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Re:	IEEE 802.16j-07/007r2:"Call for Technical Comments and Contributions regarding IEEE Project 802.16j"
Abstract	This contribution proposes a neighborhood discovery/measurement mechanism and the corresponding message for fixed/nomadic RS in IEEE 802.16j MR network.
Purpose	For TG members to adopt the proposed messages and the supporting text into the IEEE 802.16j baseline document.
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Neighborhood Discovery and Measurement for Fixed/Nomadic RS in IEEE 802.16j Multi-hop Relay Network

This contribution proposes an RS neighborhood discovery/measurement mechanism for fixed/nomadic RS in IEEE 802.16j Multi-hop Relay network. Based on this proposal, MR-BS will instruct the RSs to transmit the RS-amble in the relay zone at the designated time when necessary. Then the RSs will report its neighbor discovery/measurement results to MR-BS. When fixed/nomadic RSs are deployed in the MR network, this mechanism may not be initiated very often. The overhead can be saved by preventing unnecessary RS-amble transmission in relay zone.

I. The concept of the proposed neighborhood discovery/measurement mechanism

According to the IEEE 802.16j frame structure, an RS neighborhood discovery mechanism is proposed here to synchronize the RS-amble transmission and measurement for RS and MR-BS in relay zone, which is shown in Figure 1. Figure 1(a) represents an example of the messaging procedure, and Figure 1(b) illustrates the way to synchronize the start point of each station. Figure 1(c) represents the flexibility it can perform. In order to support this RS neighborhood discovery operation, the corresponding message design will be proposed in next

section.

In Figure 1(a), the MR-BS sends the multicast message RS_NBR-MEAS-REQ to the RSs, where the RS_1, RS_2 and RS_3 are within the multicast group in this example. In this message, the 8 LSB bits is used to identify the serial number of the frame where the amble transmission and measurement procedure is initiated. The N_Transmitter and N_Receiver_RS will instruct the RSs with the subsequent Amble Indexes to transmit or receive the amble. N_Transmitter=2 and N_Receiver_RS=1 in Figure 1(a) respectively, which means the first two Amble Indexes after the parameter 'N_Receiver_RS' are instructing the RSs to transmit its amble, and the subsequent one Amble Index is instructing RS with this index to receive. Therefore, the amble transmission and measurement can be synchronized to the same time as shown in Figure 1(b).

In the proposed RS_NBR-MEAS-REQ message, the OFDMA Symbol Offset will be removed if the amble transmitted by each RS in relay zone will be fixed all the time. For the station being instructed to receive (i.e. RS_3 in this example), it shall scan the amble transmitted over each segment at the designated OFDMA symbol time. In addition, this message can instruct the amble repetition and continuous measurement opportunities in multiple frames by setting the Measurement Duration, Interleaving Interval and Measurement Iteration, which is shown in Figure 1(c).

After the measurement, the RS shall report the measurement results associated to those amble indexes of transmitter RSs by the RS_NBR-MEAS-REP message. The measurement results can be either RSSI or CINR, which depends on the instruction by RS_NBR-MEAS-REQ.

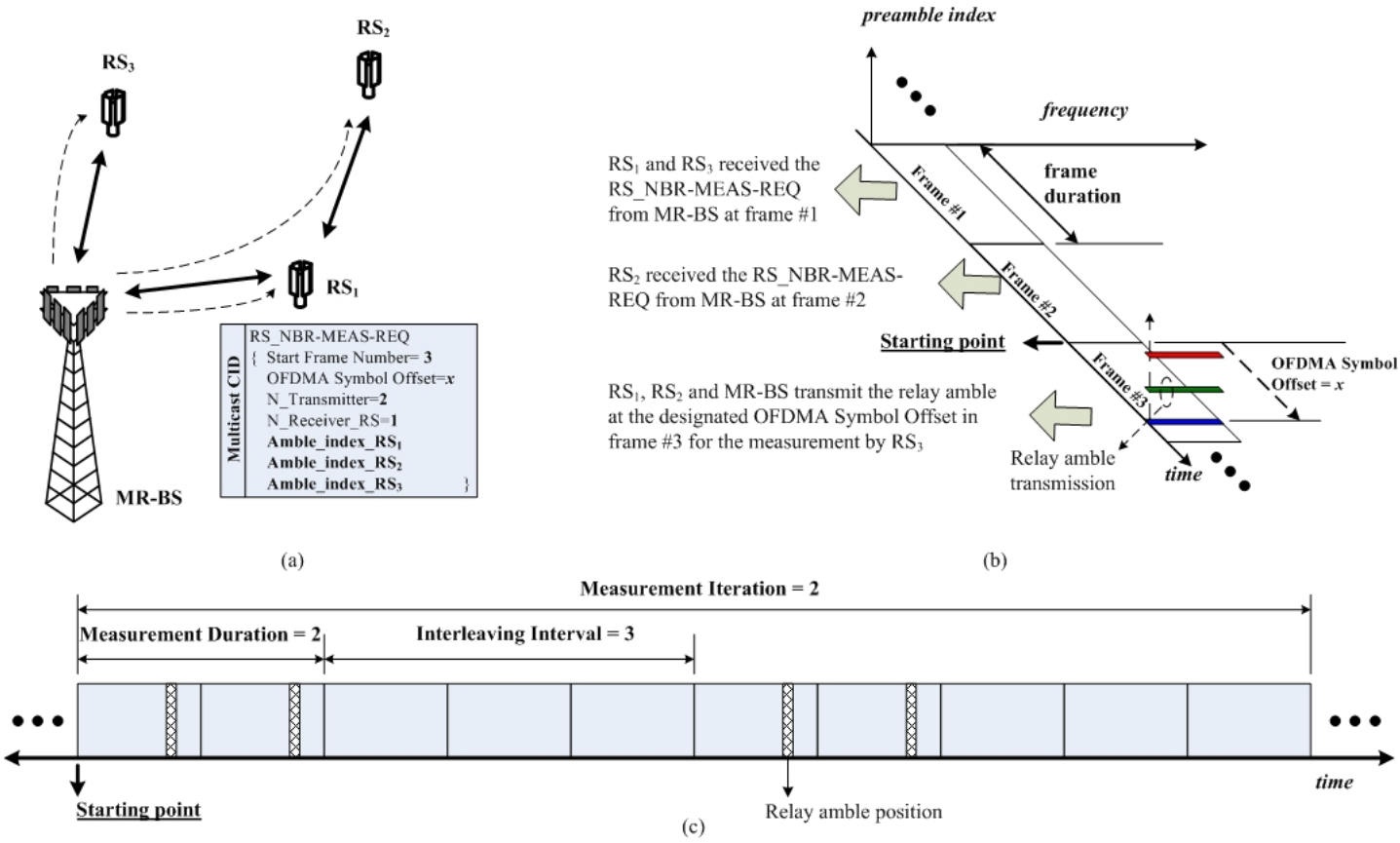

Fig.1 Proposed measurement mechanism: (a) an example of messaging procedure, (b) the position for RS-amble transmission and (c) the layout of the measurement opportunities

Moreover, the proposed mechanism can also be applied for the measurement across different MR-cell. In Figure 2, the RS_1 and RS_2 are located in different MR-cell and be instructed to transmit and receive the amble respectively. The frame index used in each cell is usually different, therefore, the 8 LSB bits Start Frame Number sent by each cell may be different. In order to ensure the transmission and reception time will be

aligned across different cell, a network coordinator may be needed to record the offset between the frame number indexes used in each cell. Since each MR-cell is synchronized with each other, the offset between each cell will be fixed. Therefore, the coordinator can instruct each MR-BS to compose the RS_NBR-MEAS-REQ message with the corresponding Start Frame Number which will align at the same time.

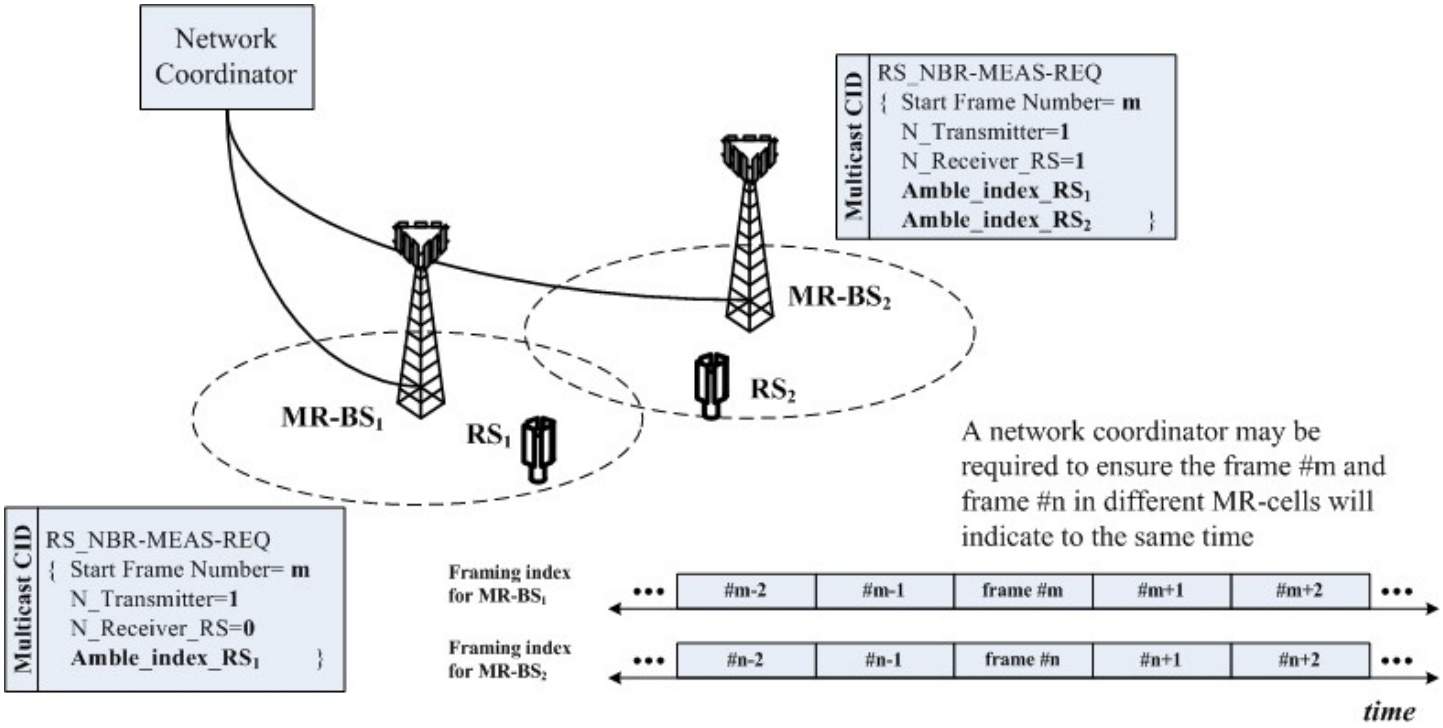

Fig.2 A network coordinator can be used to ensure the amble transmission and measurement will aligned to the same time

According to this mechanism, the MR-BS can compose the neighbor list of MOB_NBR-ADV based on the measurement results. In addition, the MR network can also predict the radio link quality in advance of allocating (reusing) the radio resources or reconfiguring its network topology based on this measurement results, so that the network management can be performed in an automatic manner.

II. Text proposal

----------Start of the text----------

Insert new subclause (6.3.2.3.62)

6.3.2.3.~~62~~ 65 RS ~~neighborhood measurement~~configuration request (RS_~~NBR-MEAS~~Config-REQ) message

The MR-BS can send a RS_~~NBR-MEAS~~Config-REQ message to instruct the RSs to transmit or receive the R-amble ~~neighborhood discovery and measurement~~ in relay zone.~~ ~~This message ~~is~~ can be sent by either~~the~~ unicast, multicast or broadcast CID of~~to include~~ the RSs~~ involved in this mechanism~~. An 8 LSB bits of the frame number index will indicate the starting point of the subsequent R-amble transmission/reception

opportunities. In order to instruct the stations in different MR-cell to transmit/receive the R-ambles at the same time, a coordinator in backhaul network is needed to ensure the Start Frame Number in the message sent by different MR-BSs will align to the same time.

When the Prefix is set as "00", the RS shall follow the pattern instructed by MR-BS to transmit/receive the R-amble in relay zone. The pattern is composed by the amble index, and the RS shall transmit/receive the R-amble according to the field where its amble index is. The transmission opportunities are identified by Duration and Interleaving Interval for each iteration. An example is given in Figure x, where the Duration = 2, Interleaving Interval = 3 and the Iteration = 2. When the Iteration is more than one, the pattern for each iteration will be carried in this message. After the last iteration, the RSs shall report the measurement results by RS_NBR-MEAS-REP message defined in 6.3.2.3.63.

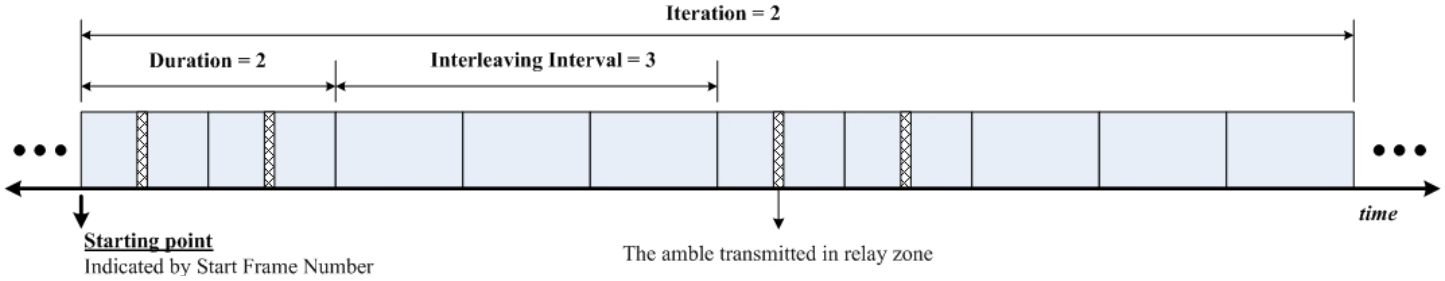

Figure x – Instructing the R-amble transmission in relay zone by RS_NBR-MEAS-REQ

If the Prefix is set "01", the RS will autonomously transmit/receive the R-amble in relay zone without periodic instruction from MR-BS. The detail design of the associated parameters is stated in 6.3.x.x. The RS is instructed to report its measurement results if the Prefix is set as "10". When the RS is instructed to transmit/receive the R-amble transmission autonomously, MR-BS can instruct the RS to report its measurement results by this message with the prefix set as "10". ~~When an RS receiving this message with its amble index in the receiver list, it shall measure the amble over the designated Frame Number Offset and the Start Frame Number in downlink; and it shall transmit the amble if its amble index in the transmitter list. Note that the Report Request TLV is defined in 11.11.~~

Syntax	Size	Notes
RS_~~NBR-MEAS~~Config-REQ_Message_Format() {		
Management Message Type = TBD	8 bits	
Start Frame Number	8 bits	8 LSB bits of the frame number
Duration	8 bits	Units are frames
OFDMA Symbol Offset	8 bits	The DL OFDM symbol location to scan the R-amble (If the R-amble location is always fixed, then this field shall be removed from this message)
~~Measurement Duration~~	~~8 bits~~	~~Units are frames~~
~~Interleaving Interval~~	~~8 bits~~	~~Units are frames~~
Prefix	2 bits	00: The R-amble transmission and reception is instructed by MR-BS.

		01: The R-amble transmission and measurement shall be performed autonomously. 10: The RSs shall report its neighbor measurement results. 11: *reserved*
If (Prefix == 00){		
Interleaving Interval	8 bits	Units are frames
~~Measurement~~ Iteration Number	8 bits	Units are frames
~~OFDMA Symbol Offset~~	~~8 bits~~	~~The DL OFDM symbol location to scan the reference signal. (If the Amble location is always fixed, then this field shall be removed from this message.)~~
N_stations	8 bits	Number of stations received this message
For (j=0, j< Iteration, j++){		
N_Transmitter	8 bits	Number of stations to transmit the ~~amble~~R-amble
~~N_Receiver_RS~~	~~8 bits~~	~~Number of RS to receive the amble~~
For (i=0, i< N_Transmitter , i++){		
Amble Index	8 bits	The RS with the amble index in this list shall transmit the ~~amble~~R-amble
}		
For (j=0, j< N_stations - N_Transmitter ~~N_Receiver_RS~~ , j++){		
Amble Index	8 bits	The RS with the amble index in this list shall receive the ~~amble~~R-amble
}		
}		
}		
If (Prefix == 01){		
Config_type	3 bits	Bit [0] = 1: R-amble for synchronization is present. Bit [0] = 0: R-amble for synchronization is not transmitted. Bit [1] = 1: R-amble for random monitoring is present; Bit [1] = 0: any current monitoring operation is to be stopped by all RSs. Bit [2] = 1: any RS which does not support subordinate RSs should transmit the R-amble for advertisement purpose Bit [2] = 0: any RS which does not support subordinate RSs should not transmit the R-amble.
If(b0 of Config_type =1){		
Synchronization cycle	8 bits	N, Units are frame (see subsection

		8.4.6.1.1.3.1)
Synchronization frame offset	4 bits	Ks, Units are frame (see subsection 8.4.6.1.1.3.1)
}		
If(b1 of Config_type =1){		
Neighbor monitoring cycle	4 bits	M, Units are frame (see subsection 8.4.6.1.1.3.2)
Neighbor monitoring frame offset	4 bits	Kn, Units are frame (see subsection 8.4.6.1.1.3.1)
Neighbor monitoring frame repetition	8 bits	L, Units are frame (see subsection 8.4.6.1.1.3.1)
}		
}		
Report Request	1 bit	0: RSSI 1: CINR
}		

Start Frame Number

The RS shall start transmitting/receiving the ~~amble~~R-amble ~~at~~ from this designated frame number

~~Measurement~~ Duration

Duration (in units of frames) of the consecutive R-amble transmission/reception opportunity~~the requested~~. If the Duration value is set to 0x00 and prefix is 0b01 monitoring is to be continued until further notice ~~neighborhood measurement period~~

Interleaving Interval

The period (in units of frames) which is interleaved between the ~~Measurement Durations~~consecutive R-amble transmission/reception opportunity

~~Measurement~~ Iteration

The requested number of iterating ~~measurement~~ intervals

N_Transmitter

Number of stations instructed to transmit ~~amble~~R-amble, the station may be RS or MR-BS.

N_Receiver_RS

Number of RSs instructed to receive ~~amble~~R-amble

Amble index

~~Amble~~R-amble means preamble, midamble or postamble transmitted in relay zone. It will be determined by ~~amble~~R-amble location in downlink relay zone.

Synchronization Cycle Length

This field is used to indicate the synchronization R-amble period if present

Synchronization Frame Offset
The offset of the second R-amble in the synchronization cycle

Neighbor Monitoring Frame Repetition Rate
This field is used to indicate the neighbor monitoring R-amble period if present

Neighbor Monitoring Frame Offset
The offset of the R-amble in the neighbor monitoring cycle

Neighbor Monitoring Cycle Length
This defines the number of neighbor monitoring amble frames in an R-amble monitoring cycle

Insert new subclause (6.3.2.3.63)

6.3.2.3.~~63~~ 66 RS neighborhood measurement report (RS_NBR-MEAS-REP) message

Syntax	Size	Notes
RS_NBR- MEAS -REP_Message_Format() {		
Management Message Type = TBD	8 bits	
N_Amble_Index	8 bits	Number of amble indexes
Begin PHY Specific Section {		
For (i=0, i<N_Amble _Index, i++){		
Amble Index	8 bits	
Report Response TLVs	Variable	TLV specific
}		
}		
}		

The RS_NBR- MEAS -REP shall contain the Report Response TLV (define in 11.11 REP-RSP management message encodings).

Amble index
Amble means preamble, midamble or postamble. It will be determined by amble location in downlink relay zone.

Insert a the following text into 6.3.26

6.3.26 Relay station neighborhood discovery

When a RS newly deployed into a MR network, it can act as a SS/MS and scan the preamble transmitted by the existing stations before network entry. The RS can report its initial neighborhood discovery and measurement results to MR-BS by RS_NBR-MEAS-REP (6.3.2.3.6366). The neighboring station list may be instructed by MR_NBR-INFO (6.3.2.3.63). Because not every RS will transmit preamble or transmit its own preamble and the existing RSs in MR network need to perform measurement over the new RS, MR-BS can instruct the RSs to perform complete neighborhood discovery by following procedure:

First, the MR-BS sends the RS_NBR-MEASConfig-REQ message to the RSs which will be involved in the neighborhood discovery mechanism, and the message is either sent by the broadcast CID, or multicast CID or unicast CID for these RSs. The Start Frame Number is the 8 LSB bits of frame number shall be set to instruct the starting time to the RSs. If the RSs involved in this mechanism are in different MR-cell, each of the Start Frame Number sent by different MR-BSs shall synchronize to the same frame time. The Prefix shall be set "00" and attach the transmit/receive pattern for each iteration.

Second, the neighbor stations follow the instruction to transmit/receive the ambleR-amble at the designated frames and OFDMA symbol offset for the measurement by target RS in each iteration.

Third, the target RSs reports the RSSI or CINRmeasurement results with corresponding amble index by RS_NBR-MEAS-REP to MR-BS.

Note that this mechanism can also be applied to the RSs during normal operation. So that the R-amble can be transmitted in relay zone when necessary.

Insert a new subclause 6.3.27.1

6.3.27.1 Interference prediction by RS neighborhood measurement

In order to predict the interference or SINR of the radio links for different MR network topology and radio resource reuse pattern, the following prediction method can be considered based on the RSSI reported by RS_NBR-MEAS-REP message (see 6.3.2.3.63).

1. Prediction of the interference plus noise power received by node #*i*: The interference can be the summation of (1) the thermal noise plus background interference power received by node #*i* and (2) the signal power not intended to be received by node #*i* but transmitted by the same radio resource.
2. Prediction of the received SINR of node #*i*: The SINR can be the ratio of "the total signal power destined to node # *i*" to "the interference plus noise power obtained in Step 1".

----------End of the text----------

III. References

[1] C802.16j-07/43r4, “RS Neighborhood Discovery and Measurement for IEEE 802.16j Multi-hop Relay Network.”

[2] C802.16j-07/139, “Reduced Neighbor Information Generation and Customized Delivery.”