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Re:	IEEE 802.16j-06/027: “Call for Technical Proposals regarding IEEE Project P802.16j”
Abstract	This contribution proposes the ranging process for IEEE 802.16j Multi-hop Relay system
Purpose	Propose the ranging process for IEEE 802.16j Multi-hop Relay system
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Ranging Process for IEEE 802.16j

I. Introduction

RSs (relay stations) are developed in the 802.16j MR (multi-hop relay) network to provide relay services for MSs (mobile stations). The ranging process in such a network is foreseen to be more complicated than that defined in IEEE 802.16e-2005 because it involves not only MR-BS (base station) and MS but also a number of RSs. In this contribution, we propose ranging processes for MS and RS in 802.16j.

II. MS and RS ranging in 802.16j

To support legacy MSs, the ranging procedure for MSs in 802.16j needs to be the same as specified in IEEE 802.16e-2005. On the other hand, in addition to its own ranging, an RS shall be able to facilitate MSs' and other RSs' ranging through relaying and/or processing the ranging messages to/from MSs/RSs.

II.1 Two methods of ranging channel allocations

RSs need to be allocated a ranging sub-channel in order to support the MS and/or RS ranging. Two types of allocation are possible, namely the separate allocation and aggregate allocation which are shown in Figure 1(a) and (b), respectively. In the separate allocation, a separate ranging sub-channel is allocated to each RS whose location is indicated by an MAP-IE in the respective UL-MAP. On the other hand, in the aggregate allocation, the ranging sub-channel is shared by the MR-BS and RSs. Again, its location is indicated by an MAP-IE in the respective UL-MAP. In addition, in the separate allocation, an RS is allowed to reply ranging response by itself, while in the aggregate allocation, the ranging message of an MS/RS needs to be forwarded to the MR-BS, and the MR-BS then decides which RS is to respond to the ranging request. The following two example MR networks are used to explain the usage of the two ranging allocations in more details.

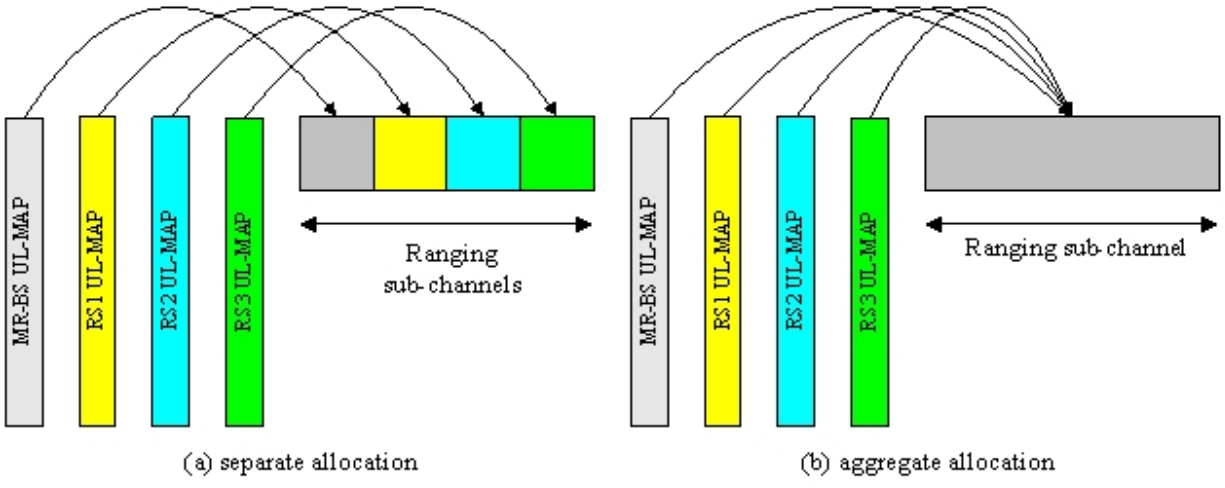

Figure 1: Two ranging sub-channel allocations

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II.2 Ranging with separate allocation

Figure 2 shows an example MR network, where MR-BS and RS2 have their own DL- and UL-MAP and ranging sub-channel. The ranging process of MS and RS1 in this network is given as follows.

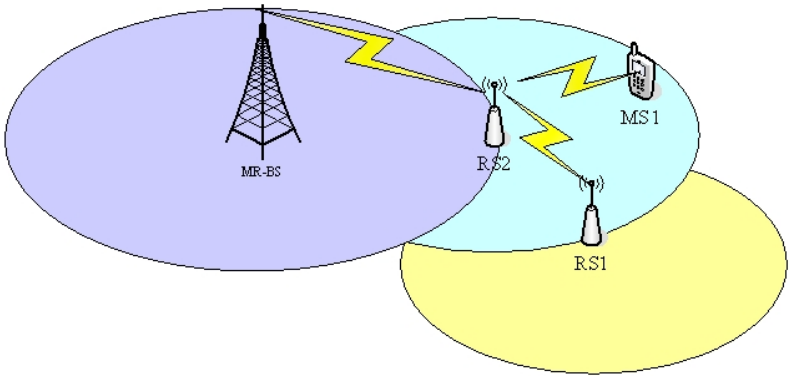

Figure 2: An example MR-network to illustrate the usage of separate ranging sub-channel allocation

(1) Ranging for MS1

According to the requirement of 802.16j TG, the ranging processes (including CDMA initial ranging, periodic CDMA ranging, and CDMA handover ranging) of MS1 shall remain unchanged [1]. The MS1 sees RS2 as a BS and employs the ranging processes specified in IEEE 802.16e-2005 Std. [2] without any modifications.

(2) Ranging for RS1

(A) CDMA initial ranging

When RS1 enters the MR network, it behaves like an MS and performs its network entry and initial ranging with RS2 (RS1's access station). The procedure shall be the same as specified in section 6.3.10.3.1 of IEEE 802.16e-2005 Std.

(B) Periodic ranging

To maintain the radio quality of relay link, RS1 needs to perform periodic ranging with RS2 no matter its relaying service for MSs is active or not. When the relaying service is active, RS1 may put its RNG-REQ message in its UL data burst for requesting the periodic ranging process. If there is no active relaying service for MSs and the T48 timer (controlled by RS2) expires, RS2 shall grant RS1 a transmitted opportunity to send an RNG-REQ message for its periodic ranging. After receiving the RNG-RSP message from RS2, RS1 carries out PHY parameter adjustments that are specified when the status in the RNG-RSP message is continue or initiates a restart of MAC activities when the status is aborted.

(C) Handover ranging

If RS1 is a mobile-RS, this process is required. Under this case, RS1 is treated as an MS when handover from one access station to another, the process needs to be the same as Section 6.3.10.3.3 specified in IEEE 802.16e-2005 Std.

(3) RS2's support for MS1 and RS1 ranging

Since RS2 is the access station of MS1 and RS1, it needs to behave like a BS to support the ranging of MS1 and RS1. RS2 would perform ranging process following the legacy one defined in 802.16e-2005

except that when receiving an RNG-REQ message with an MAC-address (during initial ranging process), RS2 shall transmit an RLY_RNG-REP message (The RLY_RNG-REP message is given in the proposed text, this message would include the original RNG-REQ message and RS2's RSID.) to the MR-BS to inform the incoming request. Then the MR-BS needs to respond an RNG-RSP message that contains the assigned CID information to RS2, and RS2 forwards it to MS1 or RS1. The message flows of the ranging processes are show in Figures 3, 4, and 5.

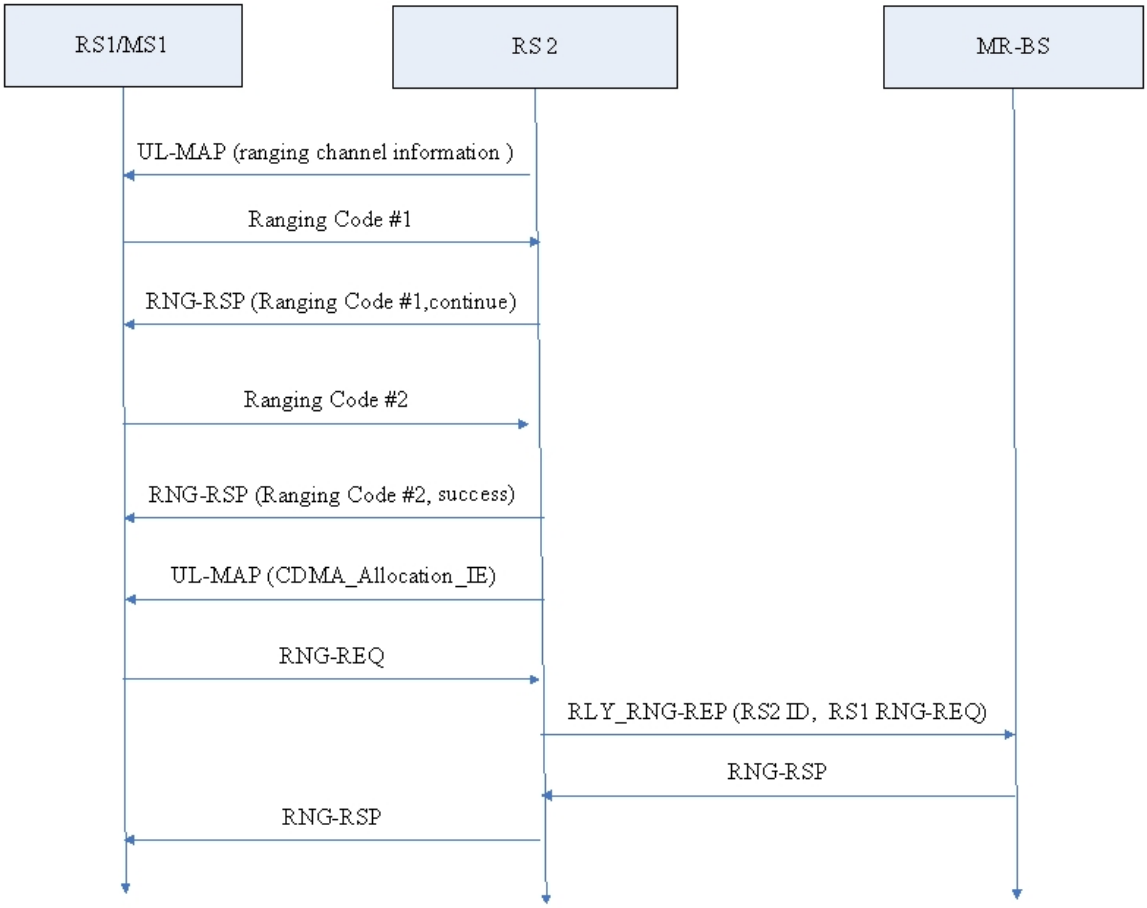

Figure 3: Initial ranging for RS1/MS1 with separate ranging sub-channel allocation

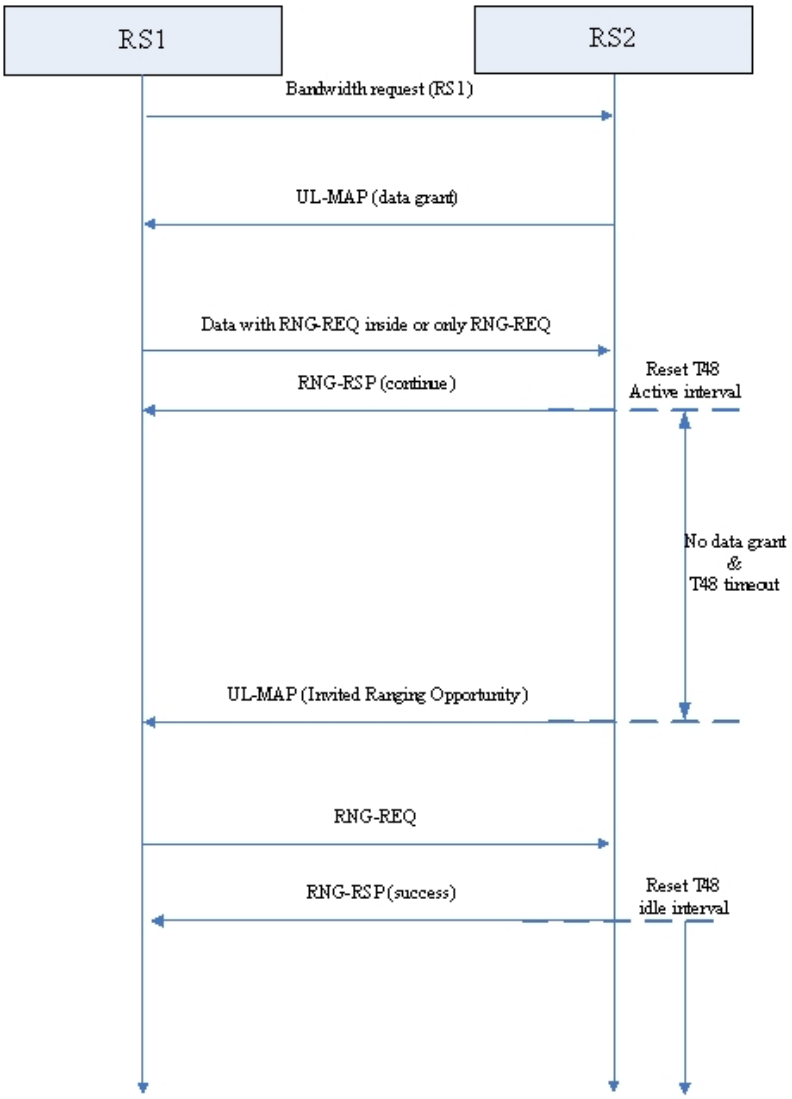

Figure 4: Periodic ranging for RS1 with separate ranging sub-channel allocation

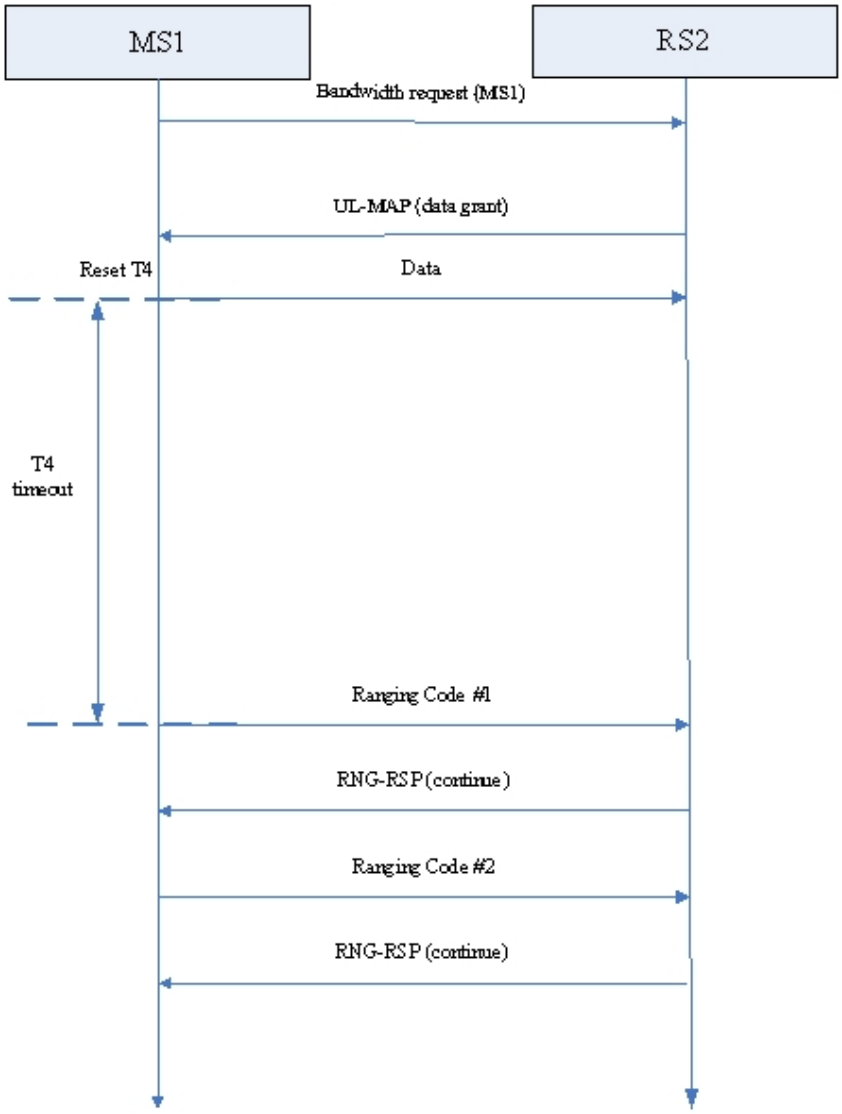

Figure 5: Periodic ranging for MS1 with separate ranging sub-channel allocation

II.3 Ranging with aggregate allocation

Figure 6 is an example of MR-network to explain the usage of aggregate ranging sub-channel allocation, where MR-BS, RS2 and RS3 share the same ranging sub-channel (The type of ranging sub-channel allocation for RS1 doesn't matter in this example, it can be separate allocation or aggregate allocation.).

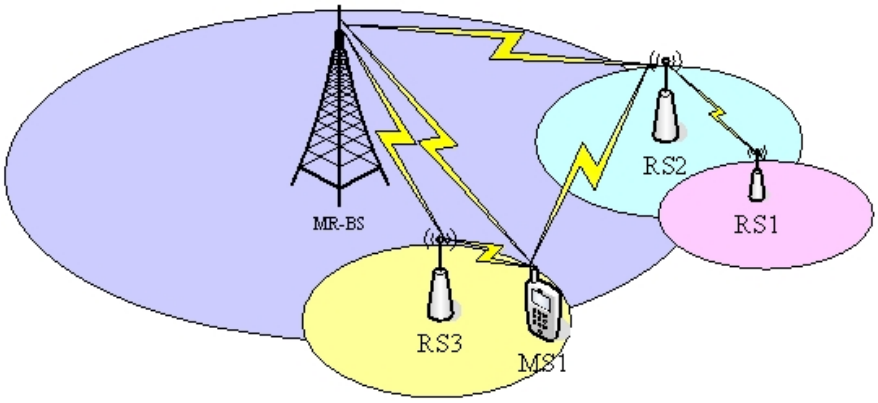

Figure 6: An example MR-network to illustrate the usage of aggregate ranging sub-channel allocation

Under this allocation, MR-BS, RS2 and RS3 shall listen to the aggregate ranging sub-channel. Besides, RS2 and RS3 shall measure and report the ranging request to MR-BS for a decision on which station is selected to respond to the ranging request. The ranging process for MS1 and RS1 is the same as discussed in the case of separate allocation except that a different relaying functionality of RS2 and RS3 is needed to facilitate the MS1 and RS1 ranging.

(4) RS2/RS3's support for RS1 and MS1 ranging

RS2 and RS3 shall listen to the aggregate ranging sub-channel and send an RLY_RNG-REP message to the MR-BS after it successfully receives a Ranging Code or an RNG-REQ message. (The RLY_RNG-REP message is given in the proposed text.) In the RLY_RNG-REP message, measurements such as timing offset and received power are provided to assist the MR-BS to make a decision. Due to the possible latency variation between RSs in an MR-network, MR-BS shall manage a timer to wait the possible late RLY_RNG-REP messages (with the same Ranging Code or RNG-REQ at the same received frame number) from RS2 and RS3. After that, MR-BS will select a suitable station as a ranging target and response with an RNG-RSP message based on the target station's PHY parameters.

The message signalling flows of the ranging processes are shown in Figures 7, 8, and 9.

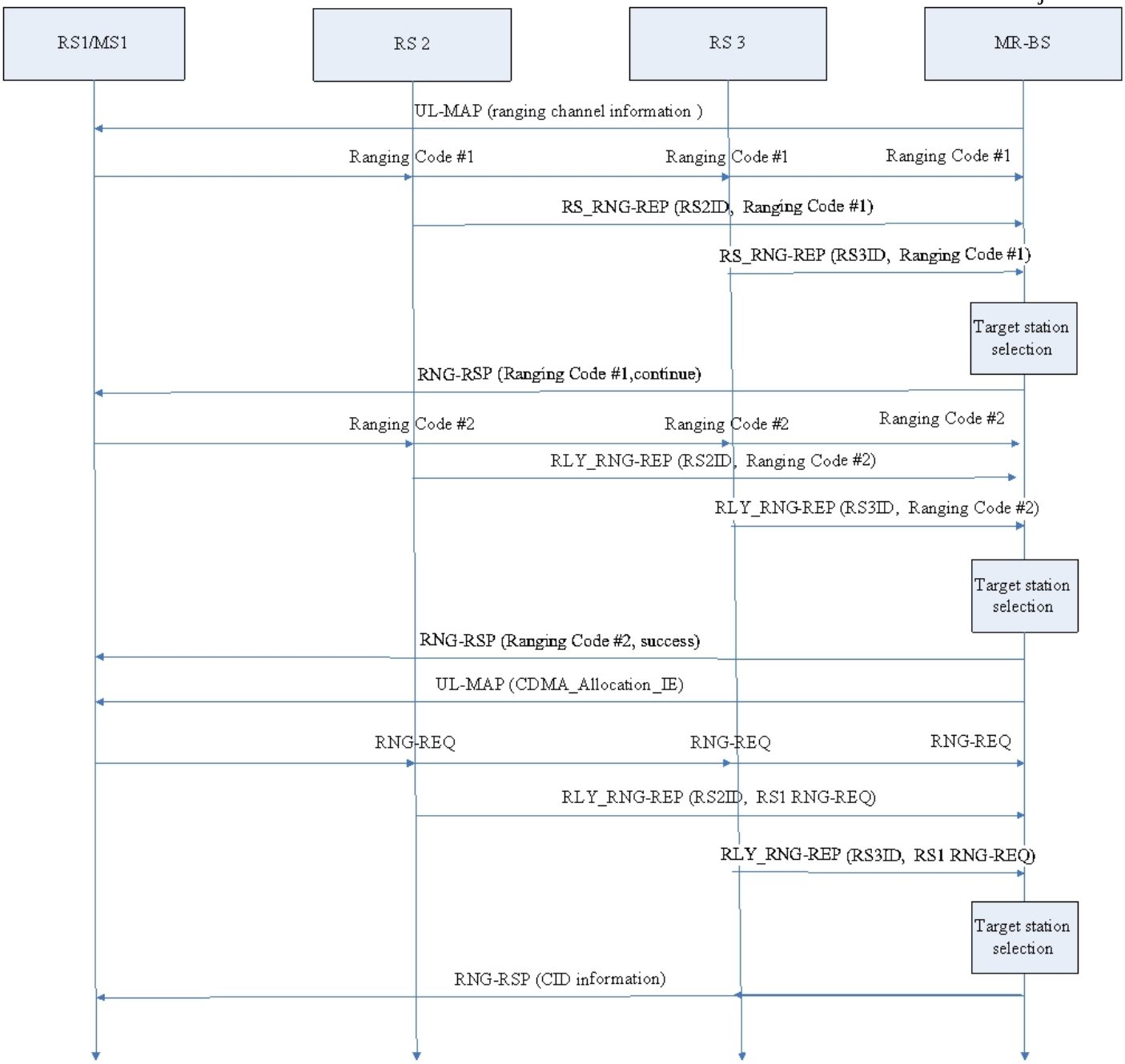

Figure 7: CDMA initial ranging process with aggregate ranging sub-channel allocation

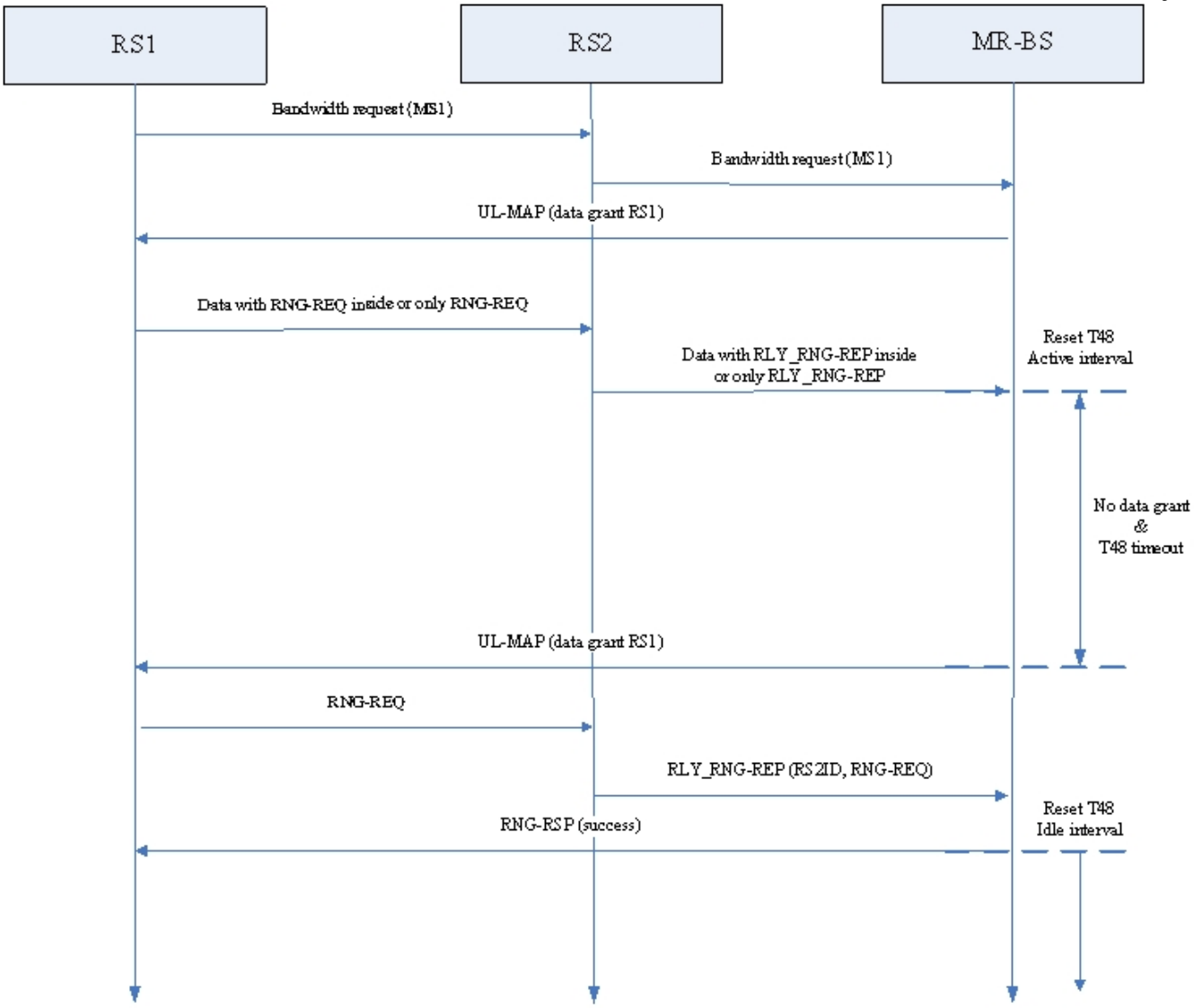

Figure 8: RS periodic ranging with aggregate ranging sub-channel allocation

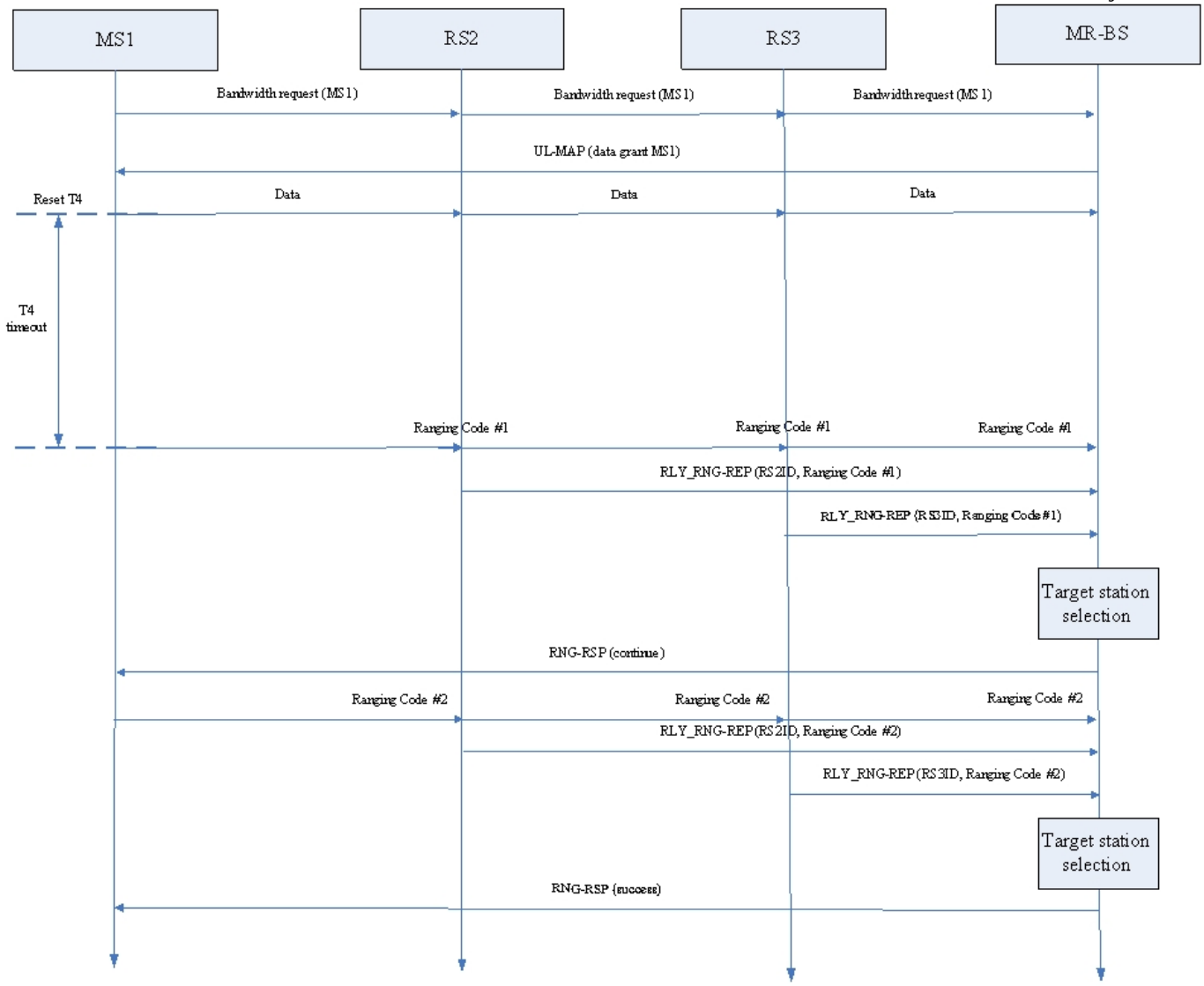

Figure 9: MS periodic ranging with aggregate ranging sub-channel allocation

III. Proposed text

----------Start text proposal----------

6.3.10.3 OFDMA based ranging

[Insert the following text into this section]

An RS that wishes to perform initial ranging shall perform the ranging process defined in 6.3.10.3.1.

Since a configured RS is always allocated with some reserved bandwidth for relaying service, when an RS wishes to perform periodic ranging, a contention-free based ranging specified in section 6.3.10.2 is employed.

6.3.10.3.4 Relaying support for OFDMA based ranging

[Insert the following text into this section]

6.3.10.3.4.1 Relaying support for OFDMA based ranging with separate ranging sub-channel allocation

In the separate ranging sub-channel allocation, the relaying support for OFDMA based ranging shall take the following actions:

—When a Ranging Code or an RNG-REQ message with Basic CID information is received, the RS shall response with an RNG-RSP message. This Ranging Response message contains all the needed adjustments (e.g. time, power, and possibly frequency corrections) and a status notification.

—When responding to an RNG-RSP message with success status for the received Ranging Code, the RS shall provide BW allocation for its subordinate stations using the CDMA_Allocation_IE message to send an RNG-REQ message.

—When receiving an RNG-REQ message with an MAC address, the RS shall send an RLY_RNG-REP message to the MR-BS. This message contains the original RNG-REQ message and an RSID of this RS.

—When receiving an RLY_RNG-REP message, the MR-BS shall transmit an RNG-RSP message which contains a valid basic CID to this specific access-RS. After receiving RNG-RSP, the access-RS shall transmit this message to its subordinate stations.

The ranging and adjustment processes given in Figure A, Figure B, and Figure C shall be followed by the access-RS and MR-BS.

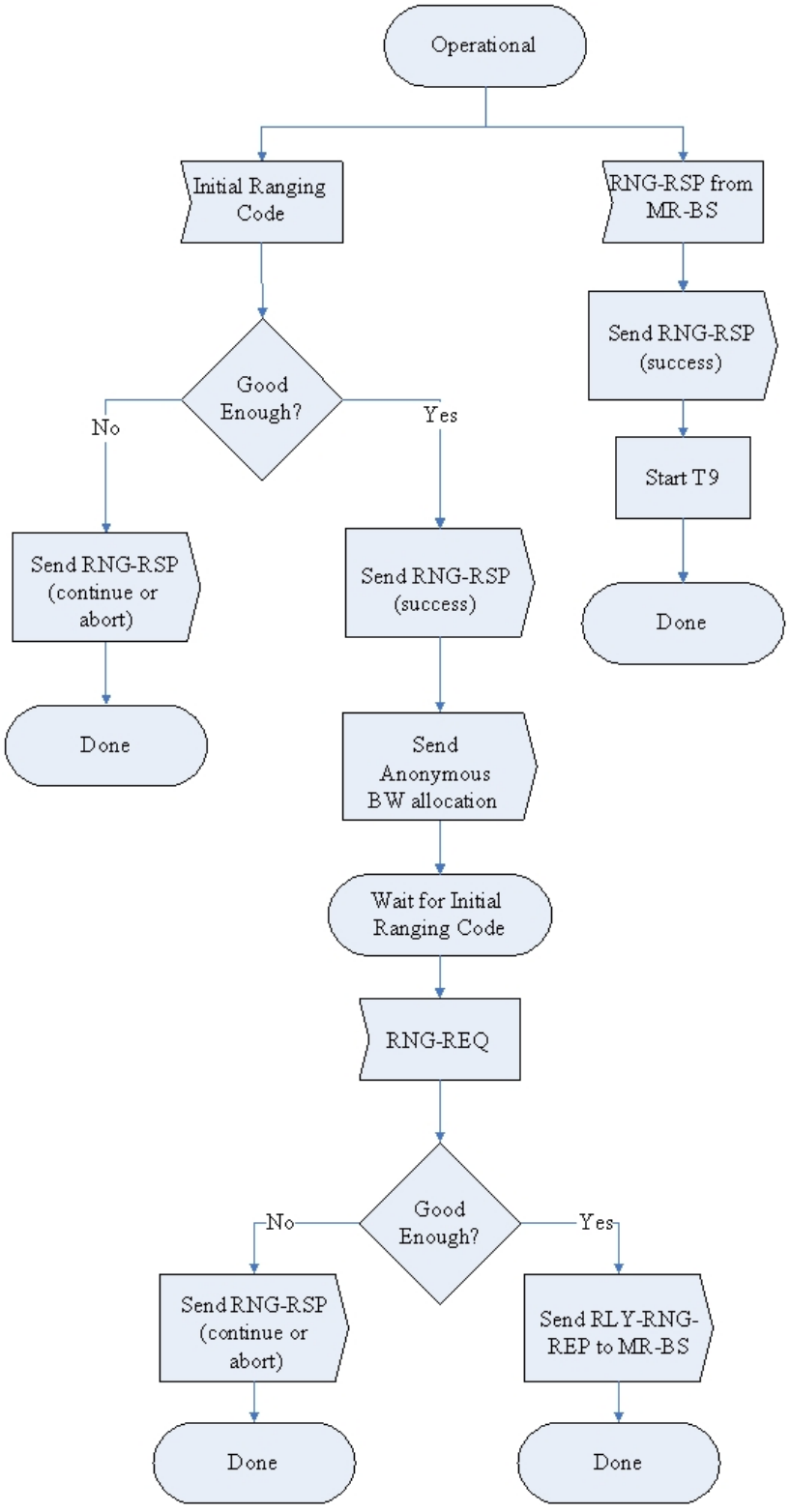

Figure A: CDMA initial ranging process with separate ranging sub-channel allocation (access-RS)

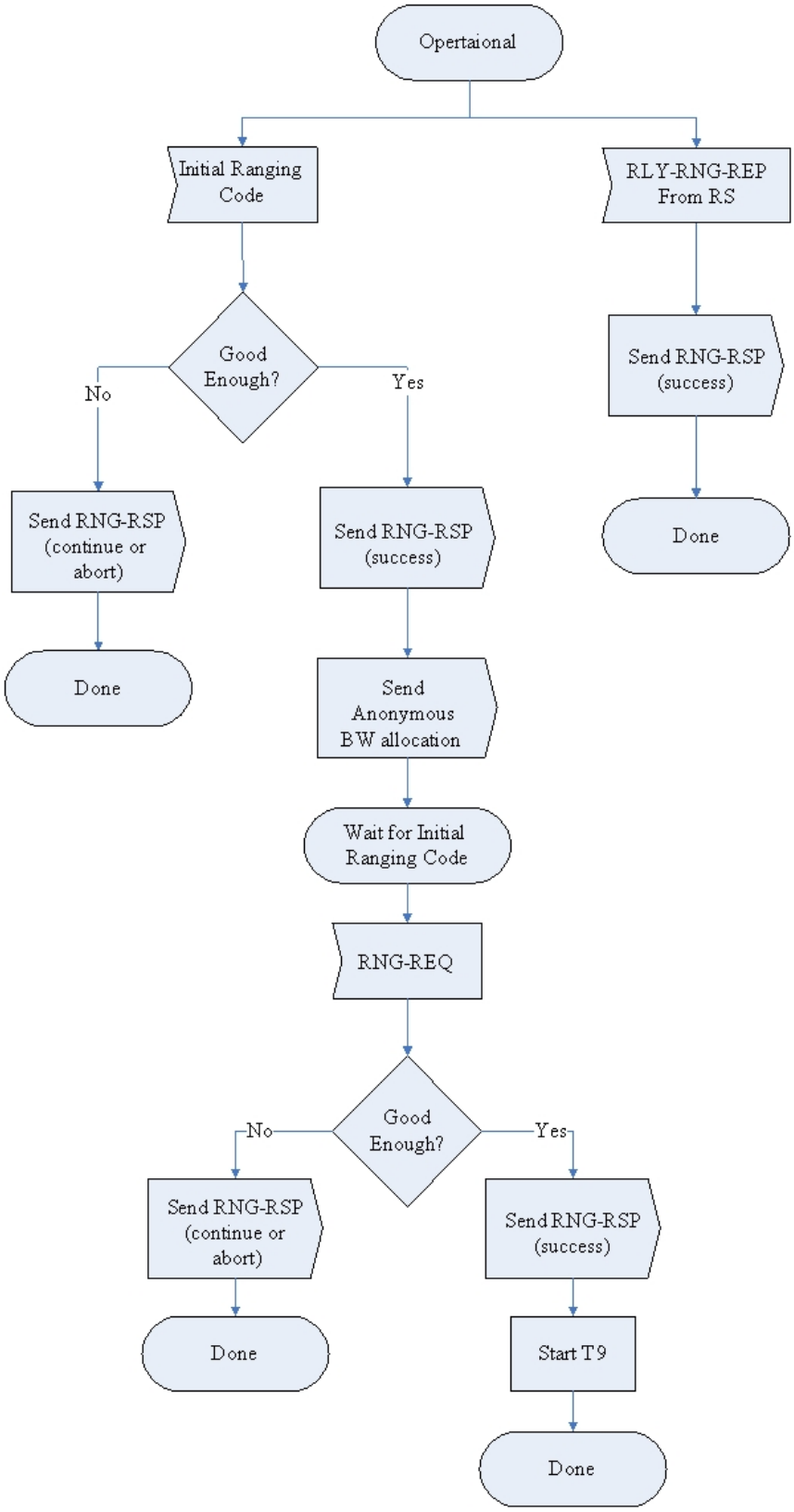

Figure B: CDMA initial ranging process with separate ranging sub-channel allocation (MR-BS)

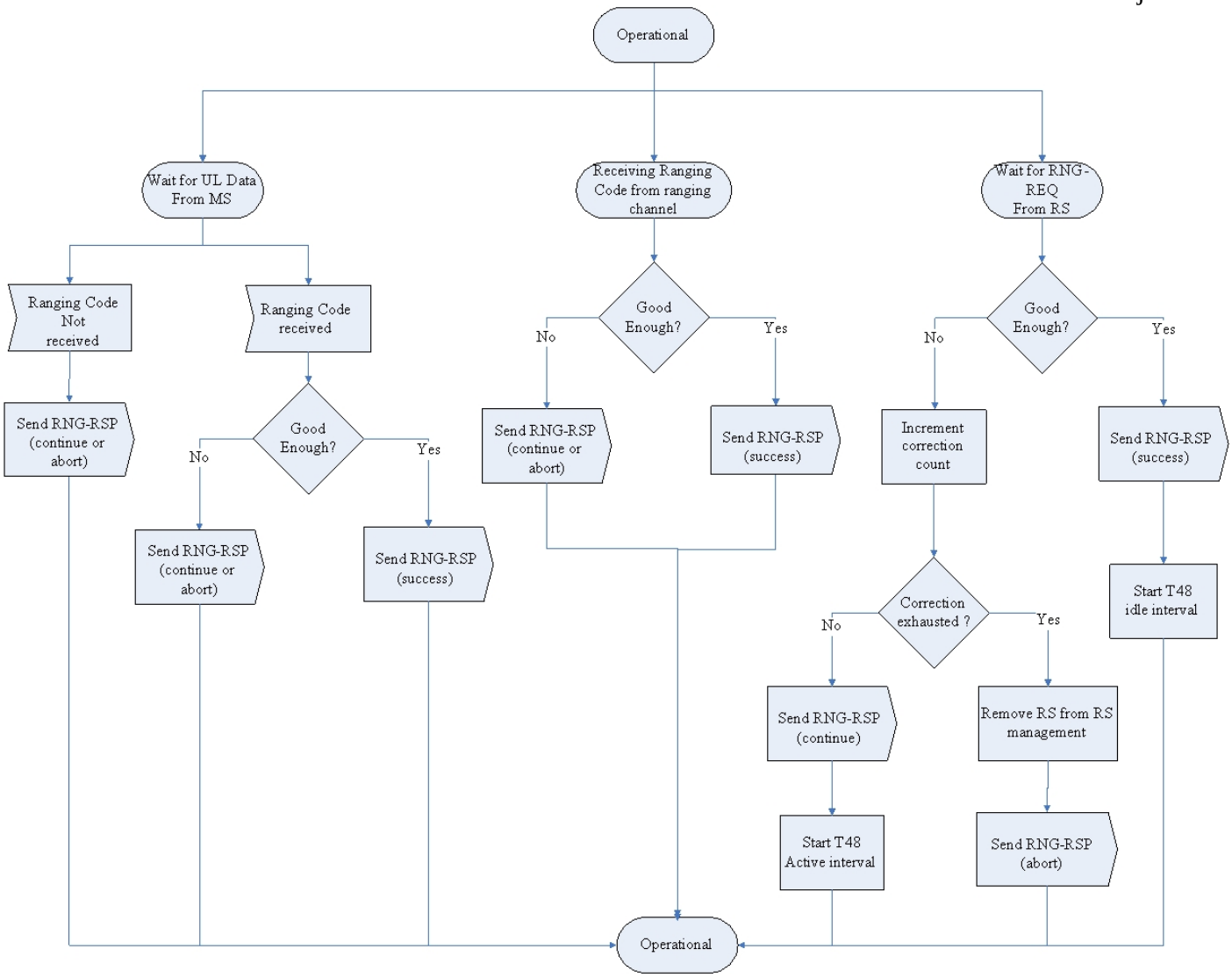

Figure C: Periodic CDMA ranging process with separate ranging sub-channel allocation (access-RS/ MR-BS)

6.3.10.3.4.2 Relaying support for OFDMA based ranging with aggregated ranging sub-channel allocation

In the aggregate raging sub-channel allocation, the relaying support for OFDMA based ranging shall take the following actions:

—When receiving a Ranging Code or an RNG-REQ message, the RS shall send an RLY_RNG-REP message to the MR-BS. This message contains its RSID, required adjustments and status about received Ranging Code (or RNG-REQ message).
—The MR-BS shall identify the received RLY_RNG-REP messages from its subordinate RSs by checking the Ranging Code (or RNG-REQ) and frame number to see if they are coming from the same user's ranging request during a period of time (timer T49).
—The MR-BS shall select a suitable station from these candidate access stations as the ranging target and response with an RNG-RSP message based on the target station's PHY parameters. This Ranging Response

message contains the needed adjustments (e.g. time, power, and possibly frequency corrections) and a status notification or contains a valid basic CID after success adjustments.

The ranging and adjustment processes given in Figure D, Figure E, Figure F, and Figure G shall be followed by superordinate RS and MR-BS.

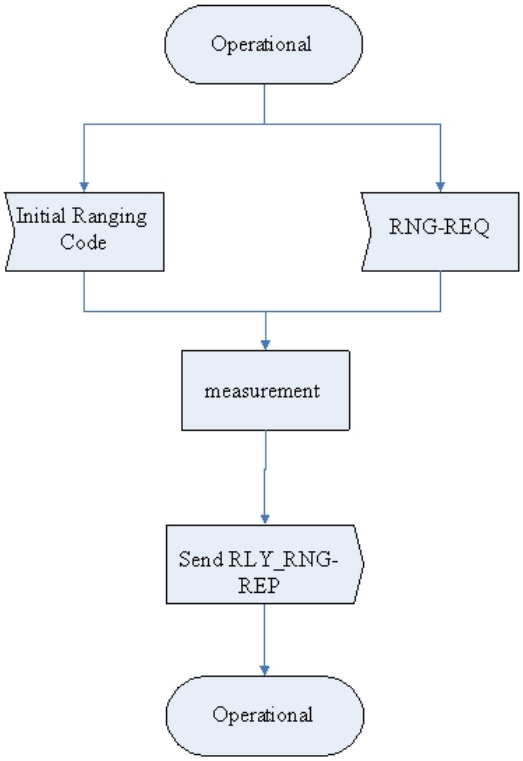

Figure D: CDMA initial ranging process with aggregate ranging sub-channel allocation (access RS)

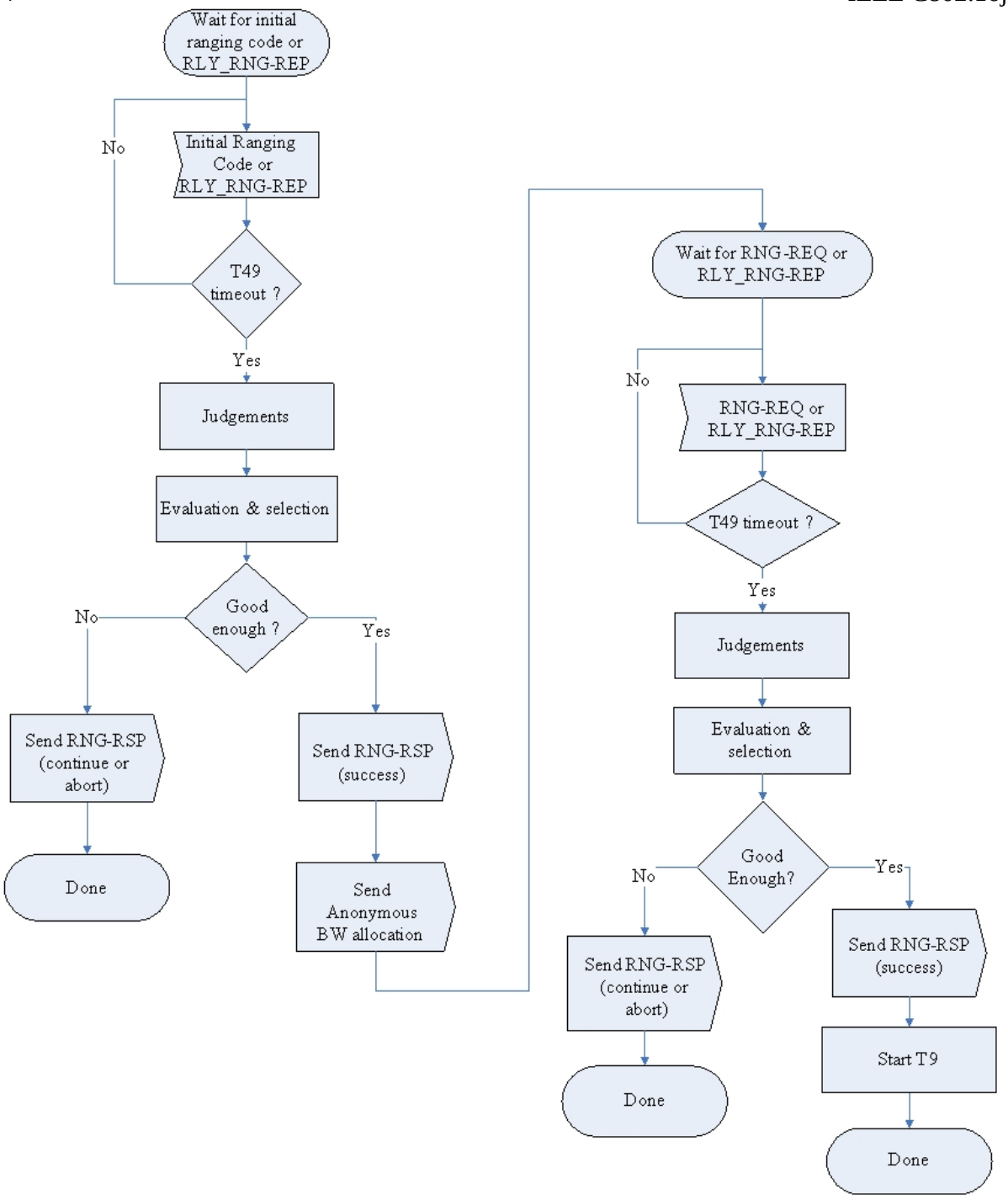

Figure E: CDMA initial ranging process with aggregate ranging sub-channel allocation (MR-BS)

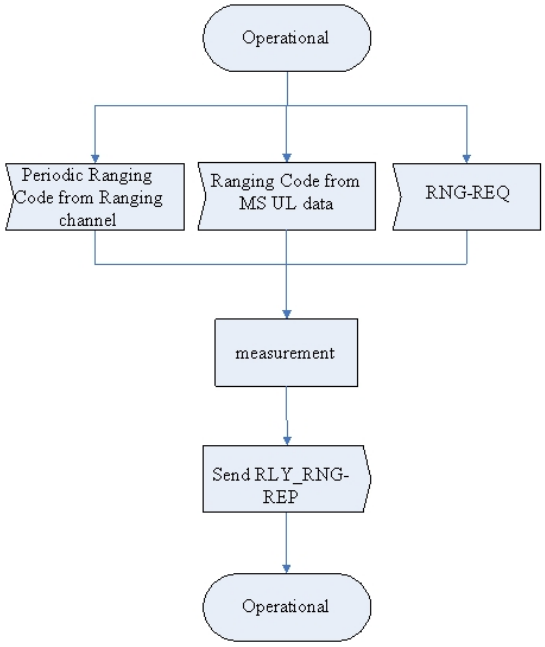

Figure F: Periodic CDMA ranging process with aggregate ranging sub-channel allocation (access-RS)

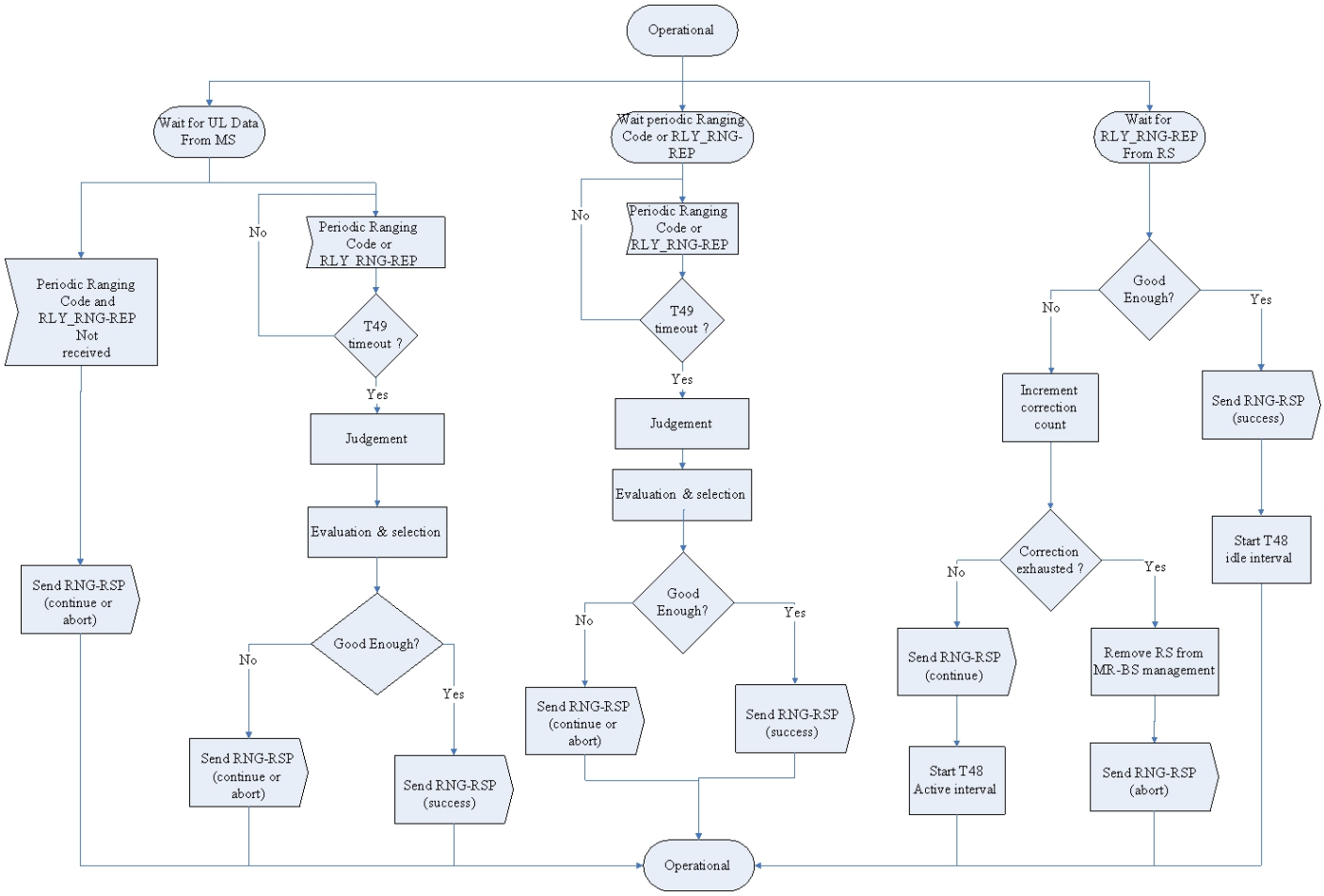

Figure G: Periodic CDMA ranging process with aggregate ranging sub-channel allocation (MR-BS)

6.3.2.3 MAC management messages

[Insert the following text into this section]
Add the columns into Table 14 as indicated.

Table 14—MAC Management messages

Type	Message name	Message description	Connection
74	RLY_RNG-REP	Relaying mode Relaying support ranging report message	Primary management

Relaying mode RS ranging report (RLY_RNG-REP) message

After receiving a Ranging Code or RNG-REQ message, RS shall transmit an RLY_RNG-REP message to report the ranging results to MR-BS. The message shall be transmitted on the Primary Management CID.

The format of the RLY_RNG-REP message is depicted in Table A.

Table A—RLY_RNG-REP message format

Syntax	Size	Notes
RLY_RNG-REP_Message_format(){	—	—
Management Message Type=74	8 bits	—
BSID	48 bits	BSID of access RS
Ranging type	2 bits	0b00: receiving a Ranging Code 0b01: receiving a RNG-REQ with MAC address 0b10: receiving a RNG-REQ with Basic CID 0b11: *Reserved*
Padding	6 bits	Shall be set to zero
If (Ranging type==0b00) {	—	—
N_Received_Ranging _Code	8 bits	Number of Ranging Code received in this frame number
For (j=0; j<N_Received_Ranging_Code; j++){	—	—
Ranging Code attributes	32 bits	Bits 31:22 – Used to indicate the OFDM time symbol reference that was used to transmit the ranging code. Bits 21:16 – Used to indicate the OFDMA subchannel reference that was used to transmit the ranging code. Bits 15:8 – Used to indicate the ranging code index that was sent by the SS. Bits 7:0 – The 8 least significant bits of the frame number of the OFDMA frame where the SS sent the ranging code.
Timing adjust	32 bits	Tx timing offset adjustment (signed 32-bit). The time required to advance subordinate station transmission so frames arrive at the expected time instance at the superordinate station. Units are PHY specific (see 10.3).
Power Level Adjust	8 bits	Tx Power offset adjustment (signed 8-bit, 0.25 dB units) Specifies the relative change in transmission power level that the subordinate station is to make in order that transmissions arrive at the superordinate station at the desired power. When sub-channelization is employed, the subscriber shall interpret the power offset adjustment as a required change to the transmitted power density.
Offset Frequency Adjust	32 bits	Tx frequency offset adjustment (signed 32-bit, Hzunits) Specifies the relative change in transmission frequency that the subordinate station is to make in order to better match the superordinate station. (This is fine-frequency adjustment within a channel, not reassignment to a different channel.)
Ranging Status	4 bits	Used to indicate whether uplink messages are received within acceptable limits by superordinate station. 1 = continue, 2 = abort, 3 = success, 4 = rerange

}	—	—
}	—	—
If (Ranging type==0b01) {	—	—
N_Received_RNG-REQ	8 bits	Number of RNG-REQ message received in this frame number
For (j=0; j<N_Received_RNG-REQ; j++){	—	—
TLV encoding	variable	RNG-REQ management message encodings
}	—	—
}	—	—
If (Ranging type==0b10) {	—	—
N_Received_RNG-REQ	8 bits	Number of RNG-REQ message received in this frame number
For (j=0; j<N_Received_RNG-REQ; j++){	—	—
Timing adjust	32 bits	Tx timing offset adjustment (signed 32-bit). The time required to advance subordinate station transmission so frames arrive at the expected time instance at the superordinate station. Units are PHY specific (see 10.3).
Power Level Adjust	8 bits	Tx Power offset adjustment (signed 8-bit, 0.25 dB units) Specifies the relative change in transmission power level that the subordinate station is to make in order that transmissions arrive at the superordinate stationat the desired power. When subchannelization is employed, the subscriber shall interpret the power offset adjustment as a required change to the transmitted power density.
Offset Frequency Adjust	32 bits	Tx frequency offset adjustment (signed 32-bit, Hzunits) Specifies the relative change in transmission frequency that the subordinate station is to make in order to better match the superordinate station. (This is fine-frequency adjustment within a channel, not reassignment to a different channel.)
Ranging Status	4 bits	Used to indicate whether uplink messages are received within acceptable limits by superordinate station. 1 = continue, 2 = abort, 3 = success, 4 = rerange
TLV encoding	variable	RNG-REQ management message encodings
}	—	—
}	—	—
Padding	variable	Optional
}	—	—

10.1 Global values

[Add the columns into Table 342 as indicated]

Table 342 Parameters and constants

System	Name	Time reference	Minimum value	Default value	Maximum value
MR-BS RS	T48 as Idle Timer	Maximum time between unicast grants to MS or RS when access station believes uplink transmission quality is good enough	Ranging Response Processing Time		
MR-BS RS	T48 as Active Timer	Maximum time between unicast grants to MS or RS when access station believes uplink transmission quality is not good enough	Ranging Response Processing Time		
MR-BS	T49	Time duration of Ranging report reception of the MR-BS	1 frame	=	=

----------End text proposal----------

References

[1] IEEE 802.16j-06/016r1, “Proposed Technical Requirements Guideline for IEEE 802.16 Relay TG”
[2] IEEE 802.16e-2005 specification