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Re:	This is in response to the call for proposal, 80216j-06_027.pdf, sent out by 802.16j TG.	
Abstract	This contribution proposes MRS Paging Group Update procedure that would support MS location update very efficiently.	
Purpose	Add proposed spec changes.	
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MRS Paging Group Update

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Introduction

In IEEE802.16e-2005 Std, an MS in Idle mode perform a Location update procedure if any of the Location update condition is met. There are four different location update conditions defined in the IEEE Std 802.16e-2005: Paging Group Update, Timer Update, Power Down Update and MAC HASH Skip Threshold Update. In the multi-hop relay system, there could be one or more RS in between the MMR-BS and MS. In addition, RS could be fixed, Nomadic and Mobile. Location update procedure needs to consider the involvement of RS in the procedure.

When Mobile RS moves along with its sub-ordinate MSs from one paging group area to another paging group area, all the sub-ordinate MS in idle mode detects the change in paging group and performs location update procedure almost simultaneously. This would increase the signaling load, congestion and contention on the access link and relay link. Resulting in failure of ranging procedures, and require sudden demand of extra bandwidth on the target MMR-BS. In multi-hop relay system, modification will be required to efficiently support MS location update via Mobile RS. This contribution proposes an efficient location update process for sub-ordinate MS attached to MRS. This behavior corresponds to the usage scenario where RS moves together with MS e.g. RS attached to Bus, ferry or train and MS's attached to Mobile RS.

This contribution analyzes the requirement of location update procedure for different RS type (Fixed, Nomadic and Mobile), proposes the new procedure for **Mobile RS Paging Group update** which will efficiently support MS location update in multi-hop replay system without requiring changes to MS. This contribution also specifies the required changes in the IEEE802.16-2004/IEEE 802.16e-2005 specifications.

RS Location update

There is no foreseen requirement for RS to support idle mode operation therefore no location update process is required for RS. However, similar to BS, RS could have its own PG_ID in some scenarios.

Fixed and Nomadic RS (FRS & NRS)

FRS and NRS either relay/rebroadcast the DCD/MOB_PAG_ADV messages received from MMR-BS/Upstream RS or they generate and broadcast their own DCD/MOB_PAG_ADV messages. In either case RS can transmit same or different PGID list as that of MMR-BS.

Impact on MS location update

MS attached to the MMR-BS via FRS/NRS follow the existing location update procedure as defined in IEEE Std. 802.16e-2005.

Mobile RS (MRS)

As mentioned above, it is not expected that mobile RS will have an idle mode. Therefore there is no requirement for Mobile RS to support location update procedure. It is expected that there could be many sub-ordinate MS attached to MRS. When MRS moves from one PG area to another, it would be possible that many attached idle mode sub-ordinate MS would initiate location update almost at the same time. This will create significant traffic load almost at the same time. This section describes the new procedure called “Mobile RS paging Group Update” procedure that will support the MS location update signaling very efficiently.

This section describes the following

- Mobile RS paging group update procedure between MMR-BS and MRS
- Efficient Location update procedure for subordinate MS attached to MRS.

Mobile RS paging group update

MRS shall perform the paging group update procedure with MMR-BS when the MRS detects a change in paging group. MRS shall detect the change of paging group by monitoring the paging group identifier, PG_ID, which is transmitted by the preferred MMR-BS in the DCD message or MOB_PAG_ADV broadcast message. If the PG_ID detected does not match the Paging Group to which MRS belongs, the RS shall perform the Paging Group update procedure with MMR-BS by exchanging RNG_REQ/ RNG_RSP messages. Figure 1 shows the example view of PG and path of MRS through different PG area.

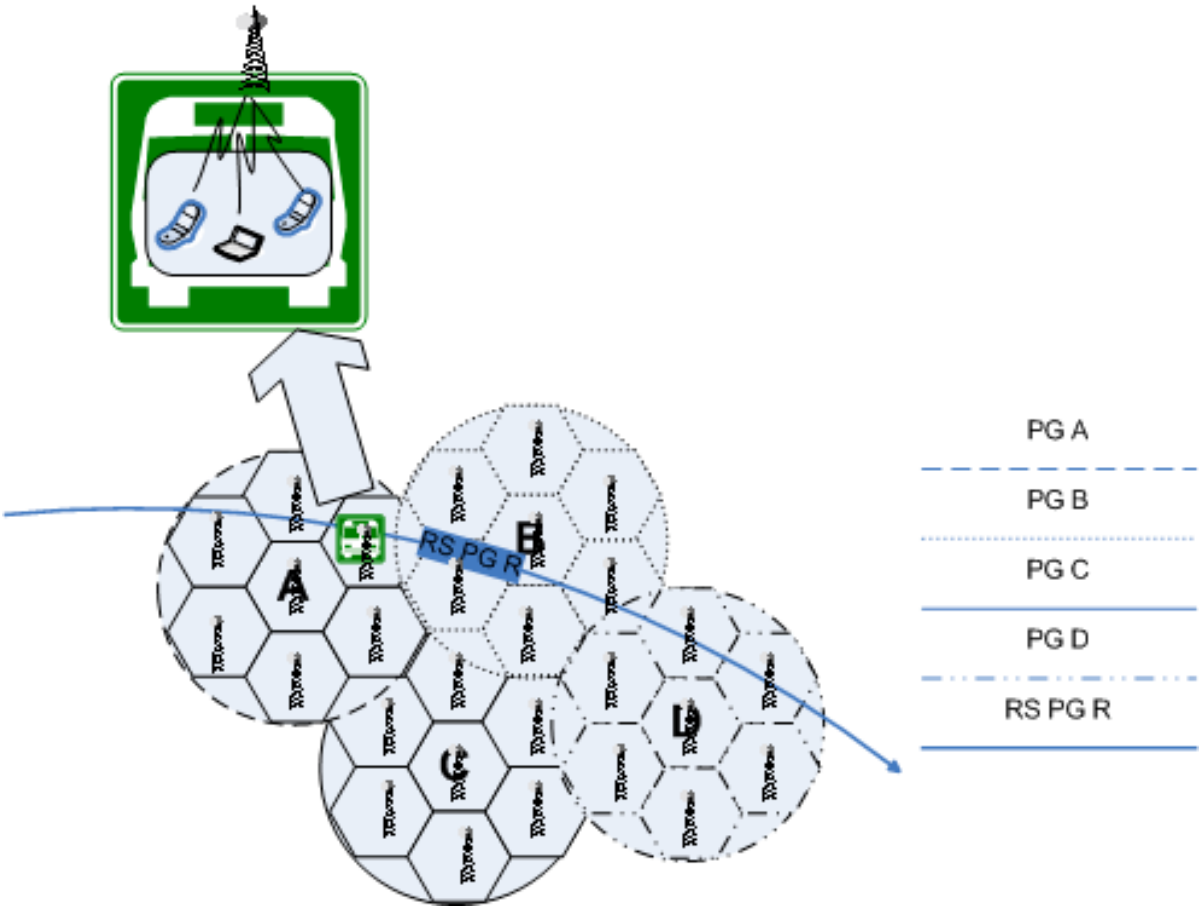

Figure 1: Example view of PG and path of MRS through different PG area

When MRS enters into the new PG area and detect the change in PG_ID, MRS will send RNG_REQ message with RS PG_ID to MMR-BS requesting MMR-BS to add RS' own PG_ID (RS PG_ID) to the current PG_ID list that is being transmitted by the MMR-BS and all other MMR-BS's in the new Paging Group area. Upon receipt of RNG_REQ message, if MMR-BS decides to add RS PG_ID to its PG_ID list; MMR-BS using backbone network, exchange (multicast) messages with other BS's in its Paging Group area to add the RS PG_ID to their PG_ID list. Upon successful addition of RS's PG_ID in the PG_ID list of MMR-BS's, Target MMR-BS transmit RNG_RSP message to MRS with result code = Success otherwise it will transmit the same message with result code = Failure. This procedure ensures that MMR-BS or other network entity e.g. Paging Coordinator (PC) knows the location of MRS.

While above procedure between MRS and MMR-BS is ongoing, Depending upon the MRS capability, it will either keep modifying DCD and/or MOB_PAG_ADV messages by adding its own PG_ID in the PG_ID list or block the transmission of DCD and MOB_PAG_ADV message. When MRS receives RNG_RSP, it will stop modifying or blocking these broadcast messages. Figure 2 describes the message interaction between MMR-BS, MRS and sub-ordinate MSs. Modifications are shown in RED *italic*.

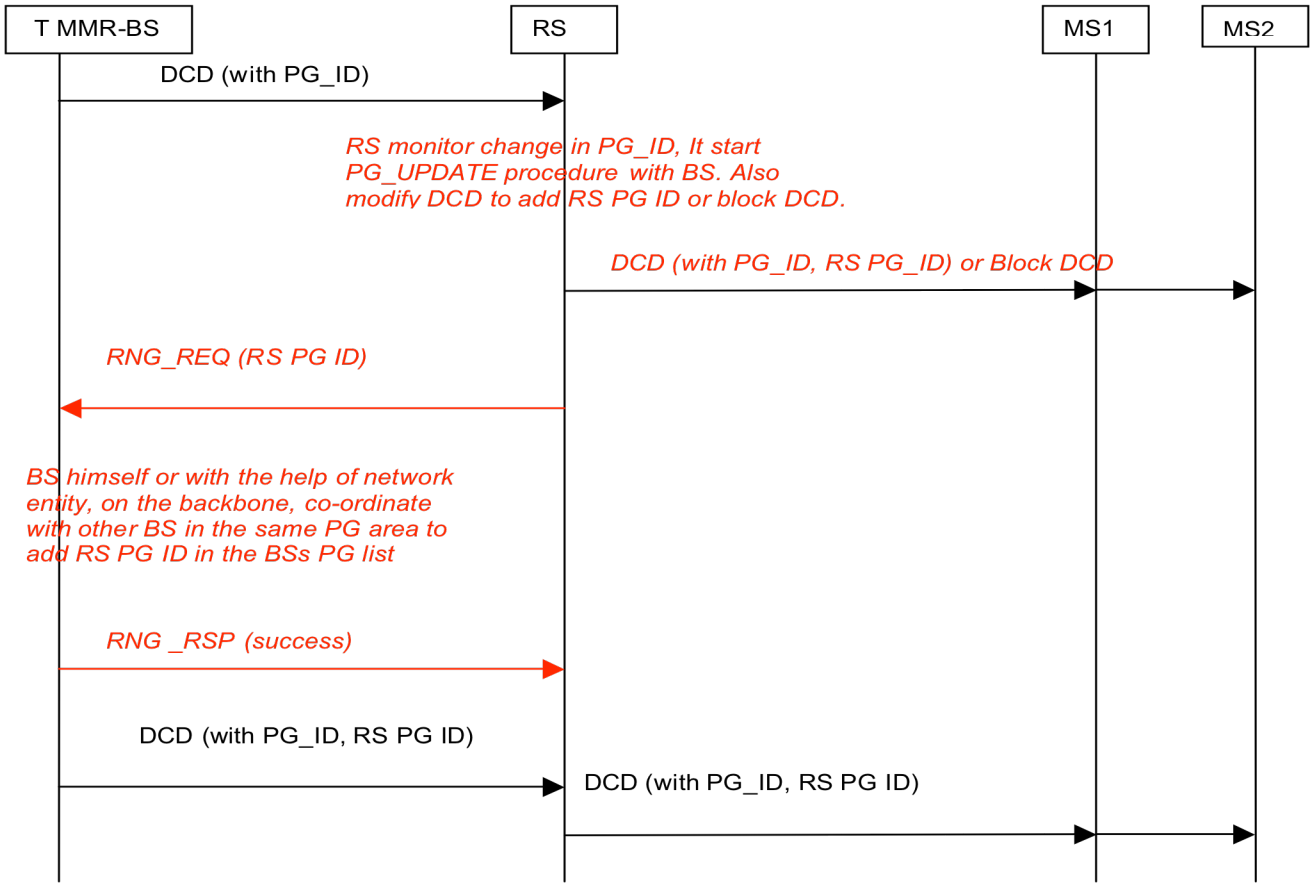

Figure 2: Message sequence for the proposed MRS Paging Group Update process

When MMR-BS or any other network entity add the RS PG_ID in the PG_ID list of the MMR-BSs in new Paging Group area, it also remove the RS PG_ID from the PG list of MMR-BSs in the old Paging Group in order to avoid unnecessary transmission of RS PG_ID from the MMR-BS's in old Paging Group area.

Granularity of initiating RS Paging Group Update Procedure can be configurable depending upon the signaling load, network policy etc. MRS can perform RS Paging Group Update procedure either when MRS crosses PG area boundary or when MRS crosses MMR-BS/RS coverage boundary.

Impact on Location update for subordinate MS

When MS enters in to the MRS coverage, its PG_ID will be different from MRS PG_ID. When MRS crosses the PG Area boundary, it will perform the procedure as defined in section [Mobile RS paging group update]. However, MS whose PG_ID is different from MRS PG_ID will still initiate location update procedure. This contribution proposes that when sub-ordinate MS perform the location update procedure as defined in IEEE 802.16e Std with MMR-BS via MRS, BS or other network entity e.g. PC provide new PG_ID to sub-ordinate MS which is same as RS_PG_ID in RNG_RSP (location update response).

Now onward, as long as sub-ordinate MS's moving along with MRS, only MRS will perform the Paging Group update procedure as defined in section [Mobile RS paging group update]. MS will not be required to perform location update procedure when crossing the Paging Group area boundary. This proposed scheme requires only MRS paging group update procedure and no sub-ordinate MS location update procedure. This MRS Paging Group Update procedure will take care of sub-ordinate MS location update through MRS. This scheme efficiently supports MS location update and significantly reduces the signaling load, congestion and contention in the access and relay link.

Advantages

The proposed MRS Paging Group Update procedure has the following advantages:

- Spectrally efficient signaling by minimizing the number of location update attempt.
- Congestion is reduced and distributed on the multiple BS-RS and RS-MS link.
- Reduces the overall latency for MS location update into the network via RS because of low congestion.
- Probability of loosing paging messages for MS during transition period is lower.
- Required very minimum changes on the air interface (one TLV in both RNG_REQ and RNG_RSP)

Specs changes for MRS Paging Update Procedure

Insert following statement at the end of the paragraph 3, which is located just above the figure 130i.

FRS and NRS may have same or different Paging Groups compared to controlling MMR-BS. MRS shall be assigned one or more Paging Groups, which shall be different from MMR-BS.

Insert following sections/subsection in new sub clause in 6.3.24 MS Idle Mode (Optional) section

6.3.24.10 MRS Paging Group Update

This process is only applicable to MRS. In principle, triggers and process for MRS Paging Group Update is similar to MS location update. However, MS location update is performed in idle mode where as MRS does not have idle mode. Paging Group update is performed anytime when MRS detects change in Paging Groups.

MRS shall perform the paging group update procedure with MMR-BS when the MRS detects a change in paging group. MRS shall detect the change of paging group by monitoring the paging group identifier, PG_ID, which is transmitted by the preferred BS in the DCD message or MOB_PAG_ADV broadcast message. If the PG_ID detected does not match the Paging Group to which MRS belongs, the RS shall perform the Paging Group update process with MMR-BS. MRS Paging Group update would take care of MS location update through MRS.

6.3.24.10.1 Paging Group Update process

If MRS determines to update its location, depending on the security association the MRS shares with the target MMR-BS, the MRS shall use one of the two processes: Secure MRS Paging Group Update Process or Unsecured MRS Paging Group Update Process.

6.3.24.10.1.1 Secure Paging Group Update process

If the MRS shares a valid security context with the target BS such that the MRS may include a valid HMAC/CMAC Tuple in the RNG-REQ, then the MRS shall conduct initial ranging with the target BS by sending a RNG-REQ including Ranging Purpose Indication TLV with Bit #2 set to 1, Paging Group Update Request and RS Paging Group ID TLVs and HMAC/CMAC Tuple. If the target BS evaluates the HMAC/CMAC Tuple as valid and can supply a corresponding authenticating HMAC/CMAC Tuple, and wants to add RS PG_ID to its PG_ID list based on the policy out of the scope of standard, target BS may exchange backbone messages with the other BSs in its PG to request the addition of RS PG_ID to their PG_ID list. Upon successful response from all of the BSs, the target BS shall reply with the RNG-RSP including the Paging Group Update Response TLV and HMAC/CMAC Tuple completing the Paging Group Update process. If the target BS responds with a successful Paging Group Update Response=0x01, Success of Paging Group Update, the target BS shall notify the Paging Controller via the backbone of the MRS new location information, and the Paging Controller may send a backbone message to inform the BSs to which the MRS was earlier attached that the MRS has transitioned to a different Paging Group. If the target BS evaluates the HMAC/CMAC Tuple as invalid, cannot supply a corresponding authenticating HMAC/CMAC Tuple, or otherwise elects to direct the MRS to use Unsecured Paging Group Update, then the target BS shall instruct the MRS to continue network re-entry using the Unsecured Paging Group Update process by inclusion of Paging Group Update Response TLV in RNG-RSP with a value of 0x00= Failure of Paging Group Update.

6.3.24.10.2 Unsecured Paging Group Update process

For an MRS and target BS that do not share current, valid security context, they shall process Paging Group Update using the Network Re-Entry.

6.3.24.11 Network Re-Entry for MRS Paging Group Update

For the Network Re-Entry, the MRS shall initiate network re-entry with the target BS by sending a RNG-REQ including Ranging Purpose Indication TLV with Bit #2 set to 1, Paging Group Update Request and RS Paging Group ID TLVs

If the MRS shares a valid security context with the target BS such that the MRS may include a valid HMAC/CMAC Tuple in the RNG-REQ, then the MRS shall conduct initial ranging with the target BS by sending a RNG-REQ including HMAC/CMAC Tuple.

If MRS RNG-REQ includes a Ranging Purpose Indication TLV with Bit #2 set to 1 and Paging Group ID TLVs, and target BS had not previously received MRS information over the backbone, then target BS may make an MRS information request to Paging Controller over the backbone network and Paging Controller may respond. Regardless of having received MRS information from Paging Controller, target BS may request MRS information from another network management entity via the backbone network.

Network re-entry proceeds per 6.3.9.5 except as may be shortened by target BS possession of MRS information obtained from Paging Controller or other network entity over the backbone network. Rest of the network entry procedure for MRS is similar to MS as defined in section 6.3.24.9.

6.3.2.3.5 Ranging request (RNG-REQ) message

Insert following text at the end of this section

The following parameter shall be included in the RNG-REQ message when the RS is attempting to perform Paging Group Update:

RS MAC Address

RS MAC Address shall be included

Ranging Purpose Indication

Presence of item in message indicates RS action as follows:
If Bit #2 is set to 1, in combination with RS Paging Group ID indicates the RS is currently attempting to Paging Group Update process

Paging Group ID (16 bit)

One or more logical affiliation grouping of MRS (see 6.3.2.3.56)

The following parameter may be included in the RNG-REQ message when the RS is attempting to perform Paging Group Update and the RS has a valid HMAC/CMAC Tuple necessary to expedite security authentication.

HMAC/CMAC Tuple (see 11.1.2)

The HMAC/CMAC Tuple shall be the last attribute in the message.

6.3.2.3.5 Ranging Response (RNG-RSP) message

Insert following text at the end this section

When a MMR-BS sends RNG-RSP message in response to a RNG-REQ message containing MRS Paging Group ID, the MMR-BS shall include the following TLV parameter in the RNG-RSP message:

Paging Group Update Response
Response to Paging Group Update Request:
0b00=Failure of Paging Group Update. The MRS shall perform Network Re-entry
0b01=Success of Paging Group Update
0b10, 0b11: Reserved

11.5 RNG-REQ message encodings

Modify/add the following rows into Table 364:

Table 364—RNG-REQ message encodings

Ranging Purpose Indication	6	1	Bit #0: HO indication (when this bit is set to 1 in combination with other included information elements indicates the MS is currently attempting to HO or Network Re-entry from Idle Mode to the BS) Bit #1: Location Update Request (when this bit is set to 1, it indicates MS action of Idle Mode Location Update Process) Bit #2: MRS Location Update Request Bits 3-7: Reserved
Paging Group ID	35	2	MRS Paging Group ID.