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Title	Relay-Station Preamble Segment Assignment/Re-Assignment Scheme
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Re:	Call for Technical Proposals regarding IEEE Project P802.16j (IEEE 802.16j-06/027)
Abstract	This contribution proposes relay-station preamble segment assignment/ re-assignment scheme in order to eliminate the system interference during the initial RS network entry and RS in moving.
Purpose	Propose the text regarding relay-station preamble segment assignment for multi-hop relay
Notice	
Release	
Patent Policy and Procedures	

Relay-Station Preamble Segment Assignment/Re-Assignment Scheme

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1. Introduction

The initial network entry process for MS to BS is listed in IEEE Std. 802.16-2004 & 802.16e-2005. In the frame structure, the first OFDMA symbol of the downlink transmission is preamble. There are three types of preamble carrier-sets and they are defined by allocation of different subcarriers for each one of them. Each segment uses a preamble composed of a carrier-set out of the three available carrier-sets in the following manner: segment 0 uses preamble carrier-set 0, segment 1 uses preamble carrier-set 1, and segment 2 uses preamble carrier-set 2. In the DL (DownLink) PUSC (Partial Usage of Subchannels) mode, any segment used in the preamble shall be allocated at least one group (default is 12 subchannels in case of OFDM-2048) in the DL First Zone that contains FCH and DL-MAP. The default allocated subchannel sets for segments 0, 1, 2 are subchannels 0-11, 20-31, and 40-51, respectively. For example, when segment 0 is detected in the DL preamble of the frame structure, the immediately followed First Zone PUSC (i.e., FCH and DL-MAP) messages shall use at least 12 subchannels 0-11 to encode the FCH and DL-MAP control signaling. Note that the First Zone PUSC subchannel does not have the DL permutation applied to protect the subchannel interference.

In the MR-BS enabled system, a RS can be turned on at anytime/anywhere and with mobility. If the RS overlaps in coverage with its neighboring RSs/BSs and the same segment values are used, than in this situation may cause co-channel interference and MS/SS (mobile station/subscriber station) can not decode the Cell-ID and control message such as FCH and DL-MAP signals. In order to eliminate the interference, we propose RS preamble segment assignment/re-assignment methods during the initial RS network entry and RS in moving.

2. Initial RS Preamble Segment Configuration

In order to perform the initial RS preamble segment configuration, the following two steps may be considered.

2.1 Initial RS Neighboring Detection

This specification defines a relay station function that enables RS neighbor detection at initial network entry. For instance, a RS powered on in a MR-BS coverage area shall perform the initial network entry with MR-BS and try to register to the MR-BS via initial ranging. In the initial phase, the RS acts as a MS/SS, and informs the BS that it has relay capabilities, thus at this point it is only a potential (candidate) RS, not an enabled RS. After the network entry, BS requests the potential RS to scan its neighboring and search for preambles for all three possible segments or using another mechanism such as, by embedding into the frame structure a specific RS signature signal that is transmitted at well-known time instants, with periodic scanning of RS signature signal transmission, the RS can detect the presence of the RSs in its coverage area, and can inform the BS about the detection results. In general, the preamble transmits 9dB more energy than the normal data signal energy. The preamble coverage radius is larger than the normal control/data signal coverage radius, as can be seen from Figure 1. The potential RS reports all the detected neighboring preambles to the BS. If the potential RS is able to detect a neighboring preamble signals above a pre-defined threshold value (threshold value is implementation dependent), than the control signal coverage between the potential RS and the neighboring RS/BS may be overlapped, and these control signals (i.e., FCH and DL-MAP signals) can cause co-channel interfere to the serving MS/SS. Therefore, it is advisable for the BS to assign a different segment value to the potential RS such that the co-channel interference that a MS detects is minimized. The initial RS preamble segment assignment for the potential RS is discussed subsequently.

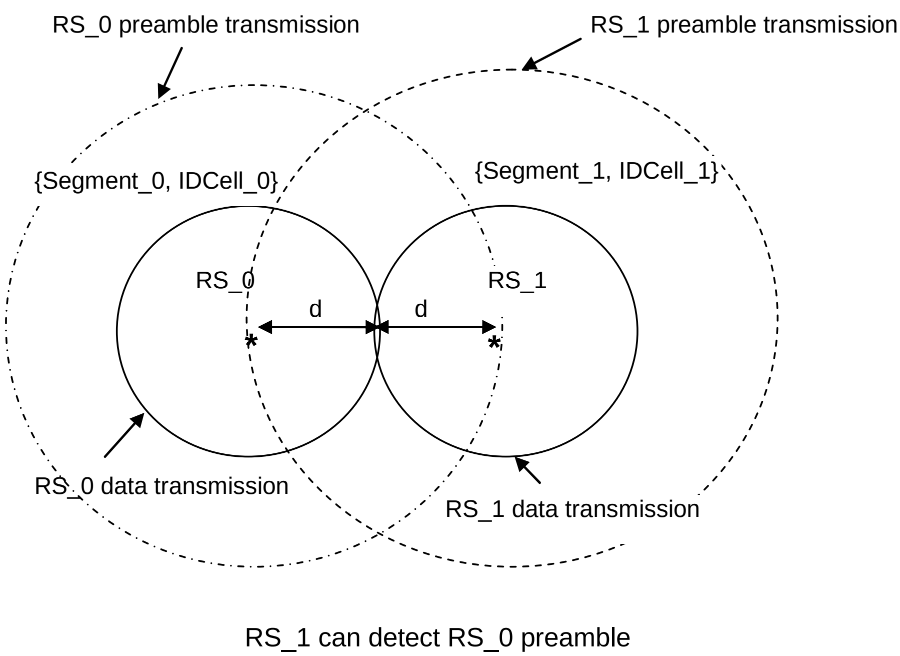

Figure 1. An example of RS neighbor detection concept and RS segment assignment, where the pathloss exponent is 3.

2.2 Initial RS Preamble Segment Assignment

MR-BS requests the potential RS to act as a mobile station and to scan its neighboring RS preambles (i.e., scanning the frequency bands for segment 0, 1, and 2) or neighboring RS signature signals. The potential RS reports all of the detectable neighboring preambles, RSS (receiver signal strengths), and ID-Cells to the MMR-BS. Note from Figure 2 flow chart, if the potential RS does not detect all segments from the segment set (i.e., segments 0, 1 and 2), the MR-BS assigns to the potential RS a segment that was not reported by it. On the other hand, if the potential RS detects all the segments, the MR-BS may have two options. First option (Option=1) would be simply not to enable the potential RS to operate as a relay. The second option (Option=2) would be to allow the potential RS to act as a cooperative-diversity relay in the operating coverage area. This means that the MR-BS configures the potential RS to be fully managed (i.e., its scheduler is done centralized by the MR-BS). Therefore, the MR-BS and the potential RS will transmit the same data burst simultaneously. The message signaling of the initial RS segment assignment is shown in Figure 3.

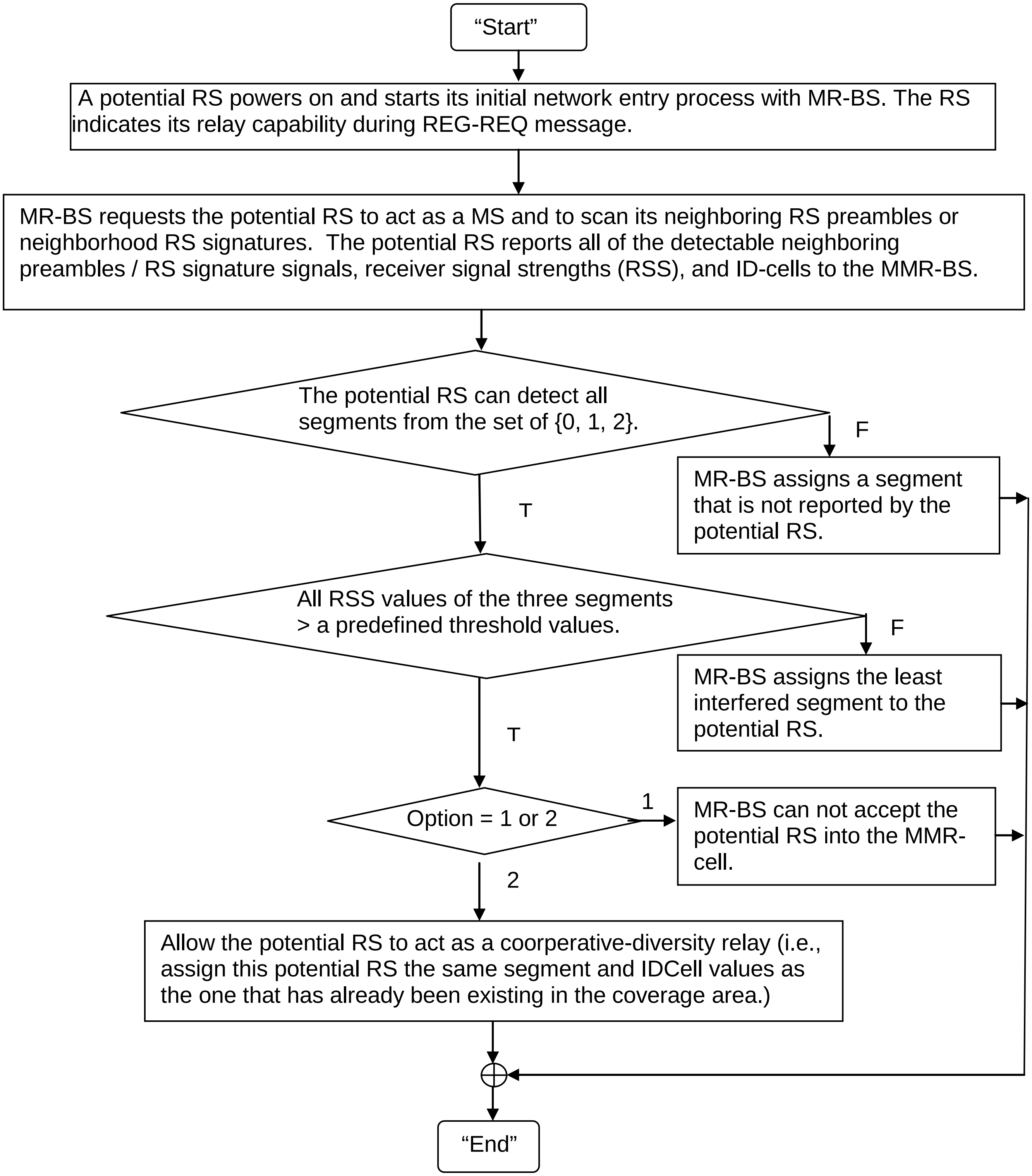

Figure 2. A RS preamble segment assignment algorithm based on the initial RS neighbor detection.

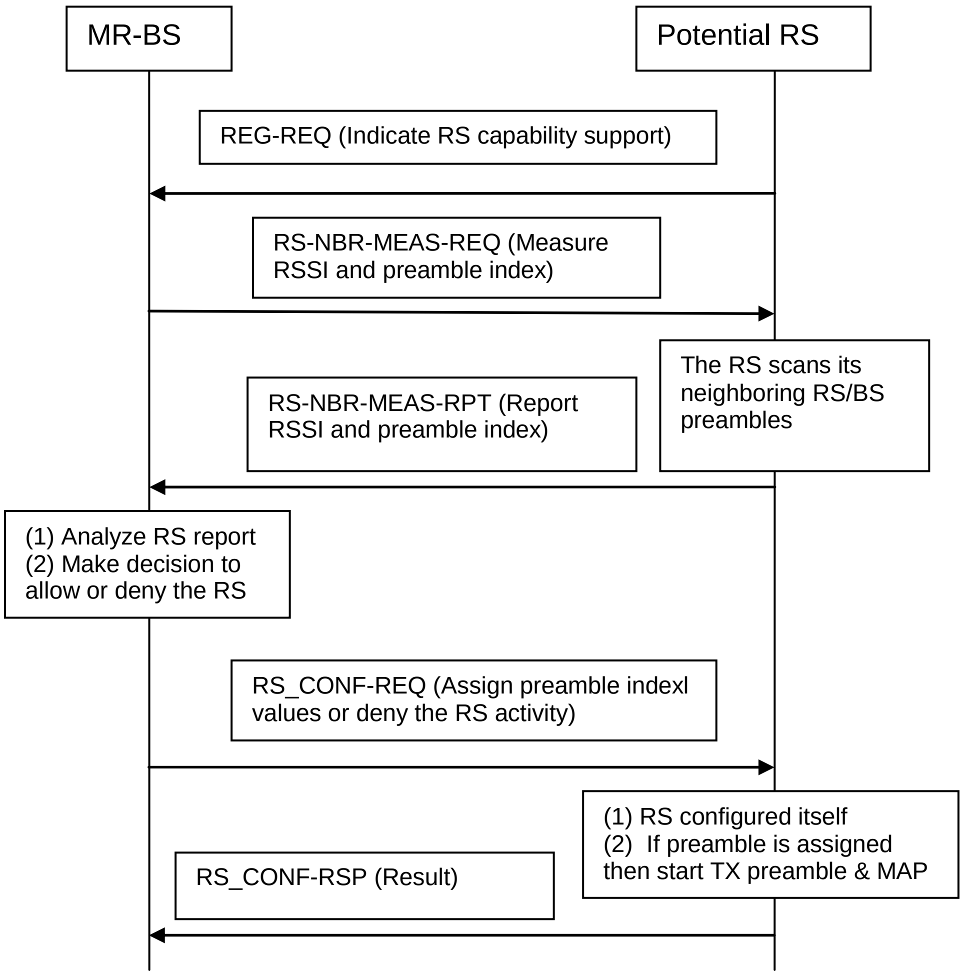

Figure 3. The message signaling for initial RS preamble segment assignment.

To be more explicit, two examples are described as following:

In the first example considered, the potential RS reports to the MR-BS that it has been detected two BSs or RSs in the area (labeled as RS0 and RS1, respectively), that have the pair {segment, ID-Cell} as following: RS0 = {0, 11} and RS1 = {2, 23}. In this case the MR-BS can enable the potential RS to operate as a relay having assigned the segment 1, which has not been detected as being used in the area of operation.

In the second example, the potential RS detects the presence of the following BSs or RSs: RS_0 = {0, 11}, RS_1 = {1, 30}, and RS_2 = {2, 23}. Let's assume that the signal strengths from these RSs are relatively strong, above a certain pre-defined threshold value. The MR-BS can conclude that the area where the potential RS is located is well served by other RSs, so it may choose not to enable this potential RS. Now let's assume that the signal strength reported for the RS_0 and RS_1 are close to the threshold value mentioned above. The

MR-BS chooses to enable the potential RS to operate as being fully managed, and assigns to it RS_p = {(0, 11), (1, 30)}, and at the same time reconfigures the RS_0 and RS_1 to operate also as fully managed shown in Figure 4. Note that the RS_p will be acting as a supportive relay (everything is transparent) for the MSs that are served already by RS_0 and RS_1; RS_p acts like another transmission antenna that can improve the cooperative-diversity gain.

We have considered a RS preamble segment and ID-Cell assignment in the initial network entry stage by means of initial RS neighbor detection reports. Note that it is understandable that in order to enable an RS, the BS may consider some other issues, such as the traffic load in the area where the RS would operate, interference that it may generate to the neighbor RSs/BSs, etc.

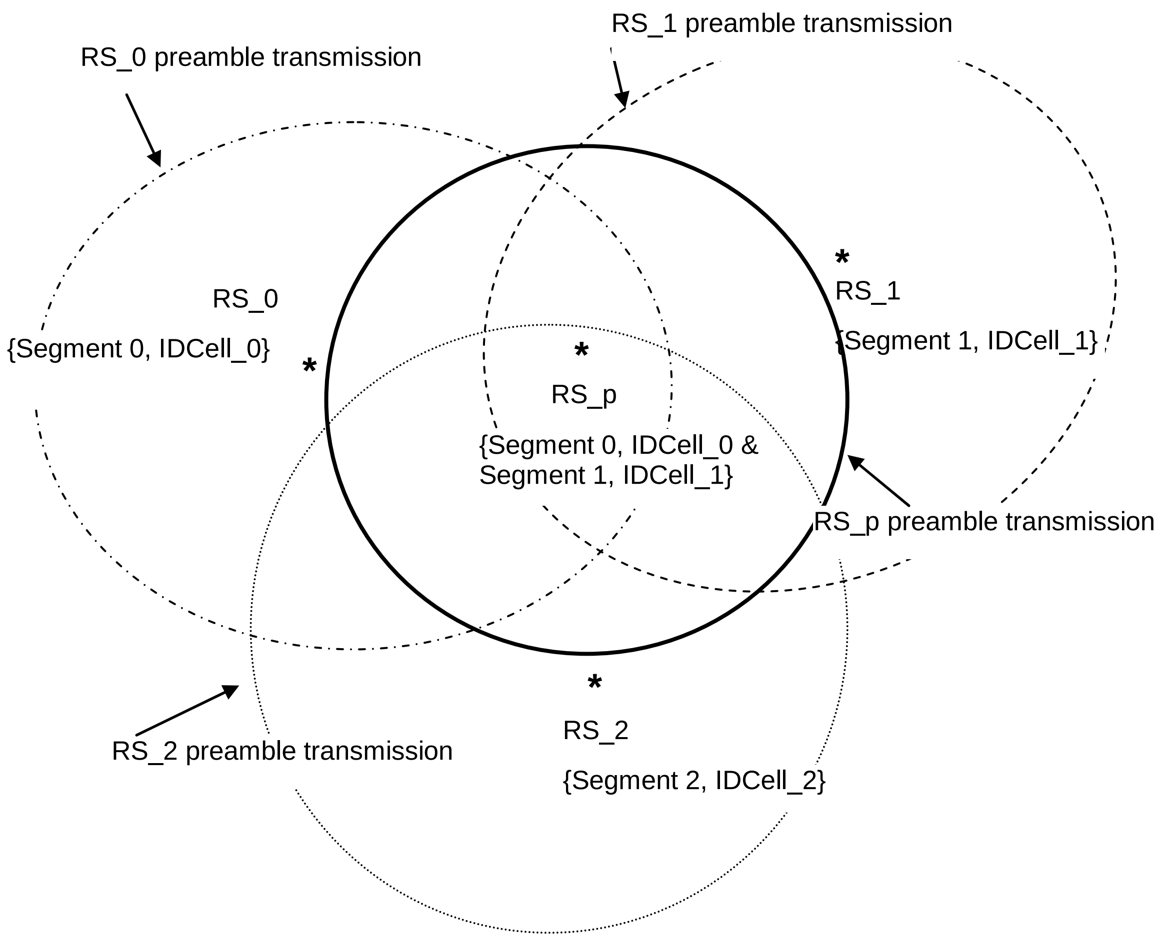

Figure 4. The RS_p relay is acting as a cooperative relay for RS_0 as well as RS_1.

3. Mobile/nomadic RS Preamble Segment Configuration

After the mobile/nomadic RS has registered to the MR-BS, it is capable of moving around. In this case, two RSs (nomadic/mobile/fixed RS) may end up being closely located and they interfere to each other if they have the same segment value. In order to eliminate the co-channel interference due to the RS mobility, we propose a preamble segment re-assignment method associated with mobility handover management scheme between the mobile/nomadic RS and its serving MR-BS.

3.1 RS Neighboring Detection

There are many mechanisms that allow an RS to detect its neighbors. For example, by embedding into the frame structure a specific RS signature signal that is transmitted at well-known time instants, with periodic scanning of RS signature signal transmission, RS can detect the presence of the nomadic RSs in their coverage area, and can inform the BS about the situation shown in the reference. Another example is to use the MS/SS DL/UL incoming/outgoing neighboring RSSI reports and serving cell C/I report resulting from the handover measurement process. The BS based on these RSSI and C/I measurements can evaluate if it may exist the situation that at least two RSs located in same coverage area and their segment value identical, which can lead to interference. If this situation exists, the BS may proceed with re-assigning the segment value for one of the interferer RSs. The mobile RS preamble segment re-assignment is discussed in the following.

3.2 Mobile/nomadic RS Preamble Segment Re-Assignment

In the initial network entry stage, the MR-BS has assigned a segment “0”, “1”, or “2” to each RS in its coverage. MR-BS can simply re-assign a different segment value to mobile/nomadic RS that interfere to other fixed RSs via some configuration signaling. If both RSs are mobile RS, than we can re-assign one of them. Before the mobile RS whose segment will be re-assigned to another segment by the MR-BS, the BS/RS will request all the MSs within the mobile RS’s serving coverage to switch to the newly assigned preamble segment at pre-determined action time via MOB_BSHO_REQ and MOB_HO_IND handover procedure seen in Figure 6. With this handover process, all the MSs does not really handover to the other target RS. The targeted RS is the same as the previous serving RS but re-assigned a new RS preamble segment value and all the MSs covered by this RS are switch to this newly re-assigned RS preamble segment value with the same or different ID-Cell seen in Figure 5. The message signaling of mobile RS preamble segment re-assignment method is shown in Figure 6.

Note that the MSs attached to a mobile/nomadic RS have the capability of scanning the environment in order to detect and update the active set of BSs/RSs that have the detection level energy above a certain threshold. Thus, MS attached to a nomadic RS can always use the option of handover to a new RS, independent of the fact whether the BS changes or not the segment value of a RS.

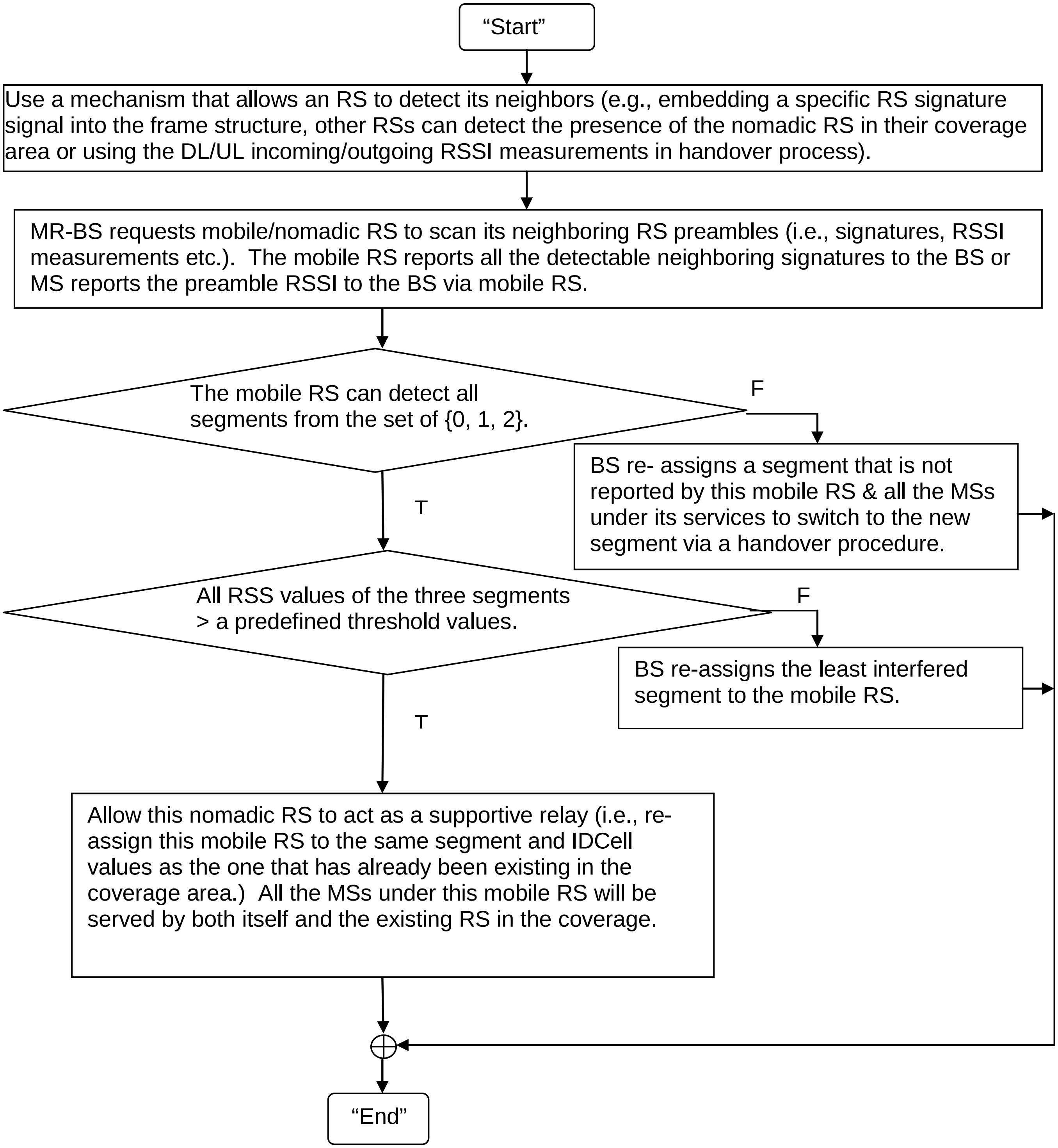

Figure 5. A RS segment re-assignment algorithm based on the mobile/ nomadic RS usage scenario.

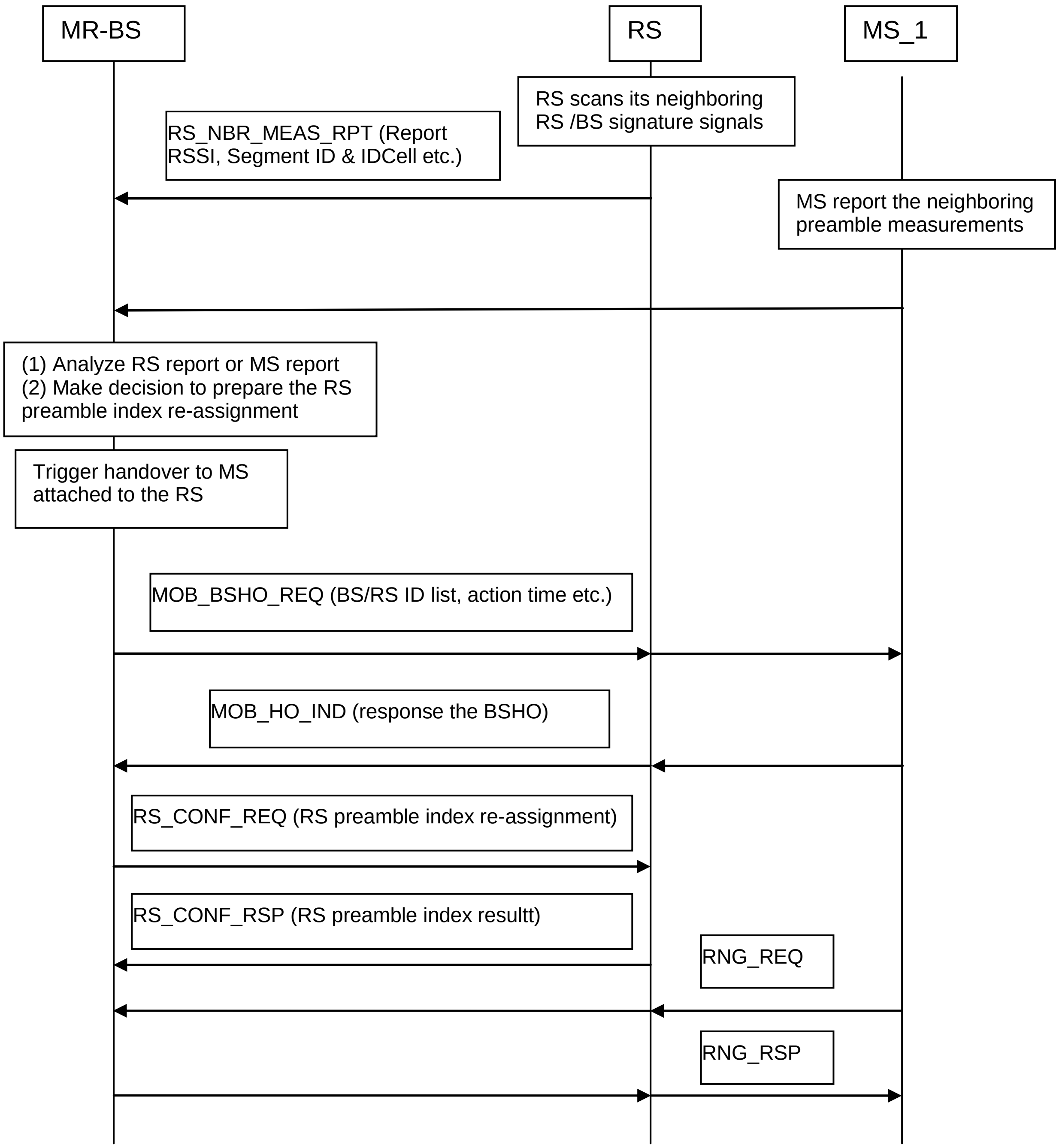

Figure 6. The message signaling for the mobile/nomadic RS preamble segment re-assignment.

4. Changes to the specification

Insert the following text at the end of 6.3.2.3.7

For a MR-BS operation, the REG-REQ shall contain the following TLV.

RS_capability_support TLV (11.7.27)

Insert new subclause at the end of 6.3.9

During the registration process, the RS acts as a MS/SS and use REG-REQ message to inform the MR-BS that it has relay capability to MR-BS.

Insert new subclause (6.3.2.3.62)

6.3.2.3.62 RS neighborhood measurement request (RS_NBR-MEAS-REQ) message

Syntax	Size	Notes
RS_NBR-MEAS-REQ_Message_Format() {		
Management Message Type = TBD	8 bits	
N_NBR_LIST	8 bits	Number of neighboring RS/BS in the neighbor list
Begin PHY Specific Section {		
For (i=0, i<N_NBR_LIST, i++){		
Frame Number	24 bits	
OFDMA Symbol Offset	8 bits	
Preamble Index	8 bits	Scan the preamble index and RSSI values in the neighboring list
}		
Report Request TLVs	Variable	TLV specific
}		
}		

N_NBR_LIST
Number of neighboring RS/BS in the neighbor list.

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

Insert new subclause (6.3.2.3.63)

6.3.2.3.63 RS neighborhood measurement request (RS_NBR-MEAS-RPT) message

Syntax	Size	Notes
RS_NBR-MEAS-RPT_Message_Format() {		
Management Message Type = TBD	8 bits	
N_NBR_LIST	8 bits	Number of neighboring RS/BS in the neighbor list
Begin PHY Specific Section {		
For (i=0, i<N_NBR_LIST, i++){		
Frame Number	24 bits	
OFDMA Symbol Offset	8 bits	
Preamble Index	8 bits	Record the preamble index and RSSI values from the neighborhood discovery
Report Response TLVs	Variable	TLV specific
}		
}		
}		

N_NBR_LIST
Number of neighboring RS/BS in the neighbor list.

The RS_NBR-MEAS-RPT shall contain the Report Request TLV (define in 11.11 REP-REQ management message encodings).

Insert new subclause (6.3.2.3.64)

6.3.2.3.64 RS preamble configuration request (RS_CONF-REQ) message

Syntax	Size	Notes
RS_CONF-REQ_Message_Format() {		
Management Message Type = TBD	8 bits	
Preamble index	8 bits	Assign a preamble index value to the potential RS
}		

Insert new subclause (6.3.2.3.65)

6.3.2.3.65 RS preamble configuration request (RS_CONF-RSP) message

Syntax	Size	Notes
RS_CONF-RSP_Message_Format() {		

Management Message Type = TBD	8 bits	
Result	1 bit	0 = Fail 1 = Success
}		

Result
Result indicates the RS preamble configuration request message; a bit of 0 indicates the message fail and a bit of 1 indicates the message success.

Insert new subclause (6.3.26)

6.3.26 Relay station neighborhood discovery
During the RS neighborhood discovery procedure, MR-BS sends a RS_NBR-MEAS-REQ message (6.3.2.3.62) to the initial registered RS requesting the report of RSS measurement and preamble index (segment ID and ID Cell). Then, the RS sends a RS_NBR-MEAS-RPT message (6.3.2.3.63) back to the RS to response the measurement report.

Insert new subclause (9.4)

9.4 RS configuration
After the measurement report from RS neighborhood discovery process, MR-BS sends a RS preamble configuration request (RS_CONF-REQ) message (6.3.2.3.64) to the RS for configuring the preamble segment and ID-Cell values. The RS sends a RS_CONF-RSP message to the BS for responding the preamble assignment result.

Insert new subclause 11.7.27

11.7.27 RS_capability_support
The “RS_capability_support” field indicates the MS has RS capability or not. A bit of 0 indicates “support RS capability”.

Type	Length	Value	Scope
TBD	1	Bit #0=1; Support RS capability. Bit #1- bit #7; Reserved	REG-REQ