Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**Changes to 802.16.1 Physical Layer Specification as Agreed on 11 July 2000**	
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Source(s)	Jeff Foerster Alcatel 1221 Crossman Ave. Sunnyvale, CA 94089	Voice: 408-745-3983 Fax: 408-745-0390 mailto: jeff.r.foerster@alcatel.com
Re:	PHY task group meeting of 2000-07-11.	
Abstract	This contribution documents the changes to the PHY draft specification that were agreed upon during the PHY task group meeting on 2000-07-11.	
Purpose	To document changes in the new working draft (IEEE 802.16.1p-00/07r2).	
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Changes to 802.16.1 Physical Layer Specification as Agreed on 11 July 2000

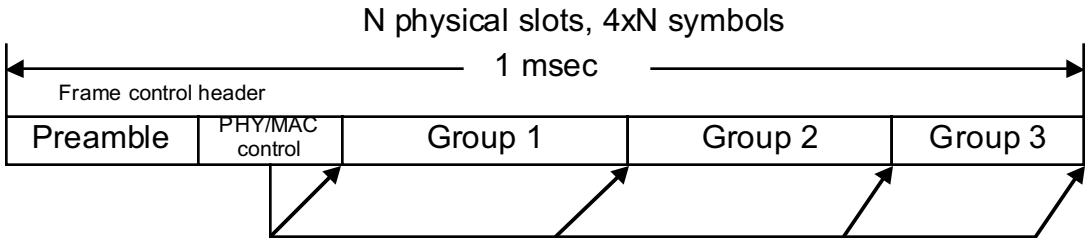
Jeff Foerster

Overview

An important decision was made regarding the PHY draft specification during the 802.16.1 Task Group meeting on 2000-07-11. A motion was passed to change the PHY draft specification to support a flexible coding scheme on the downstream burst mode of operation (Mode B). As a result, a group of volunteers met to examine the impacts this change would have on the current draft PHY specification, and the following recommended changes to the draft are summarized here. These changes are also incorporated into a revised PHY draft specification that is attached to the end of this document.

Summary of Changes

Based upon the various channel conditions and deployment scenarios that are envisioned for BWA systems, there is a desire to have some flexibility in the coding for the burst mode of operation (FDD with adaptive modulation, FSDD, or TDD). In order to address this need, the following approach has been taken in the PHY layer to support this flexibility. The following diagram illustrates the modified frame structure that is used.



In this case, the PHY/MAC control data is treated as a separate group from the user data portion of the frame, which has a clearly defined coding scheme. This PHY/MAC control portion of the frame is used to transmit any pertinent information to the subscribers in order to allow them to enter the network and obtain certain registration information, which includes the configurations of the active modulation and FEC groups for the user data portion of the frame. The rest of the user data portion of the frame is divided into different modulation/FEC groups, where each group is allowed to have different modulation and/or coding structures. The frame should still have the modulation levels increase from QPSK to 16-QAM to 64-QAM, but the coding schemes could be allowed to vary. The downstream allocation map shall contain the location where each modulation/FEC group begins and ends.

The 802.16.1 task group also decided to adopt a flexible upstream and downstream burst mode PHY that supports the following mandatory coding schemes:

1. RS based on GF(256) with k=6-255 and t=0-16

2. RS based on GF(256) with k=6-255 and t=0-16 with inner parity check bit on each RS byte.

3. RS based on GF(256) with k=6-255 and t=0-16 with inner (24,16) block convolution code using a constraint length 3 tail biting code.

And the following optional codes:

1. BTC based on a product code with the rows and columns encoded with a (64,57) Extended Hamming code with k=1-57 for the upstream and downstream.

2. BTC based on a product code with the rows and columns encoded with a (32,26) Extended Hamming code with k=1-26 for the upstream.

3. BTC based on parity check codes (K+1, K) , for K=8 – 64 for the upstream.

Based upon these decisions, a group of volunteers identified the following changes that would be needed to support these new features.

1. In order to support these changes, some changes to existing MAC messages are required in order to send the modulation/FEC group descriptions to the subscriber stations. The following table lists the various parameters that are required, which has been included in the revised PHY layer specification in the downstream Mode B PMD sublayer definition.

Downstream modulation/FEC group descriptions

Parameter description	**Parameter needed from MAC**
Modulation	1=QPSK 2=16-QAM 3=64-QAM (Optional)
FEC code type	1 = Reed-Solomon only 2 = Reed-Solomon + Inner (9,8) Parity Check Code 3 = Reed-Solomon + Inner Block Convolutional Code 4 = Block Turbo Code (Optional) 5-255 = Reserved
RS information bytes (K)	K=6-255
RS error correction capability (T)	T=0-16
BCC code type	1 = (24,16)

	2-255 = Reserved
BTC Row code type	1 = (64,57) Extended Hamming 2 = (32,26) Extended Hamming 3-255 = Reserved
BTC Column code type	1 = (64,57) Extended Hamming 2 = (32,26) Extended Hamming 3-255 = Reserved
BTC Row code shortening	0-255 columns
BTC Column code shortening	0-255 rows
BTC Product code shortening bits	0-255 bits
Last codeword length	1=fixed; 2=shortened (**optional**). This allows for the transmitter to shorten the last codeword, based upon the allowable shortened codewords for the particular code type.

Some changes were also required to the upstream burst descriptions in order to support the new coding options.

2. In addition, since there exists some optional modulation and coding schemes, the subscriber stations need some method of communicating that information to the base station. As a result, the following additional capability set information is required to be sent to the base station upon registration.

Downlink Physical Layer Terminal Capability Set Parameters

Standard Version Number	
Highest Modulation Order	1 = 16-QAM 2 = 64-QAM
Optional FEC Type	00000000 = None xxxxxxx1 = BTC1: (32,26) Extended Hamming xxxxxx1x = BTC2: (64,57) Extended Hamming other = Reserved
Minimum shortened last codeword size and capability	TBD

Uplink Physical Layer Terminal Capability Set Parameters

Standard Version Number	
Highest Modulation Order	1 = 16-QAM 2 = 64-QAM
Optional FEC Type	00000000 = None xxxxxxx1 = BTC1: (32,26) Extended Hamming xxxxxx1x = BTC2: (64,57) Extended Hamming other = Reserved

3. In order to ensure interoperability, the modulation and FEC coding for the PHY/MAC control portion of frame must be clearly defined. It was decided that this coding scheme will be based upon one of the code types 1-3, but the specific parameters are TBD.

4. Additional text has been added to clarify the shortening procedure for the Reed-Solomon codes.

5. A clear description of the Block Turbo Codes has been added.

6. A clear description of the Block Convolutional codes has been added.

7. Changes to the downstream allocation map need to be incorporated into the MAC description.