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Source(s)	Sungjin Lee, Geunhwi Lim, Brian Shim Samsung Electronics	Voice: +82-31-279-5248 E-mail: steve.lee@samsung.com
	Hyunjeong Hannah Lee Xiangying Yang	E-mail: hyunjeong.hannah.lee@intel.com
	Intel	
	Vladimir Yanover, Nadav Lavi	E-mail : vladimir.yanover@alvarion.com
	Alvarion	
	Tzavidas Stavros	E-mail : stavros.tzavidas@motorola.com
	Motorola	
	Kiseon Ryu	E-mail : ksryu@lge.com
	LGE	
	Yerang Hur	E-mail : yehur@posdata-usa.com
	Posdata	
Re:	LB26a	
Abstract		
Purpose	Review and adopt.	
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Handover Latency Reduction

Sungjin Lee, Geunhwi Lim, Brian Shim
Samsung Electronics

Hyunjeong Hannah Lee, Xiangying Yang
Intel

Vladimir Yanover, Nadav Lavi
Alvarion

Tzavidas Stavros
Motorola

Yerang Hur
Posdata

Kiseon Ryu
LGE

Problem Overview

When an MS moves toward a target cell performing a hard handover (HHO), it disconnects with the current serving base station (BS) and performs network re-entry procedure in order to connect with the target BS. During HHO, there then exists a service interruption time for which the MS cannot send/receive data traffic to/from any BS. Thereby, it is essential to maintain the service interruption time short enough so that during HHO the performance degradation of delay sensitive applications such as VoIP can be unnoticeable. According to the current IEEE 802.16e, the service interruption time begins right after the MS sends the MOB_HO-IND message and lasts until the network re-entry completes..

Once the MS moves to the target cell, the MS must achieve PHY synchronization first, and then update MAC context information to connect to the target BS by exchanging MAC management messages. The MAC context update procedure includes RNG-REQ/RSP, SBC-REQ/RSP, Authorization, and REG-REQ/RSP message exchanges. In order to reduce the service interruption time, the current IEEE 802.16e protocol employed HO optimization. Especially for the fully optimized HO, all the MAC context update steps can be combined into one step and thus the MS is required to exchanges only RNG-REQ/RSP with the target BS before resuming data transmission/reception at the target BS.

This contribution proposes a way to further reduce the service interruption time for the fully optimized HO by omitting this RNG-REQ/RSP exchange procedure. To this end, several problems are to be addressed, including CID pre-allocation and security issues during HO.

When the serving BS contacts the potential target BSs for a HO, the potential target BSs actually assign the connection IDs and then respond the serving BS with these pre-assigned CIDs for the MS performing HO. Then, the pre-allocated CID update information is delivered to the MS prior to HO execution, i.e., during HO preparation, via the serving BS through MOB_BSHO-REQ or MOB_BSHO-RSP messages. Resultantly, the

size of these messages becomes larger. Because MOB_BSHO-REQ or MOB_BSHO-RSP messages are usually transmitted when the MS is located in the cell edge, it is desirable to reduce their sizes as much as possible.

As RNG-REQ/RSP is omitted, AK validation and TEK update (if TEK is not shared) are an additional issue to be resolved.

Proposed Text Changes: CID Pre-Allocation

[Include following parameter in line 35 on page 215, MOB_BSHO-REQ message format as indicated:]

HO full optimization flag	*1*	0 : HO without full optimization 1 : HO with full optimization
Padding	~~5~~*4*	Shall be set to zero

[Include following parameters in line 39 on page 216, MOB_BSHO-REQ message format, as indicated:]

If (HO full optimization flag==1) {		
TLV Encoded Information	*Variable*	TLV-specific
}		

[Include following parameter in line 42 on page 229 as indicated:]

HO full optimization flag	*1*	0 : HO without fully optimization 1 : HO with fully optimized

Reserved	~~5~~4	Shall be set to zero

[Include following parameter in line 36 on page 230 as indicated:]

If (HO full optimization flag==1) {		
TLV Encoded Information	*Variable*	TLV-specific
}		

[change lines 15-23 on page 436 as indicated:]

Serving BS criteria for recommendation of target BS may include factors such as expected MS performance at potential target BS, BS and network loading conditions, and MS QoS requirements. The serving BS may obtain expected MS performance, ~~and~~ BS ~~and network~~ loading conditions at a potential target BS and Basic CID to be used at a potential target BS through the exchange of messages with that BS over the backbone network. When a potential target BS allocates Basic CID for an MS, it also reserves a block of transport CIDs for the MS. The serving BS may negotiate 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, and is indicated by Action Time.

If a potential Target BS provides a pre-allocated Basic CID for an MS via Basic CID pre-allocation TLV (see 11.21.1), the MS shall derive primary management CID and transport CIDs to be used at the potential target BS by itself in order to shorten network re-entry time at target BS during actual handover.

The MS understand how CID regions are allocated at a BS by calculating CIDs table using *'m'* if Connection Identifier descriptor is broadcasted in DCD. When an MS is allocated Basic CID in MOB_MSHO-RSP or MOB_BSHO-REQ, the MS shall pre-update new CIDs to be used for a potential target BS knows that a block of transport CID is also reserved for the MS. The MS can calculate the range with the equation *{(2m+1) + (Basic CID-1) x a}* where the parameter *'a'* means transport CID block size and already given by DCD via MOB_NBR-ADV. In order to derive new transport CIDs by itself, the MS update current transport CID with new transport CID of the block from the smallest number in ascending order. For example, the smallest number of transport CID used in Serving BS may be updated by smallest number of transport CID of the block assigned by the potential target BS. Then the MS takes the primary management CID of same order with Basic CID.

For example, if the MS is allocated by a fifth Basic CID from the Basic CID range in the table 529, the MS should take fifth Primary management CID from the of Primary management CID range. The new Primary management CID shall be calculated by adding 'm' to the given Basic CID.

If the MS receives CID pre-allocation TLV for a potential target BS in MOB_BSHO-REQ or MOB_BSHO-RSP message instead of Basic CID pre-allocation TLV, this indicates that the automatic derivation for the primary/transport CIDs is not used. The first CID of the pre-allocated block of contiguous numbered CIDs is explicitly encoded in the TLV. CID pre-allocation TLV uses the common region of Transport CID which is not reserved. For example, this CID pre-allocation TLV can be used if the target BS has no more reserved CIDs

using automatic derivation for the pre-allocation and/or if the number of pre-allocated transport CIDs exceeds '*a*' in Connection Identifier descriptor.

[Include following text in line 22 on page 1186 as indicated:]

11.15.2 Fully Optimized Handover

11.15.2.1 Basic CID pre-allocation

The Basic CID pre-allocation TLV provides a Basic CID allocated by a potential target BS and a bitmap. The bitmap shall be included only if any of transport connection is not acceptable by the potential target BS and it indicates whether each active transport connection is accepted or not.

Name	Length (byte)	Value (variable length)	Scope
Basic CID pre-allocation TLV	variable	Basic CID allocated by potential target BS. If any of transport connection is not acceptable by the potential target BS, the Basic CID shall be followed by a bitmap to identify which transport connection is accepted or not.	MOB_BSHO-REQ MOB_BSHO-RSP

If the length is 2, the value field includes only Basic CID pre-allocated by the potential target BS and bitmap is not present. No bitmap means that all the active connections are accepted by the potential target BS.

If length is 3, value field include Basic CID pre-allocated by the potential target BS and 1byte bitmap. The bitmap means there is at least one transport connection which is not accepted at the potential target BS. For example, if the value is 11101111, the MS understand the fourth transport connection is not accepted at the potential target BS and need to setup new transport connection for this service flow at the potential target BS in actual handover. The transport connections are ordered by ascending order of transport CID number.

If length is 4, value field include Basic CID pre-allocated by the potential target BS and 2 byte bitmap. In order to indicate second and thirteenth transport connections are not accepted by the potential target BS, the bitmap should be 1011111111110111.

11.15.2.2 CID block pre-allocation

CID pre-allocation encodings field provides a Basic CID, an optional BITMAP for the acceptance indication of each transport connection if needed, and the first CID of a block of contiguous secondary/transport CIDs to be used at a potential target BS. Although one block may cover most cases, a target BS may have to allocate multiple blocks of secondary/transport CIDs. In this case, the first CIDs for each block (2 bytes) and the number of CIDs allocated in the corresponding block (1byte) shall appear. The CIDs encoded in this TLV are the ones allocated by the corresponding potential target BS via the backbone message exchange. An optional BITMAP

appears only if the service level prediction parameter value is “1” of the corresponding target BS. The length of BITMAP is variable as a multiple of 8 bits (e.g., 8 bits, 16 bits, etc) computed based on of the number of secondary/transport connections. For example, one byte BITMAP is used if the number of secondary/transport connections is less than or equal to 8, and two bytes are used if the number of secondary/transport connections is greater than 8 and less than or equal to 16, and so on. If the service level prediction parameter value is “2”, the bitmap is not encoded because all the connections are pre-allocated. If the service level prediction parameter value is “0” or “3”, CID pre-allocation TLV shall not be included in the MOB_BSHO-REQ or MOB_BSHO-RSP message.

Name	Type (1 byte)	Length (byte)	Value (variable length)	Scope
CID pre-allocation TLV	xx	variable	The first two bytes indicate the new Basic CID. Then, the optional BITMAP may follow if Service Level Parameter value is “1”. The BITMAP indicates each transport connection acceptance at the corresponding potential target BS. The n-th bit, starting from the MSB of the BITMAP is set to 1 when the n-th SFID is to be updated to a new CID where, the SFIDs are sorted with increasing order. Then, if one block is used, the first CID (i.e., starting point CID) of the block of the contiguous secondary/transport CIDs is encoded. If more than one CID blocks are used, each starting point CID of each block (2 bytes) and the number of CIDs per this block (1 byte) are encoded.	MOB_BSHO-REQ MOB_BSHO-RSP

[Include following parameter in line 14 on page 1072 as indicated:]

Name	Type (1byte)	Length	Value	PHY scope
Connection Identifier descriptor	155	2	MSB 11 bits = *m* (See Table 529) LSB 5 bits = *a* (number of reserved transport CIDs per an MS)	OFDMA

[Proposed Text Changes for Seucity: TBD]