS bands". Even so, the case is somewhat overstated here as well. Indeed, the U.S. GPS Industry Council should

want to avoid too much increase in the noise floor experienced by deployed GPS receivers. But they have not made the case that any increase is too much increase. And by not being specific with the term "the noise floor", they are not taking into account any directionality that antennas used with GPS receivers may have. The effect that an UWB emitter will have on "the noise floor" that you observe will depend on what kind of antenna you have and in what direction you point it.

Proper consideration should be given to how GPS receivers work today (including their antenna) and how they may work in the future. When this sort of consideration is given here, the issue appears to be a perfect example of how spatial reuse of spectrum may be accomplished by having passive receivers use directionality of the receive antenna to select the desired signal and reject the interfering sources. I expect that well-designed GPS receiver antennas already have the necessary directional gain and are deployed in ways that could allow ground-based UWB emitters to radiate some amount of energy in the GPS bands without causing harmful interference.

Regarding comments filed by the American Radio Relay League (ARRL)

Paragraph 4 of the ARRL comments states that "The interference potential of communication-type UWB devices increases substantially if directional antennas are used to permit communication over long distances." Appendix A of the ARRL comments includes many pages of scenarios showing by how many decibels the noise floor will be increased. The FCC should note that the use of directional antennas increases the potential of interference only if the directional antenna employed by the source is pointed directly at the victim receiver. As antenna gain is increased, the chances that the victim receiver is in the main lobe is correspondingly reduced. The scenarios provided in appendix A all seem to assume that the victim receiver is directly in the main lobe of the transmitter antenna. This is unlikely, especially if the transmitter is using an antenna with a gain of 33 dBi (a very tight beam indeed!).

Employment of directional antennas by unlicensed ad-hoc radio devices generally decreases the chance that harmful interference will be caused by operation of the ad-hoc devices. The use of directional antennas also allows for greater sharing of spectrum resources. The FCC should take note of this and draft regulations which encourage (and which do not discourage) the use of directional antennas where such use is appropriate.

Regarding comments filed by Interval Research Corporation

The commission should take special note of the well-drafted comments filed by Interval Research Corporation. I enthusiastically support the conclusions in paragraphs 21, 22, 23, and 24 of the Interval's comments. The FCC should proceed in a way that encourages (and that does not stifle) the development of new and beneficial technologies as much as possible.

Interval's observation that the widespread deployment of computer and

other sources of unintentional electro-magnetic radiation have not resulted in problematic aggregate levels of interference is an important one. In determining whether or not an aggregate level of interference from many sources is a problem, the intentionality of the emissions is hardly relevant. (Electro-magnetic radiation does not combine in different ways depending on whether it was emitted intentionally or not!) Computers and embeded microprocessors are already deployed at very high densities in urban areas and continue to be deployed even more and more. The experiment is already well underway, and no particular problem due to aggregation has been observed.

Respectfully Submitted,

Timothy J. Shepard, Ph.D.
122 Beech Street
Belmont, MA 02478

Phone: +1 617 489 7135
E-mail: shep@alum.mit.edu