Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Combining Burst FDD and FSDD modes in 802.16.1**
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Re:	Call for comments on IEEE 802.16.1-00/01r1.
Abstract	TDM and TDMA can co-exist in the PHY mode B FDD cases, simplifying the system options while increasing both system efficiency and statistical multiplexing.
Purpose	Since the proposed change is large with respect to it's impact on the document, this document explains the change in a form better suited to presenting the idea than a text-only comment form.
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Combining Burst FDD and FSDD Modes in 802.16.1

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Issue

One issue addressed by PHY Mode B is the need to efficiently support both half and full-duplex terminals in FDD systems. On a channel that has predominantly half-duplex terminals, simply requiring terminals to always receive earlier in the frame than they transmit does not efficiently use the resources. For half-duplex terminals to be able to receive data later in a frame than their uplink allocation requires a means for the terminals to re-sync with the downlink. This requires a downlink that is structured in a TDMA manner. On a channel that has predominantly full-duplex terminals, the extra overhead of TDMA on the downlink makes it less efficient than using a TDM downlink. Additionally, in a system with many terminals of each type, the dynamics of bursty traffic may make one mode more efficient some frames and the other more efficient other frames. Because of this, the current proposed draft 802.16.1 specification contains the burst FDD and the FSDD modes. If these modes could be combined, the specification would be simplified. A solution must, however, attempt to gain the efficiency of TDM from the burst FDD mode and the statistical multiplexing gain for half-duplex terminals of FSDD mode.

Downlink Subframe Structure

The solution is to allow both simultaneously. Since all full-duplex terminals and any half-duplex terminal which receives later than it transmits can take advantage of a TDM format, a frame can **always** start with a TDM section. Additionally, to increase statistical multiplexing gain, it should be noted that full-duplex terminals are able to re-sync in a TDMA downlink just as easily as half-duplex terminals. With these concepts in mind, a downlink subframe can be constructed of a TDM portion followed by a TDMA portion. This is shown in Figure 0-1.

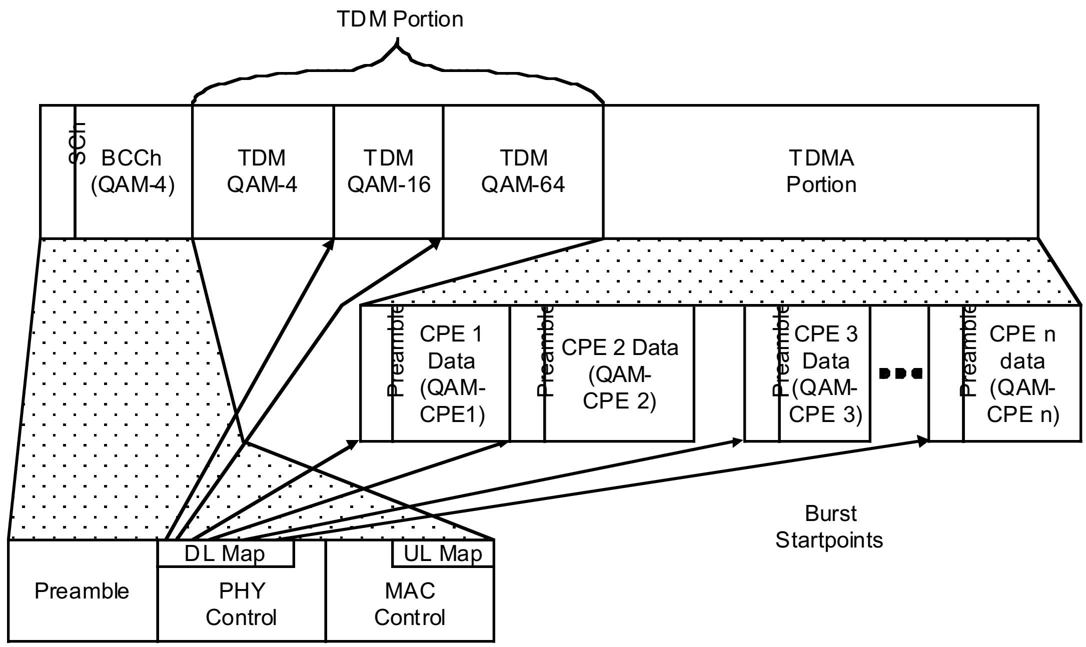

Figure 0-1: Combined TDM and TDMA Downlink Subframe

DL Map Format

The downlink map would have MAP elements with the general format shown in Table 1.

Table 1: Downlink Map Element Format

Field	Size	Comments
CID	15	Terminal Basic CID or Broadcast CID (truncated to 15 bits)
DL IUC	4 bits	See
PS start of interval	13 bits	Referenced from start of frame (note that these MAP entries aren't used for the un-framed PHY mode A)

The Downlink IUCs are defined in Table 2

Table 2: DL IUC Definitions

Interval Type	IUC	Comments
TDM, QPSK, default Q4 FEC	0x0	Well known FEC, same as Frame Control header
TDM, QPSK, secondary Q4 FEC	0x1	FEC defined in DCD message.
TDM, 16-QAM, Q16 FEC	0x2	FEC defined in DCD message.
TDM, 64-QAM, Q64 FEC	0x3	FEC defined in DCD message.
Reserved for more TDM intervals	0x4-0x6	
End of TDM	0x7	
TDMA, QPSK, default Q4 FEC	0x8	FEC defined in DCD message.
TDMA, QPSK, secondary Q4 FEC	0x9	FEC defined in DCD message.
TDMA, 16-QAM, Q16 FEC	0xA	FEC defined in DCD message.
TDMA, 64-QAM, Q64 FEC	0xB	FEC defined in DCD message.
Reserved for more TDMA intervals	0xC-0xE	
End of TDMA	0xF	

Because, all terminals can listen to bursts of equal or lesser robustness than there current negotiated DL modulation and FEC, the CID is not truly necessary in the DL MAP elements. Alternative map elements are shown in Table 3.

Table 3: Alternative Downlink MAP Element Format

Field	Size	Comments
DL IUC	4 bits	See
PS start of interval	14 bits	Referenced from start of frame (note that these MAP entries aren't used for the un-framed PHY mode A)