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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 or Key Rest / reply handshake (or both) are omitted there is no direct guidance when Network Re-entry should be considered completed. A new RNG-RSP TLV is suggested for this purpose.

Yet another problem is that HO process optimization field in HO-REQ/RSP messages may request omitting REG-RSP message while description of HO process optimization TLV (in RNG-RSP) makes REG-RSP mandatory. Suggested solution: make REG-RSP mandatory only in case when certain capabilities of Target BS differ from Serving BS.

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 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 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 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. 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~~ messages ~~the BS~~ shall indicate group of neighbor BSs for which ~~either~~ only Scanning or Scanning with Association are requested by MS (recommended by BS). ~~, Scan type = 0, or Association, 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 Serving BS may coordinate ~~negotiate~~ over the backbone with ~~the~~ a BS recommended for Association ~~BS ID~~ allocation of ~~non-contention based~~ dedicated ranging ~~opportunity~~ opportunities. Then the MS will be informed on Rendezvous time, CDMA code and transmission opportunity offset ~~, 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~~ dedicated 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 interval**s** 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, contention, or non-contention based, during the Scanning Interval ~~to one or more available BS~~ to better ~~more completely~~ evaluate PHY channel characteristics with ~~available~~ respect to the BS, and 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 6.3.21.2:]

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 dedicated ~~non-contention based Fast_UL_ranging_IE MS~~ Initial Ranging opportunity ~~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~~ HO ranging — MS and target BS ~~shall~~ may conduct Ranging per 6.3.10.3.3 to adjust MS transmitter offsets .~~6.2.9.5~~ ~~to begin network re-entry~~.
- NW re-entry – Target BS provides UL allocation for MS to send RNG-REQ.
If ~~MS~~ the RNG-REQ message 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~~. Depending 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 (Bit #0 in HO Process Optimization TLV in RNG-RSP is set)
2) Authorize SS (Bit #1 in HO Process Optimization TLV is set)
3) Perform key exchange via Key Request / Key Reply (Bit #2 in HO Process Optimization TLV is set)
4) Send REG-REQ (Bit #9 in HO Process Optimization TLV is set)
5) Send REG-RSP message (Bit #10 in HO Process Optimization TLV is unset)

In case bit #6 in HO Process Optimization TLV is set, full service and operational state transfer or sharing between Serving BS and Target BS is assumed (ARQ state, all timers, counters, MAC state machines, CIDs, Service Flows information and other connection information), so BS and MS do not exchange network re-entry messages after ranging before resuming normal operations.

In case Network Re-entry includes Key Request/Reply handshake BS shall provide sufficient time to the MS to process received TEK information before moving to next step as specified by HO TEK processing time TLV.

Step of setting up connections shall be omitted if TLVs for re-establishment of service flows (11.7.9) are used in RNG-RSP or REG-RSP. In this case BS shall provide sufficient time to the MS to process connections information as specified by MS HO connections parameters processing time TLV.

In case Key Request / Key Reply handshake is not omitted, BS shall send REG-RSP, solicited or not. If REG-RSP is not omitted, network re-entry process completes with establishment REG-RSP message 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 Resource_Retain_Time interval after transmission of MOB_HO-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 reselection 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 connections 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~~ shall 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.

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. Serving BS may negotiate with candidate Target BSs location of common time interval where dedicated initial ranging transmission opportunity for the MS will be provided by all potential Target BSs. This information may be included into MOB_BSHO-RSP message.

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 new section, page 529 line 28]

11.7.25 MS HO parameters processing time

Name	Type	Length	Value	Scope
MS HO connections parameters processing time	??	1	Time in ms the MS needs to process information on connections provided in RNG-RSP or REG-RSP message during HO	REG-REQ/RSP

MS HO TEK processing time	??	1	Time in ms the MS needs to completely process TEK information during HO	REG-REQ/RSP

[Change at p. 516, line 1]

11.6 RNG-RSP TLVs ~~for re-establishment of service flows~~

CID update encodings (11.7.9) and SAID update encodings (11.7.18) may be used in RNG-RSP for re-establishment of connections.

[Insert the following rows to table 367:]

[Change at p. 516, line 56]
Bit #8 : BS shall send an unsolicited SBC-RSP management
message with updated capabilities information in case capabilities of Target BS are different from the ones of Serving BS ~~during current re-entry processing~~
Bit #9 : Omit REG-REQ management message during current re-entry processing
Bit #10 : BS shall send an unsolicited REG-RSP management
message~~s~~ with updated capabilities information in case capabilities of Target BS are different from the ones of Serving BS ~~during current re-entry processingBit~~
~~Bit #10 : BS shall send an unsolicited REG-RSP management~~
~~messages with updated capabilities information~~
~~during current re-entry processingBit~~
#11-15 : Reserved