
Title: Proposal to Amend Section 8.3.5.16 of TG3&4 Draft Document

Date Submitted: 2001-07-06

Source(s): Brian Eidson
Conexant Systems, Inc.
9868 Scranton Rd
San Diego, CA 92121
Voice: (858) 713-4720
Fax: (858) 713-3555
mailto: brian.eidson@conexant.com

Re: TG3&4 Draft document

Abstract: This document proposes a new section 8.3.5.16 to replace the old one in the 802.16ab draft
document. Section 8.3.5.16 describes some example burst configurations and affiliated processing
techniques within the Single Carrier mode.

Purpose: To propose replacement of section 8.3.5.16 and its dependent, descending subsections with the
contents of this document.

Notice: This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on
the contributing individual(s) or organization(s). The material in this document is subject to change in form and
content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained
herein.

Release: The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution,
and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE’s name
any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE’s sole
discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The
contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

Patent Policy and Procedures: The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures (Version 1.0)
<http://ieee802.org/16/ipr/patents/policy.html>, including the statement “IEEE standards may include the known
use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-
developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants
under reasonable terms and conditions for the purpose of implementing the standard.”

Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to
reduce the possibility for delays in the development process and increase the likelihood that the draft publication
will be approved for publication. Please notify the Chair <mailto:r.b_marks@ieee.org> as early as possible, in written
or electronic form, of any patents (granted or under application) that may cover technology that is under
consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE
802.16 web site <http://ieee802.org/16/ipr/patents/notices>.
Proposal to Amend Section 8.3.5.16 of TG3&4 Draft Document

Brian Eidson
Conexant Systems, Inc.

8.3.5.16 Examples of Burst for 256-point FFTs

The following example burst profiles and burst processing techniques are based on a U = 63-symbol length Unique Word, and a 256 T-symbol based FFT. The Acquisition sequence is assumed to be composed of 1 Unique Word, but could be composed of 2 Unique Words or more.

One standard signaling burst involves the repetition of Unique Words (UWs), at regular intervals. Such repetition facilitates the FFT processing associated with frequency domain equalization. Figure 1 illustrates such a burst, which concludes with a (suffixing) UW, followed by a null transmit region, RxDS—which allows the delay spread to clear a receiver. Note that, for this signaling case, the payload length must be an integer multiple of 193 symbols. Note also the amount of overhead required, for both the repeated UWs, and for both the final UW and RxDS block. (No one can transmit while the delay spread is being cleared, although, in this case, this region could be used in the Rx/Tx transition gap switching.) The transmit efficiency (coefficient) for this case is $E = 193 J / (256 J + 63 N + 63)$, where $J$ is the number of 193 symbol payload sections transmitted, and $N$ is the number of Unique Words (1 or more) composing the (initial) acquisition sequence.

Payload length = 193 $J$ symbols

![Figure 1: Repetitive UW patterned Burst with 256 pt Prefix-aided FFTs and suffixing UW](image)

A slightly more efficient approach is to not transmit the last UW, as is illustrated in Figure 2. Observe that the last data payload is not cyclic, since it does not conclude with a Unique Word. Therefore, in order to perform FFT processing, the last FFT must overlap the earlier data by at least 63 symbols. What's more, some data must be thrown away, post-FFT. The payload length restriction in this case is that the payload must be $M + 193 J$ symbols long, where $J = 0,1,2, \ldots$ and $M < 131$ is the size of the final payload block. (Figure 2 illustrates the case of $M = 130$.) Note that here the transmit efficiency is $E = (M + 193 J)/(256 J + 63 N)$, where $J$ is the number of 193 symbol payload subblocks transmitted, and $N$ is the number of Unique Words (1 or more) composing the (initial) acquisition sequence.
Since bursts tend to be short, the channel estimation performed at the beginning of the burst may be sufficient. What's more, overlap FFT processing is possible, so the repetitive UW-pattern may not always be necessary—if one is willing to use more FFTs to process a block. Figure 3 illustrates one example of how overlapping FFTs may be used in an overlap-save processing scheme. Note that the first and last 63 symbols of an FFT are eliminated, post equalization. The payload length restriction in the illustrated case is that the payload must be 130 J symbols long, where J = 0, 1, 2. Here the transmit efficiency is $E = (130J)/(130J + 63N + 63)$, where J is the number of 130 symbol payload subblocks transmitted, and N is the number of Unique Words (1 or more) composing the (initial) acquisition sequence. Note that by increasing the overlap factor, the payload granularity may be decreased, so that payloads are M J symbols long, where M < 131. For this more general case, $E = M J / (M + 63N + 63)$.

A variation on the aforesaid technique is to use regularly overlapping FFTs for the main data, and use an extended overlap to cover the last payload subblock, which may be smaller than the preceding payload subblocks. This approach is illustrated in Figure 4. Note that any arbitrary payload larger than 129 symbols can be accommodated with this approach. The transmit efficiency for this case is $E = \text{Payload Length} / (\text{Payload Length} + 63N + 63)$, where N is the number of Unique Words (1 or more) composing the (initial) acquisition sequence.
The technique described in Figure 4 is quite flexible in terms of payload sizes, but it does require the final FFT to back up in further time, to realize a larger overlap. A more regular FFT processing technique, with regular overlaps, might be better. A receiver processing technique that realizes this goal, using the same transmit format as used in Figure 4, is illustrated in Figure 5. Note that with this technique, the receiver insert zeros into the data stream following the RxDS delay spread clearing section, so that the final FFT is a full 256 points long. Mark that the transmitter does not transmit these zero pad symbols. The great advantage is that, with this technique, payloads of any size may be accommodated. Like the technique of Figure 4, the transmit efficiency is $$E = \frac{\text{Payload Length}}{\text{Payload Length} + 63 N + 63}$$, where N is the number of Unique Words (1 or more) composing the (initial) acquisition sequence. Note that, if addition pilot symbols are needed for channel estimation in long burst, Unique Words could be added to the payload stream of Figure 5, without the requirement that they be utilized within the data FFT processing. They may be still used to estimate the channel, using separate channel estimation processing.

Although not as efficient in terms of yielded data per FFT as the technique of Figure 1, the technique and frame format of Figure 5 is probably the most accepting and flexible in terms of payload sizes and transmit efficiency. Figure 6 illustrates how the technique may be applied to very short bursts, involving one FFT of data. Note that, even in these cases, a single 256 point FFT may be used, and payload sizes of 1 to 130 symbols can be supported, with high transmit efficiencies: $$E = \frac{\text{Payload size}}{\text{Payload size} + 63 N + 63}$$. No dummy data need to be added to the payload to fill out a block. This is particularly important for BW request messages, which are only 6 bytes in length, and would be sent with the most robust modulation, rate _ QPSK. Even with a very powerful rate _ Reed-Solomon outer code (N=12 bytes,K=6 bytes,T=3 bytes), and 6 tail symbols to terminate the inner code, the total number of payload symbols required, $$X = 48 + 48 + 6 = 102$$ symbols, could be easily accommodated within a single FFT, and transmitted without any payload bit stuffing.
payload length any arbitrary number > 0 symbols

Figure 5: Burst with Regular Overlapping 256 point FFTs and zero-pad pre-FFT processing at the Receiver

Figure 6: Short burst involving single 256 pt FFT (and zero-pad pre-FFT processing).