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Re:	Working Group Letter Ballot Recirc #28b, Technical Comments and Contributions regarding IEEE Project P802.16j; Draft Amendment P802.16j/D3.
Abstract	This contribution describes the Direct Signaling messages transmitted in the access channel of the AAS Relay Zone to accomplish ranging and bandwidth request and grant.
Purpose	This document provides the necessary access messaging to properly accomplish ranging and bandwidth request/grant within the AAS Relay Zone for Direct Signaling mode of operation.
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Access Messages for Direct Signaling in the AAS Relay Zone

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This document describes the access messages required to support bandwidth request/grant, ranging, frequency, and power adjustment in Direct Signaling mode of operation within the AAS Relay Zone.

Background

Direct Signaling operation within the relay zone provides a bandwidth request mechanism that can scale with an M-fold increase in the number of users afforded by muti-user beamforming.

Section 8.4.4.7.2.3 of Draft P802.16j/D3 describes the AAS Relay Zone access channel but does not detail the access messaging required for managing channel descriptor request, initial bandwidth request/grant, codeword assignment and range/frequency/power adjustment.

Proposed Solution

The proposed solution is to describe the Uplink bandwidth request/grant mechanism and the required Direct Signaling Access Messages to accomplish it within the AAS Relay Zone.

Detailed Solution

Overview

The AAS-DS Private Map structure provides information for supporting bandwidth grant. AAS-DS Resource allocation utilizes the follow definitions:

1) Partition – a partition of frequency within the carrier channel. AAS-DS partitions utilize AMC slots and are therefore comprised of 1 or 2 bins as defined by the AMC subchannel permutation (1 bin x 6 symbols or 2 bins x 3 symbols). The partition is the smallest unit of allocation granularity within a burst for the AAS Relay Zone. Partitions are numbered with an index in ascending order based on frequency (starting with an index of 0). A partition allocation is a coupled resource allocation which is granted in both the DL subframe and UL subframe for each frame of allocation.
2) Burst – a burst is the unit resource allocation within the AAS zone. A burst is comprised of 1 to 8 partitions. The AAS zone can support 1 to 4 bursts per user. Bursts are defined to be HARQ enabled or disabled within the partition control structure described in the DL Access Message section.
3) Partition Control actions
   a) Probe – a training preamble that allows the BS to unobtrusively determine interference characteristics between the probing users and current active users within a single partition of frequency.
   b) Open – an allocation grant of the partition resource

c) Close – a de-allocation of the partition resource
d) Maintain – maintain the allocation of partition resource (used to maintain synchronization of partition resource allocation between the BS and RS since the partition controls are all delta state related.).

The initial ranging message sequence for an entering RS shows the migration from the Access partition utilizing the DLA for bandwidth grant and physical layer control to a traffic partition as part of a burst allocation where the PMAP is then used for bandwith grant and physical layer control. The initial ranging message sequence for an RS entering the network in the AAS Relay zone is as follows:
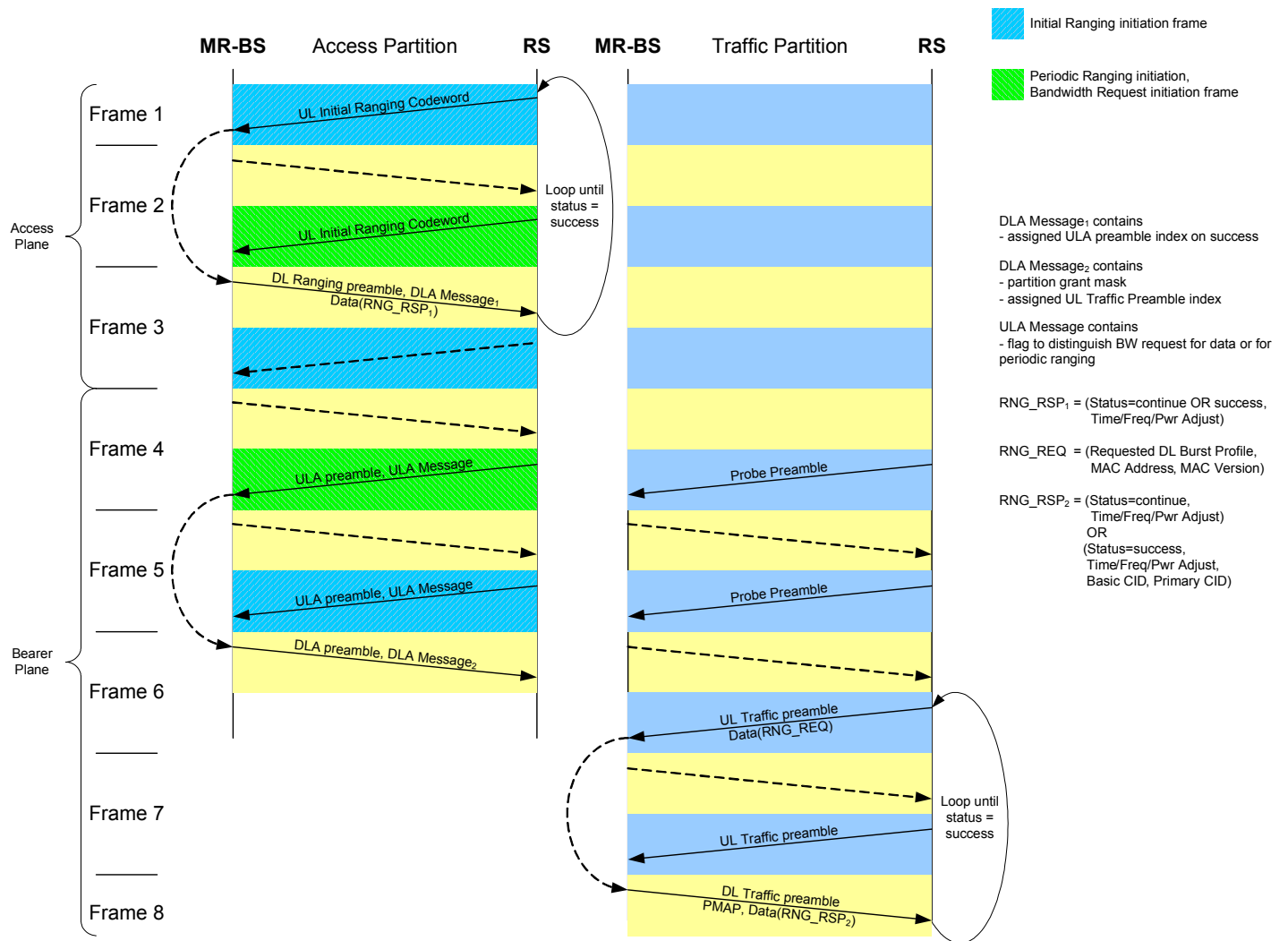
Uplink Access (ULA) Message

The ULA is sent from the RS to MR-BS and is used to:

- request bandwidth for ranging (via the ULA purpose) or for transport (via the ULA purpose, transport CID, and queue depth) as described in the AAS network entry procedure (within 8.4.4.7.2.3) or to
- request the compact or full channel descriptor (as described in 8.4.4.7.2.3.3) via the ULA purpose.

The following table defines the AAS_ULA Message structure:
.

Table 1: Structure of AAS_ULA()

ULA Component	Bits	Reps	Slot	Comment
AAS_ULA Message {				
CID	16	1		Transport CID
Partition Exploratory Map	24	1		Sized for 24 partitions (i.e 10 MHz)
Probe Codeword index	2	1		Probe Codeword index
Queue Depth	2	1		Sized for 4 levels
ULA Purpose	4	1		value 0=Transport BW Request 1=Ranging BW Request 2=Compact Chan Description Req 3=Full Chan Description Req
Reserve	40	1		Reserved for Future use
CRC	8	1		CRC-8
}				
Total ULA Bits	96		2	

1) **CID -** Transport CID for which a bandwidth request is being made
2) **PEM -** Partition Exploratory Map. Partitions are the unit of resource allocation in AAS Direct Signaling mode. They are logical groupings of one or more subchannels based on the AMC subchannel permutation contruction (either 2x3 or 1x6 as described in 8.4.4.7.2.3). The PEM describes the partitions for which the UL Probe training was transmitted. One bit per partition - sized for 24 partitions (i.e 10 MHz)
3) **Probe Codeword Index –** Identifies an UL training preamble (as described in 8.4.4.7.2.3) transmitted in a traffic partition in order for the BS to determine link quality and interference characteristics.
4) **Qdepth –** Encode for an aggregate CID Queue depth level of the transport CID that is requesting an initial bandwidth allocation. One of four pre-defined depth levels can be described.
       00 – 0 bytes to 64 bytes
       01 – 65 bytes to 128 bytes
       10 – 129 to 512 bytes
       11 – > 512 bytes
5) **ULA Purpose**
6) The pupose for which the asynchronous access is being requested, including:
   i) 0x0 = Transport Bandwidth Request
   ii) 0x1 = Ranging Bandwidth Request
   iii) 0x2 = Compact Channel Description Request as described in section 8.4.4.7.2.3.3
   iv) 0x3 = Full Channel Description Request as described in section 8.4.4.7.2.3.3
7) **CRC -** CRC-8 covers both slots

4

Downlink Access (DLA) Message

The DLA is sent from the MR-BS to the RS and provides code word assignments (as defined by section 8.4.4.7.2.3.1), bandwidth grant, supportable MCS for UL/DL, and range time/frequency/power adjustment during the AAS network entry and subsequent allocations procedure defined in section 8.4.4.7.2.3. Link adjustments (time/frequency/power) are provided in the DLA message to support more accurate transmission of subsequent messages in the access channel or beamforming of subsequent messages in the allocated traffic partitions.

The following table defines the AAS_DLA Message structure:

Table 2: Structure of AAS_DLA()

DLA Component	Bits	Reps	Slot	Comment
AAS_DLA Message {				
PB_Ctl_0	7	1		Partition/Burst control described in Table2
PB_Ctl_1	7	1		Partition/Burst control described in Table2
PB_Ctl_2	7	1		Partition/Burst control described in Table2
DIUC	3	1		DL MCS level
PB_Ctl_3	7	1		Partition/Burst control described in Table2
PB_Ctl_4	7	1		Partition/Burst control described in Table2
PB_Ctl_5	7	1		Partition/Burst control described in Table2
Codeword Type	1	1		0=access, 1=transport
UIUC Offset	2	1		UL MCS offset from the DIUC index
Reserved	6	1		
UL Range Adjust	2	1		
UL Frequency Adjust	2	1		
UL Access PwrCtrlt	2	1		2 bits/partition
UL PwrCtl	12	1		2 bits/partition
Assigned Codeword Index	16	1		
CRC	8	1		
}				
Total DLA Bits	96		2	

1) **PB_Ctl_x** (7 bit encode) – This structure describes a control action related to the state of an allocation. Probe, open, maintain mean to initiate or continue the codeword (preamble) training sequence on the allocated partition. Close means the resource is no longer allocated.. The other attributes of the partition/burst are contained in the FLP (DLA) Message or Private Map (PMAP) which contains this control structure. The partition/burst control encode is described in Table 3 below

Table 3: Partition/Burst Control encode

5 bit Value	2 bit encode Value	Description
0-23	0-3 (burst index)	Probe, Open or Maintain (p,o,m) the partition indexed by the 5 bit value in the burst indexed by the 2 bit encode value.
24	0-3 (partition index)	Close Partition in the 4 partition range 0-3 indexed by the 2 bit encode value

25	0-3 (partition index)	Close Partition in the 4 partition range 4-7 indexed by the 2 bit encode value
26	0-3 (partition index)	Close Partition in the 4 partition range 8-11 indexed by the 2 bit encode value
27	0-3 (partition index)	Close Partition in the 4 partition range 12-15 indexed by the 2 bit encode value
28	0-3 (partition index)	Close Partition in the 4 partition range 16-19 indexed by the 2 bit encode value
29	0-3 (partition index)	Close Partition in the 4 partition range 20-23 indexed by the 2 bit encode value
30	0-3 (burst index)	Close all partitions in burst using 2 bit encode as burst number
31	0-3	0: Fast power control for MCS increase (affects all partitions in current burst) 1-3: *Reserved*

2) **DIUC** (3 bit encode) – DL MCS, one of eight defined MCS levels
3) **Codeword Type** - Describes the codeword type that is being assigned (0 = Access codeword 1=Transport codeword). (as defined in section 8.4.4.7.2.3.1).
4) **UIUC Offset** (2 bit encode) – UL Differential MCS equals the number of MCS levels below the DL MCS
5) **UL Time (Range) Adjust** (2 bit encode) - A step size of $d_t = 0.714$ us is proposed. 0.714 us corresponds to 4 samples at a 5.6 MHz sample rate. Four samples corresponds to a "PS". The range adjustment encode is described in Table 4 below:

Table 4: UL Range (Time) Adjustment Encoding

Encoded bits	Time Delay @ BS	RS UL Adjustment
00	$t_e < -\delta_t$	Delay
01	$-\delta_t \le t_e < 0$	Delay
10	$0 \le t_e < \delta_t$	Advance
11	$\delta_t \le t_e$	Advance

6) **UL Frequency Adjust** (2 bit encode) – The frequency adjustment encode is described in Table 5 below:

Table 5: UL Frequency Adjustment Encoding

Encoded bits	Frequency Error @ BS	RS UL Adjustment
00	$f_e < -d_f$	Increase frequency
01	$-d_f \le f_e < 0$	Increase frequency
10	$0 \le f_e < d_f$	Decrease frequency
11	$d_f \le f_e$	decrease frequency

7) **UL Power Adjust (Traffic Ps)** (2 bit encode/partition) – 4 levels of adjustment per partition
8) **UL Power Adjust (Access P)** (2 bit encode) – 4 levels of adjustment
9) **Assigned Codeword Index** - Assigned codeword (may be ULA or ULT) as defined by codeword construction in section 8.4.4.7.2.3.1.

Downlink Initiation (DLI) Signaling

BS Initiated Traffic and Paging

The base station can initiate traffic or page the RS using the DLI mechanism. The DLI is a unique code provided to the RS registered with the base station. The DLI codeword has a one to one correspondence with the ULA codeword that is assigned to an RS in the DLA Message. The RS continuously search for the DLI using a correlation process using the assigned code as the paradigm. One DLI allocation is included in the MAP in the last slot of symbols 2 and 3. The DLI(i) is the paging mechanism informing the ith user to respond on both the access partition and available traffic partitions. DLIs start BS initiated traffic. 200 DLIs per second are available. RS(i) responds to the DLI on the access and traffic partitions with an ULA training sequence and an ULA message to perform an initial bandwidth request. This will allow a resource allocation for the pending DL traffic.

DLI Codeword Transmission

The Map is constructed to fit into 15 PUSC slots available in symbols 2 and 3. 4 slots are dedicated to the FCH, either 8 or 10 slots are reserved for the Map, and 0 or 2 slots are allocated for broadcast messages such as the DCD/UCD message or the Neighbor Advertisement message. The remaining slot is allocated to the Downlink Initiation (DLI) paging signal.

There are 48 sub-carriers allocated to the DLI. The 48 sub-carriers are split into two groups of 24. If the 48 were numbered sequentially, the first group would be the even sub-carriers and the second group would be the odd subcarriers.. Each group contains a column of a 24 × 24 Hadamard matrix and is BPSK modulated. BPSK has two values. Two values times 24 different columns is 48 total combinations per group. 48 combinations in the first group times 48 combinations in the second group is 2304 total. The BS can ring up 2304 RS per 5 MHz channel.

The signal processing for the transmitter is shown in Figure 1. *b* represents the DLI codeword and ranges from 0 to 2303. It is then broken down into two groups of 24. i_0 selects one of 24 Hadamard columns for the first group and ranges from 0 to 23. k_0 selects the BPSK modulation for the first group. i_1 selects one of 24 Hadamard columns for the second group. k_1 selects the BPSK modulation for the second group. The Hadamard(24) matrix is as follows:

```
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
1 -1  1 -1  1  1  1 -1 -1 -1  1 -1  1 -1  1 -1  1  1  1 -1 -1 -1  1 -1
1 -1 -1  1 -1  1  1  1 -1 -1 -1  1  1 -1 -1  1 -1  1  1  1 -1 -1 -1  1
1  1 -1 -1  1 -1  1  1  1 -1 -1 -1  1  1 -1 -1  1 -1  1  1  1 -1 -1 -1
1 -1  1 -1 -1  1 -1  1  1  1 -1 -1  1 -1  1 -1 -1  1 -1  1  1  1 -1 -1
1 -1 -1  1 -1 -1  1 -1  1  1  1 -1  1 -1 -1  1 -1 -1  1 -1  1  1  1 -1
1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1
1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1
1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1
1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1
1 -1  1  1  1 -1 -1 -1  1 -1 -1  1  1 -1  1  1  1 -1 -1 -1  1 -1 -1  1
1  1 -1  1  1  1 -1 -1 -1  1 -1 -1  1  1 -1  1  1  1 -1 -1 -1  1 -1 -1
1  1  1  1  1  1  1  1  1  1  1  1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
1 -1  1 -1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1 -1 -1 -1  1  1  1 -1  1
1 -1 -1  1 -1  1  1  1 -1 -1 -1  1 -1  1  1 -1  1 -1 -1 -1  1  1  1 -1
1  1 -1 -1  1 -1  1  1  1 -1 -1 -1 -1 -1  1  1 -1  1 -1 -1 -1  1  1  1
1 -1  1 -1 -1  1 -1  1  1  1 -1 -1  1 -1  1 -1  1 -1 -1 -1  1  1  1 -1  1
1 -1 -1  1 -1 -1  1 -1  1  1  1 -1 -1  1  1 -1  1 -1 -1 -1 -1  1  1
1 -1 -1 -1  1 -1 -1  1 -1  1  1  1 -1  1  1  1 -1  1 -1  1 -1 -1 -1 -1
1  1 -1 -1 -1  1 -1 -1  1 -1  1  1 -1 -1  1  1  1 -1  1  1 -1  1 -1 -1
1  1  1 -1 -1 -1  1 -1 -1  1 -1  1 -1 -1 -1  1  1  1 -1  1  1 -1  1 -1
1  1  1  1 -1 -1 -1  1 -1 -1  1 -1 -1 -1 -1 -1  1  1  1 -1  1  1 -1  1
1 -1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1 -1 -1 -1  1  1  1 -1  1  1 -1
1  1 -1  1  1  1 -1 -1 -1  1 -1 -1 -1 -1  1 -1 -1 -1  1  1  1 -1  1  1
```

The first group of 24 sub-carriers is multiplexed with the second group of 24 sub-carriers. If the indices to the sub-carriers of a slot were numbered from 0 to 47, the even numbered sub-carriers come from the first group of 24 and the odd number sub-carriers come from the second group of 24. The first sub-carrier of the slot is $H(0, i_0) k_0$, the second, is $H(0, i_1) k_1$, the third is $H(1, i_0) k_0$, the fourth is $H(1, i_1) k_1$, etc., where zero-based indexing is assumed when accessing the Hadamard matrix, $H(n, i)$.
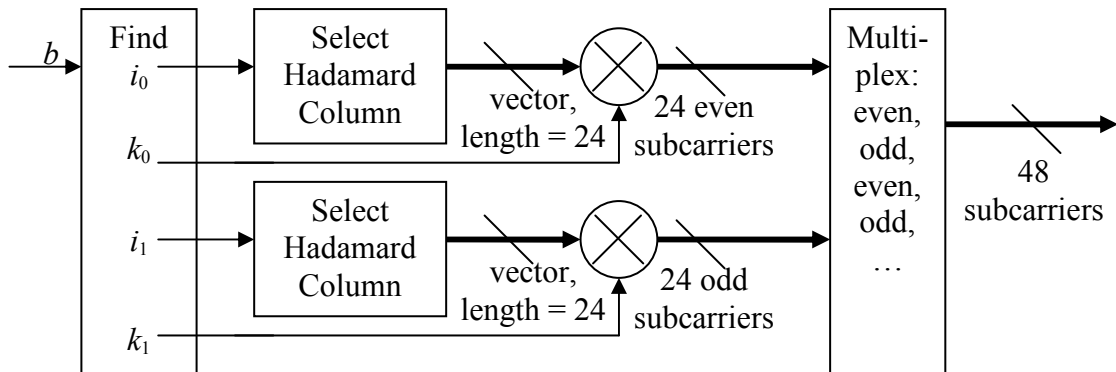

Figure 1. Transmitter Signal Processing

$$g_0 = \lfloor b \div 48 \rfloor \qquad (1)$$

$$g_1 = b - 48g_0 \tag{2}$$

$$k_0 = \begin{cases} -1 & \text{if } g_0 < 24 \\ +1 & \text{otherwise} \end{cases} \tag{3}$$

$$k_1 = \begin{cases} -1 & \text{if } g_1 < 24 \\ +1 & \text{otherwise} \end{cases} \tag{4}$$

$$i_0 = g_0 - 12(1 + k_0) \tag{5}$$

$$i_1 = g_1 - 12(1 + k_1) \tag{6}$$

Proposed Text Changes

Insert new subclause 8.4.4.7.2.3.4:

8.4.4.7.2.3.4 AAS Relay Zone Access Channel Messaging

Insert new subclause 8.4.4.7.2.3.4.1:

8.4.4.7.2.3.4.1 Uplink Access (ULA) Message
The ULA is sent from the RS to MR-BS and is used to
- request bandwidth for ranging (via the ULA purpose) or for transport (via the ULA purpose, transport CID, and queue depth) as described in the AAS network entry procedure (within 8.4.4.7.2.3) or to
- request the compact or full channel descriptor (as described in 8.4.4.7.2.3.3) via the ULA purpose.

The following table defines the AAS_ULA Message structure:
Insert Table 270a (.16e)/Table 386a (Rev2) as indicated:

Table xxx—Structure of AAS_ULA()

Syntax	Size	Notes
AAS_ULA() {		
CID	16 bits	Transport CID
PEM	24 bits	Partition Exploratory Map
Probe Codeword Index	2 bits	Partition Probe codeword
Qdepth	2 bits	Qdepth level 0b00 = level1 0b01 = level2 0b10 = level3 0b11 = level4
ULA Purpose	4 bits	0x0 = Transport Bandwidth Request 0x1 = Ranging Bandwidth Request 0x2 = Compact Channel Description Request 0x3 = Full Channel Description Request 0x4-0xF = *Reserved*
Reserved	40 bits	Shall be set to zero
CRC	8 bits	CRC-8

}		

Insert the following parameter descriptions following Table 270a (.16e)/Table 386a (Rev2) as indicated:

CID
  Transport CID for which a bandwidth request is being made
PEM
  Partition Exploratory Map. Partitions are the unit of resource allocation in AAS Direct Signaling mode. They are logical groupings of one or more subchannels based on the AMC subchannel permutation contruction (either 2x3 or 1x6 as described in 8.4.4.7.2.3). The PEM describes the partitions for which the UL Probe training was transmitted. One bit per partition - sized for 24 partitions (i.e 10 MHz).
Partition Probe Codeword Index
  Identifies an UL training preamble (as described in 8.4.4.7.2.3) transmitted in a traffic partition in order for the BS to determine link quality and interference characteristics.
Qdepth
  Encode for an aggregate CID Queue depth level of the transport CID that is requesting an initial bandwidth allocation. One of four defined depth levels can be described.
   00 – 0 bytes to 64 bytes
   01 – 65 bytes to 128 bytes
   10 – 129 to 512 bytes
   11 – > 512 bytes

ULA Purpose
  The pupose for which the asynchronous access is being requested, including:
   0x0 = Transport Bandwidth Request
   0x1 = Ranging Bandwidth Request
   0x2 = Compact Channel Description Request as described in section 8.4.4.7.2.3.3
   0x3 = Full Channel Description Request as described in section 8.4.4.7.2.3.3
CRC
  CRC-8 covers both slots

Insert new subclause 8.4.4.7.2.3.4.2:

8.4.4.7.2.3.4.2 Downlink Access (DLA) Message
The DLA is sent from the MR-BS to the RS and provides code word assignments (as defined by section 8.4.4.7.2.3.1), bandwidth grant, supportable MCS for UL/DL, and range time/frequency/power adjustment during the AAS network entry and subsequent allocations procedure defined in section 8.4.4.7.2.3. Link adjustments (time/frequency/power) are provided in the DLA message to support more accurate transmission of subsequent messages in the access channel or beamforming of subsequent messages in the allocated traffic partitions.

The following table defines the AAS_DLA Message structure:
Insert Table 270b (.16e)/Table 386b (Rev2) as indicated:

Table xxx—Structure of AAS_DLA()

Syntax	Size	Notes
AAS_DLA() {		
PB_Ctl_0	7 bits	partition control structures as described in Table xxx

PB_Ctl_1	7 bits	partition control structures as described in Table xxx
PB_Ctl_2	7 bits	partition control structures as described in Table xxx
DIUC	3 bits	DL MCS
PB_Ctl_3	7 bits	partition control structures as described in Table xxx
PB_Ctl_4	7 bits	partition control structures as described in Table xxx
PB_Ctl_5	7 bits	partition control structures as described in Table xxx
Codeword Type	1 bit	0 = Access codeword 1=Transport codeword
UIUC offset	2 bits	UL MCS differential offset from the DIUC index
Reserved	6 bits	Shall be set to zero
UL Range Adjust	2 bits	Encoded step adjustments
UL Frequency Adjust	2 bits	Encoded step adjustments
UL Access Power Adjust	2 bits	Encoded step adjustments
UL Partition Power Adjust	12 bits	2 bits encoded adjustment per described partition
Assigned Codeword Index	16 bits	
CRC	8 bits	CRC-8
}		

Insert the following parameter descriptions following Table 270b (.16e)/Table 386b (Rev2) as indicated:

PB_Ctl_x

This structure describes a control action related to the state of an allocation. Probe, open, maintain mean to initiate or continue the codeword (preamble) training sequence on the allocated partition. Close means the resource is no longer allocated.. The other attributes of the partition/burst are contained in the Downlink Access (DLA) Message or Private Map (PMAP) which contains this control structure. The partition/burst control encode is described in the Table 3below:

Table xxx - Partition/Burst Control encode

5 bit Value	2 bit encode Value	Description
0-23	0-3 (burst index)	Probe, Open or Maintain (p,o,m) the partition indexed by the 5 bit value in the burst indexed by the 2 bit encode value.
24	0-3 (partition index)	Close Partition in the 4 partition range 0-3 indexed by the 2 bit encode value
25	0-3 (partition index)	Close Partition in the 4 partition range 4-7 indexed by the 2 bit encode value
26	0-3 (partition index)	Close Partition in the 4 partition range 8-11 indexed by the 2 bit encode value
27	0-3 (partition index)	Close Partition in the 4 partition range 12-15 indexed by the 2 bit encode value
28	0-3 (partition index)	Close Partition in the 4 partition range 16-19 indexed by the 2 bit encode value
29	0-3 (partition index)	Close Partition in the 4 partition range 20-23 indexed by the 2 bit encode value
30	0-3 (burst index)	Close all partitions in burst using 2 bit encode as burst number
31	0-3	0: Fast power control for MCS increase (affects all partitions in current burst) 1-3: *Reserved*

DIUC

DIUC

Codeword Type

Describes the codeword type that is being assigned(0 = Access codeword 1=Transport codeword). (as defined in section 8.4.4.7.2.3.1).

UIUC Offset

Offset from the DIUC

11

UL Range Adjust

Range Adjustment encode. A step size of $d_t = 0.714$ us is proposed. 0.714 us corresponds to 4 samples at a 5.6 MHz sample rate. Four samples corresponds to a "PS". The range adjustment encode is described in the table below:

Table xxx - UL Range (Time) Adjustment Encoding

Encoded bits	Time Delay @ BS	RS UL Adjustment
00	$t_e < -\delta_t$	Delay
01	$-\delta_t \leq t_e < 0$	Delay
10	$0 \leq t_e < \delta_t$	Advance
11	$\delta_t \leq t_e$	Advance

UL Frequency Adjust

Frequency Adjustment encode described via the following table:

Table xxx - UL Frequency Adjustment Encoding

Encoded bits	Frequency Error @ BS	RS UL Adjustment
00	$f_e < -d_f$	Increase frequency
01	$-d_f \leq f_e < 0$	Increase frequency
10	$0 \leq f_e < d_f$	Decrease frequency
11	$d_f \leq f_e$	decrease frequency

UL Access Power Adjust
  Power adjustment for the access channel
UL Partition Power Adjust
  Power adjustment for bearer partitions (2 bit encode per partition described in partition control structures)
Assigned Codeword Index
  Assigned codeword (may be ULA or ULT) as defined by codeword construction in section 8.4.4.7.2.3.1.
CRC
  CRC-8 covers both slots

Insert new subclause 8.4.4.7.2.3.5:

8.4.4.7.2.3.5 AAS Relay Zone Downlink Initiation (DLI) Signaling

Insert new subclause 8.4.4.7.2.3.5.1:

8.4.4.7.2.3.5.1 BS Initiated Traffic and Paging

The base station can initiate traffic or page the RS using the DLI mechanism. The DLI is a unique code provided to the RS registered with the base station. The DLI codeword has a one to one correspondence with the ULA codeword that is assigned to an RS in the DLA Message. RS continuously search for the DLI using a correlation process using the assigned code as the paradigm. One DLI allocation is included in the MAP in the last slot of symbols 2 and 3. The DLI(i) is the paging mechanism informing the ith user to respond on both the access partition and available traffic partitions. DLIs start BS initiated traffic. 200 DLIs per second are available. RS(i) responds to the DLI on the access and traffic partitions with an ULA training sequence and an ULA message to perform an initial bandwidth request. This will allow a resource allocation for the pending DL traffic.

Insert new subclause 8.4.4.7.2.3.5.2:

8.4.4.7.2.3.5.2 DLI Codeword Transmission

The Map is constructed to fit into 15 PUSC slots available in symbols 2 and 3. 4 slots are dedicated to the FCH, either 8 or 10 slots are reserved for the Map, and 0 or 2 slots are allocated for broadcast messages such as the DCD/UCD message or the Neighbor Advertisement message. The remaining slot is allocated to the Downlink Initiation (DLI) paging signal.

There are 48 sub-carriers allocated to the DLI. The 48 sub-carriers are split into two groups of 24. If the 48 were numbered sequentially, the first group would be the even sub-carriers and the second group would be the odd subcarriers.. Each group contains a column of a 24 × 24 Hadamard matrix and is BPSK modulated. BPSK has two values. Two values times 24 different columns is 48 total combinations per group. 48 combinations in the first group times 48 combinations in the second group is 2304 total. The BS can ring up 2304 RS per 5 MHz channel.

The signal processing for the transmitter is shown in Figure 1. *b* represents the DLI codeword and ranges from 0 to 2303. It is then broken down into two groups of 24. i_0 selects one of 24 Hadamard columns for the first group and ranges from 0 to 23. k_0 selects the BPSK modulation for the first group. i_1 selects one of 24 Hadamard columns for the second group. k_1 selects the BPSK modulation for the second group. The Hadamard(24) matrix is as follows:

13

```
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
1 -1  1 -1  1  1  1 -1 -1 -1  1 -1  1 -1  1 -1  1  1  1 -1 -1 -1  1 -1
1 -1 -1  1 -1  1  1  1 -1 -1 -1  1  1 -1 -1  1 -1  1  1  1 -1 -1 -1  1
1  1 -1 -1  1 -1  1  1  1 -1 -1 -1  1  1 -1 -1  1 -1  1  1  1 -1 -1 -1
1 -1  1 -1 -1  1 -1  1  1  1 -1 -1  1 -1  1 -1 -1  1 -1  1  1  1 -1 -1
1 -1 -1  1 -1 -1  1 -1  1  1  1 -1  1 -1 -1  1 -1 -1  1 -1  1  1  1 -1
1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1
1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1
1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1
1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1  1  1  1 -1 -1 -1  1 -1 -1  1 -1
1 -1  1  1  1 -1 -1 -1  1 -1 -1  1  1 -1  1  1  1 -1 -1 -1  1 -1 -1  1
1  1 -1  1  1  1 -1 -1 -1  1 -1 -1  1  1 -1  1  1  1 -1 -1 -1  1 -1 -1
1  1  1  1  1  1  1  1  1  1  1  1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
1 -1  1 -1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1 -1 -1 -1  1  1  1 -1  1
1 -1 -1  1 -1  1  1  1 -1 -1 -1  1 -1  1  1 -1  1 -1 -1 -1  1  1  1 -1
1  1 -1 -1  1 -1  1  1  1 -1 -1 -1 -1 -1  1  1 -1  1 -1 -1 -1  1  1  1
1 -1  1 -1 -1  1 -1  1  1  1 -1 -1 -1  1 -1  1  1 -1  1 -1 -1 -1  1  1
1 -1 -1  1 -1 -1  1 -1  1  1  1 -1 -1  1  1 -1  1  1 -1  1 -1 -1 -1  1
1 -1 -1 -1  1 -1 -1  1 -1  1  1  1 -1  1  1  1 -1  1  1 -1  1 -1 -1 -1
1  1 -1 -1 -1  1 -1 -1  1 -1  1  1 -1 -1  1  1  1 -1  1  1 -1  1 -1 -1
1  1  1 -1 -1 -1  1 -1 -1  1 -1  1 -1 -1 -1  1  1  1 -1  1  1 -1  1 -1
1  1  1  1 -1 -1 -1  1 -1 -1  1 -1 -1 -1 -1 -1  1  1  1 -1  1  1 -1  1
1 -1  1  1  1 -1 -1 -1  1 -1 -1  1 -1  1 -1 -1 -1  1  1  1 -1  1  1 -1
1  1 -1  1  1  1 -1 -1 -1  1 -1 -1 -1  1 -1 -1 -1 -1  1  1  1 -1  1  1
```

The first group of 24 sub-carriers is multiplexed with the second group of 24 sub-carriers. If the indices to the sub-carriers of a slot were numbered from 0 to 47, the even numbered sub-carriers come from the first group of 24 and the odd number sub-carriers come from the second group of 24. The first sub-carrier of the slot is $H(0, i_0) k_0$, the second, is $H(0, i_1) k_1$, the third is $H(1, i_0) k_0$, the fourth is $H(1, i_1) k_1$, etc., where zero-based indexing is assumed when accessing the Hadamard matrix, $H(n, i)$.

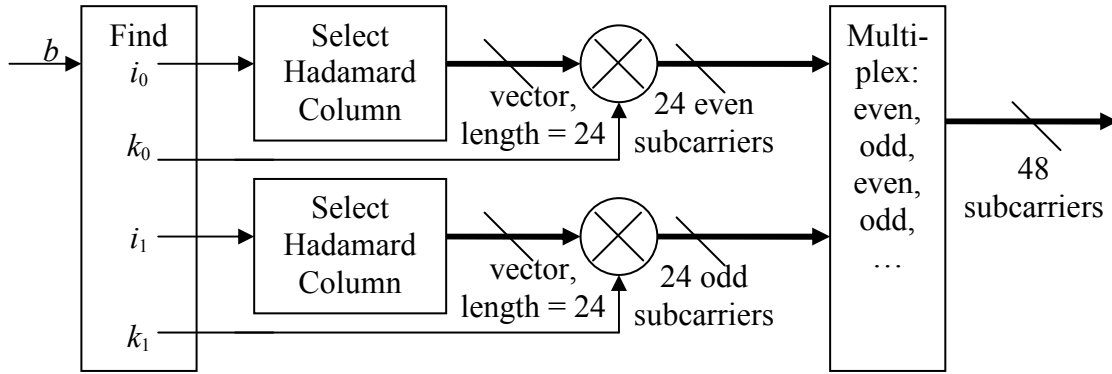*Insert Figure xxxa (.16e)/Figure xxxa (Rev2) as indicated*:

Figure 2. Transmitter Signal Processing

$$g_0 = \lfloor b \div 48 \rfloor \tag{1}$$

$$g_1 = b - 48g_0 \tag{2}$$

$$k_0 = \begin{cases} -1 & \text{if } g_0 < 24 \\ +1 & \text{otherwise} \end{cases} \tag{3}$$

$$k_1 = \begin{cases} -1 & \text{if } g_1 < 24 \\ +1 & \text{otherwise} \end{cases} \tag{4}$$

$$i_0 = g_0 - 12(1 + k_0) \tag{5}$$

$$i_1 = g_1 - 12(1 + k_1) \tag{6}$$