	IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>
Title	**Reduced Neighbor Information Generation and Customized Delivery**
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Source(s)	Rakesh Taori, Misun Do [mail to: rakesh.taori@samsung.com] Samsung Advanced Institute of Technology Sungjin Lee, Hyunjeong Kang, Hyoung Kyu Lim, Jaeweon Cho, Panyuh Joo [mail to: sungjin.lee@samsung.com hk03.lim@samsung.com] Samsung Electronics 416, Maetan-3dong, Youngtong-gu, Suwon-si, Gyeonggi-do, South Korea Hun-Jae Yeon Yonsei University, 134 Sinchon-Dong, Seodaemun-Gu, Seoul, South Korea
Re:	Call for technical proposals regarding IEEE project P802.16j
Abstract	This contribution advocates that the relay stations should deliver their location information to the MMR-BS. Location information can be used to (a) compose reduced length neighborhood advertisement messages and (b) deliver customized information to different RS according to the RS neighborhood. New messages and the corresponding message formats are proposed that enable querying and delivering of the location information.
Purpose	Discussion and Adoption in IEEE 802.16j
Notice	
Release	

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Reduced Neighbor Information Generation and Customized Delivery

Rakesh Taori, Mi-Sun Do
Samsung Advanced Institute of Technology

Sungjin Lee, Hyunjeong Kang, Hyoung Kyu Lim, Jaeweon Cho, Jungje Son, Panyuh Joo
Samsung Electronics

Hun-Je Yeon
Yonsei University

Problem Statement

The introduction of fixed, mobile and nomadic relay stations in 802.16 based networks is likely to result in an increased number of neighbors of BS and the newly introduced RSs. This in turn means that the neighbor list containing the number of neighbors will be longer and the corresponding neighbor information, e.g. the information present in the MOB-NBR-ADV messages, is likely to become larger. It is therefore clear that the larger the number of neighbors, the longer the neighbor list, the larger the neighbor information message and therefore (a) the larger the overhead in distributing the neighbor information and (b) the longer it is likely to take an MS to scan the neighbors (increases scanning time which may result in higher power consumption).

Providing the base stations with information on the location of different relay stations can aid the BS in composing reduced and meaningful information customized to fit individual RS's neighborhood. There are two problems, however: The current 802.16 specifications do not provide the base station (BS) or a relay station (RS) with a standardized mechanism for querying and delivering the location information of other BSs and RSs. Besides facilitating composition of shorter messages related to neighborhood information, location information may also be quite helpful for purposes other than composing reduced neighbor information.

Secondly, the mechanism for delivering neighbor information is based on a broadcast delivery, there is no standardized mechanism defined by the specification to transmit customized (unicast) messages to a specific RS, for instance.

Suggested Remedy

In this contribution, we suggest mechanisms for (a) composing neighbor information messages that are shorter as well as customized to individual RS's needs and (b) messages that facilitate the composition of reduced information neighbor advertisements and customized delivery to RSs.

Accordingly, we propose

(a) Making location information of the neighboring access stations available to all access

stations.

(b) Specify the messages and the protocol that enables querying and delivering the location information

(c) Specify the message and protocol that facilitates customized delivery of neighbor information to any access station.

Proposed Text Change

[Insert new subclause 6.3.2.3.62:]

6.3.2.3.62 MMR_LOC-REQ message

The MMR_LOC-REQ message may be transmitted by an MMR-BS to an RS to request the location information of the RS. This message can also be transmitted by an RS to the MMR-BS to request the location of other RSs. The sender of the MMR_LOC-REQ message can include the identity of those access stations for which it wishes to know the location information. The MMR_LOC-REQ message shall be generated in the format shown in Table 1.

The MMR_LOC-REQ message can be set to any report type as specified in Table 1. When an RS sends the MMR_LOC_REQ message, the report type field shall be set to '00' (meaning non-periodic).

Syntax	Size	Notes
MMR_LOC-REQ_Message_Format() {		
Type = xx	8 bits	
Report Mode	2 bits	0b00: Once 0b01: Periodic 0b10: Event-triggered report 0b11 : *reserved*
Report period	8 bits	Available when the value of Report Mode is set to 0b01. Report period in frames.
Report Metric	4 bits	Bitmap indicating metrics on which the corresponding triggers are based: Bit 0: Change in RS location Bits 1~3: *Reserved*; shall be set to zero.
Coordinate Type	2 bits	Coordinate type to be used for location information 00: Geographic 01: Cartesian 10~11 : *reserved*
N_RS_index	8 bits	Number of stations for which the transmitter of this message wants to know the location information
For (j=0;j<N_RS_index; j++) {		
RS_ID	48 bits	
}		
}		

Table 1.MMR_LOC-REQ message format

The following parameters shall be included in the MMR_LOC_REQ message:

Report mode

Action code for an RS's report of location information:

0b00: The RS only sends a single response to the location request message.

0b01: The RS reports the location periodically

0b10: The RS reports the location after each event according to the defined triggers.

0b11: *Reserved*

Report period

The period with which RS reports the location information when the RS is required to report the value periodically.

Report metric

Bitmap indicator of trigger metrics that the serving BS requests the RS to report. Serving BS shall indicate only the trigger metrics agreed during RS network entry. Each bit indicates whether reports will be initiated by trigger based on the corresponding metric:
Bit 0: Change in RS location
Bits 1~3: *Reserved*; shall be set to zero.

Coordinate Type

The type of coordinate system that is requested to be used in the response message.

N_RS_index

Number of RSs whose location the receiver is requested to report.

RS_ID

Relay station identifier.

[Insert new subclause 6.3.2.3.63]

6.3.2.3.63 MMR_LOC-RSP message

The MMR_LOC-RSP message shall be transmitted in response to a MMR_LOC-REQ message. The transmitter sends MMR_LOC-RSP message based on the report mode indicated in the MMR_LOC-REQ message. The transmitter of this message shall generate the MMR_LOC-RSP message in accordance with the format shown in Table 2.

Syntax	Size	Notes
MMR_LOC-RSP_Message_Format(){		
Type = xx	8 bits	
Report Mode	2 bits	00: Once 01: Periodic 10: Event-triggered report 11 : *reserved*
Report Metric	4 bits	Bitmap indicating presence of certain metrics on which the corresponding triggers are based.
Coordinate Type	2 bits	Coordinate type used for reporting the location information 00: Geographic 01: Cartesian 10~11 : *reserved*
N_RS_index	8 bits	Number of stations whose location information is included in the current MMR_LOC-RSP message
For (j=0;j<N_RS_index;j++) {	variable	
RS_ID	48 bits	The RS_ID requested in MMR_LOC-REQ message.
Location information	48 bits	The location coordinates of the "j"th node according to the coordinate type
If (Report metric[Bit 0]==1)		
Location deviation	48 bits	
}		
padding	variable	Padding bits to ensure byte aligned.
}		

Table 2:MMR_LOC-RSP message format.

The following parameters shall be included in the MMR_LOC_RSP message:

Report mode

Action code for an RS's report of location information:
0b00: The RS only sends a single response to the location request message.
0b01: The RS reports the location periodically
0b10: The RS reports the location after each event according to the defined triggers.
0b11: *Reserved*

Report metric

Bitmap indicator of trigger metrics that the serving BS requests the RS to report. Serving BS shall indicate only the trigger metrics agreed during RS network entry. For each bit location, a value '0' indicates the trigger metric is not included, while a value of '1' indicates the trigger metric is included in the message. The bitmap interpretation for the metrics shall be:
Bit 0: Change in RS location
Bits 1~3: *Reserved*; shall be set to zero.

Coordinate Type

The type of coordinate system that is used in the response message.

N_RS_index

Number of RSs whose location the receiver responses.

RS_ID

Relay station identifier

Location information

The location coordinates of a RS according to the coordinate type.

According to Report metric that RS indicates, the MMR_LOC-RSP message may include the following parameter:

Change in RS location

The change in RS location parameter indicates the change in the location of the RS with respect to the previously reported location.

[Insert new subclause 6.3.2.3.64]

6.3.2.3.64 MMR_NBR-INFO message

The MMR_NBR-INFO may be transmitted by the MMR-BS to an RS or by any RS to its downstream RS. The message shall be transmitted on the primary management CID. It consists of the fields of MOB_NBR-ADV message and location related fields to transmit customized neighbor information for the receiver node. The message format for the MMR_NBR-INFO message shall be in accordance with Table 3.

Syntax	Size	Notes
MR_NBR-INFO_Message_format(){		
Management Message type = XX	8 bits	-
Skip-optional-fields bitmap	8 bits	-
If(Skip-optional-fields-[0]=0) {	-	-
Operator ID }	24 bits	Operator's Unique ID

Configuration Change Count	8 bits	Incremented each time
Fragmentation Index	4 bits	Current fragmentation index
Total Fragmentation	4 bits	# of total fragmentations
N_NEIGHBORS	8 bits	-
for (j=0; j<N_NEIGHBORS ; j++){	-	-
Length, PHY Profile ID, FA Index, BS EIRP, Neighbor BSID	56 bits	BS means BS or RS. The sender is also included in the neighbor list.
Preamble Index/Subchannel Index, HO Optimization, Scheduling Supported, DCD/UCD CFG Cnt,	32 bits	-
Neighbor station type	4 bits	0b0000: BS 0b0001: MMR-BS 0b0010~0b0011: reserved 0b0100: fixed RS, 0b0101: nomadic RS 0b0110: mobile RS 0b0111: reserved 0b1000~0b1111: reserved
Coordinate type	2 bits	Coordinate type of location information
Location information	48 bits	location coordinates of the neighbor station according to Coordinate type
TLV Encoded Neighbor info.	Variable	-
}	-	-
}		

Table 3:MMR_NBR-INFO message format

The parameters used in the MMR_NBR-INFO message that can be found in the MOB_NBR-ADV message are not described below. The remaining parameters are:

Neighbor station type
The type of neighbor station:
0b0000: BS
0b0001: MMR-BS
0b0010~0b0011: reserved
0b0100: fixed RS
0b0101: nomadic RS
0b0110: mobile RS
0b0111: reserved

0b1000~0b1111: reserved

Coordinate Type
The type of coordinate system that is used in report of the neighbor station.

Location information
The location coordinates of the neighbor station according to the coordinate type.

[Insert the following text at the end of 6.3.22.1.1]

The MMR-BS may obtain the information about the location of an RS in its own MMR cell by sending MMR_LOC-REQ messages to an RS. An RS may also obtain location information about other RSs by sending MMR_LOC_REQ message to the MMR-BS. Upon receiving the MMR_LOC-REQ message, the receiver shall transmit the location information using the MMR_LOC-RSP message.

Based on the received location reports, the MMR-BS and RS can compose MMR_NBR-INFO messages and send these messages to downstream RSs. The MMR_NBR-INFO is a customized, unicast message composed by the transmitter according the specific neighborhood of the receiving RS. It contains information about a subset of neighbors that are advertised in the MOB_NBR-ADV message received from the serving BS or an upstream RS. The subset is chosen based on the receiver of the MMR_NBR-INFO message. While composing the MMR_NBR-INFO message, the MMR-BS can additionally utilize the neighbor location information received from the neighboring BSs.

An RS, depending on its capability and depending on the messages that it receives, can choose between one of the following options in generating the MOB_NBR-ADV message:
(a) An RS can relay the MOB_NBR-ADV message received from the serving BS or an upstream RS..
(b) An RS can compose and broadcast a shorter MOB_NBR-ADV message by omitting information from the MOB_NBR-ADV message originally received from the serving BS or an upstream RS. It omits the information on the basis of that what it judges to be irrelevant for its service area.
(c) An RS can compose and broadcast a shorter MOB_NBR-ADV message by utilizing the information from MOB_NBR-ADV and MMR_NBR-INFO messages received from an upstream RS or a BS.

After generating the MOB_NBR-ADV message, the RS can broadcast the MOB_NBR-ADV message in its service area.

Composing a MMR_NBR-INFO is based on MMR_LOC-REQ and MMR_LOC-RSP message. Upon receiving an MMR_LOC-RSP message, a receiving access station can process each RS's location. One possible way to process the location information, described here for informative purposes, is for the access station to calculate a distance (d) and an angle (ω) with respect to its own position. Based upon the information. Based upon the information, the access station can store each neighbour's location in terms of distance and angle. An RS performs this operation according to its capability. y

[Insert the following text at the end of 6.3.2.3.7: REG-REQ message]

For an RS, the REG-REQ (on initial network entry) may contain the following TLV:
Location support (11.7.8.14)

[Insert the following text at the end of 6.3.2.3.8: REG-RSP message]

For an RS, the REG-RSP (on initial network entry) may contain the following TLV:
Location support (11.7.8.14)

[Insert new subclause 11.7.8.14: 11.7.8 SS capabilities encodings]

11.7.8.14 Location Support

Name	Type	Length	Value	Scope
Location Support	24	1	0 = no location support 1 = location support	REG-REQ REG-RSP

(Note: If there will be "RS capabilities encodings" in 11.7.27 then the Location Support TLV will be inserted in the new subclause 11.7.27.)

Informative Text with example usage of the location messages and protocols

Consider the situation when MS moves from the coverage of RS1 to the coverage area of RS2. In this example scenario, RS2 is a downstream access station for RS1.

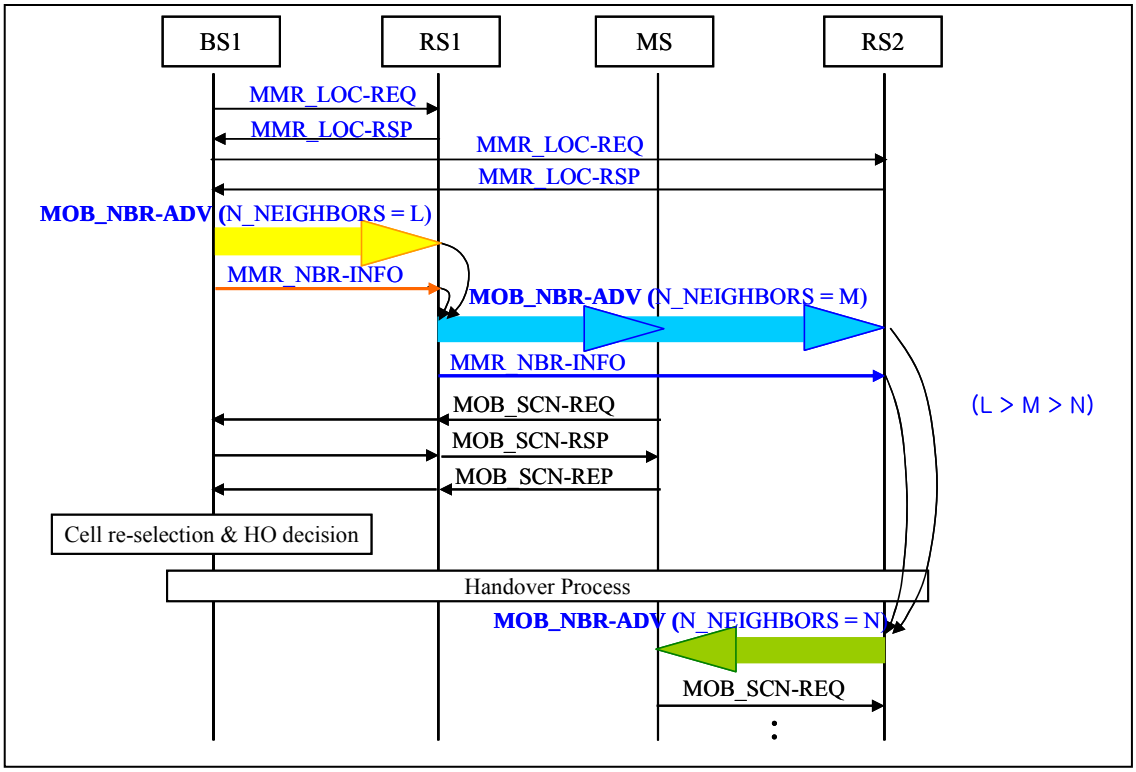

Figure 1: Message Sequence Chart illustrating the use of MMR_LOC-REQ/REP and MMR_NBR-INFO messages.

The message sequence chart shown in Figure 1, is an attempt to illustrate how the messages described above can be used. According to the message sequence charts, the BS requests the location of RS1 and RS2 using the MMR_LOC-REQ messages. RS1 and RS2 respond using the MMR_LOC_RSP message. The messages shown here are for illustration only. In practice RS1 and RS2 may send the MMR_LOC-RSP messages in accordance with the "report type" negotiated earlier between the BS and the RS. For instance, in case of a nomadic RS, the report may be periodic or event-triggered report.

The figure also shows that in addition to the MOB_NBR-ADV message that the BS1 would transmit, it can also transmit MMR_NBR-INFO message to RS1. This message would contain neighbor information that is customized according to the neighbourhood of RS1.

Based on the MMR_NBR-INFO (which is a customized neighbourhood information), RS1 can compose its own MOB_NBR-ADV messages which is likely to contain lesser neighbours than if it were to relay the complete list advertised by BS1. In the figure it is shown that the #neighbours in the MOB_NBR-ADV messages L is larger than the #neighbours in the MOB_NBR-ADV message transmitted by RS1. This is likely to have the effect that the MS has to perform a relatively lighter processing when composing the report for MOB_SCN-REQ message.