Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Proposal to Add a New Section between 8.3.5.11 and 8.3.5.12 of TG3&4 Draft Document**
Date Submitted	**2001-07-06**
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Re:	TG3&4 Draft document
Abstract	This document proposes to add a new section between 8.3.5.11 and 8.3.5.12 in the 802.16ab draft document. This new section will illustrate FDD and TDD operation for the single carrier mode, given previously described PHY frame formats and MAC/PHY interface message structures. The attempt is to graphically capture how the MAC and PHY interact, for both the FDD (with a continuous downstream) and TDD/half-duplex FDD.
Purpose	To propose the addition of a section between 8.3.5.11 and 8.3.5.12, using contents found in this document.
Notice	
Release	
Patent Policy and Procedures	

Proposal to Add a New Section between 8.3.5.11 and 8.3.5.12 of TG3&4 Draft Document

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8.3.5.12 Illustrations of FDD and TDD Operation

In the following two subsections, we illustrate FDD operation, and TDD operation, respectively, utilizing some of the framing and MAC messaging mechanisms previously introduced. The intent is to give the reader some notion of how the communicating duplexes within two-way transactions interact.

8.3.5.12.3 FDD Operation

FDD segregates the upstream and downstream on different carriers. Base stations transmit on downstreams, while subscriber units transmit on upstreams. Two different FDD formats are possible:

1. Continuous downstream and burst upstream, with multiple transmitters on the upstream
2. Burst downstream and upstream, with at one or more transmitters on the downstream, and multiple transmitters on the upstream.

8.3.5.12.1.2 FDD with Continuous Downstream

The downstream of an FDD with a continuous downstream is illustrated in **Error! Reference source not found.**. One characteristic feature of this format is that frames continuously flow on the downstream, and repeat on a regular basis. Each one of these frames is headed by a Preamble (containing Unique Words), which identifies the start of a frame. This Preamble also aids in the update or acquisition channel parameter estimates.

The Preamble is followed by a MAC message, the MAP, which is encoded using QPSK. The MAP is then followed by payloads addressed to various users, which can be sequenced in modulation types from least robust (e.g., QPSK) to most robust (e.g., 64 64-QAM). Such robustness sequencing facilitates decision-aided processing, which can, in some cases, reduce the amount of overhead that must be allocated to pilot symbols. (A receiver demodulates what it can, and if it loses lock in trying to modulate data requiring too high of an SNR, it can reacquire using the repretitive Preamble at the beginning of the next frame.)

As the breakout illustration in the middle of **Error! Reference source not found.** illustrates, the MAP itself is composed of several fields. These include a fixed sequence called the MAC Header, a Global Time Stamp (to synchronize network time between the upstream and downstream duplexes), a Downstream Schedule for downstream packets to various receivers on the downstream, and an Upstream Schedule for grants given to various users on the upstream.These schedules include the starting location of each packet, as well as the modulation, code rate, and FEC type to be used. The MAP concludes with a ARQ-related field to NACK/ACK messages previously received on the upstream.

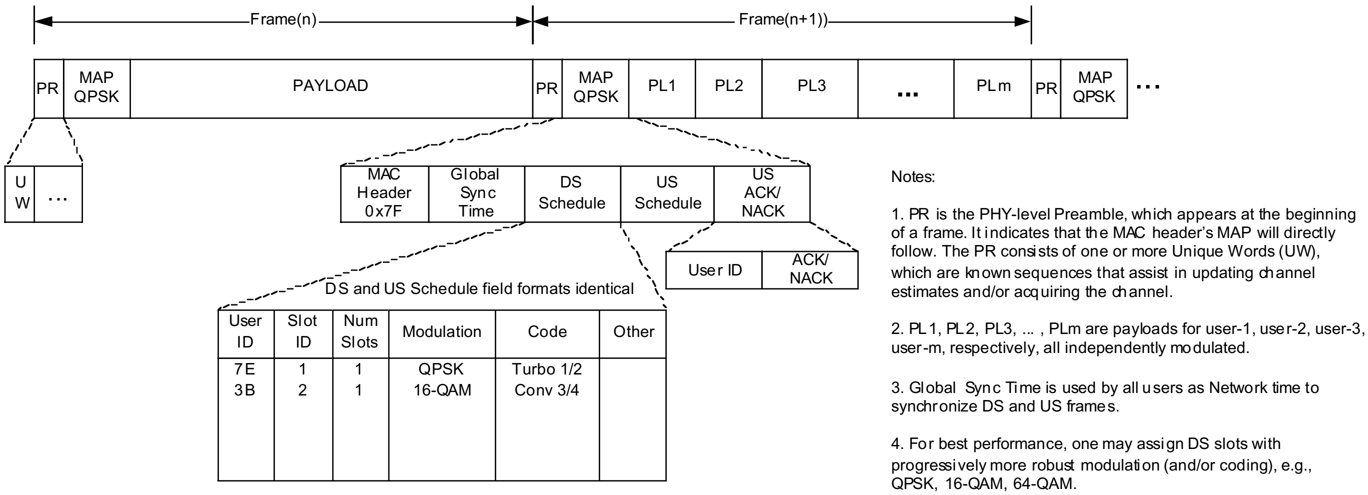

Figure 1: Downstream Duplex of FDD with a Continuous Downstream

Error! Reference source not found. juxtaposes the burst upstream, upon which many bursty subscribers transmit, with the continuous downstream. Note that an upstream frame consists of many bursts, some of which are allocated to request bursts, and others allocated to granted payloads. Each burst---whether it be a request or a payload---is a TDMA burst. As such, the burst contains an acquisition preamble (and ramp up), a payload body, and an RxDS (receiver delay spread clear) region. The request bursts may be categorized as network registration contention slots, or BW request contention slots. Additional guard intervals are likely to exist for the network registration slots. Note that the Upstream Schedule found in the downstream MAP indicates the distribution and location of bursts on the upstream.

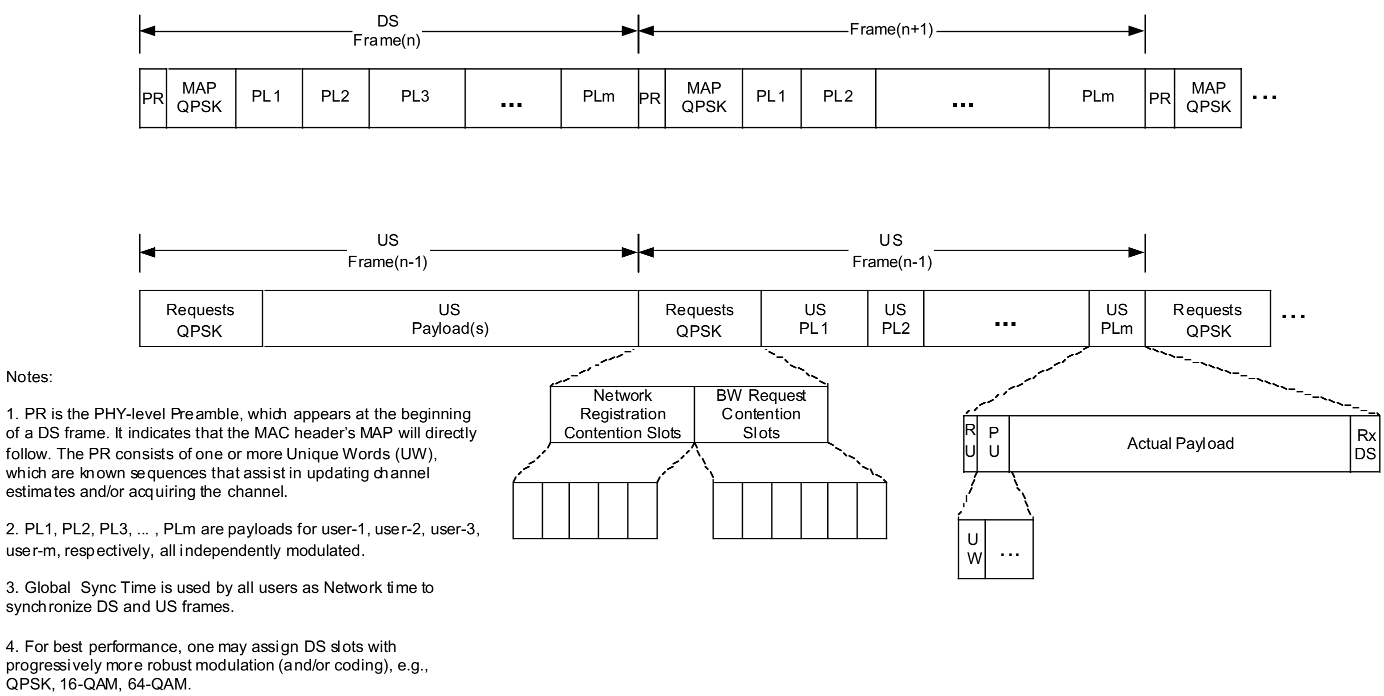

Figure 2: FDD Upstream Juxtaposed with Continuous Downstream

8.3.5.12.1.2 FDD with Burst Downstream

The only difference between FDD with a continuous downstream and FDD with a burst downstream is that the burst downstream case replaces a continuous frame with a TDM burst frame. As such, the continuous frame Preamble is replaced by a burst acquisition sequence (preamble), and the burst ends with an RxDS region, which allows delay spread to clear in the subscriber unit receivers. Figure 3 illustrates the burst FDD downstream case.

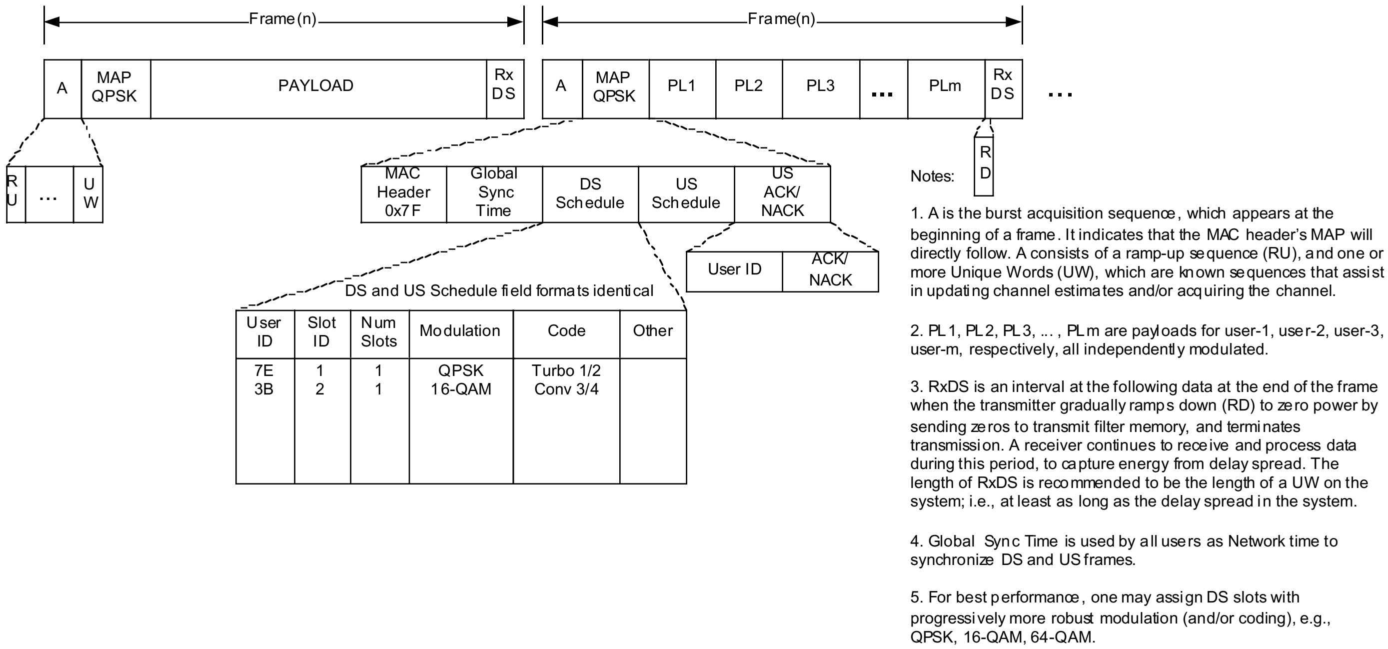

Figure 3: Burst FDD Downstream Frame

8.3.5.12.3 TDD Operation

TDD multiplexes both the upstream and downstream on the same carrier, over different time intervals. By adaptively time-sharing the bandwidth between the upstream and downstream according to duplex loading, TDD enables scare bandwidth to be more flexibly (and finely) allocated between subscriber units and base stations. TDD also offers some potential benefits related to channel response reciprocity.

Figure 4 illustrates TDD operation. Note that TDD quite resembles FDD operation, except that, with TDD, the upstream and downstream alternate between occupying the shared channel, with the amount of occupancy is typically being unequal. Like the FDD case, a TDD upstream receives its grants from a TDD downstream. frame that precedes it. In most respects other than perhaps timing, MAC message formats are almost identical between FDD and TDD.

The only completely new frame element introduced by TDD is the Guard Interval (GI). The Guard Interval separates the duplexes, allows time for a receiver to transition over to become a transmitter, and accounts for propagation delays following reception of the RxDS region which precedes the GI. It is possible for the GI to have different lengths on the upstream to downstream transition than the downstream to upstream transition.

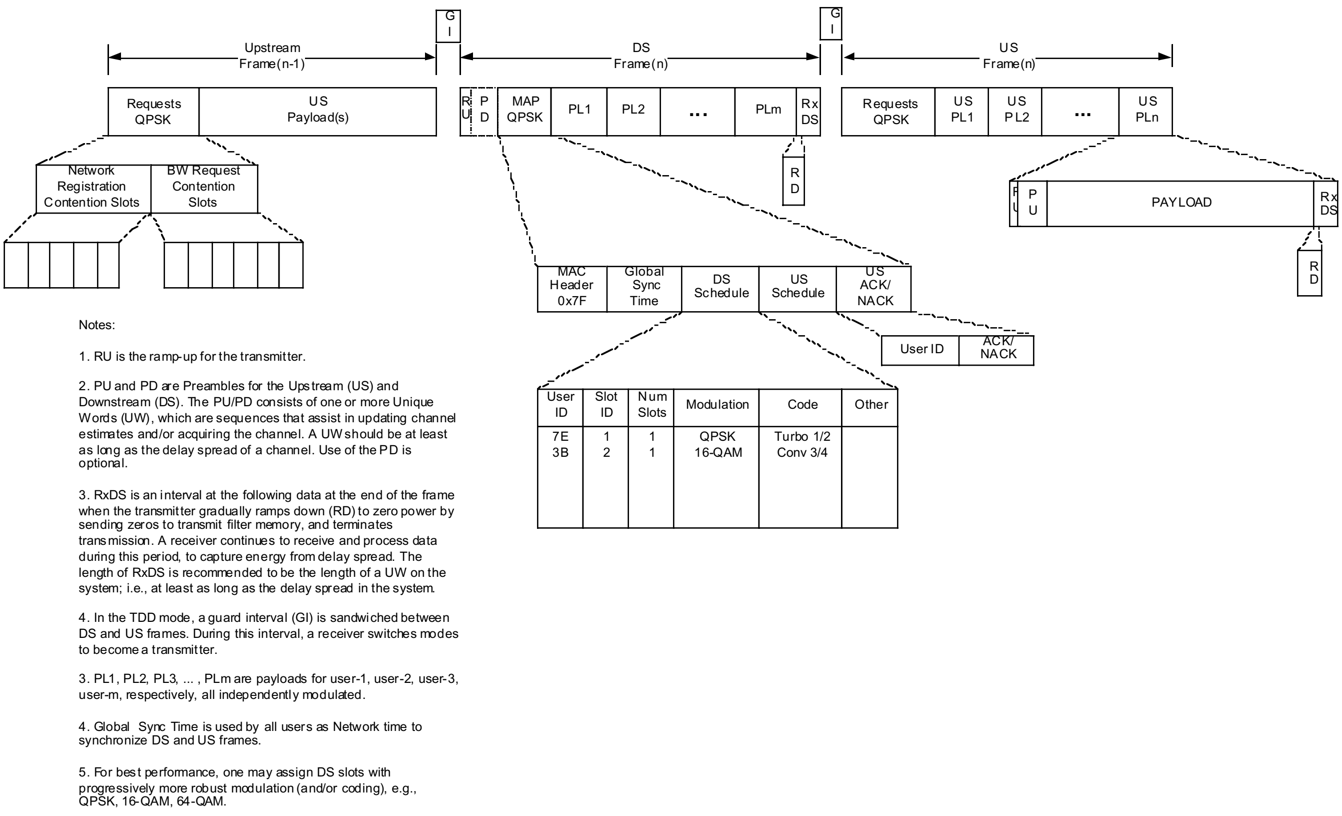

Figure 4: Ilustration of TDD messaging and operation

8.3.5.12.3 Half-duplex FDD Operation

Half-duplex FDD operation is conceptually identical to TDD operation, in that the downstream and upstream switches back and forth between two duplexes. However, these duplexes are transported at different carrier frequencies with half-duplex FDD. Because of this switching between carriers, and the incumbent tuning required, some parameter settings, such as Guard Intervals, may differ between half duplex FDD and TDD.