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Re:	Call for comments, Sponsor Ballot on 802.16e/D6
Abstract	This contribution describes coordinated association, a method to pre-schedule association attempts between the MS and the neighboring BS's
Purpose	In some systems, association may be an important part of pre-HO operations. Prescheduled association will allow minimization of each association attempt with each target BS, thus also minimizing the period the MS is unavailable at the Serving BS, which is especially crucial when MS is in an active UGS service flow (such as VoIP).
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Coordinated Association during scanning

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1. Motivation

Association is a process in which the MS performs frequent CDMA ranging with neighboring basestations. Following that, HO may be performed without ranging the designated Target BS, thus shortening the NW reentry process. It is particular beneficial to shorten the actual HO duration, to allow continuity of active services, such as VoIP.
Currently, the standard provides some level of coordination between the MS and Target BS; during the MOB_SCN-REQ/RSP exchange, the BS provides a " rendezvous time" (in frames) where the Target BS will allocate a non-contention based CDMA ranging opportunity. At that time, the Target BS issues a FAST_RANGING_IE in the UL-MAP, where it provides allocation size and offset.

The main problems with the existing association method and related messages:

- FAST_RANGING_IE may include a CDMA ranging allocation. As there are no constrictions on its place in the UL-MAP. It may be situated at a position, where it doesn't allow enough time for UL scheduling.
- Allocating a whole (non-contention based) ranging window for each MS for association imposes unacceptable BW overhead.
- The MS knows the frame number, before the association attempt, but has no knowledge of other ranging window info, such as size and offset.
- Ranging (for association) may take several frames to complete, as the following example may demonstrate (Frame N = "rendezvous frame")
  - Frame N: The MS switches to the Target BS, but only in the next frame it completes DL PHY synchronization.
  - Frame N+1: The MS searches for FAST_RANGING_IE in the UL-MAP.
  - Frame N+2: MS transmits CDMA code for ranging
  - Frame N+3: BS calculates PHY offsets
  - Frame N+4: BS sends RNG_RSP with required PHY corrections.

  This sequence is too long, if the MS is currently in an intense UGS session (e.g. VoIP) with the Serving BS where only 2 frames may be disposed for "off-line" activities such as association.
- As association is always with neighboring BS's, association related messages should use compressed BS_ID's to reduce messages lengths.

2. Proposed solution

We propose a comprehensive association mechanism, comprised of 4 different association levels:

- Level 0 – No association (i.e. scan without association)
- Level 1 – Association without coordination
- Level 2 – Association with coordination
- Level 3 – Network assisted association reporting

During the basic capabilities negotiation phase the MS and BS exchange info on the supported association levels.
The level to actually be used by the MS and BS will be negotiated during the SCN-REQ/RSP exchange session.

2.1. Association Level 0 - No association

When this association level is chosen, no pre-HO ranging of neighboring BS's will be performed and any HO to a Target BS will most likely include ranging to adjust transmitter PHY parameters.

No modifications to the current standard are required (except negotiating the supported association level during the basic capabilities negotiation phase)

2.2. Association Level 1 – Association without coordination

This is the basic (correctly supported in the standard) contention based CDMA association procedure. When this association level is chosen, the Serving BS and the MS negotiate about the association duration and intervals (via MOB_SCN-REQ and MOB_SCN-RSP). The Serving BS will allocate periodic intervals where the MS may range neighboring BS, however the Target BS has no knowledge of the MS and will only allocate contention-based ranging windows.
This association type will typically be used during or immediately after initialization.

No modifications to the current standard are required (except negotiating the supported association level during the basic capabilities negotiation phase)

2.3. Association Level 2 – Association with coordination

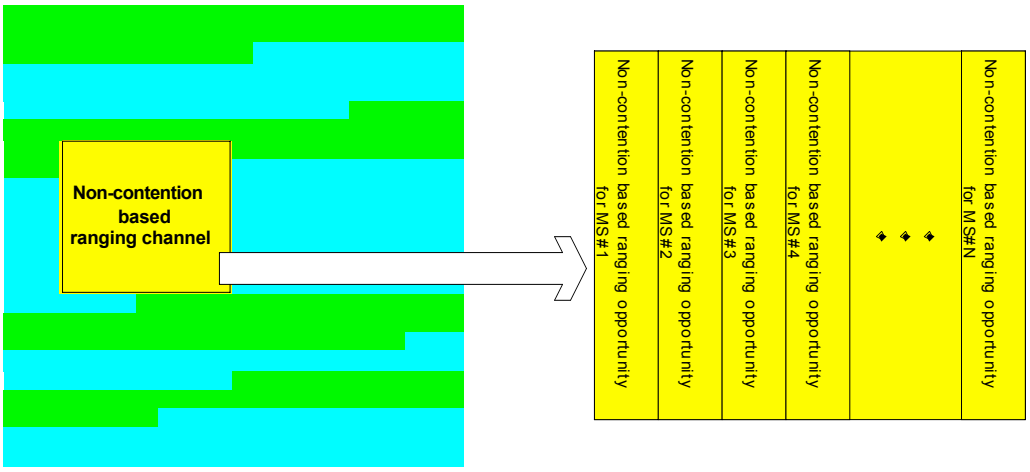
When this association level is chosen, the Serving BS negotiates association parameters with the MS and coordinates association between the MS and neighboring BS's.

Each neighboring BS will allocate a non-contention based ranging window for association, but unlike the existing situation, we propose that each BS, in addition to the frame number of the "rendezvous time", (where it will allocate the ranging window), will also assign:

- a unique code number (from within the initial ranging codeset)

- a unique transmission opportunity within the allocated ranging window (in units of symbols offset from window start)

Thus, one non-contention base ranging window may be shared and used by a multiple number of MS's; thereby reducing BW overhead.



The Target BS may assign the same code or transmission opportunity to more than one MS, but not both (otherwise it cannot distinguish between MS's).

As the proposed ranging window is allocated in a multicast fashion, FAST_RANGING_IE, which is a unicast IE, can no longer be used for that purpose. Hence, the multicast ranging window will be allocated by UIUC=12 in the UL-MAP, by assigning the reserved bit to "multicast ranging" (if "multicast ranging"=0 (default) the ranging window is contention based and is to be used by all MS's within the Serving BS and if "multicast ranging"=1, the ranging window is non-contention based and is to be used only by MS's from neighboring BS's (for association).

It is up to the Serving BS (of the associating MS), as the coordinator of this process, to assure that the neighboring BS's do not assign overlapping "rendezvous times" to the MS, i.e. allocating ranging windows in frames that are too close in time to each other (or even concurrent).

The process in summary:

- The MS negotiates association parameters with the Serving BS and is assigned a frame number ("rendezvous time"), CDMA code and transmission opportunity to use when ranging the Target BS.
- The MS is in normal operation at the Serving BS
- At "rendezvous time" (predefined frame number) the MS switches to the Target BS and transmits a CDMA sequence with the assigned code at the assigned transmission opportunity within the non-contention based ranging wondow.
- The Target BS responds via RNG_RSP with required PHY corrections (ranging status=success)

Modifications will be required to the following messages: MOB_SCN-REQ/RSP, UL-MAP (UIUC=12), FAST_RANGING_IE and SBC-REQ/RSP

2.4. Association Level 3 – NW Assisted Association Reporting

This association type functions in a way very much similar to the previous one (level 2). However, using this association type the MS does not have to wait for RNG_RSP from the Target BS. Instead, the RNG_RSP info (i.e. PHY corrections) will be sent by each Target BS to the Serving BS (over the backbone). The Serving BS aggregates all the RNG_RSP messages to a single message, namely "association report", which the Serving BS then sends to the MS. This is a new message; MOB_ASC_REPORT (resembles MOB_SCAN_REPORT).
When receiving this message, the MS updates its association database (PHY offsets) and timers for each associated BS.

Using this association type, the MS is required only to transmit the CDMA ranging code, thus is may be unavailable to the Serving BS for a very short time (up to two frames).

Modifications will be required to the following messages: MOB_SCN-REQ/RSP, UL-MAP (UIUC=12), FAST_RANGING_IE and SBC-REQ/RSP.
Addition will be required: MOB_ASC_REPORT

3. Changes summary

[In "6.3.20.1.3 Association Procedure",
After the first paragraph ending with the words "in future ranging events", add the following:

There are 4 levels of association:

- Association Level 0 – No association (i.e. scan without association)
- Association Level 1 – Association without coordination
- Association Level 2 – Association with coordination
- Association Level 3 – Network assisted association reporting

6.3.20.1.3.1 Association Level 0 – No association

When this association level is chosen, no pre-HO ranging of neighboring BS's will be performed and any HO to a Target BS will most likely include ranging to adjust transmitter PHY parameters.

6.3.20.1.3.2 Association Level 1 – Association without coordination

When this association level is chosen, the Serving BS and the MS negotiate about the association duration and intervals (via MOB_SCN-REQ and MOB_SCN-RSP). The Serving BS will allocate periodic intervals where the MS may range neighboring BS, however the Target BS has no knowledge of the MS and will only allocate contention-based ranging windows.
This association type will typically be used during or immediately after initialization.

6.3.20.1.3.3 Association Level 2 – Association with coordination

When this association level is chosen, the Serving BS negotiates association parameters with the MS and coordinates association between the MS and neighboring BS's.

Each neighboring BS will allocate a non-contention based ranging window for association at a predefined "rendezvous time", (the relative frame number where it will allocate the ranging window). The neighboring BS will also assign:

- a unique code number (from within the initial ranging codeset)
- a unique transmission opportunity within the allocated ranging window (in units of symbols offset from window start)

The non-contention base ranging window may be shared and used by a multiple number of MS's. The Target BS may assign the same code or transmission opportunity to more than one MS, but not both.

The ranging allocation will be provided to the MS in the MOB_SCN-RSP from the Serving BS. MS's to whom the Target BS is their Serving BS, the multicast ranging window is prohibited for use and will be allocated by UIUC=12 in the UL-MAP, with "multicast ranging" bit set to 1.

The Serving BS (of the associating MS), assures that the neighboring BS's do not assign overlapping "rendezvous times" to the MS, i.e. allocating ranging windows in frames that are too close in time to each other (or even concurrent).

6.3.20.1.3.4 Association Level 3 – NW Assisted Association Reporting

When using this association type, the MS does not have to wait for RNG_RSP from the Target BS. Instead, the RNG_RSP info (i.e. PHY corrections) will be sent by each Target BS to the Serving BS (over the backbone). The Serving BS aggregates all the RNG_RSP messages to a single message, namely MOB_ASC_REPORT, which the Serving BS then sends to the MS.

When receiving this message, the MS updates its association database (PHY offsets) and timers for each associated BS.

Using this association type, the MS is required only to transmit the CDMA ranging code at the Target BS.

In 6.3.20.1.3 delete the following paragraph:

~~MSS may perform scheduled Association through non-contention based initial ranging opportunity using the method provided in 6.3.20.1.2.~~

[In 6.3.2.3.48 Scanning Interval Allocation Request (MOB_SCN-REQ) message, change table 106g as follows:

Table 106g – MOB_SCN-REQ message format

Syntax	Size	Notes
MOB_SCN_REQ_Message_Format() {		
Management Message Type = 54	8 bits	
Scan duration	8 bits	In frames
Association type	3 bits	0b000: Scanning with association level 0: scanning without association. 0b001: Scanning with association level 1: association without coordination. 0b010: Scanning with association level 2: association with coordination. 0b011: Scanning with association level 3: NW assisted association reporting. 0b100-0b111: Reserved
Padding	1 bit	Shall be set to zero
~~If (Scan type = 0) {~~		
Interleaving interval	8 bits	Units are frames
Scanning iteration	8 bits	
If NOT (Scan type = 000) {		
Comp_NBR_BSID_IND	1 bit	
Padding	3 bits	Shall be set to zero
If (Comp_NBR_BSID_IND ==1) {		
Configuration change count for MOB_NBR_ADV	8 bits	Configuration Change Count value of referring MOB_NBR_ADV message
}		
N_Recommended_BS	8 bits	Number of neighboring BS's to be scanned/associated
For (j=0;J<N_Recommended_BS;j++) {		
If (Comp_NBR_BSID_IND ==1) {		
Neighbor_BS_index	8 bits	BS index corresponds to position of BS in MOB_NBR_ADV message
}		
Else {		
Neighbor_BS_ID	48 bits	
}		
}		
}		
Padding	variable	Padding bits to complement message length to an integer number of bytes
HMAC tuple		Full size or truncated
}		

Association type

Type of association to be used by the MS and coordinated by the Serving BS (if Association type >=0b010).

Comp_NBR_BS_ID_IND
Indicates whether to use BS index (8 bits) or BS_ID (48 bits) or.

BS_index
BS_index is a compressed identifier of a neighboring BS, with the index assigned in the order of appearance of the BS in the MOB_NBR_ADV message.

[In 6.3.2.3.49 Scanning Interval Allocation Response (MOB_SCN-RSP) message, change table 106h as follows:

Table 106h – MOB_SCN-RSP message format

Syntax	Size	Notes
MOB_SCN_RSP_Message_Format() {		
Management Message Type = 55	8 bits	
Scan duration	8 bits	In frames
Start frame	4 bits	
Association type	3 bits	0b000: Scanning with association level 0: scanning without association. 0b001: Scanning with association level 1: association without coordination. 0b010: Scanning with association level 2: association with coordination. 0b011: Scanning with association level 3: NW assisted association reporting. 0b100-0b111: Reserved
Padding	1 bit	Shall be set to zero
~~If (Scan type = 0) {~~		
Interleaving interval	8 bits	Units are frames
Scanning iteration	8 bits	
Report mode		
Scan report period	8 bits	Available when the value of Scan report is set to 0b01. Scan report period in frames
If NOT (Scan type == 000) {		
Comp_NBR_BSID_IND	1 bits	
Padding	3 bits	Shall be set to zero
If (Comp_NBR_BSID_IND ==1) {		
Configuration change count for MOB_NBR_ADV	8 bits	Configuration Change Count value of referring MOB_NBR_ADV message
}		
N_Recommended_BS	8 bits	Number of neighboring BS's to be scanned/associated
For (j=0;J<N_Recommended_BS;j++) {		
If (Comp_NBR_BSID_IND ==1) {		
Neighbor_BS_index	8 bits	BS index corresponds to position of BS in MOB_NBR_ADV message
}		
Else {		
Neighbor_BS_ID	48 bits	
}		
If (Scan type == 001) OR (Scan type == 010) {		
Rendezvous time	8 bits	Units are frames
CDMA_code	8 bits	From initial ranging codeset
Transmission_opportunity	8 bits	Units are symbols
}		
}		
Padding	variable	Padding bits to complement message length to an integer number of bytes
HMAC tuple		Full size or truncated
}		

Rendezvous time
The time offset (relative to this message) in which the Target BS is expected to allocate a non-contention based ranging opportunity for association-related ranging.
When Association type ==0b000 or 0b001, this field shall be set to zero.

CDMA code
A unique code assigned to the MS, to be used for association with the Target BS. Code is from the initial ranging codeset

Transmission opportunity
A unique transmission opportunity assigned to the MS, to be used for association with the Target BS. Units are symbol.

[Change table 298g as follows:

Table 298g – FAST_UL_RANGING_IE message format

Syntax	Size	Notes
FAST_UL_RANGING_IE {		
Extended UIUC	4 bits	0x06
Length	4 bits	variable
HO ID indicator	1 bit	0: MAC Address is present 1: HO ID is present
padding		Shall be set to zero
if (HO ID indicator == 1) {		
HO ID	8 bits	
} else {		
MAC address	48 bits	MSS MAC address as provided on the RNG_REQ message on initial system entry
}		
UIUC	4 bits	UIUC °¡ 15. A four-bit code used to define the type of uplink access and the burst type associated with that access.
~~if (UIUC == 12) {~~		
~~OFDMA Symbol offset~~	~~8 bits~~	
~~Subchannel offset~~	~~7 bits~~	
~~No. OFDMA Symbols~~	~~7 bits~~	
~~No. Subchannels~~	~~7 bits~~	
~~Ranging Method~~	~~2 bits~~	~~0b00 - Initial Ranging over two symbols~~ ~~0b01 - Initial Ranging over four symbols~~ ~~0b10 - BW Request/Periodic Ranging over one symbol~~ ~~0b11 - BW Request/Periodic Ranging over three symbols~~
~~reserved~~	~~1 bit~~	~~Shall be set to zero~~
~~} else {~~		
Duration	10 bits	In OFDMA slots (see 8.4.3.1)
Repetition coding indication	2 bits	0b00 - No repetition coding 0b01 - Repetition coding of 2 used 0b10 - Repetition coding of 4 used 0b11 - Repetition coding of 6 used
}		
}		

[Delete the following text from the message:

~~OFDMA symbol offset~~
~~The offset of the OFDMA symbol in which the burst starts, the offset value is defined in units of OFDMA symbols and is relevant to the Allocation Start Time field given in the UL-MAP message.~~

~~Subchannel offset~~
~~The lowest index subchannel used for carrying the burst, starting from subchannel 0. When allocation of mini-subchannels is used this offset will always be even numbered and will point to the first subchannel of the couple splitted into mini-subhcnannels and used in the allocation.~~

~~No. OFDMA symbols~~
~~The number of OFDMA symbols that are used to carry the uplink Burst.~~

~~No. subchannels~~
~~The number of subchannels with subsequent indices~~

~~Ranging method~~
~~Specifies option of CDMA code transmission according to 8.4.7~~

[add the following after section 6.3.2.3.50

6.3.2.3.51 Association Result Report (MOB_ASC-REPORT) message

Table 107h – MOB_ASC-REPORT message format

Syntax	Type	Size	Notes
MOB_ASC_REPORT_Message_Format() {			
Management Message Type = 66		8 bits	
Report mode			0: Event triggered
Comp_NBR_BSID_IND		1 bits	
Padding		3 bits	Shall be set to zero
If (Comp_NBR_BSID_IND ==1) {			
Configuration change count for MOB_NBR_ADV		8 bits	Configuration Change Count value of referring MOB_NBR_ADV message
}			
N_Recommended_BS		8 bits	Number of neighboring BS's to be scanned/associated
For (j=0;J<N_Recommended_BS;j++) {			
If (Comp_NBR_BSID_IND ==1) {			
Neighbor_BS_index		8 bits	BS index corresponds to position of BS in MOB_NBR_ADV message
}			
Else {			
Neighbor_BS_ID		48 bits	
}			
Basic CID		16 bits	
Primary management CID		16 bits	
Timing adjust	1	32 bits	
Power level adjust	2	8 bits	
Offset frequency adjust	3	32 bits	
Ranging status	4	8 bits	
}			
}			
Padding		4 bits	Padding bits to complement message length to an integer number of bytes
}			

Rreport mode

The offset of the OFDMA symbol in which the burst starts, the offset value is defined in units of OFDMA symbols and is relevant to the Allocation Start Time field given in the UL-MAP message.

Comp_NBR_BSID_IND
This bit indicates whether neighbor BS IDs are compressed or not. MSS can compress BS ID, only when NBR_BS_Index_Validity_Time is larger than the difference of MOB_SCAN_REPORT message transmitting time and MOB_NBR_ADV message receiving time (MOB_NBR_ADV message should be referred in order to compress neighbor BS IDs). This difference time is calculated from Frame number of DL-MAP PHY Synchronization Field.

BS_index
BS_index is a compressed identifier of a neighboring BS, with the index assigned in the order of appearance of the BS in the MOB_NBR_ADV message.

NBR BS_ID
BS_ID of the neighboring BS with which the MS is associated.

Configuration Change Count for MOB_NBR_ADV
The value of Configuration Change Count in MOB_NBR_ADV message referred in order to compress neighbor BSID

Basic CID
The Basic CID assigned by the Target BS to the MS during association

Primary management CID
The primary management CID assigned by the Target BS to the MS during association

Timing adjust
The time required to advance MS transmissions so frames arrive at the expected time instance at the Target BS.

Power level adjust
The power level offset adjustment required so that MS transmissions arrive at the desired level at the Target BS.

Frequency offset adjust
The relative frequency adjustment required so that MS transmissions arrive at the desired frequency at the Target BS.

Ranging status
Used to indicate whether MS ranging attempt is within acceptable limits of the Target BS.

N_Recommended_BS
Number of BS included in this association report.

[add the following to SBC_REQ/RSP messages

11.8.X.X Association type supported

Type	Length	Notes	Scope
XXX	1	Bit #0: Scanning with association level 0: scanning without association. Bit #1: Scanning with association level 1: association without coordination. Bit #2: Scanning with association level 2: association with coordination. Bit #3: Scanning with association level 3: NW assisted association reporting. Bit #4 – Bit #7: Reserved	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)