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Re:	The document accompanies a comment submitted to 802.16e Sponsor Ballot	
Abstract	The document suggests changes in Handover section to make possible shortening of traffic interruption time	
Purpose	The document should be considered during resolution of 802.16e Sponsor Ballot comments	
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Clarification for HO section

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1. Background

Section 6.3.21 contains unclear expressions and in some cases is inconsistent with formats of MAC messages in 6.3.2.3

Just for example, the following is the text of clause 6.3.21 “MAC layer HO procedures” with markup pointing to problematic fragments.

This section contains the procedures performed during HO on the air-interface *[the whole scope of 802.16 is limited to air interface]*.
The Hand-over process defined in this paragraph may be used in a number of situations, some examples being:
— When the MS moves and (due to signal fading, interference levels, etc.) needs to change the Base Station to which it is connected in order to provide a higher signal level [*signal level* means *probably RSSI; while CINR is really important]* ;
— When the MS is stationary *[unnecessary restriction]*, but it can receive higher bandwidth */particular case of higher QoS]* / better QoS from a neighbor Base Station, which is less heavily loaded *[just one of possible reasons: another one is that MS got signal of better quality]*. Such load balancing situations *[misleading language]* are generated by the dynamic character of Internet traffic *[the most typical reason of load misbalance is one BS gets more terminal]*, having an average traffic that is dependent on application and server loading.*[what does it mean?]*
The Hand-over Policy Manager *[undefined term]* is beyond the scope of the standard, and complex factors may affect the decision to initiate the Hand-over *[probably the sense is that algorithm of HO decision is out of the scope of the standard?]*.

One of specific problems is that in case REG-REQ/RSP handshake is omitted, there is no signaling for completion of Network Re-entry. A new RNG-RSP TLV is suggested for this purpose.

The following are specific changes suggested for 802.16e/D7.
[Italic font means editorial marks based on 802.16-2004]
[Bold Italic font means editorial marks of contribution’s author]

1. Specific changes in 802.16e/D7

[Insert new subclause 6.3.21:]

6.3.21 MAC layer ~~HO~~ handover procedures

This section contains the procedures performed during handover (HO) ~~on the air-interface~~ [the whole scope of 802.16 is limited to air interface].
The Hand-over [or handover or hand over?] process defined in this paragraph may be used in a number of situations, some examples being:

— When the MS moves and (due to signal fading, interference levels, etc.) needs to change the Base Station to which it is connected in order to provide a higher signal ~~level~~ quality;
— When the MS is ~~stationary, but it~~ can be serviced with higher QoS ~~receive higher bandwidth / better QoS from a~~ at another ~~neighbor~~ Base Station~~, which is less heavily loaded. Such load balancing situations are generated by the dynamic character of Internet traffic, having an average traffic that is dependent on application and server loading.~~
The algorithm of Hand-over decision ~~Policy Manager~~ is beyond the scope of the standard~~, and complex factors may affect the decision to initiate the Hand-over~~.

[Insert new subclause 6.3.21.1:]

6.3.21.1 Network topology acquisition

[Insert new subclause 6.3.21.1.1:]

6.3.21.1.1 Network topology advertisement

A BS ~~shall~~ may broadcast information about the network topology using the MOB_NBR-ADV MAC Management message. The message provides channel information for neighboring base stations normally provided by each BS' own DCD/UCD message transmissions. A BS may obtain that information ~~neighboring base stations' DCD/UCD~~ over the backbone. Availability of this information facilitates MS synchronization with neighboring BS by removing the need to monitor transmission from the target BS for DCD/UCD broadcasts.

[Insert new subclause 6.3.21.1.2:]

6.3.21.1.2 MS Scanning of ~~available~~ neighbor BSs

A BS may allocate time intervals to MS for the purpose of MS seeking and monitoring ~~available BS~~ suitability of neighbor BSs as targets for HO. The time during which the MS scans for available BS will be referred to as a Scanning Interval.
An MS may request an allocation of a group of Scanning Intervals with Interleaving intervals of normal operation using the MOB_SCN-REQ MAC Management message. The MS indicates in this message the estimated duration of time it requires for the scan.
~~The MS or BS may request group of Scanning Intervals with Interleaving intervals of Normal Operation be allocated through a single exchange of MOB_SCN-REQ/RSP management messages for the purpose of reducing the number of MOB_SCN-REQ and MOB_SCN-RSP messages required to create multiple scanning opportunities when frequent scanning is required~~.
Scanning Interval and Interleaving interval repeat
with the number of Scan iteration.
In the MOB_SCN-REQ MAC management message the MS~~, and in~~ (the MOB_SCN-RSP MAC management message the BS) shall indicate group of neighbor BSs for which ~~either~~ only Scanning or Scanning with Association are requested by MS (recommended by BS). Presence of those BSs for which Association is requested (recommended) is indicated by ~~, Scan type = 0, or Association,~~ encoding of Scan type = 1~~, as the intended MS activity during the Scanning Interval. If Scan type = 1, Association, then the MS and BS may include, in their respective messages, one or more Recommended BS IDs.~~ The BS may negotiate over the backbone with ~~the~~ a BS recommended for Association ~~BS ID~~ allocation of ~~non-contention based~~ unicast ranging ~~opportunity~~ opportunities. Then the MS will be informed on Rendezvous time ~~, at the~~

~~appropriate timing interval, for MS~~ to conduct Association ranging with the recommended BS ~~ID~~. When conducting initial ranging to a BS recommended for Association ~~BS ID~~, MS shall use allocated ~~non-contention based~~ unicast ranging opportunity, if available. Regardless of ~~value of Scan type and~~ the presence of ~~one or more~~ Recommended BS IDs, MS may determine and perform any scanning or ~~ranging or~~ Association activities during Scanning Interval at its own discretion.

Upon reception of the MOB_SCN-REQ message, the ~~serving~~ BS shall respond with a MOB_SCN-RSP MAC Management message. The MS may retransmit the MOB_SCN-REQ message if it does not receive the MOB-SCN-RSP message within the T31 timer. The serving BS may also send MOB_SCN-RSP MAC management message unsolicited. The MOB_SCN-RSP MAC Management message shall either grant the requesting MS a Scanning Interval that is at least as long as requested by that MS, or deny the request. A value of zero for Duration in MOB_SCN-RSP shall indicate the request for an allocation of Scanning Interval is denied~~,~~ ; in this case ~~and~~ the BS ~~may~~ shall omit the rest of ~~scan~~ parameters ~~(e.g., Start frame, Scan type, Interleaving interval) except Scan Duration~~ in the MOB_SCN-RSP MAC Management message.

Following reception of a MOB_SCN-RSP MAC Management message granting the request, beginning at Start frame an MS ~~shall~~ may scan for one or more BS during the time intervals allocated in the message. When a ~~available~~ BS ~~are~~ is identified through scanning, the MS may attempt to synchronize with ~~their~~ its downlink transmissions, and estimate the quality of the PHY channel. MS may also perform contention, or non-contention if available, based initial ranging during the Scanning Interval ~~to one or more available BS~~ to more completely evaluate PHY channel characteristics with ~~available~~ the BS, obtain Service Level Predictions ~~for MS service flows, and assess for Association~~.

The serving BS may buffer incoming data addressed to the MS during the Scanning Interval and transmit that data after the Scanning Interval during any Interleaving interval or after exit of the Scanning ~~Mode and resumption of normal operation~~.

An MS may terminate scanning and return to normal operation anytime that may be indicated to the BS by sending a MAC PDU (for example, Bandwidth request) ~~to the serving BS~~ during any Scanning Interval. If a serving BS receives a MAC PDU message during any Scanning Interval from an MS that is supposed to be in Scanning Mode, the BS shall assume that the MS is no longer in Scanning Mode.

~~Any UL message from the MS to the serving BS during a Scanning Interval shall interrupt the Scanning Interval, and shall signal the serving BS that the MS is still active and has not dropped the connection during the Scanning Interval~~. The group of intervals is terminated at any time if the MS sends MOB_SCN-REQ message or serving BS sends MOB_SCN-RSP message during any Interleaving interval with Scan Duration set to zero.

[Insert new subclause 6.3.21.1.3:]

6.3.21.1.3 Association Procedure

Association is an optional initial ranging ~~parameter negotiation~~ procedure occurring during Scanning Interval with respect to one of neighbor BSs. The function of Association is to enable the MS to acquire and record ranging parameters and service availability information for the purpose of proper selection of HO target and/or expediting a potential future hand-over to a target BS. Recorded ranging parameters of an Associated BS may be further used for setting initial ranging values in future ranging events during actual handover.

There are 3 levels of association as follows:

— Association Level 0: Scan / Association without coordination

— Association Level 1: Association with coordination
— Association Level 2:Network assisted association reporting

MS may perform scheduled Association through ~~non-contention based~~ unicast initial ranging opportunity using the method provided in 6.3.~~20~~21.1.2.
Upon completion of a successful MS initial-ranging of a BS, if the RNG-RSP message contains a Service Level Prediction parameter set to 2, the MS may mark the BS as Associated in its MS local Association table of identities, recording elements of the RNG-RSP to the MS local Association table, and setting an appropriate aging timer (See Table 340a Parameters and Constants, ASC-AGING-TIMER). Association state in the MS local Association table shall be aged-out after ASC-AGING-TIMER timeout and the Association entry removed.

[Insert new subclause 6.3.21.2:]

6.3.21.2 HO process

The section defines the HO process in which an MS migrates from the air-interface provided by one BS to the air-interface provided by another BS. The HO process consists of the stages:
— Cell Reselection — MS may use Neighbor BS information acquired from a ~~decoded~~ MOB_NBR-ADV message, or may make ~~an independent decision~~a request to schedule scanning intervals or sleep-intervals to scan, and possibly range, Neighbor BS for the purpose of evaluating MS interest in hand-over to potential target
BS. The Cell Reselection process need not occur in conjunction with any specific, contemplated HO Decision.
— HO Decision & Initiation — a hand-over begins with a decision for an MS to hand-over ~~its air interface, service flow, and network attachment~~ from a Serving BS to a Target BS. The decision may originate either at the MS, or the Serving BS. The HO Decision consummates with a notification of MS intent to hand-over through MOB_MSHO-REQ or MOB_BSHO-REQ MAC Management Message.
— Synchronization to Target BS downlink ~~Scanning~~ — MS shall synchronize to downlink transmissions of ~~scan~~ Target BS ~~for downlink channel & synchronization~~, obtain DL and UL transmission parameters. ~~and uplink channel & synchronization.~~ If MS had previously ~~decoded~~ received a MOB_NBR-ADV message including target BSID, Physical Frequency, DCD and UCD, ~~then the scanning and synchronization~~ this process may be shortened. If the Target BS had previously received HO notification from Serving BS over the backbone ~~(see Backbone network HO procedures)~~, then target BS may ~~place~~ allocate a non-contention based ~~Fast_UL_ranging_IE MS~~ Initial Ranging opportunities ~~opportunity in the UL-MAP~~. ~~MS shall scan target BS for ULMAP that includes either a contention or non-contention based MS Initial Ranging opportunity.~~
— ~~Network Re-entry~~Initial ranging — MS and target BS shall conduct Ranging per 6.~~2~~3.9.5 ~~to begin network re-entry~~. If MS RNG-REQ includes ~~an unexpired~~ Serving BS ID ~~and Target BS had not previously received MS information over the backbone (see Backbone network HO procedures)~~, then target BS may make ~~an MS information~~ a request ~~of~~ to Serving BS for information on the MS over the backbone network and Serving BS may respond.
Regardless of having received MS information from Serving BS, Target BS may request MS information from an Authorizing Station via the backbone network. Network re-entry proceeds per 6.~~2~~3.9.5 except as may be shortened by Target BS possession of MS information obtained from Serving BS over the backbone
network. Dependently on the amount of that information Target BS may decide to skip one or several of the following Network Entry steps:

1) Negotiate basic capabilities
2) Authorize SS and perform key exchange
3) DSA-REQ/RSP handshake to set up connections
4) REG-REQ/RSP handshake

In case REG-REQ/RSP handshake omitted, completion of Network Re-entry is signaled by RNG-RSP with Normal_Operations_Start TLV parameter. Otherwise network re-entry process completes with ~~establishment~~ REG-REQ/RSP handshake ~~of MS normal operations~~.
— Termination of Service — The final step in hand-over is any termination of MS services with previous serving BS. Termination of Service is defined as serving BS termination of all connections belonging to the MS and the context associated with them (i.e,. information in queues, ARQ state-machine, counters, timers, header suppression information, etc. is discarded).
— HO Cancellation — an MS may cancel ~~a pending~~ HO at any time prior to expiration of System Resource_Retain_Time interval after transmission of MOB_MSHO-IND message.
~~NOTE—Annex C.1 provides message sequence charts for the examples of HO procedures.~~
The HO process, and its similarity to the initial network entry process, is depicted in Figure 130b.

[Insert new subclause 6.3.21.2.1:]

6.3.21.2.1 Cell Reselection

Cell selection refers to the process of an MS Scanning and/or ~~Ranging~~ Association with one or more BS in order to determine their suitability, along with other performance considerations, ~~for network connection or hand-over~~ as a handover target. MS may incorporate information acquired from a MOB_NBR-ADV message to give insight into available Neighbor BSs for cell reselection consideration. ~~If currently connected to a~~ Serving BS may ~~, an MS shall~~ schedule scanning intervals or sleep-intervals to conduct Cell Reselection activity ~~for the purpose of evaluating MS interest in hand-over to potential target BS~~. Such procedure does not involve termination of existing connection~~s~~ to a serving BS ~~and their re-opening in a target BS. If ranging a target BS for hand-over, any newly assigned basic and primary CIDs are specific to the target BS and do not replace or supplant the basic and primary CIDs the MS employs in its communication with its serving BS~~.

[Insert new subclause 6.3.21.2.2:]

6.3.21.2.2 HO decision & initiation

A handover begins with a decision for an MS to hand-over ~~its air interface, service flow, and network attachment~~ from a Serving BS to a Target BS. The decision may originate either at the MS, the serving BS, or on the network. The HO may proceed with a notification through either MOB_MSHO-REQ or MOB_BSHO-REQ
MAC Management messages. The HO notification is recommended, but not required. Acknowledgement with MOB_BSHO-RSP of a notification is required.
If an MS that transmitted a MOB_MSHO-REQ message detects an incoming MOB_BSHO-REQ message, it may respond with a MOB_MSHO-REQ or a MOB_HO-IND message and ignore its own previous request. ~~Similarly, a~~ A BS that transmitted a MOB_BSHO-REQ message and detects an incoming MOB_MSHO-REQ ~~or MOB_HO-IND~~ message from the same MS shall ignore ~~its own previous request~~ MOB_MSHO-REQ. A BS that transmitted a MOB_BSHO-REQ

message and detects an incoming MOB_HO-IND message from the same MS shall ignore its own previous request.
When MOB_MSHO-REQ is sent by an MS, the MS may indicate one or more possible Target BS. When MOB_BSHO-REQ is sent by a BS, the BS may indicate one or more possible Target BS. MS may evaluate possible target BS through previously performed Scanning, ~~ranging,~~ and Association activity.
Serving BS criteria for recommendation of target BS may include factors such as expected ~~target BS~~ MS ~~QoS~~ performance at potential Target BS and MS QoS requirements. Serving BS may obtain expected ~~Target BS QoS~~ MS performance at potential Target BS ~~indication~~ through the exchange of backbone ~~messaging~~ messages with ~~Neighbor~~ that BS.

The MOB_MSHO-REQ message may also include an indication of the estimated time for performing the HO.

If Network Assisted HO supported flag is set to "1" in MOB_BSHO-REQ message, MS may perform a hand-over to any BS among the recommended BSs in MOB_BSHO-REQ without notifying the serving BS of a selected target BS. As an acknowledgement to the MOB_BSHO-REQ message, the MS may send a
MOB_HO-IND message with its target BSID set to "0x00000000".
When the serving BS, transmitted MOB_BSHO-REQ with ~~Netowrk~~Network Assisted HO supported flag = "1", receive MOB_HO-IND with target BS ID = "0x00000000", it may neglect target BS ID included in MOB_HO-IND message.

[The rest of section* 6.3.21.2.2 *remains unchanged]

[Add to the Table 367a—RNG-RSP message encodings, page 517 line 48]

Power_Saving_Class_Parameters	27	variable	Compound TLV to specify Power Saving Class definition and/or operation
Normal_Operations_Start	29	1	Time instant when Network Re-entry is considered completed and BS and MS may start normal operations after HO. Encoded as offset in frames from the frame where the message was sent