Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**MAC Support of PHY Layers**
Date Submitted	**2001-09-10**
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Re:	**MAC Support of SC PHY Layer**
Abstract	The document suggests output of MAC-PHY Interface Ad Hoc
Purpose	The document intended for the review of Ad Hoc Group and TG3/TG4
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8.3.4 MAC Support of PHY Layers

8.3.4.1 Common

8.3.4.2 MAC Support of SC PHY Layer

Two modes of operation have been defined for the point-to-multi-point downlink channel:

- Mode A: supports a continuous transmission stream format, and
- Mode B: support a burst transmission stream format.

Having this separation allows each format to be optimized according to its respective design constraints, while resulting in a standard that supports various system requirements and deployment scenarios.

In contrast, only one mode of operation is defined for the upstream channel:

- one targeted to support a burst transmission stream format

This single mode of operation is sufficient for the upstream, since the upstream transmissions are point-to-point burst transmissions between each transmitting subscriber station (SS) and each receiving base station (BS).

8.3.4.2.1 Downlink and Uplink Operation

Two different downlink modes of operation are defined: Mode A and Mode B. Mode A supports a continuous transmission format, while Mode B supports a burst transmission format. The continuous transmission format of Mode A is intended for use in an FDD-only configuration. The burst transmission format of Mode B supports burst-FDD as well as TDD configurations. Devices operating in license-exempt bands shall employ only TDD.

The A and B options give service providers choice, so that they may tailor an installation to best meet a specific set of system requirements. Standards-compliant subscriber stations are required to support at least one (A or B) of the defined downlink modes of operation.

A single uplink mode of operation is also defined. This mode supports TDMA-based burst uplink transmissions. Standards-compliant subscriber stations are required to support this uplink mode of operation.

8.3.4.2.1.1 Mode A - Continuous Downlink

Mode A is a downlink format intended for continuous transmission. The Mode A downlink physical layer first encapsulates MAC packets into a convergence layer frame as defined by the transmission convergence sublayer. Modulation and coding which is adaptive to the needs of various SS receivers is also supported within this framework.

In Mode A, the downstream channel is continuously received by many SSs. Due to differing conditions at the various SS sites (e.g., variable distances from the BS, presence of obstructions), SS receivers may observe significantly different SNRs. For this reason, some SSs may be capable of reliably detecting data only when it is derived from certain lower-order modulation alphabets, such as QPSK. Similarly, more powerful and redundant FEC schemes may also be required by such SNR-disadvantaged SSs. On the other hand, SNR-advantaged stations may be capable of receiving very high order modulations (e.g., 64-QAM) with high code rates. Collectively, let us define the adaptation of modulation type and FEC to a particular SS (or group of SSs) as 'adaptive modulation', and the choice of a particular modulation and FEC as an 'adaptive modulation type.' Mode A supports adaptive modulation and the use of adaptive modulation types.

A MAC Frame Control header is periodically transmitted over the continuous Mode A downstream, using the most robust supported adaptive modulation type. So that the start of this MAC header may be easily recognized during initial channel acquisition or re-acqusition, the PHY inserts an uncoded, known (but TBD) QPSK code word, of length

TBD symbols, at a location immediately before the beginning of the MAC header, and immediately after a Unique Word. (See PHY framing clause for more details on the Unique Word). Note that this implies the interval between Frame Control headers should be an integer multiple of F (the interval between Unique Words).

Within MAC Frame Control header, a PHY control map (DL_MAP) is used to indicate the beginning location of adaptive modulation type groups which follow. Following this header, adaptive modulation groups are sequenced in increasing order of robustness. However, the DL_MAP does not describe the beginning locations of the payload groups that immediately follow; it describes the payload distributions some MAC-prescribed time in the future. This delay is necessary so that FEC decoding of MAC information (which could be iterative, in the case of turbo codes) may be completed, the adaptive data interpreted, and the demodulator scheduling set up for the proper sequencing.

Note that adaptive modulation groups or group memberships can change with time, in order to adjust to changing channel conditions.

In order that disadvantaged SNR users are not adversely affected by transmissions intended for other advantaged SNR users, FEC blocks end when a particular adaptive modulation type ends. Among other things, this implies that the FEC interleaver depth is adapted to accommodate the span of a particular adaptive modulation type.

8.3.4.2.1.2 Mode B - Burst Downlink

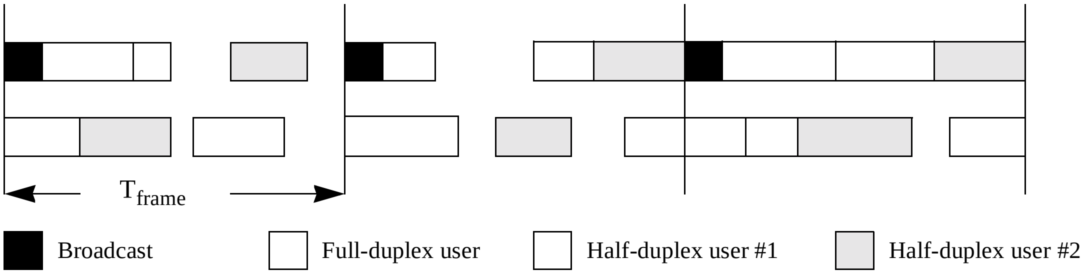

Figure 161—Example of burst FDD Bandwidth Allocation

Mode B is a downlink format intended for burst transmissions, with features that simplify the support for both TDD systems and half-duplex terminals. A Mode B compliant frame can be configured to support either TDM or TDMA transmission formats; i.e., a Mode B burst may consist a single user's data, or a concatenation of several users' data. What's more, Mode B supports adaptive modulation and multiple adaptive modulation types within these TDMA and TDM formats.

A unique (acquisition) preamble is used to indicate the beginning of a frame, and assist burst demodulation. This preamble is followed by PHY/MAC control data. In the TDM mode, a PHY control map (DL_MAP) is used to indicate the beginning location of different adaptive modulation types. These adaptive modulation types are sequenced within the frame in increasing order of robustness (e.g., QPSK, 16-QAM, 64-QAM), and can change with time in order to adjust to the changing channel conditions.

In the TDMA mode, the DL_MAP is used to describe the adaptive modulation type in individual bursts. Since a TDMA burst would contain a payload of only one adaptive modulation type, no adaptive modulation type sequencing is required. All TDMA format payload data is FEC block encoded, with an allowance made for shortening the last codeword (e.g., Reed Solomon codeword) within a burst.

The Mode B downlink physical layer goes through a transmission convergence sublayer that inserts a pointer byte at the beginning of the payload information bytes to help the receiver identify the beginning of a MAC packet.

8.3.4.2.1.3 Uplink

The uplink mode supports TDMA burst transmissions from an individual SSs to a BS. This is functionally similar (at the PHY level) to Mode B downlink TDMA operation. As such, for a brief description of the Physical Layer protocol used for this mode, please read the previous clause on Mode B TDMA operation.

Of note, however, is that many of the specific uplink channel parameters can be programmed by MAC layer messaging coming from the base station in downstream messages. Also, several parameters can be left unspecified and configured by the base station during the registration process in order to optimize performance for a particular deployment scenario. In the upstream mode of operation, each burst may carry MAC messages of variable lengths.

8.3.4.2.2 Multiplexing and Multiple Access Technique

The uplink physical layer is based on the combined use of time division multiple access (TDMA) and demand assigned multiple access (DAMA). In particular, the uplink channel is divided into a number of 'time slots.' The number of slots assigned for various uses (registration, contention, guard, or user traffic) is controlled by the MAC layer in the base station and can vary over time for optimal performance.

As previously indicated, the downlink channel can be in either a continuous (Mode A) or burst (Mode B) format. Within Mode A, user data is transported via time division multiplexing (TDM), i.e., the information for each subscriber station is multiplexed onto the same stream of data and is received by all subscriber stations located within the same sector. Within Mode B, the user data is bursty and may be transported via TDM or TDMA, depending on the number of users which are to be borne within in burst.

8.3.4.2.2.1 Duplexing Technique

Several duplexing techniques are supported, in order to provide greater flexibility in spectrum usage. The continuous transmission downlink mode (Mode A) supports frequency division duplexing (FDD) with adaptive modulation; the burst mode of operation (Mode B) supports FDD with adaptive modulation or time division duplexing (TDD) with adaptive modulation. Systems in the licensed-exempt bands shall use TDD only. Furthermore, Mode B in the FDD case can handle (half duplex) subscribers incapable of transmitting and receiving at the same instant, due to their specific transceiver implementation.

8.3.4.2.2.1.1 Mode A: Continuous Downstream for FDD Systems

In a system employing FDD, the uplink and downlink channels are located on separate frequencies and all subscriber stations can transmit and receive simultaneously. The frequency separation between carriers is set either according to the target spectrum regulations or to some value sufficient for complying with radio channel transmit/receive isolation and de-sensitization requirements. In this type of system, the downlink channel is (almost) "always on" and all subscriber stations are always listening to it. Therefore, traffic is sent in a broadcast manner using time division multiplexing (TDM) in the downlink channel, while the uplink channel is shared using time division multiple access (TDMA), where the allocation of uplink bandwidth is controlled by a centralized scheduler. The BS periodically transmits downlink and uplink MAP messages, which are used to synchronize the uplink burst transmissions with the downlink. The usage of the mini-slots is defined by the UL-MAP message, and can change according to the needs of the system. Mode A is capable of adaptive modulation.

8.3.4.2.2.1.2 Mode B: Burst Downstream for Burst FDD Systems

A burst FDD system refers to a system in which the uplink and downlink channels are located on separate frequencies but the downlink data is transmitted in bursts. This enables the system to simultaneously support full duplex subscriber stations (ones which can transmit and receive simultaneously) and, optionally, half duplex subscriber stations (ones which cannot transmit and receive simultaneously). If half duplex subscriber stations are supported, this mode of operation imposes a restriction on the bandwidth controller: it cannot allocate uplink bandwidth for a half duplex subscriber station at the same time that the subscriber station is expected to receive data on the downlink channel.

Frequency separation is as defined in clause ???. Figure 162 describes the basics of the burst FDD mode of operation. In order to simplify the bandwidth allocation algorithms, the uplink and downlink channels are divided into fixed sized frames. A full duplex subscriber station must always attempt to listen to the downlink channel. A half duplex subscriber station must always attempt to listen to the downlink channel when it is not transmitting on the uplink channel.

8.3.4.2.2.1.3 Mode B: Burst Downstream for TDD Systems

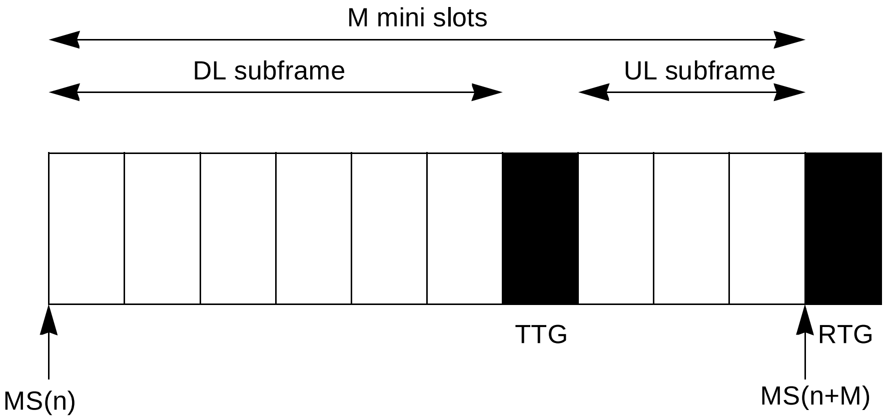

Figure 162—TDD Frame

In the case of TDD, the uplink and downlink transmissions share the same frequency, but are separated in time Figure 161). A TDD frame also has a fixed duration and contains one downlink and one uplink subframe. Allocation of bandwidth within a frame is performed in terms of mini-slots (MS). Mini-slots are defined in terms of a finer resolution entity called a physical slot. The relationship between mini-slots and physical slots is given by the following expression.

Mini-Slot = Physical Slot * 2^m when m = 0, 1, 2, 3, 4, 5, 6, 7

The definition of a physical slot is dependent on the underlying PHY. The split between the uplink and downlink is a system parameter, expressed as a number of mini-slots, occurs at a mini-slot boundary within the frame, and is controlled at higher layers within the system.

8.3.4.2.2.1.3.1OFDM Time Base

For OFDM based systems, the physical slots are defined as 4 * Sample Time.

8.3.4.2.2.1.3.2SC Time Base

For single carrier (SC) based systems, physical slots are defines as 4 * Symbol Duration.

8.3.4.2.2.1.3.3Tx / Rx Transition Gap (TTG)

The TTG is a gap between the Downlink burst and the Uplink burst. This gap allows time for the BS to switch from transmit mode to receive mode and SSs to switch from receive mode to transmit mode. During this gap, the BS and SS are not transmitting modulated data, but it simply allows the BS transmitter carrier to ramp down, the Tx / Rx antenna switch to actuate, and the BS receiver clause to activate. After the TTG, the BS receiver will look for the first symbols of uplink burst. The TTG has a configurable duration, which is an integer number of mini slots. The TTG starts on a mini slot boundary.

8.3.4.2.2.1.3.4Rx / Tx Transition Gap (RTG)

The RTG is a gap between the Uplink burst and the Downlink burst. This gap allows time for the BS to switch from receive mode to transmit mode and SSs to switch from transmit mode to receive mode. During this gap, BS and SS are not transmitting modulated data but simply allowing the BS transmitter carrier to ramp up, the Tx / Rx antenna switch to actuate, and the SS receiver section to activate. After the RTG, the SS receivers will look for the first symbols of QPSK modulated data in the downlink burst. The RTG consists of an integer number of physical slots that starts on a mini-slot boundary and extends to the end of the frame.

8.3.4.2.2.1.4 Mode B: Downlink Data

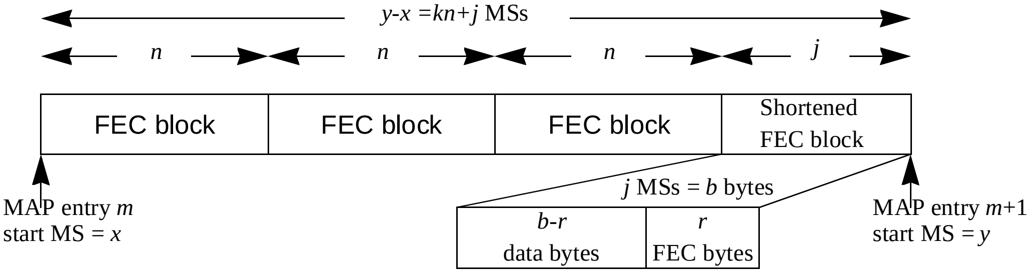

Figure 163—DL-MAP usage and shortened FEC blocks

The downlink data clauses are used for transmitting data and control messages to specific SSs. This data is always FEC coded and is transmitted at the current operating modulation of the individual SS. In the burst mode cases, data is transmitted in robustness order in the TDM portion. In a burst TDMA application, the data is grouped into separately delineated bursts, which do not need to be in modulation order. The DL-MAP message contains a map stating at which mini slot the burst profile change occurs. If the downlink data does not fill the entire downlink sub-frame and Mode B is in use, the transmitter is shut down. The DL-MAP provides implicit indication of shortened FEC (and/or FFT) blocks in the downlink. Shortening the last FEC block of a burst is optional (see 11.1.2.2????). The downlink map indicates the number of MS, p allocated to a particular burst and also indicates the burst type (modulation and FEC). Let n denote the number of MS required for one FEC block of the given burst profile. Then, p= kn + j, where k is the number of integral FEC blocks that fit in the burst and j is the number of MS remaining after integral FEC blocks are allocated. Either k or j, but not both, may be zero. j denotes some number of bytes b. Assuming j is not 0, it must be large enough such that b is larger than the number of FEC bytes r, added by the FEC scheme for the burst. The number of bytes available to user data in the shortened FEC block is b - r. These points are illustrated in Figure 163. Note that a codeword may not possess less than 6 information bytes.

In the TDM mode of operation, SSs listen to all portions of the downlink burst to which they are capable of listening. For full-duplex SSs, this implies that a SS shall listen to all portions that have a adaptive modulation type (as defined by the DIUC) which is at least as robust as that which the SS negotiates with the BS. For half-duplex SSs, the aforesaid is also true, but under an additional condition: an SS shall not attempt to listen to portions of the downlink burst that are coincident---adjusted by the SS's Tx time advance---with the SS's allocated uplink transmission, if any.

In the burst TDMA mode of operation, bursts are individually identified in the DL_MAP. Hence, a SS is required to turn on its receiver only in time to receive those bursts addressed to it. Unlike the TDM mode, there is no requirement that the bursts be ordered in order of decreasing robustness.

8.3.4.2.2.2 Uplink Burst Subframe Structure

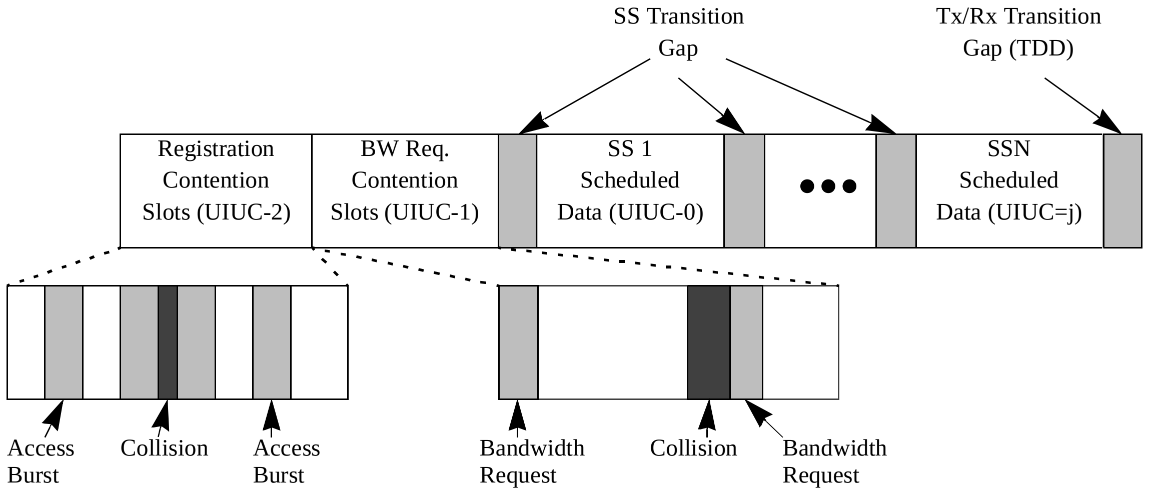

Figure 164—Uplink Subframe Structure

The structure of the uplink subframe used by the SSs to transmit to the BS is shown in Figure 164. There are three main classes of bursts transmitted by the SSs during the uplink subframe:

- Those that are transmitted in contention slots reserved for station registration.
- Those that are transmitted in contention slots reserved for response to multicast and broadcast polls for bandwidth needs.
- Those that are transmitted in bandwidth specifically allocated to individual SSs.

8.3.4.2.2.2.1 Mode A and Mode B: Uplink Burst Profile Modes

The uplink uses adaptive burst profiles, in which different SSs are assigned different modulation types by the base station. In the adaptive case, the bandwidth allocated for registration and bandwidth request contention slots is grouped together and is always used with the parameters specified for Request Intervals (UIUC=1) (Remark: It is recommended that UIUC=1 will provide the most robust burst profile due to the extreme link budget and interference conditions of this case). The remaining transmission slots are grouped by SS. During its scheduled bandwidth, an SS transmits with the burst profile specified by the base station, as determined by the effects of distance, interference and environmental factors on transmission to and from that SS. SS Transition Gaps (STG) separate the transmissions of the various SSs during the uplink subframe. The STGs contain a gap to allow for ramping down of the previous burst, followed by a preamble allowing the BS to synchronize to the new SS. The preamble and gap lengths are broadcast periodically in the UCD message. Shortening of FEC blocks in the uplink is identical to the handling in the downlink as described in 3.2.2.1.4????.

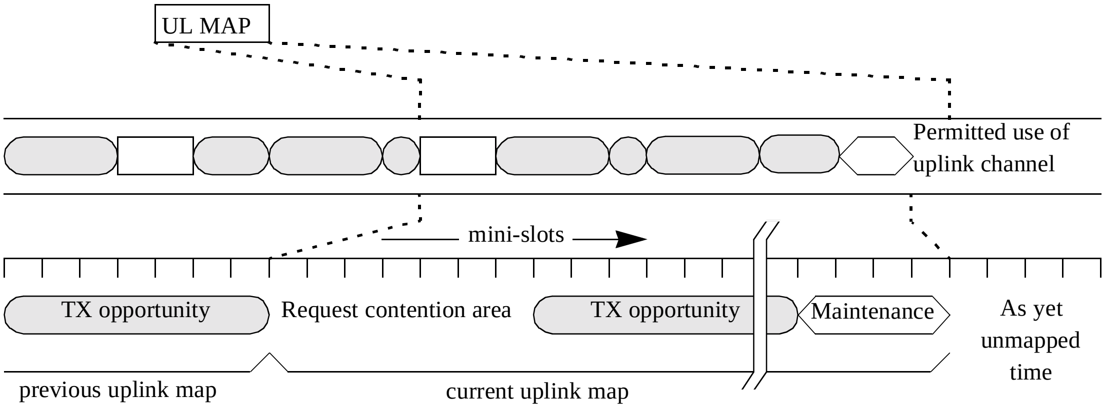

Figure 165—Uplink Mapping in the Continuous Downstream FDD Case

8.3.4.2.3 PHY SAP Parameter Definitions

TBD

8.3.4.2.4 Downlink Physical Layer

This clause describes the two different downlink modes of operation that have been adopted for use in this proposal. Mode A has been designed for continuous transmission, while a Mode B has been designed to support a burst transmission format. Subscriber stations must support at least one of these modes.

8.3.4.2.4.1 Physical layer type (PHY type) encodings

The value of the PHY type parameter (X.X.X) as defined must be reported as shown in theTable 155.

Table 155—PHY Type Parameter encoding

Mode	value	Comment
A(FDD)	2	Continuous downlink
B(FDD)	1	Burst downlink in FDD mode
B(TDD)	0	Burst downlink in TDD mode

8.3.4.2.4.2 Mode A: Continuous Downlink Transmission

This mode of operation has been designed for a continuous transmission stream, using a single modulation/coding combination on each carrier, in an FDD system. The physical media dependent sublayer has no explicit frame structure. Where spectrum resources allow, multiple carriers may be deployed, each using different modulation/coding methods defined here.

8.3.4.2.4.3 Downlink Mode A: Message field definitions

8.3.4.2.4.3.1 Downlink Mode A: Required channel descriptor parameters

The following parameters shall be included in the UCD message:

TBD

8.3.4.2.4.3.2 Mode A: Required DCD parameters

The following parameters shall be included in the DCD message:

TBD

8.3.4.2.4.3.2.1 Downlink Mode A: DCD, Required burst decriptor parameters

TBD.

8.3.4.2.4.3.3 Mode A: DL-MAP

For PHY Type = 2, no additional information follows the Base Station ID field.

8.3.4.2.4.3.3.1Mode A: DL-MAP PHY Synchronization Field definition

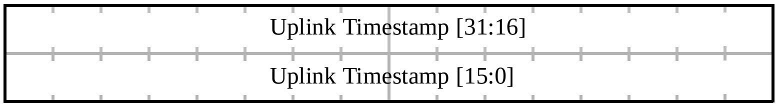

Figure 166—PHY Synchronization Field (PHY Type = 2)

The SYnchronization Field is a 32-bit counter that holds the number of physical slots that have elapsed from base station initialization up to the start of the current frame. When the counter reaches the highest value possible, it wraps around to zero. The format of the PHY Synchronization field is given in Fig 166.

8.3.4.2.4.3.4 Mode A:UL-MAP Allocation Start Time definition

The field Allocation Start Time appears in both the downlink (DL_MAP) and uplink (UL_MAP) map messages. The value specifies a mini-slot boundary that is the reference point for all mini-slot offset values appearing in the same map message. The value is expressed as the elapsed time in units of physical slots from base station initialization to the start of the mini-slot of interest.

8.3.4.2.4.3.5 UL-MAP Ack Time definition

The Ack Time Field value specifies the transmission time of the last subscriber information processed by the base station. The value is expressed as the elapsed time in units of physical slots from base station initialization to the start of the mini-slot following the last information processed by the base station.

8.3.4.2.4.4 Mode B: Burst Downlink Transmission

This mode of operation has been designed to support burst transmission in the downlink channel. In particular, this mode is applicable for systems using adaptive modulation in an FDD system or for systems using TDD, both of which require a burst capability in the downlink channel. In order to simplify phase recovery and channel tracking, a fixed frame time is used. At the beginning of every frame, a preamble is transmitted in order to allow for phase recovery and equalization training. A description of the framing mechanism and the structure of the frame is further described in 3.2.4.5.1????.

8.3.4.2.4.4.1 Mode B: Downlink Framing

In the burst mode, the uplink and downlink can be multiplexed in a TDD fashion as described in 3.2.2.1.3???, or in an FDD fashion as described in 3.2.2.1.2???. Each method uses a frame with a duration as specified in 3.2.5.1???. Within this frame are a downlink subframe and an uplink subframe. In the TDD case, the downlink subframe comes first, followed by the uplink subframe. In the burst FDD case, uplink transmissions occur during the downlink frame. In both cases, the downlink subframe is prefixed with information necessary for frame synchronization.

The available bandwidth in both directions is defined with a granularity of one mini slot (MS). A mini-slot is defined as a powr of two multiple of a physical slot. The definition of a physical slot is PHY dependent.

The structure of the downlink subframe used by the BS to transmit to the SSs, using Mode B, is shown in Figure 167. This burst structure defines the downlink physical channel. It starts with a Frame Control Header, that is always transmitted using the most robust set of PHY parameters. This frame header contains a preamble used by the PHY for synchronization and equalization. It also contains control clauses for both the PHY and the MAC (DL_MAP and UL_MAP control messages) that is encoded with a fixed FEC scheme defined in this standard in order to ensure interoperability. The Frame Control Header also may periodically contain PHY Parameters as defined in the DCD and UCD.

There are two ways in which the downstream data may be organized for Mode B systems:

- Transmissions may be organized into different modulation and FEC groups, where the modulation type and FEC parameters are defined through MAC layer messaging. The PHY Control portion of the Frame Control Header contains a downlink map stating the MSs at which the different modulation/FEC groups begin. Data should be transmitted in robustness order. For modulations this means QPSK followed by 16-QAM, followed by 64-QAM. If more than 1 FEC is defined (via DCD messages) for a given modulation, the more robust FEC/modulation combination appears first. Each SS receives and decodes the control information of the downstream and looks for MAC headers indicating data for that SS.
- Alternatively, transmissions need not be ordered by robustness. The PHY control portion contains a downlink map stating the MS (and modulation/ FEC) of each of the TDMA sub-bursts. This allows an individual SS to decode a specific portion of the downlink without the need to decode the whole DS burst. In this particular case, each transmission associated with different burst types is required to start with a short preamble for phase re-synchronization.

There is a Tx/Rx Transition Gap (TTG) separating the downlink subframe from the uplink subframe in the case of TDD

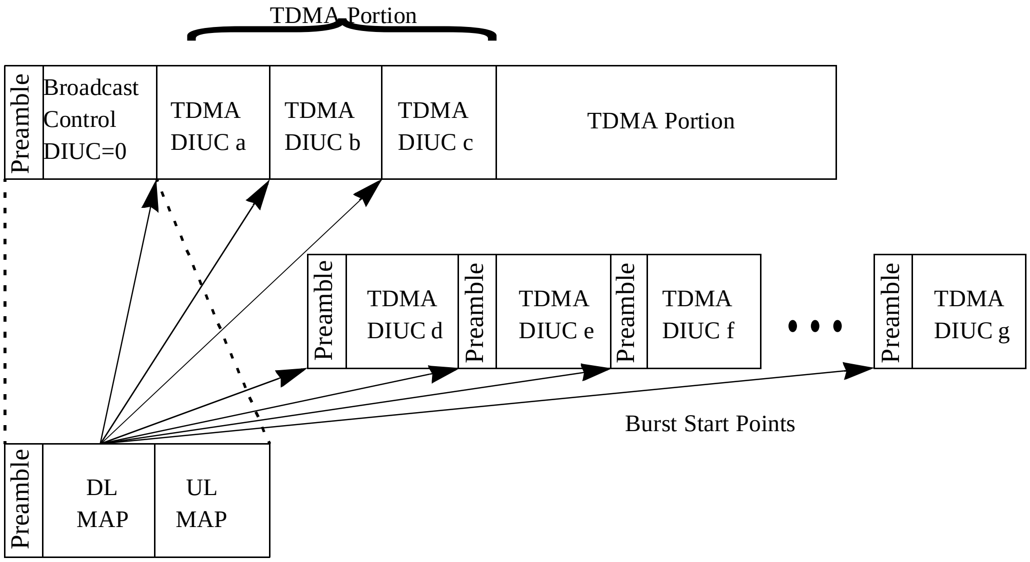

Figure 167—Mode B Downlink Subframe Structure

8.3.4.2.4.4.2 Frame Control

The first portion of the downlink frame is used for control information destined for all SS. This control information must not be encrypted. The information transmitted in this section is always transmitted using the well known DL Burst Type with DIUC=0. This control section must contain a DL-MAP message for the channel followed by one UL-MAP message for each associated uplink channel. In addition it may contain DCD and UCD messages following the last UL-MAP message. No other messages may be sent in the PHY/MAC Control portion of the frame.

8.3.4.2.4.4.3 Downlink Mode B: Required DCD parameters

The following parameters shall be included in the DCD message:

TBD

8.3.4.2.4.4.3.1Downlink Mode B: DCD, Required burst decriptor parameters

Each Burst Descriptor in the DCD message shall include the following parameters:

TBD

8.3.4.2.4.4.4 Downlink Mode B: Required UCD parameters

The following parameters shall be included in the UCD message:

TBD

8.3.4.2.4.4.5 Downlink Mode B: DL-MAP elements

For PHY Type = {0, 1}, a number of information elements as defined as in Figure ???? follows the Base Station ID field. The MAP information elements must be in time order. Note that this is not necessarily IUC order or connection ID order.

8.3.4.2.4.4.6 Allowable frame times

Table 156 indicates the various frame times that are allowed for the current downlink Mode B physical layer. The actual frame time used by the downlink channel can be determined by the periodicity of the frame start preambles

Table 156—Allowable Frame Times

Frame Length Code	Frame time (T_F) (ms)
0x01	0.5
0x02	1.0
0x03	1.5
0x04	2.0
0x05	2.5
0x06	3.0
0x07	3.5
0x08	4.0
0x09	4.5
0x0A	5.0

8.3.4.2.4.4.7 Mode B: DL-MAP PHY Syncronization Field definition

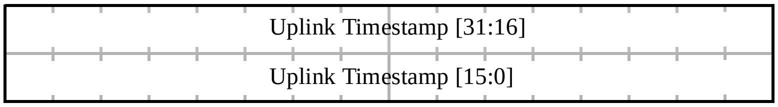

Figure 168—PHY Synchronization Field (PHY Type = {0,1})

The Synchronization Field time is 32-bit counter that holds the number of physical slots that have elapsed from base station initialization up to the start of the current frame. When the counter reaches the highest value possible, it wraps around to zero. The format of the PHY Synchronization Field is given in Figure 168.

8.3.4.2.4.4.8 UL-MAP Allocation Start Time definition

The field Allocation Start Time appears in both the downlink (DL_MAP) and uplink (UL_MAP) map messages. The value specifies a mini-slot boundary that is the reference point for all mini-slot offset values appearing in the same map message. The value is expressed as the elapsed time in units of physical slots from base station initialization to the start of the mini-slot of interest.

8.3.4.2.4.4.9 UL-MAP Ack Time definition

The Ack Time Field value specifies the transmission time of the last subscriber information processed by the base station. The value is expressed as the elapsed time in units of physical slots from base station initialization to the start of the mini-slot following the last information processed by the base station.

8.3.4.3 OFDM PHY Burst Definition and MAP Messages

8.3.4.4 OFDMA PHY Burst Definition and MAP Messages

8.3.4.4.1 Introduction

This clause describes the MAC-PHY considerations and MAC-PHY information exchange needed for support OFDMA/OFDM based PHY layer.

The OFDMA access scheme defines an access scheme of a two dimensional grid that combines time and frequency division access technique.

In a MAC protocol that supports OFDMA PHY layer, sub-channelization should be supported, mini-slot duration should last for the time duration of a full OFDM symbol and should be used as a time symbol reference. In addition, for each time symbol reference, a sub-channel reference should be provided for an OFDMA access resolution.

Each of the Uplink and Downlink symbols are built from subcarriers, which are divided statically into sub-channels that are groups of 53 (48 useful) sub-carriers. A sub-channel does not necessarily contain consequent subcarriers.

The OFDMA defines a slot as a pair {N,m} that represents a combination of an OFDM time symbol (N) and number of a sub-channel (m).

In each cell a single FFT size is used.

8.3.4.4.2 Basic Parameters

This clause defines OFDMA related basic terminology and relevant parameters.

8.3.4.4.2.1 Region and PHY Burst

For both Uplink and Downlink transmissions, several consequent sub-channels may be aggregated for several consequent symbol duration intervals (OFDM Symbols). Such an aggregation is figured by a rectangle Region at the Sub-carrier(frequency)-Time domain. Figure 169 illustrates an allocation pattern instance of a Region

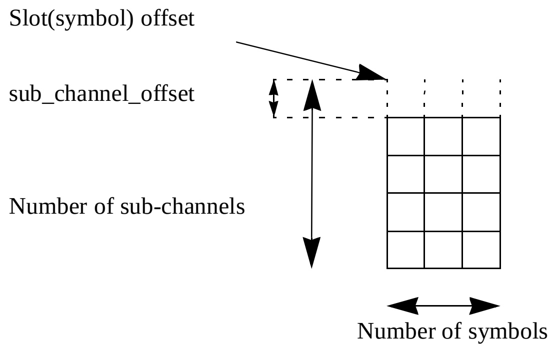

Figure 169—Example of a Two dimensional Pattern

A Region can be assigned in the UL to a specific SS (or a group of subscribers) or can be transmitted in the DL by the BS as a transmission to a (group of) SS. The SS's transmission at the Region is called UL PHY Burst. The BS's transmission at the Region is called DL PHY Burst.

8.3.4.4.2.2 UL Transmission

The PHY Burst properties will be figured:

- In the MAC-PHY interface primitives.
- In UCD message within Burst Profile TLV encodings.
- In UL-MAP message, implicitly identified by UIUC.

The BS learns each of SS's specific working parameters (during the SS's UL maintenance Ranging and data transmission) and assigned internally UL PHY Burst profile for each SS.

<<<<<<<<<<<<<<The following paragraph is clearly a part of OFDM PHY

The parameters the BS uses are:

- *The CIR <<< SIR? >>> of the channel (which can be achieved when using the CDMA synchronization approach).*
- *The C/N of the user (by measurement from a user message).*

The basic suggested (partial) profiles for the uplink transmission can be summarized inTable 157:

Table 157—UL profiles

Profile	**0**	**1**	**2**	**3**	**4**	**5**
C/N (dB)	3-6	6-9	9-12	12-17	17-20	>20
Modulation	QPSK	QPSK	QAM16	QAM16	QAM64	QAM64
Code rate	1/2	3/4	1/2	3/4	2/3	3/4

The defined values are used for a reference, bad CIR can cause the BS to chose lower profile or allocation of fewer Sub-Channels enables the BS to choose higher profile.

>>>>>>>>>>>>>>>>>>>>>>

The UL MAP IEs shall have the UIUC that represent the relevant profile that determined by the BS.

Figure 170 describes the logical structure of UL PHY Burst.

<<< Note: for the next figures, the size (number of symbols) of the preamble is still under discussion of the PHY group. >>>

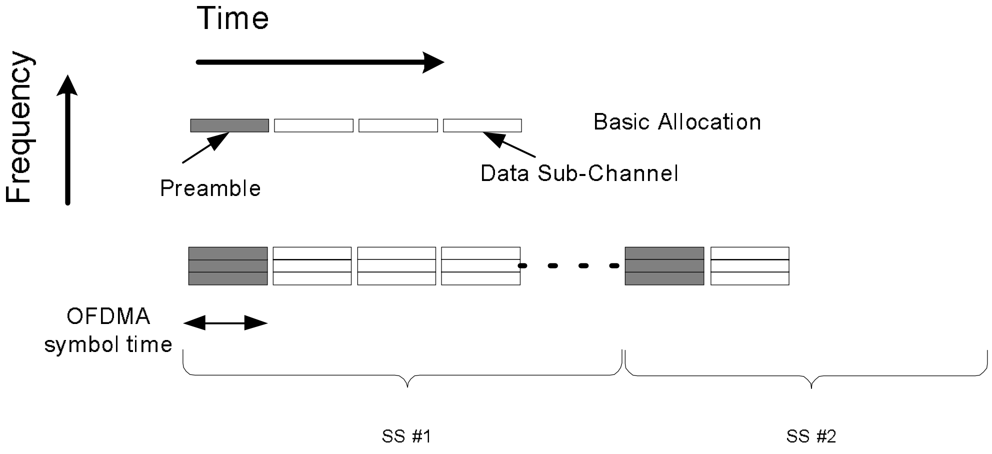

Figure 170—UL PHY Burst example

Figure 171 describes two different subscribers with different PHY Burst structures and profiles.

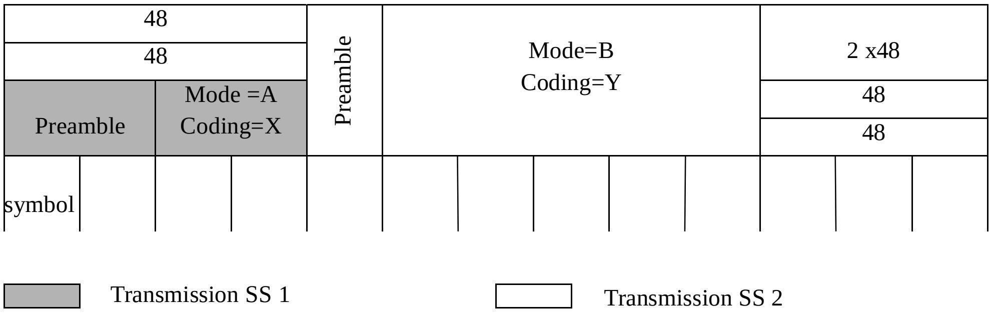

Figure 171—UL Burst definition Example #1

Figure 172 describes two different subscribers with similar PHY Burst structure and with different profiles

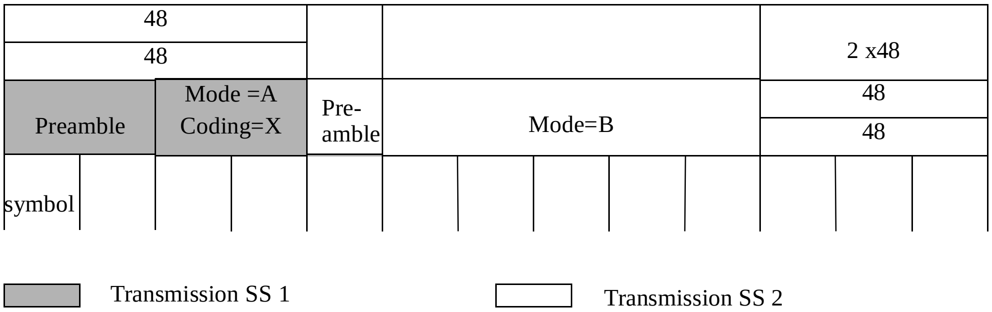

Figure 172—UL Burst Definition Example #2

8.3.4.4.2.3 DL Transmissions

The DL PHY Burst properties will be figured:

- In the MAC-PHY interface primitives
- In DCD message within Burst Profile TLV encodings
- In DL-MAP message, implicitly identified by DIUC.
- In the RNG-RSP or DBTC-RSP messages, implicitly identified by the Downlink Burst Type.

The set of DL PHY Burst parameters is specified in <Reference to OFDM PHY relevant clause> and includes at least:

- Modulation type
- FEC type
- Tx Power

The forward adaptive profiles are relevant in the Bursty working modes (FDD-B and TDD).

The SS requests from the BS a specific DL PHY Burst type (using the DBTC-REQ or RNG-REQ messages), the BS will acknowledge the user with a downstream working mode (using the DBTC-RSP or RNG-RSP messages).

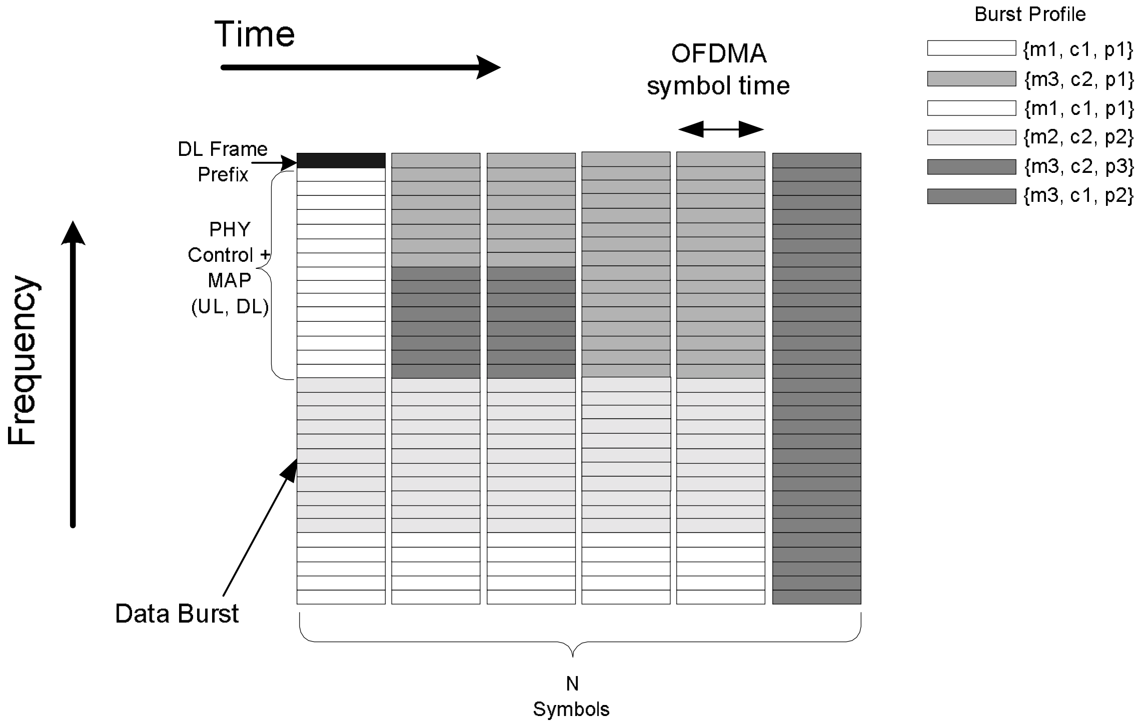

Figure 173—DL Period example #1

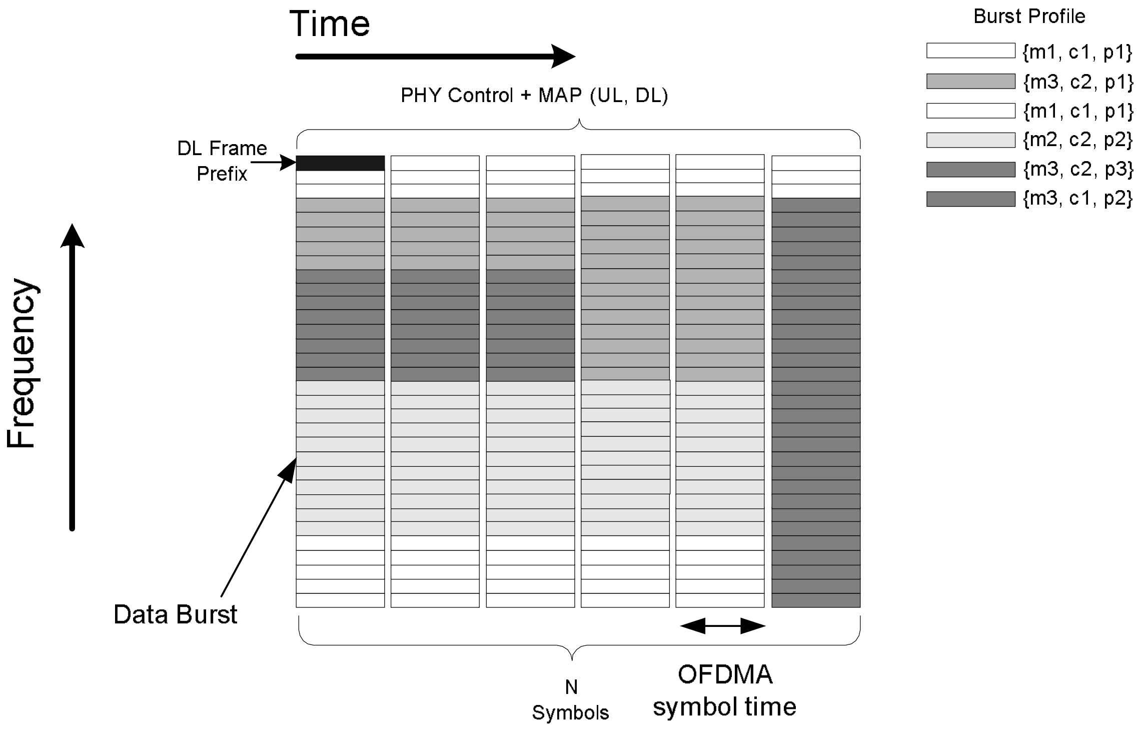

Figure 174—DL Period example #2

Figure 173 and Figure 174 describe two scenarios of DL OFDMA allocation with two options of sending DL MAP.

In the OFDM working modes (small FFT sizes), TDM\TDMA working model is used. This means that the unit of allocation is a full OFDM symbol. In those modes, the frame control information (DL/UL MAP) shall be sent on the first Symbol(s).

In the high FFT sizes modes, OFDMA working model is used. This means that the unit of allocation is a Burst (which is a combination of a sub-channels and time symbols). In those modes, there are two possibilities to transmit the DL\UL MAP:

- To take advantage of the option of forward power control, and robust transmission of frame control information, the transmission of the DL\UL MAP can be done by using 1-2 sub-channels for the duration of the whole frame while power boosting the used carriers.
- To use the basic method of the OFDM case, but with size optimization. This means that the DL\UL MAP shall be transmitted at the beginning of the frame, using all or part of the sub-channels.

The frame control information should be transmitted in a deterministic pre-defined (and robust) configuration, therefore indication about the frame control information should be defined. To be able to support a generic formation of frame control message in the downlink in the context of OFDMA\OFDM PHY modes, we propose the notion of DL Frame prefix.

DL Frame Prefix: One symbol long; it is transmitted at the well-known modulation/coding and occupies the well-known set of sub-carriers, e.g. the first N x 48 (for the FFT-64 always N = 1, for FFT-256 OFDM always N = 4 or For FFT-2048 OFDMA always N=1 etc.). It contains the information on the modulation/coding and formation of the DL frame control information (DL\UL MAP messages) relevant to the next frame or to the same frame. Figure 175 describes the structure of DL Frame Prefix:

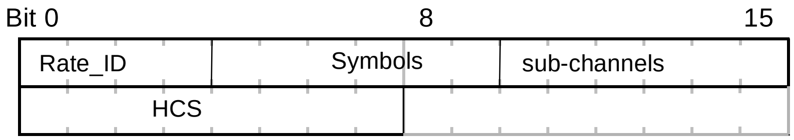

Figure 175—DL Frame Prefix Structure

Rate_ID: Enumerated field that describes the transmission parameters of the DL\UL MAP messages.

Symbols: Number of time symbols dedicated to the DL\UL MAP message.

Sub_Channels: Number of sub-channels dedicated to the DL\UL MAP message.

HCS: An 8-bit Header Check Sequence used to detect errors in the DL Frame Prefix. The generator polynomial is g(D)= D8 + D2 + D + 1

DL Frame Prefix can contain also MAP message(s) (for FFT-512 for example, the full first symbol will contain the DL Frame Prefix and beginning of the DL\UL MAP messages) and the "MAP" PHY burst may contain also the data. For the lowest modulation it is exactly 3 bytes.

The Combination of the fields Symbols and Sub_Channels defines the structure of the MAP message and position (relative to the top left entry of the DL frame). In the small FFT cases (OFDM modes) Sub_Channels field will always indicate full OFDM symbol.