

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

In the Matter of:)
The Amendment of Part 97 of the Commission's)
Amateur Radio Service Rules to Permit Greater)
Flexibility in Digital Data Communications)
By: Glenn L. Williams, AF8C)
To: Chief, Wireless, Telecommunications Bureau)
Commissioners)

RM-11708

REPLY TO COMMENTS

Although the time for comments and replies to comments has technically passed, I hereby convey the following additional information that is pertinent to the topic.

These paragraphs do not request any additional changes to the bandwidths and symbol rates requested by the Petitioner in this matter.

In the interest of full disclosure, I am a retired federal employee. Formerly I worked for the National Aeronautics and Space Administration John H. Glenn Research Center in Cleveland, Ohio. While employed there, a few years ago I published a Technical Memorandum (TM) discussing the merits of Probability Density Function (PDF) modulation. The TM now can be found on various NASA and private servers, often for payment of a fee. The mere existence of the TM does not imply that the following comments express the opinion of NASA. The following comments are to be taken solely as input from a retired amateur radio operator. The reader can download the document from one of the public domain sources and form any opinion regarding the document's contents. The information below is, I believe, sufficient to carry forth my opinions as just opinions from a retired private citizen.

I wish to make known to the Commission that PDF Modulation is capable of carrying data (binary information, being that of unspecified ONEs and ZEROs) at any data rate below the limits requested by the Petitioner. Such Modulation includes any number of data rates lower than, for example, one symbol per second, without violation of any of the proposed symbol rate limits in the Petition or in existing paragraphs of Part 97.

However, one of the benefits of PDF Modulation is that of its steganographic capabilities. That is, without literally using any forms of published digital data encryption, the shape of the modulated waveform itself can be formed by computer software previous to transmission, and then sent out through a Digital-to-Analog Converter (DAC) as a bandlimited analog waveform that would not resemble classical AM, FM, or PM waveforms. Yet, only forming two subtle variations in the shape of the waveform (shape here does not imply amplitude, frequency, or phase shifts per se) would suffice to allow transmission of ONEs and ZEROs to a receiving destination over a radio circuit path. A

knowing receiver (a computer receiving the waveform and with use of an Analog-to-Digital Converter, or ADC) would have sufficient information to decode the digital data from the analog waveform.

For an example, assume a square wave would signal a ONE, and a triangle wave would signal a ZERO. Assume a 0.01 Hz waveform frequency. The analog waveform would then be bandlimited (filtered) to a bandwidth as requested in the Petition without suffering any significant distortion of the intended waveform shape. Assume that the users of such a waveform are satisfied to only have a final data rate of 0.001 bit per second. So there would be ten cycles of such a waveform for each data bit desired. Nothing in the Petition would preclude use of such waveform frequencies. The reader may note that transmitting information at 0.001 bits-per-second might have very little practical use. The example is only here to show what is technically possible with PDF modulation. I anticipate that experimental use of PDF Modulation would employ waveforms much more subtle than square waves and triangle waves. Do not prejudge "practical use". The reader is able to see this document because of technical advancements on innumerable discoveries that might have been of "no practical use" when initially found.

The further point is hereby made that, in the words of the Petitioner, permitting a "multiplexed emission using an unspecified digital code" is very nearly the equivalent of permitting PDF modulation. I claim this because, in the end, on amateur radio, the final transmitted digital data stream is nothing other than an analog waveform with some bandwidth of frequencies and having the characteristics of a continuous cyclical analog waveform of electromagnetic radiation in free space. And all cyclical waveforms do have a measurable probability density function.

But I have to add that permitting any form of unspecified digital code opens up the possibility of using PDF Modulation for steganographically transmitting information over the airwaves such that only a knowing receiver could accurately decode the information. Without using any published form of data encryption, which is prohibited by Part 97, the PDF modulation would appear to meet all the requirements of Part 97 and yet effectively hide information from view by the unsophisticated public and from interested authorities.

Respectfully submitted:
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