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Source(s)	Shashikant Maheshwari, Yousuf Saifullah, Haihong Zheng Nokia 6000 Connection Drive, Irving, TX	Voice: 972 839 1878 Fax: shashikant.maheshwari@nokia.com, Yousuf.saifullah@nokia.com, haihong.1.zheng@nokia.com
Re:	This is in response to the call for proposal, 80216j-06_027.pdf, sent out by 802.16j TG.	
Abstract	This contribution proposes RS support for MS Initial and Periodic Ranging in multi-hop system.	
Purpose	Add proposed spec changes.	
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RS support for OFDMA Based Ranging

Shashikant Maheshwari, Yousuf Saifullah and Haihong Zheng
Nokia

Introduction

As defined in IEEE 802.16-2004 & IEEE 802.16e-2005, network entry procedure for OFDMA PHY can be described in two steps.

- CDMA contention based initial ranging and automatic adjustments
- CID allocation and remaining network entry procedure

The CDMA contention based initial Ranging procedure (step 1) may take multiple iterations over the air interface. In 802.16j system, there could be one or more RS between MMR-BS and MS. The CDMA based initial ranging has to traverse over the multiple hops of the air interface. This would cause increased delay and it is spectrally inefficient. This contribution proposes that CDMA contention based initial ranging and automatic adjustments should be performed by access RS (last hop RS) while the CID allocation and remaining network entry procedure are desired to be performed by the BS. In addition this contribution also proposes that CDMA contention based periodic ranging and automatic adjustments should also be performed by access RS without involving MMR-BS.

This contribution assumes that MMR-BS manages and maintains the MS context. In addition, RS may maintain some of MS context. MMR-BS shall be responsible for the allocation of CIDs and other parameters. It is assumed that RS transmits its own preamble. This contribution does not exclude any type of scheduling, both centralized and distributed scheduling is assumed.

CDMA contention based initial ranging and automatic adjustments in 802.16j system

In 802.16j system, there could exist one or more RS between MMR-BS and MS. MS after synchronization with RS and receiving downlink and uplink parameters, shall perform the CDMA contention based initial ranging with access RS. Access RS will process the MS's CDMA ranging request and locally adjust the access link and manages the MS's timing, power and frequency offsets. Access RS as part of CDMA contention based initial ranging process will require to send RNG_RSP and at some point CDMA_Alloc_IE() to MS on the access link. Procedure to send these messages to MS will depend on RS capability and scheduling scheme implemented at access RS. This is described in detail in section [Bandwidth request and scheduling]

Access RS shall relay all the other messages (including complete RNG_REQ/RNG_RSP) between MMR-BS and MS. MS context shall be anchored at MMR-BS. It is desired that MMR-BS shall allocate parameters

(Basic, primary CID etc.) and process remaining network entry procedure for MS. RS can perform the bandwidth request to upstream node (BS/RS) either in parallel or sequential to get the UL allocation and use that allocation to transmit MS's completes RNG_REQ.

CDMA contention based periodic ranging and automatic adjustments in 802.16j system

In 802.16j system, there could exist one or more RS between MMR-BS and MS. MS that chooses to initiate periodic ranging shall perform the CDMA contention based periodic ranging with access RS (last hop RS, attached directly with MS). Access RS will process the MS's CDMA ranging request and locally adjust the RS-MS link and manages the MS's timing, power and frequency offsets.

Bandwidth request and scheduling

This contribution propose that access RS will manage access link locally. However, scheduling of RNG_RSP and CDMA_Alloc_IE() messages on the RS-MS link depends upon the access RS capability (centralized or distributed).

For the message transmission on the relay link, access RS should utilize already specified methods for Bandwidth request in IEEE 802.16-2004 & IEEE 802.16e-2005 Std to request resources for sending complete RNG_REQ to BS or may utilize fast resource request methods defined in [1].

Centralized scheduling

In case of centralized scheduling, all the allocation of radio resources and transmission of messages are centrally controlled by the MMR-BS. In order to send RNG_RSP and CDMA_ALLoc_IE() on the access link, access RS will require to send bandwidth request to MMR-BS. Access RS can either use the already defined mechanism in [2][3] or can utilize the fast resource request methods proposed in [1]. Figure 1 below shows the message sequence diagram for proposed procedure in case of centralized scheduling using bandwidth request procedure defined in [2][3].

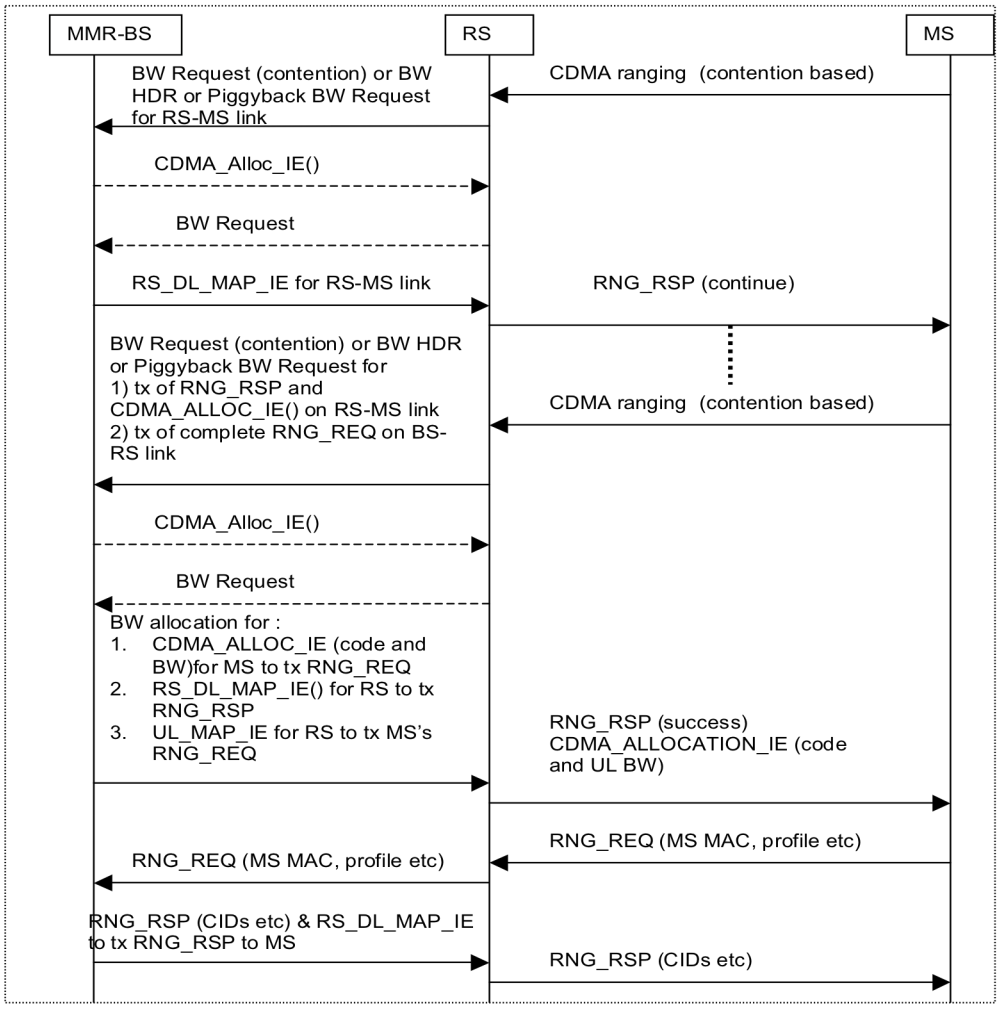

Figure 1: RS Support for Ranging Procedure (Centralized Scheduling)

Figure 2 below shows the message sequence diagram for access RS bandwidth request procedure in case of centralized scheduling using fast resource request procedure defined in [1].

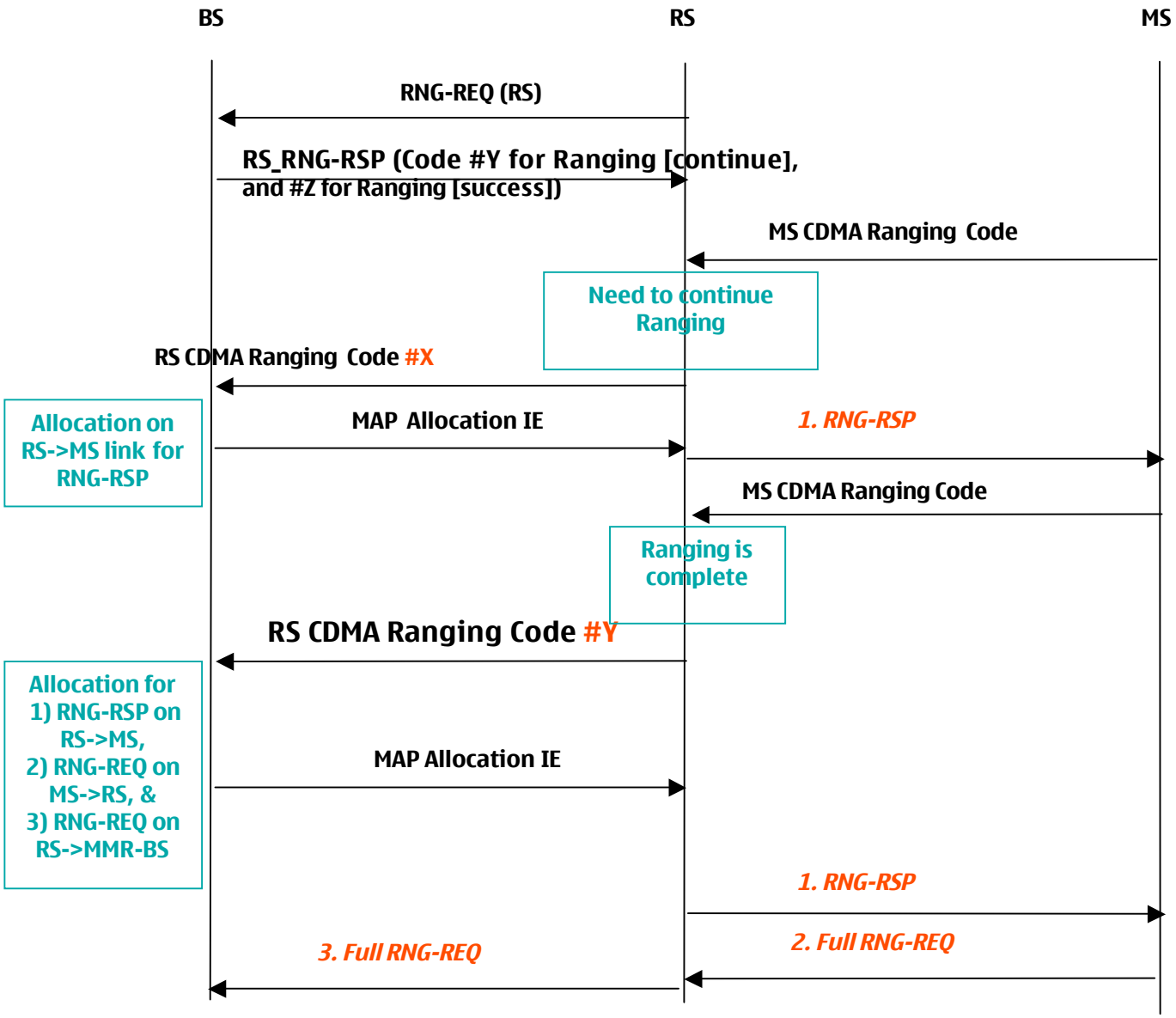

Figure 2: Fast bandwidth Request method using assigned RS CDMA Codes (C80216j-06_189)

Distributed scheduling

In case of distributed scheduling with central co-ordination with BS, access RS shall schedule RNG_RSP and CDMA_Alloc_IE() on its own. Figure 3 below shows the message sequence diagram for the proposed procedure in case of distributed scheduling.

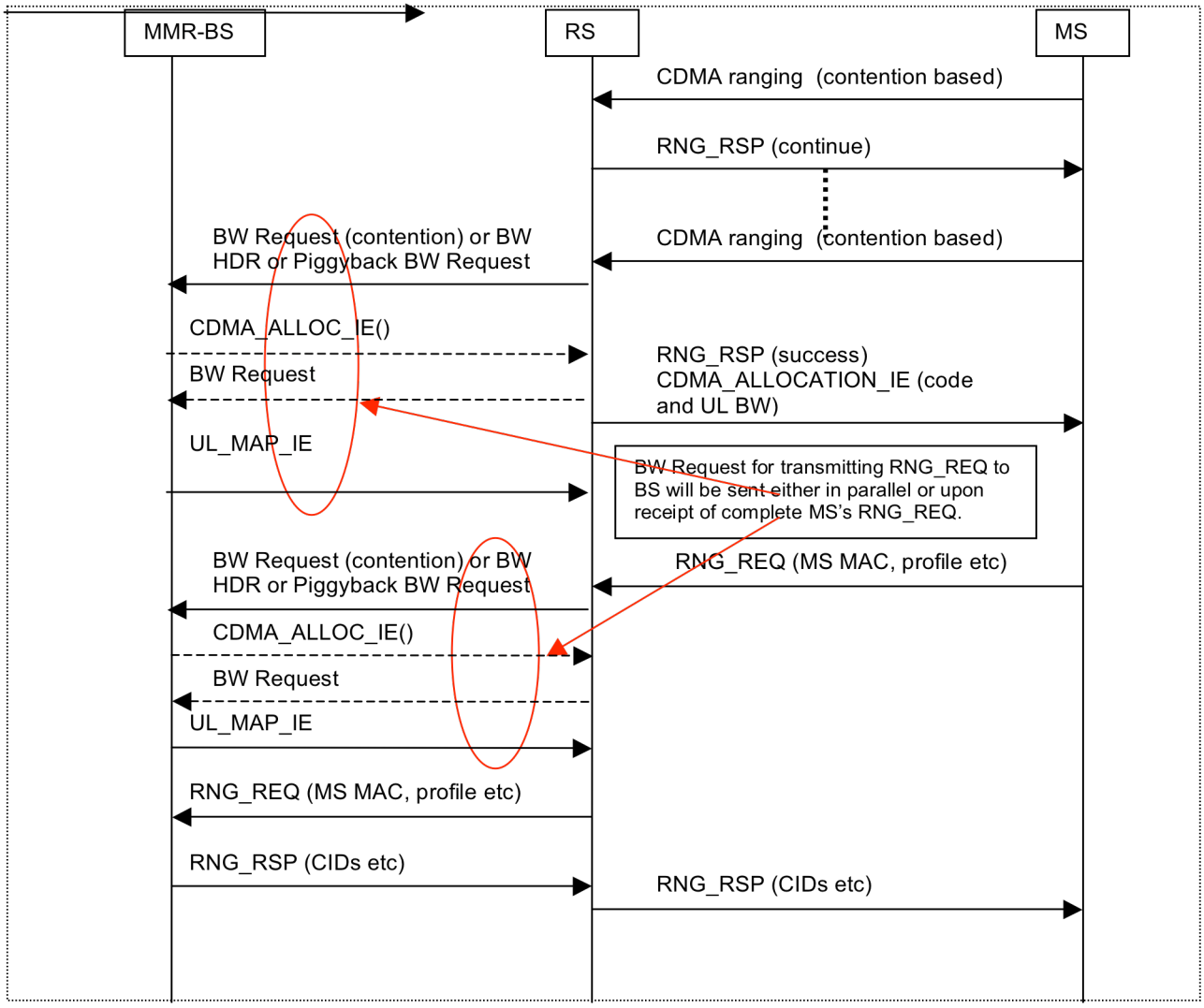

Figure 3: RS Support for Ranging Procedure (Distributed Scheduling)

Advantages

- Reduces overall latency for MS's initial ranging process. The main time consuming step of back and forth ranging with CDMA code is done only on the access link.
- Proposed scheme does not require RS to relay CDMA Ranging codes and adjustment parameters back to BS, therefore it is spectrally efficient. It saves bandwidth on both DL and UL.
- Using Fast resource request method as defined in [1] further reduces the latency in MS Ranging procedure.

Changes to the specification

6.3.10.3 OFDMA-based ranging

Insert the following at the end of the subclause:

When one or more RS introduced between the MMR-BS and MS. MS shall perform the CDMA contention based ranging process with access RS (last hop RS, attached directly with MS) as defined in section 6.3.10.3.1 and 6.3.10.3.2. Access RS will process the MS's CDMA ranging request and locally adjust the RS-MS link (access link) and manages the MS's timing, power and frequency offsets. Access RS as part of CDMA contention based initial ranging process also require to send RNG_RSP and at some point CDMA_Alloc_IE() to MS on the RS-MS link. Procedure to send these messages to MS will depend on RS capability and scheduling scheme implemented at access RS. In case of centralized scheduling, access RS shall request the transmission opportunity for RNG_RSP and CDMA_alloc_IE() from upstream node (RS or MMR-BS) and in case of distributed scheduling, access RS shall schedule transmission of RNG_RSP and CDMA_ALLoc_IE() on its own.

6.3.10.3.1 Contention-based initial ranging and automatic adjustments

Change the text as indicated:

— The SS, after acquiring downlink synchronization and uplink transmission parameters, shall choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, then it chooses randomly a Ranging Code (from the Initial Ranging domain) and sends it to the BS/RS (as a CDMA code).
— The BS/RS cannot tell which SS sent the CDMA ranging request; therefore, upon successfully receiving a CDMA Ranging Code, the BS/RS broadcasts a Ranging Response message that advertises the received Ranging Code as well as the ranging slot (OFDMA symbol number, subchannel, etc.) where the CDMA Ranging code has been identified. This information is used by the SS that sent the CDMA ranging code to identify the Ranging Response message that corresponds to its ranging request. The Ranging Response message contains all the needed adjustment (e.g., time, power, and possibly frequency corrections) and a

status notification. Depending upon the RS capability, RS may need to request resources from BS for transmission of Ranging Response message on the access link.

— Upon receiving a Ranging Response message with continue status, the SS shall continue the ranging process as done on the first entry with ranging codes randomly chosen from the Initial Ranging domain sent on the Periodic Ranging region.

— When the BS/RS receives an initial-ranging CDMA code that results in sending an RNG-RSP message with success status, the BS/RS shall provide BW allocation for the SS using the CDMA_Allocation_IE to send an RNG-REQ message. Depending upon the RS capability, RS may need to request resources from BS for transmission of Ranging Response message and CDMA_Allocation_IE on the access link.

— Initial ranging process is over after receiving RNG-RSP message, which includes a valid basic CID (following a RNG-REQ transmission on a CDMA_Allocation_IE). If this RNG-RSP message includes 'continue' indication, the ranging process should be continued using the periodic ranging mechanisms.

— The timeout required for SS to wait for RNG-RSP, following or not following CDMA Allocation IE, is defined by T3.

— Using the OFDMA ranging mechanism, the periodic ranging timer is controlled by the SS, not the BS.

Change Table 121 as indicated:

BS/RS		SS
[Time to send the CDMA Initial Ranging opportunity]		
Send map containing CDMA Initial Ranging IE with a broadcast Connection ID	----------UL-MAP---------->	
	<---------Ranging Code-------	Transmit randomly selected Initial Ranging code in a randomly selected Ranging Slot from available Ranging Region
[Receive Ranging Code] Send RNG-RSP with Time and Power Corrections and original Ranging Code and Ranging Slot Status = Continue RS May need to request transmission opportunity from upstream node (RS/BS)	----------RNG-RSP------->	Receive RNG-RSP message with Ranging Code and Ranging Slot matching sent values Adjust Time and Power parameters
[Time to send the CDMA Initial Ranging opportunity]		

Send map containing CDMA Initial Ranging IE with a broadcast Connection ID ----------UL-MAP----------->

<---------Ranging Code------- Transmit randomly selected Initial Ranging code in a randomly selected Ranging Slot from available Periodic Ranging Region

[Receive Ranging Code]

Send RNG-RSP with Time and Power Corrections and original Ranging Code and Ranging Slot
RS may need to request transmission opportunity from upstream node (RS/BS)
Status = Success ----------RNG-RSP-------> Receive RNG-RSP message with Ranging Code and Ranging Slot matching sent values Adjust Time and Power parameters

[Time to send the next map]
Send map containing anonymous BW allocation with original Ranging Code and Ranging Slot ----------UL-MAP----------->
RS May need to request transmission opportunity from upstream node (RS/BS)

<---------RNG-REQ------- Transmit RNG-REQ and continue with regular Initial network entry

replace title of figure 87 from "Figure 87—CDMA Initial Ranging—SS" to "Figure 87—CDMA Initial Ranging—BS/RS (Distributed scheduling)"

Insert following new figures 87a

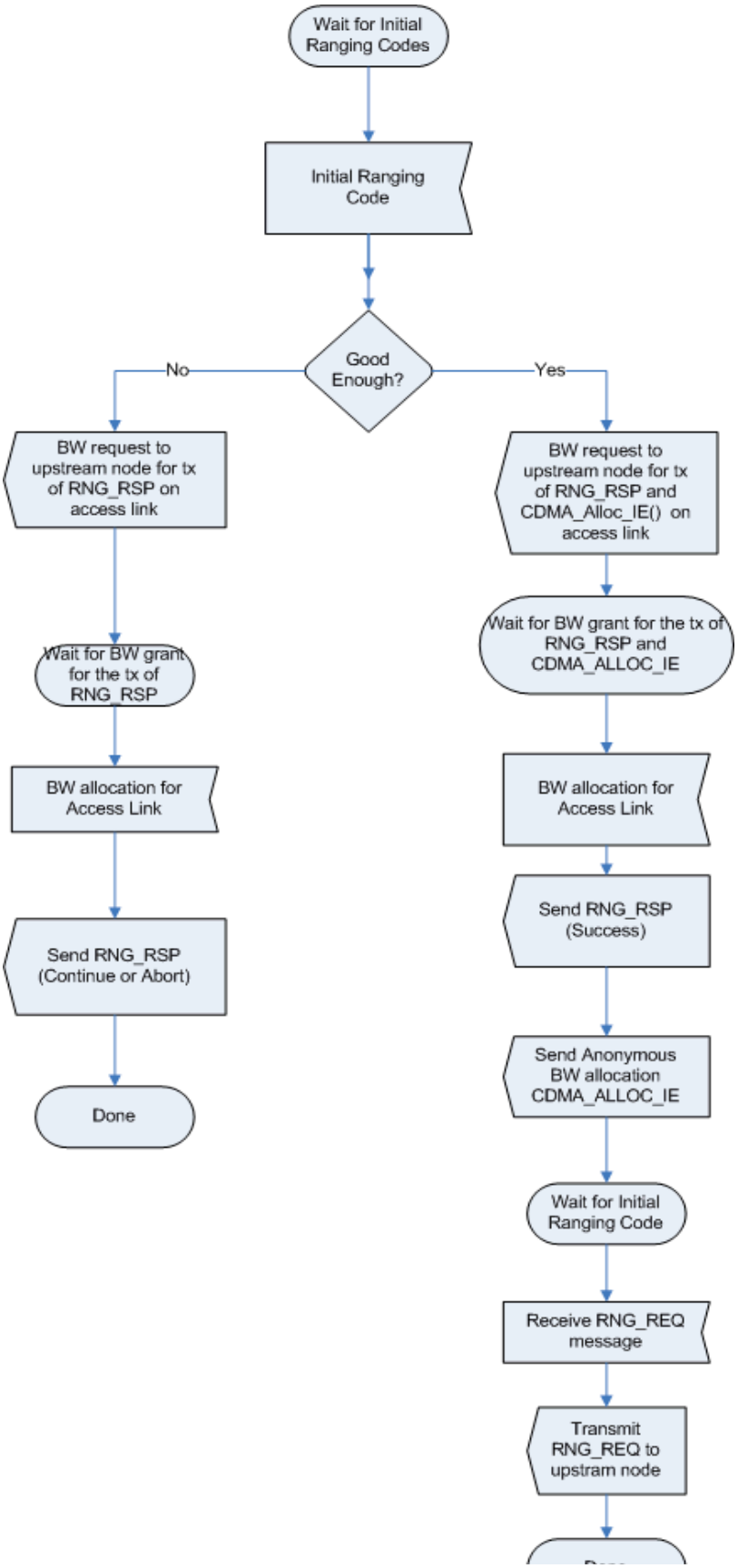
Wait for Initial Ranging Codes
Initial Ranging Code
Good Enough?
No
Yes
BW request to upstream node for tx of RNG_RSP on access link
Wait for BW grant for the tx of RNG_RSP
BW allocation for Access Link
Send RNG_RSP (Continue or Abort)
Done
BW request to upstream node for tx of RNG_RSP and CDMA_Alloc_IE() on access link
Wait for BW grant for the tx of RNG_RSP and CDMA_ALLOC_IE
BW allocation for Access Link
Send RNG_RSP (Success)
Send Anonymous BW allocation CDMA_ALLOC_IE
Wait for Initial Ranging Code
Receive RNG_REQ message
Transmit RNG_REQ to upstram node

Figure 87a – CDMA Initial Ranging – RS (centralized scheduling)

6.3.10.3.1 Periodic ranging and automatic adjustments

Change the text as indicated:

An SS that wishes to perform periodic ranging shall take the following steps:
— The SS, shall choose randomly a Ranging Slot (with the use of a binary truncated exponent algorithm to avoid possible re-collisions) at the time to perform the ranging, then it chooses randomly a Periodic Ranging Code (from the Periodic Ranging domain) and sends it to the BS/RS (as a CDMA code).
— If the MS does not receive a response, the MS may send a new CDMA code at the next appropriate periodic Ranging transmission opportunity and adjust its power level up to PTX_IR_MAX (6.3.9.5.1).
— The BS/RS cannot tell which SS sent the CDMA ranging request; therefore, upon successfully receiving a CDMA Periodic Ranging Code, the BS/RS broadcasts a Ranging Response message that advertises the received Periodic Ranging Code as well as the ranging slot (OFDMA symbol number, subchannel, etc.) where the CDMA Periodic Ranging code has been identified. This information is used by the SS that sent the CDMA Periodic ranging code to identify the Ranging Response message that corresponds to its ranging request. The Ranging Response message contains all the needed adjustment (e.g., time, power, and possibly frequency corrections) and a status notification. Depending upon the RS capability, RS may need to request resources from BS for transmission of Ranging Response message on the access link.
— Upon receiving a Ranging Response message with continue status, the SS shall continue the ranging process with further periodic ranging codes randomly chosen from the Periodic Ranging domain.
— Using the OFDMA ranging mechanism, the periodic ranging timer is controlled by the SS, not the BS/RS.
— The BS/RS may send an unsolicited RNG-RSP as a response to a CDMA-based bandwidth-request or any other data transmission from the SS.

Replace title of figure 88 from "Figure 88—Periodic CDMA Ranging—BS" to "Figure 88—Periodic CDMA Ranging—BS/RS (Distributed scheduling)"

Replace title of figure 89 from "Figure 89—Periodic Ranging—Received ranging code -BS" to "Figure 89—Periodic Ranging—Received ranging code -BS/RS (Distributed scheduling)"

Insert following new figures 89a

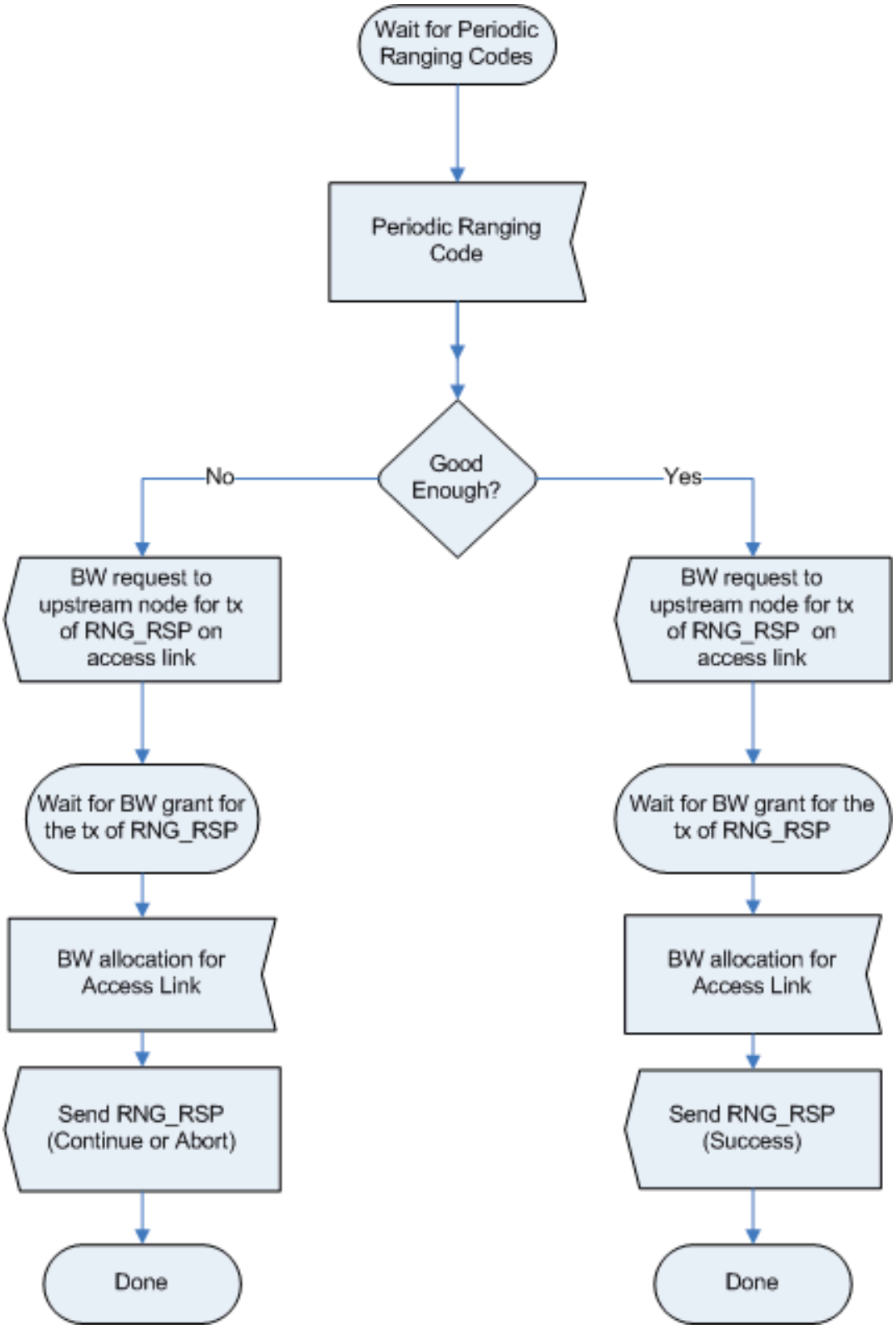
Wait for Periodic Ranging Codes
Periodic Ranging Code
Good Enough?
No
Yes
BW request to upstream node for tx of RNG_RSP on access link
Wait for BW grant for the tx of RNG_RSP
BW allocation for Access Link
Send RNG_RSP (Continue or Abort)
Done
BW request to upstream node for tx of RNG_RSP on access link
Wait for BW grant for the tx of RNG_RSP
BW allocation for Access Link
Send RNG_RSP (Success)
Done

Figure 89a – CDMA Periodic Ranging – RS (centralized scheduling)

References

[1] C80216j-06_189 Resource Request for Bandwidth (Yousuf Saifullah, Shashikant Maheshwari, Haihong Zheng; 2006-11-07)
[2] IEEE 802.16-2004 Part 16: Air Interface for Fixed Broadband Wireless Access Systems
[3] IEEE 802.16e-2005 Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands and Corrigendum 1