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802.16n Amendment Working Draft

NOTE- The editing instructions are shown in ***bold italic***. Four editing instructions are used: ***change***, ***delete***, ***insert***, and ***replace***. ***Change*** is used to make small corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using strike through (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make large changes in existing text, subclauses, tables, or figures by removing existing material and replacing it with new material. New materials to be added to existing standard (in Clauses 1 to 16) are blue underlined. New materials under Clause 17 are in black and are not underlined.

1. Overview

1.1 Scope

1.2 Purpose

2. Normative references

3. Definitions

[Insert the following definitions (renumbering may be required):]

3.148 Degraded Network: The failure of one or more 802.16 network infrastructure nodes or network connectivity.

3.149 Robustness: The capability of the network to withstand and automatically recover from degradation to provide the required availability to support mission critical applications (essential to the core function of society and the economy) including recovery from a single point of failure.

3.150 Mobile Base Station: A base station which is capable of maintaining service while moving.

3.151 Radio Path Redundancy: The ability to provide alternative paths between base stations, relay stations, and subscriber stations.

3.152 HR-MS: A subscriber station that complies with the requirements for subscriber stations in high reliable network.

3.153 HR-BS: A base station that complies with the requirements for base stations in high reliable network.

3.154 HR-RS: A relay that complies with the requirements for relays in high reliable network.

3.155 HR-Network: A network whose stations comply with their respective HR requirements.

3.156 HR-station: An HR-MS, HR-BS, or HR-RS.

3.157 Infrastructure station: An HR-BS or HR-RS.

3.158 Directly Associated: An HR-MS is directly associated with an infrastructure station if it is effectively controlled directly by it.

3.159 Indirectly Associated: An HR-MS is indirectly associated with an infrastructure station if it is effectively controlled by it through a forwarding HR-MS.

3.160 Coexistence: Coexistence is a state by which multiple wireless communications systems in same vicinity share a same radio frequency channel while minimizing harmful interference to each other by appropriate measures.

3.161 Self-coexistence: In HR network, self-coexistence is coexistence of multiple HR cells.

3.162 Self-coexistence mode: Self-coexistence mode is an operation mode of HR network, in which multiple HR cells share the same frequency channel in time.

4. Abbreviations and acronyms

[Insert the following abbreviations:]

HR	High Reliability
PPDR	Public Protection and Disaster Relief
SPOF	Single Point of Failure

5. Service Specific CS

6. MAC common part sublayer

6.3.2.3.5 RNG-REQ (ranging request) message

[Change the text in 6.3.2.3.5 RNG-REQ (ranging request) message as follows:]

…….

The following TLV parameter shall be included in the RNG-REQ message when the MS is attempting to perform reentry, HO, or location update:

Ranging Purpose Indication

The presence of this item in the message indicates the following MS action:

If Bit 0 is set to 1, in combination with a serving BSID, it indicates that the MS is currently attempting to HO or reentry; or, in combination with a

Paging Controller ID, indicates that the MS is attempting network reentry from idle mode to the BS.

If Bit 1 is set to 1, it indicates that the MS is initiating the idle mode location update process.

Bit 2: Seamless HO indication. When this bit is set to 1 in combination with other included information elements, it indicates the MS is initiating ranging as part of seamless HO procedure.

Bit 3: Ranging Request for Emergency Call Setup. When this bit is set to 1, it indicates MS action of Emergency Call Process.

Bit 4: MBS update. When this bit is set to 1, the MS is currently attempting to perform location update due to a need to update service flow management encodings for MBS flows.

Bit 5: HR Multicast service flow update. When this bit is set to 1, the MS is currently a need to update multicast service flow management encodings for multicast transmission due to crossing Multicast Group zone.

Bits ~~5~~6–7: *Reserved*

…….

6.3.2.3.6 RNG-RSP (ranging response) message

[Insert the following text at the end of 6.3.2.3.6 RNG-RSP (ranging response) message as follows:]

The following parameters shall be included only if the bit 4 of ranging purpose indication in the RNG-REQ message is set to 1.

HR multicast service flow update mapping info (see 11.1.13)

HR multicast service flow update mapping info is used by the BS' in one multicast zone to provide consistency of HR Multicast CID mapping used in other multicast zone as determined by the serving multicast zone.

6.3.2.3.42 MOB_NBR-ADV (neighbor advertisement) message

[Insert the following text at the end of 6.3.2.3.42 MOB_NBR-ADV (neighbor advertisement) message as follows:]

HR multicast service flow update mapping info (see 11.1.13)

HR multicast service flow update mapping info is used by the BS' in one multicast zone to provide consistency of HR Multicast CID mapping used in other multicast zone as determined by the serving multicast zone.

6.3.2.3.47 MOB_BSHO-REQ (BS HO request) message

[Change Table 150 as indicated:]

Table 150 – MOB_BSHO-REQ message format

Syntax	Size (bit)	Notes
…		
Mode	3	0b000: HO Request 0b001: MDHO/FBSS request: Anchor BS update with CID update 0b010: MDHO/FBSS request: Anchor BS update without CID update 0b011: MDHO/FBSS request: Diversity set update with CID update 0b100: MDHO/FBSS request: Diversity set update without CID update 0b101: MDHO/FBSS request: Diversity set update with CID update for newly added BS 0b110: MDHO/FBSS request: Diversity set update without CID update for newly added BS ~~0b111: *Reserved.*~~ 0b111: Alternative Path (only for HR-Network)
Padding	5	Shall be set to zero.
If (Mode == 0b000 or 0b111)	-	-
…		
HO_authorization policy indicator	1	Indicates whether Seamless HO mode is supported 0: Not supported 1: Supported
Seamless HO mode flag	1	Indicates whether Seamless HO mode is supported 0: Not supported 1: Supported
If (Mode == 0b111) {	-	-
Role	1	0b0: Stay as HR-MS; 0b1: Change to HR-RS;

CDMA_code	8	-
Transmission_opportunity_offset	8	-
Basic CID	16	-
}		

[Change the definition for Action Time in **MOB_BSHO-REQ message as** *indicated:]*

Action Time

For HO, this value is defined as number of frames until the Target BS allocates a dedicated transmission opportunity for RNG-REQ message to be transmitted by the MS using Fast_Ranging_IE. Dedicated allocation for transmission of RNG-REQ means that channel parameters for that BS learned by the MS before HO stay valid and can be reused during actual Network Re-entry without preceding CDMA-based Ranging. Final Action Time shall be decided by the Serving BS based on the information obtained from potential Target BSs over the backbone network. A value of zero indicates no opportunity to allocate Fast Ranging IE in any candidate target BS.

For MDHO/FBSS, this is the time of update of Anchor BS and/or Diversity Set. A value of zero in this parameter signifies that this parameter shall be ignored.

For Alternative Path, this is the wait time in units of 1 ms before the HR-MS performs fast network reentry to target station.

7. Security sublayer

8. Physical layer (PHY)

8.4 WirelessMAN-OFDMA PHY

8.4.1 Introduction

[Insert the following sentence into section 8.4.1 on Page 694 at the end of 2nd paragraph:]

The OFDMA PHY may support the VHF mode specified in 17.2.12.

8.4.3 OFDMA basic terms definition

8.4.3.1 Slot and data region

[Change the 2nd and 3rd bullet points in Section 8.4.3.1as indicated:]

— For DL PUSC (defined in 8.4.6.1.2.1), one slot is one subchannel by two OFDMA symbols. For VHF mode DL PUSC, one slot is one subchannel by four OFDMA symbols.
— For UL PUSC (defined in 8.4.6.2.1 and 8.4.6.2.5) and for DL TUSC1 and TUSC2 (defined in 8.4.6.1.2.4 and 8.4.6.1.2.5), one slot is one subchannel by three OFDMA symbols. For VHF mode UL PUSC, one slot is one subchannel by seven OFDMA symbols.

8.4.4.3 OFDMA Frame Parameters and Operations

[Insert the following text at the end of Section 8.4.4.3:]

In VHF mode, subcarrier allocation scheme of PUSC (defined in 8.4.6.1.2.1.1 and 8.4.6.2.2) is used for both UL and DL and duplex method is TDD, and MIMO, STC scheme are not used.

8.4.4.4 DL frame prefix

[Insert the following text at the end of Section 8.4.4.4:]

For VHF mode, CC encoding used on DL-MAP is selected as “Coding_Indication” from DL frame prefix format shown in Table 314. The FFT size of 1024 is selected from Table 315.

8.4.5 Map message fields and IEs

8.4.5.2 Frame duration codes

[Change Table 320 as indicated:]

Table 320—OFDMA frame duration (*Tf* ms) codes

Code (N)	Frame duration (ms)	Frames per second
0	*Reserved*	N/A
1	2	500
2	2.5	400
3	4	250
4	5	200
5	8	125
6	10	100
7	12.5	80

8	20	50
9-255~~5~~4	Reserved	
255	Infinity	0

[Insert the following text at the end of Section 8.4.5.2:]

The code 255 is used for HR-MS direct communication without infrastructure station only.

8.4.5.3 DL-MAP IE format

[Change the text in 8.4.5.3.2.3 as follows:]

8.4.5.3.2.3 DL-MAP Extended-3 IE encoding format

A DL-MAP IE entry with an Extended-2 DIUC = 0xF indicates that the IE carries special information and conforms to the structure shown in Table 327. A station shall ignore an extended-3 IE entry with an extended-3 DIUC value for which the station has no knowledge. In the case of a known extended-3 DIUC value but with a length field longer than expected, the station shall process information up to the known length and ignore the remainder of the IE.

Table 327—DL-MAP Extended-3 IE format

Syntax	Size (bit)	Notes
DL_Extended-3_IE() {		
Extended-2 DIUC	4	0xF
Length	8	Length in bytes of the unspecified data field plus the extended-3 DIUC field
Extended-3 DIUC	4	0x0 … 0xF
Unspecified data	variable	
}		

Table 328 defines the encoding for extended-3 DIUC that shall be used by DL-MAP Extended-3 IEs.

Table 328—Extended-3 DIUC code assignment for Extended-2 DIUC = 15

Extended-3 DIUC	Usage
0x0	Power Boosting IE
0x1	HR Multicast DL MAP IE
0x~~1~~2 – 0xF	Reserved

[Change the text in 8.4.5.3.21 as follows:]

8.4.5.3.21 HARQ DL MAP IE

The following modes of HARQ shall be supported by the HARQ DL MAP IE:

a) Chase combining HARQ for all FEC types (HARQ Chase). In this mode, the burst profile is indicated by a DIUC.

b) Incremental redundancy HARQ with CTC (HARQ IR). In this mode, the burst profile is indicated by the parameters NEP, NSCH.

c) Incremental redundancy HARQ for convolutional code (HARQ CC-IR).

d) HR Multicast DL burst. In this mode, the burst profile is indicated by a DIUC.

The IE may also be used to indicate a non-HARQ transmission when ACK disable = 1.

……

Table 350—HARQ DL MAP IE format

Syntax	Size (bit)	Notes
HARQ_DL_MAP_IE() {		
Extended-2 DIUC	4	HARQ_DL_MAP_IE() = 0x7
Length	8	Length in bytes
RCID_Type	2	0b00: Normal CID 0b01: RCID11 0b10: RCID7 0b11: RCID3 For HR Multicast, RCID_Type is set to 0b00 and Normal CID is replaced by HR Multicast CID
ACK region index	1	The index of the ACK region associated with all subbursts (except HR multicast DL burst) defined in this HARQ DL map IE (FDD/ H-FDD only). 0: first ACK region 1: second ACK region This bit shall be set to 0 for TDD mode.
Reserved	1	
While (data remains) {		
Boosting	3	0b000: Normal (not boosted) 0b001: +6dB 0b010: .6dB 0b011: +9dB 0b100: +3dB 0b101: .3dB 0b110: .9dB 0b111: .12dB;
Region_ID use indicator	1 bit	0: not use Region_ID 1: use Region_ID
If (Region_ID use indicator == 0) {		
OFDMA symbol offset	8	Offset from the start symbol of DL subframe

Subchannel offset	7	
Number of OFDMA symbols	7	
Number of subchannels	7	
Rectangular subburst Indication	1	Indicates subburst allocations are time-first rectangular. The duration field in each subburst IE specifies the number of subchannels for each rectangular allocation. This is only valid for AMC allocations and all allocations with dedicated pilots. When this field is clear, subbursts shall be allocated in frequency-first manner and the duration field reverts to the default operation.
Reserved	2	
} else {		
Region_ID	8	Index to the DL region defined in DL region definition TLV in DCD
}		
Mode	4	Indicates the mode of this HARQ region: 0b0000: Chase HARQ 0b0001: Incremental redundancy HARQ for CTC 0b0010: Incremental redundancy HARQ for Convolutional Code 0b0011: MIMO Chase HARQ 0b0100: MIMO IR HARQ 0b0101: MIMO IR HARQ for Convolutional Code 0b0110: MIMO STC HARQ 0b0111: HR Multicast DL subburst ~~0b0111~~0b1000 - 0b1111: *Reserved*
Subburst IE Length	8	Length, in nibbles, to indicate the size of the sub-burst IE in this HARQ mode. The MS may skip DL HARQ Subburst IE if it does not support the HARQ mode. However, the MS shall decode N ACK Channel field from each DL HARQ Subburst IE to determine the UL ACK channel it shall use for its DL HARQ burst.
If (Mode == 0b0000) {		
DL_HARQ_Chase_subburst_IE()	*variable*	
} else if (Mode == 0b0001) {		
DL_HARQ_IR_CTC_subburst_IE ()	*variable*	
} else if (Mode == 0b0010) {		
DL_HARQ_IR_CC_subburst_IE()	*variable*	
} else if (Mode == 0b0011) {		
MIMO_DL_Chase_HARQ_subburst _IE()	*variable*	

} else if (Mode == 0b0100) {		
MIMO_DL_IR_HARQ_subburst_IE ()	*variable*	
} else if (Mode == 0b0101) {		
MIMO_DL_IR_HARQ_for_CC_ subburst_IE()	*variable*	
} else if (Mode == 0b0110) {		
MIMO_DL_STC_HARQ_subburst_IE()	*variable*	
} elseif (Mode == 0b0111){		
HR Multicast DL subburst IE	*variable*	Table xx+1
}		
}		
Padding	*variable*	Padding to byte for the unspecified portion of this IE, i.e., not including the first two fields, “Extended-2 DIUC” and “Length”; shall be set to 0
}		

[Change the text in 8.4.5.3.29 as follows:]

8.4.5.3.29 Persistent HARQ DL MAP Allocation IE

Downlink persistent allocations are used by the BS to make downlink time-frequency resource assignments which repeat periodically. The logical time-frequency resource assigned using the Persistent HARQ DL MAP IE repeats at a periodic interval. For downlink persistent allocations, the BS transmits the Persistent HARQ DL MAP IE, with the mode field set to one of the following values:

- 0b0000: Persistent DL Chase HARQ
- 0b0001: Persistent DL Incremental redundancy HARQ for CTC
- 0b0010: Persistent DL Incremental redundancy HARQ for Convolutional Code
- 0b0011: Persistent MIMO DL Chase HARQ
- 0b0100: Persistent MIMO DL IR HARQ
- 0b0101: Persistent MIMO DL IR HARQ for Convolutional Code
- 0b0110: Persistent MIMO DL STC HARQ
- 0b0111: HR Multicast DL subburst

The Persistent HARQ DL MAP IE may be used for non persistent allocations by setting the persistent flag in the subburst IE to 0.

Table 366—Persistent HARQ DL MAP allocation IE

Syntax	Size (bit)	Notes
Persistent_HARQ_DL_MAP_IE() {		
Extended-2 DIUC	4	Persistent_HARQ_DL_MAP_IE = 0xD
Length	8	Length in bytes
RCID_Type	2	0b00: Normal CID 0b01: RCID11 0b10: RCID7 0b11: RCID3 For HR Multicast, RCID_Type is set to 0b00 and Normal CID is replaced by HR Multicast CID
ACK Region Index	1	The index of the ACK region associated with all subbursts (except HR multicast DL burst) defined in this Persistent HARQ DL MAP (FDD/H-FDD only)
while (data_remains){		
Region ID use indicator	1	0: Region ID not used 1: Region ID used
Change Indicator	1	0: No change occurred 1: Change occurred
if (Region ID use indicator == 0){		
OFDMA Symbol offset	8	
Subchannel offset	7	
Number of OFDMA symbols	7	
Number of subchannels	7	
Rectangular subburst indication	1	Indicates subburst allocations are time-first rectangular. The duration field in each subburst IE specifies the number of subchannels for each rectangular allocation. The slot offset field in each subburst IE specifies the subchannel offset from the first subchannel for each rectangular allocation. When this field is clear, subbursts shall be allocated in frequency-first manner and the duration field reverts to the default operation
}		
else{		
Region ID	8	Index to the DL region defined in DL region definition TLV in DCD
}		
Power boost per subburst	1	Set to 1 to signal power boost per subburst. This field shall be set to 0 if Rectangular subburst indication is set to 0
if (Power boost per subburst == 0){		
Boosting	3	0b000: Normal (not boosted) 0b001: +6dB

		0b010: –6dB 0b011: +9dB 0b100: +3dB 0b101: –3dB 0b110: –9dB 0b111: –12dB Note that if the Persistent flag is set, the boosting value applies to each allocation instance of the persistent allocation
}		
Mode	4	Indicates the mode in this HARQ region 0b0000: Persistent DL Chase HARQ 0b0001: Persistent DL Incremental redundancy HARQ for CTC 0b0010: Persistent DL Incremental redundancy HARQ for Convolutional Code 0b0011: Persistent MIMO DL Chase HARQ 0b0100: Persistent MIMO DL IR HARQ 0b0101: Persistent MIMO DL IR HARQ for Convolutional Code 0b0110: Persistent MIMO DL STC HARQ 0b0111: HR Multicast DL subburst ~~0b0111~~0b1000 to 0b1111: *Reserved*
Subburst IE Length	8	Length, in nibbles, to indicate the size of the subburst IE in this HARQ mode. The MS may skip DL HARQ Subburst IE if it does not support the HARQ mode. However, the MS shall decode NACK Channel field from each DL HARQ Subburst IE to determine the UL ACK channel it shall use for its DL HARQ burst
if(Mode == 0b0000){		
Persistent DL Chase HARQ subburst IE	*variable*	
} elseif (Mode == 0b0001){		
Persistent DL Incremental redundancy HARQ for CTC subburst IE	*variable*	
} elseif (Mode == 0b0010){		
Persistent DL Incremental redundancy HARQ for	*variable*	

Convolutional Code		
} elseif (Mode == 0b0011){		
Persistent MIMO DL Chase HARQ	*variable*	
} elseif (Mode == 0b0100){		
Persistent MIMO DL IR HARQ	*variable*	
} elseif (Mode == 0b0101){		
Persistent MIMO DL IR HARQ for Convolutional Code	*variable*	
} elseif (Mode == 0b0110){		
Persistent MIMO DL STC HARQ	*variable*	
} elseif (Mode == 0b0111){		
HR Multicast DL subburst IE	*variable*	Table xx+1
}		
}		
Padding	*variable*	Padding to byte for the unspecified portion of this IE (i.e., not including the first two fields, "Extended-2 DIUC" and "Length"); shall be set to 0.
}		

8.4.6 OFDMA subcarrier allocations

[Insert the following text at the end of Section 8.4.6:]

In VHF mode, sampling factor n is 8/7 for the channel bandwidth of 5 MHz and also subcarrier allocation scheme of PUSC (defined in 8.4.6.1.2.1 and 8.4.6.2.5) is used for both UL and DL.

8.4.6.1.2.1 Symbol structure for PUSC

[Insert the following text at the end of Section 8.4.6.1.2.1:]

For VHF mode, the symbol is first divided into basic tiles (as defined in Figure 247a) and zero carriers are allocated. Pilots and data carriers are allocated within each tile. Table 442a summaries the parameters of the symbol structure under this PHY mode.

A slot in the DL of VHF mode is composed of **four (4)** OFDMA symbols and one subchannel. Within each slot, there are **48** data subcarriers and **16** fixed-location pilots as

shown in Table 247a. The subchannel is constructed from **four(4)** DL tiles. Each tile has four successive active subcarriers, and its configuration is illustrated in Figure 247a.

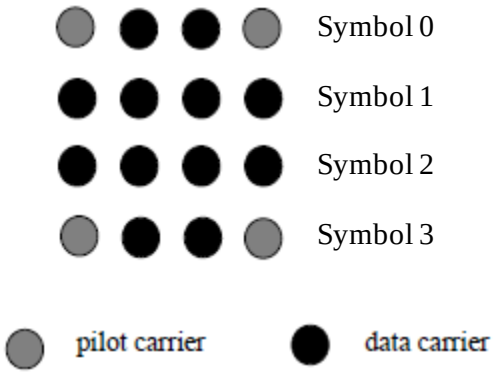


Figure 247a—Description of a DL tile in VHF Mode

8.4.6.2.1 Symbol structure for subchannel (PUSC)

[Insert the following text at the end of Section 8.4.6.2.1:]

For VHF mode, a slot in the UL is composed of **seven (7)** OFDMA symbols and one subchannel. Within each slot, there are **48** data subcarriers and 8 fixed-location pilots as shown in Table 249a. The subchannel is constructed from **two(2)** UL tiles. Each tile has four successive active subcarriers, and its configuration is illustrated in Figure 249a.

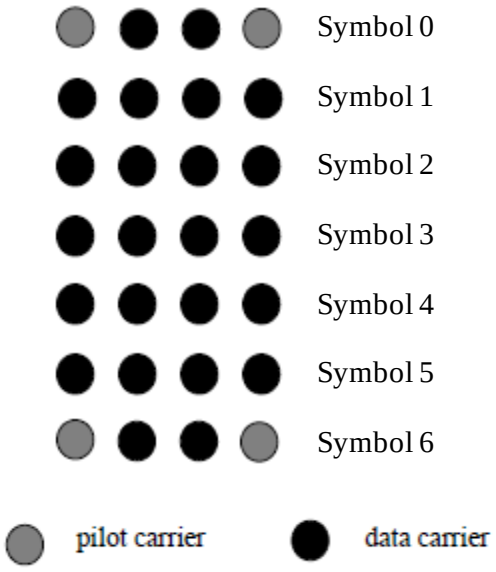


Figure 249a—Description of an UL tile in PHY Mode specified for HR-Network

8.4.9.3 Interleaving

[Insert the following text at Section 8.4.9.3 on Page 1061 before the last 2nd paragraph:]

For VHF mode, the first and second permutation follows the equations (121) and (122), respectively with d=18.

10. Parameters and constants

10. 1 Global values

[Insert the following row at the end of Table 554:]

Table 554—Parameters and constants

System	Name	Time reference	Minimum value	Default value	Maximum value
SS	T74	Wait for DSA/DSC acknowldegement timeout in case the flow runs over a direct communication link	—	—	600 ms

11. TLV encodings

11.1 Common encodings

[Change Table 559 - Type values for common TLV encodings as indicated:]

Type	Name
149	HMAC Tuple
148	MAC Version Encoding
147	Current Transmit Power
146	Downlink Service Flow
145	Uplink Service Flow
144	Vendor ID Encoding
143	Vendor-Specific Information
142	SA-TEK-Update
141	CMAC tuple
140	Short-HMAC tuple
139	Enabled-Action-Triggered
138	SLPID_Update
137	Next Periodic Ranging
136	MAC Hash Skip Threshold
135	Paging Controller ID

134	Paging Information
133	NSP List
132	Verbose NSP Name List
131	MIHF frame
130	MIHF frame type
129	Query ID
128	MCID Pre-allocation and Transmission info
127	MCID Continuity and Transmission Info
126	HR multicast service flow update mapping info

[Insert the following at the end of 11.1 (renumbering may be required):]

11.1.13 HR multicast service flow update mapping info

The TLV encodings defined in this subclause are specific to the RNG-RSP (6.3.2.3.6) and MOB_NBR-ADV (6.3.2.3.42) MAC management message. This TLV indicates the mapping of HR Multicast CID used in the current Multicast zone to new HR Multicast CID within a neighboring Multicast zone and information regarding the HR-Multicast MAP transmission in the neighbor Multicast Zone.

Type	Length (bytes)	Value	Scope
126	Variable (3+Nx4)	See Table xyz	RNG-RSP, MOB_NBR-ADV

Table xyz – HR Multicast service flow update mapping info definition

Field	Length (bits)	Note
Multicast_Group_Zone_ID	12	Multicast zone identifier for current Multicast Zone
Neighboring_Multicast Group_ZONE_ID	12	Multicast Group zone identifier for neighboring Multicast Group Zone
List of HR Multicast CID Mappings	variable (Nx4)	Current_HR_MCID(1), New_HR_MCID(1), ..., Current_HR_MCID(N), New_HR_MCID(N)

A value of 0xFFFF in the New_HR_MCID field indicates that the service flow corresponding to Current_HR_MCID is not available in the Multicast Zone identified by the TLV.

11.4 DCD management message encodings

11.4.1 DCD channel encodings

[Insert the following row at the end of Table 575:]

Multicast group zone identifier	xxx	1	This parameter shall include multicast zone identifier with which BS is associated. A Multicast Group Zone identifier is 1 byte long. bits 11 through 0 are the Multicast Group Zone Identifier, bits 16 through 13 are set to 0 in each byte. The Multicast Group Zone identifier shall not be '0'. When the parameter is part of a compound DCD_settings TLV (refer to 11.18.1), a value of 0 means that the neighbor BS is not affiliated with any Multicast Group zone	All

11.5 RNG-REQ management message encodings

[Change Table 582* - RNG-REQ message encodings *as indicated:]

Table 582—RNG-REQ message encodings

Name	Type (1byte)	Length	Value (variable length)	PHY scope
……	…	…	……	…
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 reentry 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: Seamless HO indication (when this bit is set to 1 in combination with other included information elements indicates the MS is currently initiating ranging as part of the seamless HO procedure) Bit 3: Ranging Request for Emergency Call Setup (when this bit is set to 1, it indicates MS action of Emergency Call Process)	

			Bit 4: MBS update. When this bit is set to 1, the MS is currently attempting to perform location update due to a need to update service flow management encodings for MBS flows. Bit 5: HR Multicast service flow update. When this bit is set to 1, the MS is currently a need to update multicast service flow management encodings for multicast transmission due to crossing Multicast Group zone. Bits ~~5~~6–7: *Reserved*	
.....	…	…	.....	…

11.13 **Service flow management encodings**

[Insert the following rows at the end of Table 606:]

Table 606—Service flow encodings

Type	Parameter
58	Direct Communication
59	HR multicast service
60	HR multicast group zone identifier assignment

[Insert the following row at the end of Table 607:]

Table 607—CC values

CC	Status
19	direct-comm-setup

[Insert the following section:]

11.13.46 Direct Communication Service Addition/Change TLV

The value of this field specifies that the flow specified in this DSA_REQ will be transmitted over a direct communication link.

Type	Length	Value	Scope
145.58	1	0	DSA_REQ

11.13.47 HR multicast service

This TLV indicates whether the multicast service is being requested or provided for the connection that is being setup. A value of 1 indicates that an multicast service limited to the serving BS is being requested and a value of 2 indicates multi-BS-MBS regardless of proving macro-diversity. If MS or BS wants to initiate multicast service, DSA-REQ with HR multicast service TLV shall be used. The DSA-RSP message shall contain the acceptance or rejection of request and if there is no available multicast, multicast service value shall be set to 0.

Type	Length	Value	Scope
[145/146].59	1	0: No available multicast service 1: Multicast in Serving BS Only 2: Multicast in a multi-BS Zone supporting 3-255: Reserved	DSA-REQ, DSA-RSP, DSA-ACK, DSC-REQ, DSC-RSP

11.13.48 Multicast Group Zone Identifier Assignment parameter

The DSA-REQ/RSP message may contain the value of this parameter to specify a MBS Zone identifier. This parameter indicates a MBS zone through which the connection or virtual connection for the associated service flow is valid.

Type	Length	Value	Scope
[145/146].60	1	Multicast group zone identifier (bits 11 through 0 are the Multicast Group Zone Identifier, bits 15 through 12 are set to 0)	REG-REQ, REG-RSP, DSA-REQ, DSA-RSP, DSC-REQ, DSC-RSP

16. WirelessMAN-Advanced Air Interface

16.1 Introduction

16.2 Medium access control

16.2.1 Addressing

16.2.1.3 Addressing to support machine to machine application

16.2.2 MAC PDU formats

16.2.3 MAC Control messages

[Change Table 683 as indicated (renumbering may be required):]

Table 683 – MAC control messages

No.	Functional	Message	Message	Secuirty	Connection

	Areas	**names**	**description**		
71	Backbone Enable	BBE-REQ	Backbone Enable Request		Unicast
72	Backbone Enable	BBE-RSP	Backbone Enable Response		Unicast
73	Backbone Disable	BBD-REQ	Backbone Disable Request		Unicast
74	Backbone Disable	BBD-RSP	Backbone Disable Response		Unicast
75	Backbone Enable	BBE-CMD	Backbone Enable Command		Broadcast
76	Backbone Disable	BBD-CMD	Backbone Disable Command		Broadcast
77	Multimode	AAI-MM-ADV	Multimode advertisement	N/A	Broadcast
78	Multimode	AAI-MMRS-REQ	Multimode Relay request	Encrypted/ICV	Unicast
79	Multimode	AAI-MMRS-RSP	Multimode Relay response	Encrypted/ICV	Unicast
80	Multimode	AAI-MMRL-REQ	Multimode release request	Encrypted/ICV	Unicast
81	Multimode	AAI-MMRL-RSP	Multimode release response	Encrypted/ICV	Unicast
82	Forwarding MS List	AAI-DMMS-ADV	MS list Advertisement		Broadcast or multicast or unicast
83	Forwarding MS list Update	AAI-DMLU-REQ	MS List Update Request		Unicast
84	Forwarding MS list Update	AAI-DMLU-RSP	MS List Update Response		Unicast

[Change Table 684 in section 16.2.3.1 as indicated:]

Table 684.—AAI-RNG-REQ message Field Description

Field	Size (bits)	Value/Description	Condition
Ranging Purpose Indication	4	0b0000 = Initial network entry 0b0001 = HO reentry 0b0010 = Network reentry from idle mode 0b0011 = Idle mode location update 0b0100 = DCR mode extension 0b0101 = Emergency call setup (e.g., E911) 0b0110 = Location update for updating service flow management encodings of E-MBS flows 0b0111 = Location update for transition to DCR mode from idle mode 0b1000 = Reentry from DCR mode, coverage loss or detection of different ABS restart count. 0b1001 = Network reentry from a Legacy BS 0b1010 = Zone switch to MZONE from LZONE 0b1011 = Location update due to power down. 0b1100 = Interference mitigation request to a CSG Femto ABS when experiencing interference from the CSG Femto ABS 0b1101 = NS/EP call setup ~~0b1110–0b1111 = reserved~~ 0b1110 = HR multicast service flow update 0b1111 = reserved	-
…	…	…	…

16.2.3.2 AAI-RNG-RSP

[Change Table 685 in section 16.2.3.2 as indicated:]

Table 685—AAI-RNG-RSP message field description

Field	Size (bits)	Value/Description	Condition
Ranging Abort	1	Set to 1 when an ABS rejects the AMS.	Present when an ABS rejects an AMS.
If (Ranging Abort == 1) {			
Ranging Abort Timer	16	Timer defined by an ABS to prohibit the AMS from attempting network entry at this ABS, for a specific time duration. Value: 0 (Do not try ranging again at the ABS.) Value: 1–65534, in units of seconds Value: 65535 (When the received CSGID(s) from the AMS does not	

		match any of the CSGID(s) of the Femto ABS. This value indicates the Ranging Abort Timer is not to be used, and the AMS can range any time.)	
}else{			
…	…	…	…
Location Update Response	4	0x0= Success of Location Update 0x1= Failure of Location Update 0x2 = *Reserved* 0x3 = Success of location update and DL traffic pending 0x4 = Allow AMS's DCR mode initiation request or DCR mode extension request 0x5 = Reject AMS's DCR mode initiation request or DCR mode extension request 0x6~0xF: *Reserved*	Shall be included when this message is sent in response to an AAI-RNG-REQ message used to perform location update or DCR mode initiation from Idle Mode or DCR mode extension.
If (Location Update Response == 0x0) {			
…	…	…	…
SMS	Variable	Short message contents up to the size of 140bytes	May be included when SMS contents is sent in idle mode.
New Multicast Group Zone ID	12	Indicates a Multicast Group Zone ID to update in target HR-BS.	Shall be included in HR-Network in response to the AAI-RNG-REQ message where ranging purpose indication is set to 0b1110.
For(j=1;j<=M;j++){		Number of Multicast Group ID and FID (M) to update in the target HR-BS[1..16]	Present if it needs to update in HR-Network.
Current Multicast Group ID	12		
Current FID	4		
New Multicast Group ID	12		
New FID	4		
}			
}//end of If (Location Update Response == 0x0)			
Reentry Process Optimization	5	Reentry process optimization bitmap indicates which MAC control message transactions may be omitted during an attempted reentry (i.e., reentry during	

		HO (including zone switching), and reentry from idle mode) A value of 1 in the bitmap indicates that the corresponding MAC control message transaction may be omitted, while a 0 indicates that the corresponding MAC control message transaction shall be completed. The AMS shall only commence Connected State with the T-ABS after completing all the required MAC control message transactions. Bit 0: Omit AAI-SBC-REQ and AAI-SBC-RSP MAC control messages during reentry processing Bit 1: Omit PKM Authentication phase Bit 2: Omit AAI-REG-REQ and AAI-REG-RSP message during reentry processing. Bit 3: Omit higher layer protocol triggering for IP address refresh during reentry processing Bit 4: For the case of reentry during HO including zone switching, a 1 indicates to the AMS that the T-ABS has received the full service and operational states for static and dynamic context (including ARQ window parameters and state machines). For the case of reentry from Idle mode, a 1 indicates to the AMS that the T-ABS has received the static context of the AMS. The static context includes SFIDs and related description (QoS descriptors and CS classifier information) for all service flows that the AMS has currently established as well as any SAs with their related keying information.	
…	…	…	…
If (it is under network reentry for HO){			
New Multicast Group Zone ID	12	Indicates a Multicast Group Zone ID to update in target HR-BS.	Shall be included in HR-Network in response to the AAI-RNG-REQ message where ranging purpose indication is set to 0b1110.

For (*i* = 0; *i*< M; *i*++) {		Number of Multicast Group ID and FID (M) to update in the T-ABS[1..16]. Mapping of current Multicast Group ID and FID and new Multicast Group ID and FID to be updated. Based on the value of Num of Multicast Group ID and FID to be updated.	Present if it needs to be updated.
Current Multicast Group ID	12		
Current FID	4		
New Multicast Group ID	12		
New FID	4		
}			
}//end of If (it is under network reentry for HO)			
For (*i* = 0; *i*<N_SFIDs; *i*++) {		N_SFIDs is Number of SFIDs supported in MZone when an AMS performs Zone Switching from LZone to MZone. Its maximal number is 24.	Present if CID to FID mapping is done through the AAI-RNG-RSP message during Zone Switching operation. If this field is not present, all FIDs for the transport connection should be reestablished through the AAI-DSA exchanges after completion of network reentry in MZone.
SFID	32	FID in MZone should be assigned as defined in 16.2.6.4.1.3.1 per each DL/UL connections	
}			
} //End of else (Ranging Abort==1)			

[Change section 16.2.3.5 as indicated:]

16.2.3.5 AAI-SBC-REQ

An AAI-SBC-REQ message, to which HARQ operation is applied, is transmitted by AMS to negotiate basic capability during network entry.

1 **Table 688 – AAI-SBC-REQ message field description**

Field	Size (bits)	Value/Description	Condition
If (AMS requests transmittal of NSP information) {			
SIQ (Service Information Query)	2	Bit 0: Indicates that the AMS requests transmittal of the NSP List for the list of NSP IDs supported by the Operator Network that includes the current ABS; Bit 1: Indicates that the AMS requests transmittal of the Verbose NSP Name List in addition to the NSP List; bit 1 shall not be set to a value of '1' unless bit 0 is set to 1	
} else {			
CAPABILITY_INDEX	5	It refers to the "Capability Class" that the AMS can support. Value: 0~31	
DEVICE_CLASS	5	It refers to the "Device Class" that the AMS can support. Value: 0~31	
CLC Request	*variable*	See Table 700	Present if AMS requests to activate one Type I or II CLC class for fast CLC class activation during initial network entry
Long TTI for DL	1	If Bit 0=1, it supports	Present as needed
UL sounding	2	If Bit 0=1, decimation separation based sounding (FDM) supports If Bit 1=1, cyclic shift separation based sounding (CDM) supports	Present as needed
OL Region	3	If Bit 0=1, OL Region type 0 supports If Bit 1=1, OL Region type 1, CDR and CoFIP supports If Bit 2=1, OL Region type 2 supports	Present as needed
DL resource metric for FFR	1	If Bit 0=1, it supports	Present as needed
Max. Number of streams for SU-MIMO in DL MIMO	3	The number in the range 1 through 8 that is higher by 1 than this field	Present as needed
Max. Number of streams for CL MU-MIMO (MIMO mode 4) in AMS point of view in DL MIMO	1	The number in the range 1 through 2 that is higher by 1 than this field	Present as needed
DL MIMO mode	6	If Bit 0 =1, mode0 supports If Bit 1 =1, mode1 supports If Bit 2 =1, mode 2 supports If Bit 3 =1, mode 3 supports If Bit 4 =1, mode 4 supports If Bit 5=1, mode 5 supports	Present as needed
feedback support for DL	11	If Bit 0 =1, differential mode supports If Bit 1 =1, MIMO feedback mode 0 supports If Bit 2 =1, MIMO feedback mode 1 supports If Bit 3=1, MIMO feedback mode 2 supports If Bit 4 =1, MIMO feedback mode 3 supports If Bit 5 =1, MIMO feedback mode 4 supports If Bit 6 =1, MIMO feedback mode 5 supports If Bit 7 =1, MIMO feedback mode 6 supports If Bit 8 =1, MIMO feedback mode 7 supports	Present as needed

Field	Size (bits)	Value/Description	Condition
		If Bit 9 =1, Long-term reporting disabling support for MFM 0,4,7 If Bit 10 =1, Short-term reporting disabling support for MFM 2,3,5,6	
Subband assignment A-MAP IE support	1	If Bit 0=1, DL/UL Subband assignment A-MAP IE supports	Present as needed
DL pilot pattern for MU MIMO	2	If Bit 0 =1, DL 4 stream pilot pattern for DL MU MIMO support If Bit 1 =1, DL 8 stream pilot pattern for DL MU MIMO support	Present as needed
Number of Tx antenna of AMS	2	The number in the range {1, 2, 4} that is higher by 1 than this field	Present as needed
Max. Number of streams for SU-MIMO in UL MIMO(1/2/3/4)	2	The number in the range 1 through 4 that is higher by 1 than this field	Present as needed
Max. Number of streams for MU-MIMO in AMS point of view in UL MIMO(1/2/3/4)	2	The number in the range 1 through 4	Present as needed
UL pilot pattern for MU MIMO	3	If Bit 0 =1, UL 2 stream pilot pattern support If Bit 1 =1, UL 4 stream pilot pattern support If Bit 2 =1, UL 8 stream pilot pattern support	Present as needed
UL MIMO mode	5	If Bit 0 =1, mode0 supports If Bit 1 =1, mode1 supports If Bit 2 =1, mode 2 supports If Bit 3 =1, mode 3 supports If Bit 4 =1, mode 4 supports	Present as needed
Modulation scheme	2	If Bit 0=1, DL 64 QAM supports If Bit 1=1, UL 64 QAM supports	Present as needed
UL HARQ buffering capability	7	Bit 0–6: The number that is higher by 1 than this field is the amount of information bits in 4800 bytes units the AMS can buffer in the UL.	Present as needed
DL HARQ buffering capability	7	Bit 0–6: The number that is higher by 1 than this field, is the steady amount of aggregated DL HARQ information bits per frame in units of 4800 bytes, at which the aimed combining gain or better is obtained in the benchmark scenario, as defined in 16.2.14.2.1.3.	Present as needed
AMS DL processing capability per subframe	7	Bit 0–6: The number that is higher by 1 than this field, is the steady amount of aggregated DL data information bits per subframe in units of 600 bytes that the AMS can process.	Present as needed
AMS UL processing capability per subframe	7	Bit 0–6: The number that is higher by 1 than this field, is the steady amount of aggregated UL data information bits per subframe in units of 600 bytes that the AMScan process.	Present as needed
FFT size(2048/1024/512)	3	If Bit 0 = 1, FFT 2048 supports If Bit 1 = 1, FFT 1024 supports If Bit 2 = 1, FFT 512 supports	Present as needed
Authorization policy support	1	If Bit 0 = 0, No authorization; If Bit 0 = 1, EAP-based authorization is supported.	Present as needed
Inter-RAT Operation Mode	2	0b00: single radio mode operation for inter RAT handover 0b01: multi radio mode operation for inter RAT handover 0b10–0b11: *Reserved*	Present as needed
Supported Inter-RAT type	8	1 indicates support, 0 indicates not supported:	Present as needed

Field	Size (bits)	Value/Description	Condition
		Bit 0: IEEE 802.11 Bit 1: GERAN(GSM/GPRS/EGPRS) Bit 2: UTRAN Bit 3: E-UTRAN Bit 4: CDMA 2000 Bit 5–7: *Reserved*, set to zero	
MIH Capability Supported	1	If Bit 0=1, the capability of IEEE 802.21 Media Independent Handover Services supports.	Present as needed
MAX Tx Power	24	The maximum available power of the carrier for initial network entry. Bit 0–7: Maximum transmitted power for QPSK. Bit 8–15: Maximum transmitted power for 16-QAM Bit 15–23: Maximum transmitted power for 64-QAM. Each unsigned 8-bit integer specifies the maximum transmitted power value in dBm. The maximum transmitted power is quantized in 0.5 dBm steps ranging from –64 dBm (encoded 0x00) to 63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme. If AMS does not support 64-QAM, the AMS shall report the value of 0x00 for Bit 15–23.	Present as needed
If (ARS is a sender of AAI-SBC-REQ) {			//only available during ARS network entry phase
Relay mode	1	0b0: TTR relay mode 0b1: STR relay mode	
if (Relay mode == 0b0){			
ARSTTG	6	ARSTTG value (μs). It shall be less than 50 μs.	
ARSRTG	6	ARSRTG value (μs). It shall be less than 50 μs.	
}			
}			
Visited NSP ID	24	NSP ID of the Network Service Provider the AMS intends to be the conduit for authentication to the AMS home network	Present as needed
Multimode capability supported	3	If bit0 = 1, the capability of TTR relay mode supports If bit1 = 1, the capability of STR relay mode supports If bit2 = 1, the capability of base station function supports	Present as needed in HR-Network
}			

16.2.3.12 AAI-HO-CMD

[Change Table 695 in section 16.2.3.12 AAI-HO-CMD as indicated:]

Table 695—AAI-HO-CMD message field description

Field	Size (bits)	Value/Description	Condition
Mode	2	0b00: HO command;	N/A

		0b01: Zone switch command from MZone to LZone; 0b10: AMS HO request rejected (ABS in list unavailable). In this case, AAI-HO-CMD message shall not include any T-ABS. However, if the requested ABSs in list available but MAC information is not shared, those ABSs may be included candidate T-ABS and serving ABS transfers MS information via backbone network or relay link in HR-Network ~~0b11: *Reserved*.~~ 0b11: Alternative Path (only for HR-Network).	
If (Mode == 0b00 or 0b11) {			
……	…	……	…
Resource_Retain_Time	16	The duration in units of 100 ms to which the T-ABD set the ABS-Resource-Retain-Timer	Present if needed
If (HO Reentry Mode == 0b11) {			
Role	1	0b0: Stay as HR-MS; 0b1: Change to HR-RS;	
} //end of If (HO Reentry Mode == 0b11)	-	-	
…			
Action Time	8	If HO Reentry Mode is 0b11, it is the wait time in units of 1 ms before the HR-MS starts to perform fast network reentry. Otherwise, it is ~~T~~the 8 least significant bits of the absolute frame number at the TABS where the AMS starts to perform network reentry. When CDMA_RNG_FLAG is set to 1, it indicates the frame whereafter the AMS starts a CDMA ranging process. The action time should be set to a frame that includes either a nondynamic ranging channel or a dynamic ranging channel. When CDMA_RNG_FLAG is set to 0, it indicates the frame where the AMS starts to expect the UL bandwidth allocation for transmission of RNG-REQ at target R1 BS or LZone (i.e., Fast ranging opportunity) or AAI-RNG-REQ at T-ABS.	
……	…	……	…
}else if (Mode == 0b01) {			
……	…	……	…
}else if (Mode==0b10) {			
REQ-Duration	8	The 8 least significant bits of the absolute superframe number where the AMS may perform handover again (i.e., allowing the AMS to transmit AAI-HO-REQ after REQ-Duration).	Shall be present in HR-Network
for(*i*=0; *i* < N_Target_BS; *i*++) {		N_Target_BS is the number of T-ABSs or target legacy BSs included in this message in HR-Network.	
targetBSID	48	BSID of the T-ABS or target legacy BS.	Shall be included
SA-Preamble Index	10	Indicate the SA-Preamble index of the carrier.	Shall be included if the BS is T-ABS
Preamble Index	7	Indicate the preamble index of the neighbor BS.	Shall be included if the BS is target legacy BS
Center Frequency	32	Indicates center frequency (in unit of Hz) of the carrier.	Shall be included
}			

}			

16.2.3.13 AAI-NBR-ADV

[Change the last paragraph in page 142 as indicated:]

Within each cell type, if S-ABS chooses to broadcast configuration information for each individual ABS instead of specifying SA-Preamble Index range and Physical carrier range, a list of ABSs are provided and the following parameters are carried for each ABS:

- 48-bit BS-ID
- ABS SA-Preamble Index
- Indication whether full system information or partial information is carried for this ABS, which includes the following:
  - SFH information
  - Physical carrier index (6 bits, refer to the "physical carrier index" defined in AAI-Global-CFG)
  - MAC protocol versions (8 bits)
  - Paging carrier indication (1 bit, refer to specify if a carrier is a paging carrier or not)
- Multicast service flow mapping list (for HR-Network)
  - Neighbor Multicast Group Zone ID
  - Mapping of Multicast Group ID + FID and neighbor Multicast Group ID + FID
- Indication whether the neighbor infrastructure station is HR multimode station (i.e., acting as BS or RS) for HR-Network.

where for ABS of macrocell type, all the necessary system information shall be included, and the format may only carry delta information fields with respect to the reference ABS (e.g., the S-ABS or the preceding neighbor BS/ABS of this cell type); and for Wireless-MAN-OFDMA reference system, only 48-bit BS-ID and Preamble index are included in AAI-NBR-ADV.

…

[Change Table 696 in section 16.2.3.13 as indicated:]

Table 696—AAI-NBR-ADV message field description

Field	Size (bits)	Value/Description	Condition
……	……	……	……
For (*i*=0; *i*<N-NBR-ABSs; *i*++) {		N-NBR-ABSs is the number of neighbor ABSs included in this message, and has the range of [1..64].	

BSID	48	Neighbor ABS ID	
MAC protocol version	8	MAC protocol version of the BS Consistent with IEEE Std 802.16-2009 definition, with new MAC protocol version 10 defined for AAI.	
CP time	2	CP time of the BS 0b00: 1/8 0b01: 1/16 0b10: 1/4	
HR Multimode indication	2	Indicates whether neighbor BR/RS is HR-MS acting as BS/RS or HR-BS acting as RS 0b00: neighbor BS is neither HR-MS acting as BS/RS nor HR-BS acting as RS 0b01: neighbor BS is HR-MS acting as BS/RS 0b10: neighbor BS is HR-BS acting as RS 0b11: *reserved*	Shall be present in HR-Network
Neighbor Multicast Group Zone ID	12	Indicates a Multicast Group Zone ID provided by neighbor BS.	Present in HR-Network
For(j=1;j<=M;j++){		Number of Multicast Group ID and FID (M) mapping between serving BS and neighbor BS[1..16]	Present if needed
Multicast Group ID	12		
FID	4		
Neighbor Multicast Group ID	12		
Neighbor FID	4		
}			
For(*j*=0; *j*<N-Carrier-Info; *j*++) {		N-Carrier-Info is the number of carrier information listed here for the *ABSi*	
……	……	……	……

16.2.3.31 AAI-System Configuration Descriptor (SCD) message

[Add following rows in the end of Table 714 in 16.2.3.31 as indicated:]

Multicast Group Zone ID	12	Indicates a Multicast Group Zone ID provided by this BS. Shall not be set to "0."	In HR-Network
HR Multimode indication	2	Indicates whether current BR/RS is HR-MS acting as BS/RS or HR-BS acting as RS 0b00: current BS/RS is neither HR-MS	HR Multimode indication Shall be present in HR- Networks

		acting as BS/RS nor HR-BS acting as RS 0b01: current BS/RS is HR-MS acting as BS/RS 0b10: current BS/RS is HR-BS acting as RS 0b11: reserved	

16.2.3.47.1 AAI-DSA-REQ

[Change last paragraph in section 16.2.3.47.1 AAI-DSA-REQ as indicated:]

When an ABS commences multicast service, the following parameters shall be included in the AAI-DSA-REQ message.

- Multicast Group Zone ID: Indicates multicast group zone IDs for the connection that is associated with the service flow in AAI-DSA-REQ in HR-Network.
- Multicast Group ID: Indicates multicast group for the connection that is associated with the service flow in AAI-DSA-REQ.

[Change Table 740 as indicated:]

Table 740—AAI-DSA-REQ message field description

Field	Size (bits)	Value/Description	Condition
……	……	……	……
For(*i*=0; *i*<N-FIDs-Coupled-Noncommon; *i*++) {		N-FIDs-Coupled-Noncommon is the number of non-common coupled service flow IDs The maximum value of N-FIDs-Coupled-Noncommon is 32.	
FID	4		Shall be present if NFIDs-Coupled-Noncommon is not zero
Non-common for Coupled Group	*variable*	Non-common service flow encodings that are specific to individual service flows specified in Coupled FID Parameter List Service flow/convergence sublayer parameters in Table 788, except FID, SFID, E-MBS service related information, Group Parameter Create/Change related information and Coupled Group Create/Change related	Shall be present if NFIDs-Coupled-Noncommon is not zero

		information, may be encapsulated in this field.	
}			
}			
Multicast Group Zone ID	12	Indicates a multicast group zone to add where the connection for associated service flow is valid.	Present if needed in HR-Network
For (*i*=0; *i*<Num of Multicast Group ID and FID (M); *i*++) {		Num of Multicast Group ID and FID (M) ~~is the number of Multicast Group IDs~~ to add [1..16]	Present when ABS initiates AAI-DSA-REQ
Multicast Group ID	12	ID of a group to which the flow is added	Present only if Num of Multicast Group ID and FID (M)> 0
FID	4	Multicast specific FID that is associated with Multicast Group ID	Present only if Num of Multicast Group ID and FID (M)> 0
}			
If (sleep cycle setting is included) {			
Operation	2	This indicates operation request type 0b00~0b01: *Reserved* 0b10: Change sleep cycle setting 0b11: Switch sleep cycle setting	
……	……	……	……
……	……	……	……
DC	2	00 – normal request 01 – DC request 10, 11 reserved	When direct communication is turned on
Reserved	6	--	--
if (DC == 01) {			
STID	12	STID of the direct communication link	When direct communication is turned on
}			

16.2.3.47.2 AAI-DSA-RSP

[Change last paragraph in section 16.2.3.47.2 AAI-DSA-RSP as indicated:]

When an AMS commences multicast service, the ABS shall include the following parameters in the AAI-DSA-RSP message:

- Multicast Group Zone ID: Indicates multicast group zone IDs for the connection that is associated with the service flow in AAI-DSA-RSP in HR-Network.
- Multicast Group ID: Indicates multicast group for the connection that is associated with the service flow in AAI-DSA-RSP.

[Change Table 741 in section 16.2.3.47.2as indicated:]

Table 741—AAI-DSA-RSP message field description

Field	Size (bits)	Value/Description	Condition
.....	.....	.....	.....
Carrier Switching Mode	1	0b0: carrier switching method based on Unicast Available Interval in the AAI-DSA message 0b1: carrier switching method using AAI-E-MBS-REP/RSP message	Present if ABS indicates carrier switching when receiving AMS-initiated DSA
If(Carrier Switching Mode == 0b0) {			
Unicast Available Interval Bitmap	*variable*	Indicates when the AMS should be available in the primary carrier using *N* bits *b0b1b2...bN-1* If *bi*==0, then AMS is available for E-MBS data scheduling in secondary carrier If *bi*==1, then AMS is available for unicast scheduling in primary carrier *NMSI* = 4 superframes: *N* = 4 bits *NMSI* = 8 superframes: *N* = 8 bits *NMSI* = 16 superframes: *N* = 16 bits *NMSI* = 32 superframes: *N* = 32 bits Depending on the *NMSI*, the number of bits per subframe changes, 4 frames per bit	
}			
Multicast Group Zone ID	12	Indicates a multicast group zone to add where the connection for associated service flow is valid.	Present if needed in HR-Network
For (*i*=0; *i*<Num of Multicast Group ID and FID (M); *i*++) {		Num of Multicast Group ID and FID (M) ~~is the number of Multicast Group IDs~~ to add [1..16]	
Multicast Group ID	12	ID of a group to which the flow is added	Present only if Num of Multicast Group ID and FID (M)> 0

FID	4	Multicast specific FID that is associated with Multicast Group ID	Present only if Num of Multicast Group ID and FID (M)> 0
}			
If (sleep cycle setting is included) {			May be present when sleep cycle setting needs to be changed or switched
Response_Code	2	This indicates response type of AAI-SLP-RSP message. 0b00: Request by ABS in Unsolicited manner 0b01: Approval of AAI-SLP-REQ 0b10: Rejection of AAI-SLP-REQ 0b11: *Reserved*	This parameter shall be included only when ABS transmit this control message.
Operation	2	This indicates operation request type 0b00~0b01: *Reserved* 0b10: Change sleep cycle setting 0b11: Switch sleep cycle setting	
……	……	……	……

16.2.3.47.4 AAI-DSC-REQ

[Change Table 743 in section 16.2.3.47.4 as indicated:]

Table 743—AAI-DSC-REQ message field description

Field	Size (bits)	Value/Description	Condition
……	……	……	……
For(*i*=0; *i*<N-FIDs-Coupled-Noncommon; *i*++) {		N-FIDs-Coupled-Noncommon is the number of non-common coupled service flow IDs. The maximum value of N-FIDs-Coupled-Noncommon is 32.	
FID	4	Flow identifier	Present when N-FIDs-Coupled-Noncommon >0
Non-common for Coupled Group	*variable*	Non-common service flow encodings that are specific to individual service flows specified in Coupled FID Parameter List. Service flow/convergence sublayer parameters in Table 788,	Present when N-FIDs-Coupled-Noncommon >0

		except FID, SFID, E-MBS service-related information, Group Parameter Create/Change related information and Coupled Group Create/Change related information, may be encapsulated in this field.	
}			
}			
New Multicast Group Zone ID	12	Indicates a multicast group zone to overwrite where the connection for associated service flow is valid.	Present when ABS initiates AAI-DSC-REQ in HR-Network
For (*i*=0; *i*<Num of Multicast Group ID and FID (MC); *i*++) {		Num of Multicast Group ID and FID (MC) ~~is the number of Multicast Group IDs~~ to add [1..16]	Present when ABS initiates AAI-DSA-REQ
Multicast Group ID	12	ID of a group to which the flow is added	Present only if Num of Multicast Group ID and FID (M)> 0
FID	4	Multicast specific FID that is associated with Multicast Group ID	Present only if Num of Multicast Group ID > 0
}			
For (*i* = 0; *i*< MU; *i*++) {		Number of Multicast Group ID and FID (MU) to update [1..16]. Mapping of current Multicast Group ID and FID and new Multicast Group ID and FID to update. Based on the value of Num of Multicast Group ID and FID to update.	Present if it needs to update in HR-network.
Current Multicast Group ID	12		
Current FID	4		
New Multicast Group ID	12		
New FID	4		
}			
For (*i*=0; *i*<Num of Multicast Group ID and FID (MA); *i*++) {		Num of Multicast Group ID and FID (MA) ~~is the number of Multicast Group IDs~~ to add [1..16]	Present when ABS initiates AAI-DSC-REQ Present only if Multicast Group ID to be added exists
Multicast Group ID to be added	12	Multicast Group ID to be added	Present only if Num of Multicast Group ID

			and FID (M)> 0
FID	4	Multicast specific FID which is associated with newly added Multicast Group ID	Present only if Num of Multicast Group ID and FID (M) > 0
}			
For (*i*=0; *i*<Num of Multicast Group ID and FID (MD); *i*++) {		Num of Multicast Group ID and FID (MD) ~~is the number of Multicast Group IDs~~ to delete [1..16]	Present when ABS initiates AAI-DSC-REQ Present only if Multicast Group ID to be deleted exists
Multicast Group ID to be deleted	12	Multicast Group ID to be deleted	Present only if Num of Multicast Group ID and FID (M) > 0
FID		Multicast specific FID which is associated with newly deleted Multicast Group ID	Present only if Num of Multicast Group ID and FID (M)> 0
}			
If (sleep cycle setting is included) {			May be present when sleep cycle setting needs to be changed or switched
Operation	2	This indicates operation request type 0b00~0b01: *Reserved* 0b10: Change sleep cycle setting 0b11: Switch sleep cycle setting	
……	……	……	……

[Change the text in section 16.2.3.57 as indicated:]

16.2.3.57 AAI-ARS-CONFIG-CMD message format

An ABS shall use AAI-ARS-CONFIG-CMD message to configure the TTR mode ARS PHY layer operational parameters.

An HR-BS shall use AAI-ARS-CONFIG-CMD message to configure the multimode HR-MS acting as HR-RS PHY layer operational parameters.

[Change the table 757 in 16.2.3.57 as indicated:]

Table 757—AAI-ARS-CONFIG-CMD message field description

Field	Size (bits)	Value/Description	Conditions

Field	Size (bits)	Value/Description	Conditions
If(subordinate RS (including HR-MS acting as RS) is TTR relay mode in HR-Network) {			// TTR mode
AAI_Relay_zone_AMS_ allocation_indicator	1	0b0: The ABS does not allocate resources to the AMS in the AAI DL Relay zone; 0b1: The ABS may allocate resources to the AMS in the AAI DL Relay zone	Always present
MIMO Midamble indication in AAI DL Relay zone	1	0b0: MIMO midamble is not transmitted in AAI DL Relay zone 0b1: MIMO midamble is transmitted in AAI DL Relay zone If AAI_Relay_zone_AMS_allocation_indicator == 0b0, this field is set to 0b1.	Always present
Superframe Number Action	4	LSBs of the superframe number when ARS start ARS operation and apply the PHY operational parameters.	Always present
R_IdleTime	11	Unit is 0.1 μs	Always present
If(ABS allocates resource for periodic ranging in AAI UL Relay zone) {			
Allocation periodicity of the S-RCH	2	Indicates the periodicity of the S-RCH allocation. 0b00: Every frame 0b01: The second frame in every superframe 0b10: The second frame in every 4^{th} superframe, i.e., mod(superframe number, 4) = 0 0b11: The second frame in every 8^{th} superframe, i.e., mod(superframe number, 8) = 0	Present when ABS allocates resource for periodic ranging in AAI UL Relay zone
Subframe offset of the S-RCH	2	Indicates the subframe offset (O_{SF}) of the S-RCH allocation. The range of values is $0 \le O_{SF} \le 3$. S-RCH is allocated in the (O_{SF} +UAZ) subframe.	Present when ABS allocates resource for periodic ranging in AAI UL Relay zone
Start RP code information of the S-RCH	4	Indicates the ks which is the parameter controlling the start root index of the RP codes (r_{s0}). $r_{s0}=6k_s+1$ The range of values is $0 \le k_s \le 15$.	Present when ABS allocates resource for periodic ranging in AAI UL Relay zone
N_{PE}	2	Indicates the number of periodic code (N_{PE}) according to the Table 917.	Present when ABS allocates resource for periodic ranging in AAI UL Relay zone
}			
If(ABS allocates resource for BR channel in AAI UL Relay zone) {			
UL BW REQ channel information	2	Indicates the number and the location of UL AAI subframe where the UL BW REQ channels are allocated. 0b00: *i*-th UL AAI subframe of UL relay zone in the first frame in every superframe 0b01: *i*-th UL AAI subframe of UL relay zone in the first and second frame in every superframe 0b10: *i*-th UL AAI subframe of UL relay zone in every	Present when ABS allocates resource for BR channel in AAI UL Relay zone

Field	Size (bits)	Value/Description	Conditions
		frame 0b11: *i*-th and (*i*+1)-th UL AAI subframes of UL relay zone in every frame Where *i*-th is "first" if UL R-RTI = 0, and *i*-th is "second" if UL R-RTI=*Ts*.	
UL BW REQ channel allocation	4	The DRU index for UL BW REQ channel within FPi defined by "Frequency partition location for UL control channels" in S-SFH SP1.	Present when ABS allocates resource for BR channel in AAI UL Relay zone
Bandwidth request backoff start	4	Initial backoff window size for contention BRs, expressed as a power of 2. Values of n range 0–15 (the highest order bits shall be unused and set to 0)	Present when ABS allocates resource for BR channel in AAI UL Relay zone
Bandwidth request backoff end	4	Final backoff window size for contention BRs, expressed as a power of 2. Values of n range 0–15	Present when ABS allocates resource for BR channel in AAI UL Relay zone
}			
If(AAI_Relay_zone_AMS_allocation_indicator == 0b0){			
R_DCAS_{SB0}	5/4/3	Indicates the number of subband-based CRUs in FP0 for AAI DL Relay zone. See 16.6.3.3.2 Cell-specific resource mapping For 2048 FFT size, 5 bits For 1024 FFT size, 4 bits For 512 FFT size, 3 bits	Present when AAI_Relay_zone_AMS_allocation_indicator ==0b0
R_DCAS_{MB0}	5/4/3	Indicates the number of miniband-based CRUs in FP0 for AAI DL Relay zone. See 16.6.3.3.2 Cell-specific resource mapping For 2048 FFT size, 5 bits For 1024 FFT size, 4 bits For 512 FFT size, 3 bits	Present when AAI_Relay_zone_AMS_allocation_indicator ==0b0
R_DCAS_{i}	3/2/1	Indicates the number of total allocated CRUs, in a unit of a subband, for FPi ($i > 0$) for AAI DL Relay zone. See 16.6.3.3.2 Cell-specific resource mapping For 2048 FFT size, 3 bits For 1024 FFT size, 2 bits For 512 FFT size, 1 bit	Present when AAI_Relay_zone_AMS_allocation_indicator ==0b0
R_UCAS_{SB0}	5/4/3	Indicates the number of total allocated CRUs, in a unit of a subband, for FPi ($i > 0$) for AAI DL Relay zone. See 16.6.3.5.1 Cell-specific resource mapping For 2048 FFT size, 5 bits For 1024 FFT size, 4 bits For 512 FFT size, 3 bits	Present when AAI_Relay_zone_AMS_allocation_indicator ==0b0
R_UCAS_{MB0}	5/4/3	Indicates the number of miniband-based CRUs in FP0 for AAI UL Relay zone. See 16.6.3.5.1 Cell-specific resource mapping For 2048 FFT size, 5 bits For 1024 FFT size, 4 bits For 512 FFT size, 3 bits	Present when AAI_Relay_zone_AMS_allocation_indicator ==0b0
R_UCAS_{i}	3/2/1	Indicates the number of total allocated CRUs, in a unit of a subbands, for FPi ($i > 0$) for AAI UL Relay zone. See 16.6.3.5.1 Cell-specific resource mapping For 2048 FFT size, 3 bits For 1024 FFT size, 2 bits	Present when AAI_Relay_zone_AMS_allocation_indicator ==0b0

Field	Size (bits)	Value/Description	Conditions
		For 512 FFT size, 1 bit	
}			
}			// TTR mode only
If (subordinate HR-MS is multimode MS acting as HR-RS in HR-Network) {			
SA-PREAMBLE index	10		Always present
MS functionality maintenance indication	1	0b0: MS functionality is maintained after role change 0b1: MS functionality is not maintained	Always present
Cell bar information	1	If Cell bar bit == 0b1, this cell shall not be allowed for network entry or reentry	Always present
If (subordinate HR-MS is acting as STR relay mode) {			
Frame configuration index	6	The mapping between value of this index and frame configuration is listed in Table 806, Table 807, and Table 808.	Always present
FFT size indication	2	0b00: 2048 FFT 0b01: 1024 FFT 0b10: 512 FFT 0b11: reserved	Always present
DL carrier frequency for BS and RS (F_{BR_DL})	10	Indicates the DL carrier frequency in unit of 100KHz for MS acting as RS. Used to receive from HR-BS in the DL relay zone.	Present if needed
UL carrier frequency for BS and RS (F_{BR_UL})	10	Indicates the UL carrier frequency in unit of 100KHz for MS acting as RS. Used to transmit to HR-BS in the UL relay zone.	Present if needed
DL carrier frequency for RS and MS (F_{RM_DL})	10	Indicates the DL carrier frequency in unit of 100KHz for MS acting as RS in FDD. If the duplex mode is TDD, this carrier is used for DL/UL Used to transmit to subordinate HR-MS in the DL in FDD. Used to transmit/receive to/from subordinate HR-MS in TDD.	Shall be present if F_{RM_DL} is different from that of HR-BS' DL access zone
UL carrier frequency for RS and MS (F_{RM_UL})	10	Indicates the UL carrier frequency in unit of 100KHz for MS acting as RS in FDD. Used to transmit to subordinate HR-MS in the UL in FDD.	Shall be present if F_{RM_UL} is different from that of HR-BS' UL access zone
Superframe Number Action	4	LSBs of the superframe number when HR-RS start RS operation and apply the PHY operational parameters.	Always present
}			
}			
}			

[Insert the following new sections (renumbering may be required):]

16.2.3.64 BBE-REQ

An HR-BS transmits a BBE-REQ message to notify HR-MSs of backbone connection availability on unicast control connection.

16.2.3.65 BBE-RSP

An HR-MS transmits a BBE-RSP message in response to a received BBE-REQ.

16.2.3.66 BBD-REQ

An HR-BS transmits a BBD-REQ message to notify HR-MSs of backbone connection unavailability on unicast control connection.

16.2.3.67 BBD-RSP

An HR-MS transmits a BBD-RSP message in response to a received BBD-REQ.

16.2.3.68 BBE-CMD

An HR-BS transmits a BBE-CMD message to broadcast backbone connection availability.

16.2.3.69 BBD-CMD

An HR-BS transmits a BBD-CMD message to broadcast backbone connection unavailability.

16.2.3.70 AAI-MM-ADV message

Infrastructure stations and HR-MS acting as HR-BS or HR-RS may transmit AAI-MM-ADV message to support multimode operation in the case as follows:

- When the backhaul link is down or up
- During maintaining relay link due to unavailable backhaul link, PHY/MAC layer parameters need be reconfigured such as
    - Power down
    - Power reduction
    - FA change
- Multimode service establish/release/change to inform subordinate stations to perform handover

Table 770—Parameters for AAI-MM-ADV message

Field	Size (bits)	Value/Description	Condition
Action Type	3	Used to indicate the purpose of this message 0b000: Reconfiguration of HR-BS/RS including multimode BS/RS 0b001: Restart of HR-BS/RS including multimode BS/RS	Mandatory

Field	Size (bits)	Value/Description	Condition
		0b010: Power down (including FA down) of HR-BS/RS including multimode BS/RS 0b011: Power reduction of HR-BS/RS including multimode BS/RS 0b100: Backhaul link down of HR-BS 0b101: Backhaul link up of HR-BS 0b110: FA change of HR-BS/RS including multimode BS/RS 0b111: Multimode service end of HR-MS	
If (Action Type == 0b000) {			// reconfiguration
New IDcell	10	New IDcell that the ABS will use after the reconfiguration process.	Optional
Frame configuration index	6	New mapping between value of this index and frame configuration is listed in Table 806, Table 807, and Table 808.	Optional
Unavailable Start Time (UST)	8	Start of unavailable time in unit of frame	Mandatory
Unavailable Time Interval (UTI)	8	Interval of unavailable time in unit of superframe	Mandatory
} else if (Action Type == 0b001) {			// restart
Unavailable Start Time (UST)	8	Start of unavailable time in unit of frame	Mandatory
Unavailable Time Interval (UTI)	8	Interval of unavailable time in unit of superframe	Mandatory
} else if (Action Type == 0b010) {			// power down
Time of Power Down	8	Expected time when the HR-BS will be powered down in units of frame	Mandatory
Expected uptime of BS	8	Expected uptime of BS in units of superframe	Optional
} else if (Action Type == 0b011) {			// power reduction
Tx Power Reduction	10	dB value of Tx power reduction	Mandatory
Expected time of power reduction	8	Expected resource adjustment time in units of frame	
} else if (Action Type == 0b100) {			// backhaul link down
Time of backhaul link down	8	Expected time when the backhaul link will be down in units of superframe	Optional
Expected time of backhaul link available	8	Expected time in unit of LSB of superframe when backhaul link will be available of HR-BS either itself or via neighbor HR-BS	Optional
} else if (Action Type == 0b101) {			// backhaul link up
Expected time of backhaul link up	8	Expected time in unit of LSB of superframe when the HR-BS restarts service without any help of neighbor BS using relay link but the HR-BS' backhaul link	Optional
} else if (Action Type == 0b011) {			// power reduction
Tx Power Reduction	10	dB value of Tx power reduction	Mandatory
Expected time of power reduction	8	Expected resource adjustment time in units of frame	
} else if (Action Type == 0b111) {			// multimode service end
Expected time of backhaul link up	8	Expected time in unit of LSB of superframe when the HR-MS release the multimode service and to allow subordinate MS to perform handover to other infrastructure	Optional
}			

16.2.3.71 AAI-MMRS-REQ

To establish relay link between a multimode station and superordinate HR-BS, AAI-MMRS-REQ message is transmitted by the multimode station or the superordinate HR-BS.

Table 771—AAI-MMRS-REQ message field description

Field	Size (bits)	Value/Description	Condition
Request Relay mode	1	0b0: TTR relay mode 0b1: STR relay mode	Always present
If(this request is subordinate station initiated request) {			Shall be present when subordinate station initiates AAI-MMRS-RSP
If (request relay mode == 0b0) {			// TTR
ST-TTG	6	Transmit-to-receive turnaround gap of subordinate station, i.e., HR-MS or HR-BS, in units of μs. It shall be less than 50 μs.	
ST-RTG	6	Receive-to-transmit turnaround gap of subordinate station, i.e., HR-MS or HR-BS, in units of μs. It shall be less than 50 μs.	
If (subordinate station is HR-BS) {			
T_a	11	Proposed value of timing advance T_a , in units of 0.1 μs	
T_{bs}	5	Proposed duration of the BS Operation mode, in units of frames	
T_{rs}	5	Proposed duration of the RS Operation mode, in units of frames	
}			
} else if (request relay mode == 0b1) {			// STR
Duplex mode support indication	2	If bit0 = 1, FDD supports If bit1 = 1, TDD supports	
for(i=1; i<=N-frequency; i++) {		N-frequency is the number of available frequency to communicate[1..16]	
Carrier frequency	10	Indicates the carrier frequency in unit of 100KHz.	
}			
}			
}			
If (this request is superordinate station initiated request && received subordinate station is HR-BS) {			Shall be present when Superordinate HR-BS initiates AAI-MMRS-REQ
If (request relay mode == 0b0) {			// TTR
T_a	11	Proposed value of timing advance T_a , in units of 0.1 μs	
T_{bs}	5	Proposed duration of the BS Operation mode, in units of frames	

T_{rs}	5	Proposed duration of the RS Operation mode, in units of frames	
}			
}			

16.2.3.72 AAI-MMRS-RSP

An AAI-MMRS-RSP message is transmitted by multimode station or superordinate HR-BS in response to AAI-MMRS-REQ message.

Table 772—AAI-MMRS-RSP message field description

Field	Size (bits)	Value/Description	Condition
If(the response is transmitted by superordinate HR-BS) {			Present when superordinate HR-BS responds the subordinate station initiated request
Response code	2	0b00: in response to the AAI-MMRS-REQ message to accept the request 0b01: in response to the AAI-MMRS-REQ message to allow to transmit subordinate station initiated AAI-ARE-REQ after action time expires 0b10: in response to the AAI-MMRS-REQ message to reject the request 0b11: *reserved*	
If(Response code == 0b00 and the request was sent by an HR-BS wishing to establish TTR relay link){			
T_a	11	Confirmed value of timing advance T_a, in units of 0.1 μs	
T_{bs}	5	Confirmed duration of the BS Operation mode, in units of frames	
T_{rs}	5	Confirmed duration of the RS Operation mode, in units of frames	
}			
If(Response code == 0b01) {			
Action time	4	LSBs of the superframe number when the subordinate station transmits AAI-MMRS-REQ message.	Always present
}			
} else {			Present when subordinate station responds to the superordinate HR-BS initiated request
If(received request relay mode == 0b0) {			// TTR mode
ST-TTG	6	Transmit-to-receive turnaround gap of subordinate station, i.e., HR-MS or HR-BS, in units of μs. It shall be less than 50 μs.	Shall be present if action code == 0b0 in AAI-MMRS-REQ.

Field	Size (bits)	Value/Description	Condition
ST-RTG	6	Receive-to-transmit turnaround gap of subordinate station, i.e., HR-MS or HR-BS, in units of μs. It shall be less than 50 μs.	Shall be present if action code == 0b0 in AAI-MMRS-REQ.
If (requested subordinate station is HR-BS) {			Shall be present if the subordinate station is HR-BS and action code == 0b0 in AAI-MMRS-REQ.
T_a	11	Confirmed value of timing advance T_a., in units of 0.1 μs	
T_{bs}	5	Confirmed duration of the BS Operation mode, in units of frames	
T_{rs}	5	Confirmed duration of the RS Operation mode, in units of frames	
}			
} else if (received request relay mode == 0b1) {			// STR mode
Duplex mode support indication	2	If bit0 = 1, FDD supports If bit1 = 1, TDD supports	Always present
for(i=1; i<=N-frequency; i++) {		N-frequency is the number of available frequency to communicate[1..16]	
Carrier frequency	10	Indicates the carrier frequency in unit of 100KHz.	
}			
}			
}			

16.2.3.73 AAI-MMRL-REQ message

HR-MS transmits AAI-MMRL-REQ message for the purpose as follows:

- to release its relay mode and to return its original role
- to response or reject the unsolicited AAI-MMRL-RSP message by the HR-BS

Table 773—AAI-MMRL-REQ message field description

Field	Size (bits)	Value/Description	Condition
Release_Request_Code	2	Used to indicate the purpose of this message 0b00: multimode release 0b01: response for the unsolicited AAI-MMRL-RSP message by the HR-BS 0b10: reject for the unsolicited AAI-MMRL-RSP message by the HR-BS. This code is applicable only when UL data is pending to transmit. 0b11: *reserved*	Always present

16.2.3.74 AAI-MMRL-RSP message

An AAI-MMRL-RSP message is transmitted by multimode station or superordinate HR-BS in response to AAI-MMRL-REQ message.

Table 774—AAI-MMRL-RSP message format

Field	Size (bits)	Value/Description	Condition
Action code	2	Used to indicate the purpose of this message 0b00: HR-MS shall immediately terminate multimode service and return its original HR-MS mode. 0b01: HR-MS shall terminate multimode service and return its original HR-MS mode at the action time expires 0b10: In response to an AAI-MMRL-REQ message to allow HR-MS to transmit MS-initiated request after action time expires. 0b11: In response to an AAI-MMRL-REQ message to reject the request of HR-MS.	Always present
If (action code == 0b01 or 0b10) {			
Action time	4	LSBs of the superframe number when HR-RS start releasing the multimode or transmit AAI-MMRL-REQ message.	Always present
}			

16.2.3.75 HR-DCV-CMD message

Table 775 – HR-DCV-CMD message field and description

Field	Size (bits)	Value/Description	Condition
Frame Identifier	4	Frame which contains the ranging channel. The frame identifier is the 4 least significant bits of the frame number.	
Subframe Index	3	Indicates the subframe index of the allocated ranging opportunity.	
Dedicated ranging code index	5	Indicates the index of dedicated ranging code.	
Action	1	0b0: HR-MS to transmit the ranging signal as instructed. 0b1: HR-MS to receive the ranging signal as instructed.	
If (Action == 0b0){			
Transmit power level	5	Unsigned integer from 1 to 64 in units of 1 dBm, where 0b00000 = 0dBm and 0b11111 = 31dBm	
}			
Else{			
Report mode	2	Indicate if the report mode is exclusive (all receiving HR-MS should send HR-DCV-REP message) or triggered by threshold. 0b00: exclusive reporting 0b01: triggered-based reporting 0b10: for peer-to-peer synchronization and no reporting 0b00: reserved.	
If (Report mode == 0b01){			

SINR threshold	4	Indicates the SINR threshold for the ranging signal above which report should be made by receiving station. The 4 bit value from 0b0000 to 0b1111 represent values among {–9, –8.5, –8, –7.5, –7, –6.5,–6, –5.5, –5, –4.5, –4, –3.5, –3, –2.5,–2, –1.5} dB	
}			
}			
}			

16.2.3.76 HR-DCV-REP message

Table 776 – HR-DCV-REP message field and description

Field	Size (bits)	Value/Description	Condition
For (*i* = 0; *i* < Number of ranging codes to be reported; *i*++){			
Frame Identifier	4	Frame which contains the ranging channel. The frame identifier is the 4 least significant bits of the frame number.	
Subframe Index	3	Indicates the subframe index of the allocated ranging opportunity.	
Received SINR	4	Indicates the received SINR of the ranging code. The 4 bit value from 0b0000 to 0b1111 represent values among {–9, –8.5, –8, –7.5, –7, –6.5,–6, –5.5, –5, –4.5, –4, –3.5, –3, –2.5,–2, –1.5} dB	
Timing offset	15	Time offset, in units of F_s, of the received ranging signal, with respect to the frame timing of the HR-MS. MSB 1 bit represents the sign of the value. That is, the value is negative(–) if the MSB=0b1, and the value is positive(+) if the MSB=0b0. LSB 14 bits represent timing offset correction value of [1…16384] that corresponds to 0x0000 ~ 0x3FFF,	Optional

		respectively.	
Frequency offset	9	Frequency offset, in units of 2% of the subcarrier spacing (f), of the received ranging signal, with respect to the frequency of the HR-MS. MSB 1bit represents the sign of the value. That is, the value is negative(–) if the MSB=0b1, and the value is positive(+) if the MSB=0b0. LSB 8 bits represent frequency offset correction value of [1..256] that corresponds to 0x00 ~ 0xFF, respectively	Optional
}			

16.2.3.77 AAI-DMMS-ADV

An HR-BS transmits an AAI-DMMS-ADV message to advertise an MS list for HR-MS forwarding.

16.2.3.78 AAI-DMLU-REQ

A forwarding HR-MS transmits an AAI-DMLU-REQ message to update a MS list for HR-MS forwarding.

16.2.3.79 FWD-LU-RSP

An HR-BS transmits a AAI-DMLU-RSP message in response to a received AAI-DMLU-REQ.

16.2.3.80 HR-CEX-CMD Message

Table 780 – HR-CEX-CMD message field description

Field	Size (bits)	Value/Description	Condition
Superframe Number Action (n_{start})	4	LSBs of the superframe number in which the coverage-extending cycle should be started.	Mandatory
IDCell	10	IDCell (SA-Preamble index	Mandatory

		Idx and subcarrier set index *n*) to be used by the scheduled HR-MS (If Two-Phase Discovery is used, the HR-BS should assign pre-access SA-Preamble to groups of HR-MS based on their service characteristics.)	
Number of Preamble-only Superframes (m_{prep})	4	Indicates the number of superframes (starting from superframe with number n_{start}) in which the scheduled HR-MS should broadcast PA/SA-Preambles. No NCI shall be transmitted during these superframes.	Mandatory
Number of Superframes with NCI (m_{nci})	2	Indicates the number of superframes (starting from superframe with number $n_{start} + m_{prep}$) that the scheduled HR-MS transmits NCI.	Mandatory
Start RP code information of the S-RCH	4		
Number of Ranging Opportunities (m_{rng})	2	Indicates the number of ranging opportunities given to outside-of-coverage HR-MS	Mandatory
Subframe offset of Ranging Channel	2	Indicates the subframe offset (O_{SF}) of the RCH allocation. The range of values is $0 \leq O_{SF} \leq 3$	Mandatory
HR-MS Preamble Timing Advance (t_{adv})	[TBD]	Timing advanced that should be used by scheduled HR-MS when transmitting PA/SA-Preamble, relative to the beginning of each frame as seen by the scheduled HR-MS.	Optional
HR-MS EIRP	5	Unsigned integer from 1 to 64 in units of 1 dBm, where 0b00000 = 0dBm and 0b11111 = 31dBm	Mandatory
HR-MS to HR-MS Feedback Resource Index	11	512 FFT size: 0 in first2 MSB bits + 9 bits for resource index 1024 FFT size: 11 bits for resource index	Optional

		2048 FFT size: 11 bits for resource index Resource index includes location and allocation size.	
HR-MS to HR-BS Report Resource Index	11	512 FFT size: 0 in first2 MSB bits + 9 bits for resource index 1024 FFT size: 11 bits for resource index 2048 FFT size: 11 bits for resource index Resource index includes location and allocation size.	Optional
If(Two-Phase Discovery){			
Threshold	[TBD]		
If(Post-access parameters to be pre-assigned){			
Post *IDCell*	10	*IDCell* (SA-Preamble index *Idx* and subcarrier set index *n*) to be used by the scheduled HR-MS after detecting ranging signal above a specified threshold. (The HR-BS should assign post-access SA-Preamble such that they will be unique within physical proximity.)	
Number of Superframes with NCI (m_{nci})	2	Indicates the number of superframes (starting from superframe with number $n_{start} + m_{prep}$) that the scheduled HR-MS transmits NCI.	Mandatory
Start RP code information of the S-RCH	4		
Number of Ranging Opportunities (m_{rng})	2	Indicates the number of ranging opportunities given to outside-of-coverage HR-MS	Mandatory
Subframe offset of Ranging Channel	2	Indicates the subframe offset (O_{SF}) of the RCH allocation. The range of values is $0 \leq O_{SF} \leq 3$	Mandatory
}			
}			

16.2.3.81 HR-CEX-RNG-ACK Message

1
2 **Table 781 – HR-CEX-RNG-ACK message field description**

Field	Size (bits)	Value/Description	Condition
For (*j* = 0; *j* < N_Received_Codes; *j*++) {			
Ranging Preamble Code Index	2	Ranging preamble code index received in this ranging opportunity.	
Ranging Status	2	Indicate whether ranging preamble code or UL burst is received within acceptable limits by forwarding HR-MS. 0b00 = success 0b01 = continue 0b10 = abort	
If(Ranging Status == 0b00 or 0b01){			
Adjustment parameters indication (API)	3	Bit 0: Time offset adjustment indication. Bit 1: Power level adjustment indication Bit 2: Frequency offset adjustment indication	
If(API Bit 0==0b1) {			
Timing offset adjustment	15	Amount of time required to adjust AMS transmission (in units of 1/Fs). MSB 1 bit represents the sign of the value. That is, the value is negative(–) if the MSB=0b1, and the value is positive(+) if the MSB=0b0. LSB 14 bits represent timing offset correction value of [1..16384] that corresponds to 0x0000 ~ 0x3FFF, respectively. The AMS shall advance its transmission time if the value is negative (i.e., MSB = 0b1) and delay its transmission time if the value is positive (i.e., MSB = 0b0).	
}			
If(API Bit 1==0b1) {			
Power level adjustment	4	Power level adjustment that expresses the change in power level (in multiples of 1 dB) that the AMS shall apply to its current transmission power for initial ranging. MSB 1 bit represents the sign of the value. That is, the value is negative(–) if the MSB=0b1, and the value is positive(+) if the MSB=0b0.	

		LSB 3 bits represent power level correction value of [1..8] that corresponds to 0b000 ~ 0b111, respectively	
}			
If (API Bit 2==0b1) {			
Frequency offset adjustment	9	Frequency offset adjustment. Relative change in transmission frequency. The correction is 2% of the subcarrier spacing (f) multiplied by the 9-bit number interpreted as a signed integer. MSB 1bit represents the sign of the value. That is, the value is negative(–) if the MSB=0b1, and the value is positive(+) if the MSB=0b0. LSB 8 bits represent frequency offset correction value of [1..256] that corresponds to 0x00 ~ 0xFF, respectively	
}			
}			

16.2.4 Construction and Transmission of MAC PDUs

16.2.5 AAI Security

16.2.5.2 Key Management protocol (PKMv3)

[Change Section 16.2.5.2.2 as indicated:]

16.2.5.2.2 SA Management

A security association (SA) is the set of information required for secure communication between ABS and AMS. SA is shared between ABS and its client AMS across the AAI network. SA is identified using an SA identifier (SAID). The SA is applied to the respective ~~unicast~~ flows. ~~AAI supports unicast static SA only and~~ SAs are mapped one-by-one to cryptographic methods. (See Table 764.)

SA is used to provide keying material for unicast transport/control flows. Once an SA is mapped to an unicast transport flow, the SA is applied to all the data exchanged within the unicast transport flow. Multiple flows may be mapped to the same SA. The indication to the receiver that the MAC PDU is encrypted or not is indicated by the FID 0x1 and 0x0 in AGMH respectively for unicast control flows, and indicated by the SA that is associated to FID in AGMH and SPMH for unicast transport flows.

The Flow ID in the AGMH is used to indicate whether the PDU contains a control message encrypted based on security level. Whether each control message is encrypted or

not is decided based on the security level with which the message is associated (see Table 683).

If authorization is performed successfully, SAID 0x01 is applied to flows for confidentiality and integrity, and SAID 0x02 for confidentiality only. In addition, for secure multicast service, SAID 0x03 is applied to flows for confidentiality and integrity. SAID 0x01 shall be applied to control flows as defined in Table 680. However, SAID 0x02 can be applied to transport flows only if the AMS and ABS decide to create an unprotected transport flow, the Null SAID (i.e., SAID 0x00) is used as the target SAID. SAID 0x03 can be applied to secure multicast transport flow (see Table 764.)

Table 764 – SA mapping with protection level

Name	Name of SA	Characteristics	Usage
0x00	Null SA	Neither confidentiality nor integrity protection	For non-protected transport flow.
0x01	Primary SA	Confidentiality & integrity protection(i.e., AES-CCM mode is applied)	Encryption for unicast control/ transport flow.
0x02		Confidentiality protection only(i.e., AES-CTR mode is applied)	Encryption for unicast transport flow
0x03	Multicast SA	Confidentiality & integrity protection	Encryption for multicast transport flow
~~0x03~~0x04-0xFF		*Reserved*	

Using PKM protocol, AMS shares the SAs' keying material with ABS. An SA contains keying material that is used to protect unicast flows (see SA context in 16.2.5.4.4).

16.2.5.2.2.1 Mapping of flows to SAs

The following rules for mapping flows to SAs apply:

a) The unicast transport flows shall be mapped to an SA.

b) The multicast or broadcast transport flows shall be mapped to Null SA.

c) The encrypted unicast control flows shall be mapped to the Primary SA.

d) The non-encrypted unicast control flows shall not be mapped to any SA.

e) The broadcast control flows shall not be mapped to any SA.

f) The secure multicast transport flows shall be mapped to any multicast SA.

The actual mapping is achieved by including the SAID of an SA in the DSA-xxx messages together with the FID.

Control messages which the Primary SA is applied to are predetermined according to the control message protection level depending on each control message type and its usage. Even if non-encrypted unicast control flows shall not be mapped to any SA, CMAC-based integrity protection can be applied per control message according the control message protection level (see 16.2.5.3.3).

16.2.5.5 Security mechanisms for machine to machine application

16.2.6 MAC HO procedures

16.2.6.1.2 AMS scanning of neighbor ABSs

[Change the 4th paragraph of Section 16.2.6.1.2 (page 360) as indicated:]

An AMS selects the scanning candidate ABSs using the information obtained from the ABS through messages such as AAI-NBR-ADV and AAI-SCN-RSP. The ABS should prioritize the scanning candidates (e.g. based on the reliability) by presenting the candidate ABSs in descending order of priority in the AAI-SCN-RSP message. To support high reliability, scanning candidates may be ordered based on whether the MAC context is shared or not between serving infrastructure station and neighbor station. The AMS should follow the order of scanning as suggested in the AAI-SCN-RSP message.

16.2.6.2 Trigger condition definitions

[Change Table 775 as indicated:]

Table 775—Trigger description

Name	Length (Bits)	Value
Number of Triggers	6	Total number of triggers that are defined
for (*i* = 0; *i* □Number of Triggers; *i*++) {		
Number of conditions	2	The number of conditions that are included in this trigger (see For-loop description below this table). When more than one conditions are included, this trigger is referred to as a complex trigger and is the logical AND combination of all the included conditions.

Name	Length (Bits)	Value
ABS type	4	ABS type of T-ABS for this Trigger definition: (Any, Macro ABS, Macro Hot-zone ABS, Femto ABS, etc.). A value representing "any" means this trigger applies to all T-ABSs. This value of ABS type field shall be ignored for triggers with Type= 0x3 or the Function=0x5 or 0x6 in Table 776. 0x0: Any 0x1: Macro ABS 0x2: Macro Hot-zone ABS 0x3: Femto ABS 0x4: R1 BS 0x5–0xF: *Reserved*
HR Multimode indication	2	Indicates whether neighbor BR/RS is HR-MS acting as BS/RS or HR-BS acting as RS 0b00: neighbor BS is neither HR-MS acting as BS/RS nor HR-BS acting as RS 0b01: neighbor BS is HR-MS acting as BS/RS 0b10: neighbor BS is HR-BS acting as RS 0b11: *reserved*
Trigger averaging parameter for intra-FA measurement	8	The averaging parameter used for averaging this trigger metric according to Equation (177) for T-ABS (which is defined in ABS type). If not present, the default trigger averaging parameter in AAI-SCD is used 0x0: 1 0x1: 1/2 0x2: 1/4 0x3: 1/8 0x4: 1/16 0x5: 1/32 0x6: 1/64 0x7: 1/128 0x8: 1/256 0x9: 1/512 0xA to 0xFF: *Reserved*
……	…	……

[Change Section 16.2.6.3.3 as indicated:]

16.2.6.3.3 HO preparation

During HO preparation phase, the S-ABS communicates with T-ABS(s) selected for HO. The T-ABS may obtain AMS information from the S-ABS via backbone network for HO optimization. If the either serving infrastructure station or target infrastructure station has no backhaul connection but they communicate each other via relay link, target infrastructure station may obtain MS information from the serving infrastructure station via their relay link in DL/UL relay zone using AAI-L2-XFER message described in 16.2.3.30 for HO optimization.

During HO preparation phase, the T-ABS may allocate a dedicated ranging code and dedicated ranging opportunity to the AMS via the S-ABS through the AAI-HO-CMD message. The dedicated code shall be used by the AMS if the ABS assigns the dedicated ranging code and the Ranging Initiation Deadline has not expired. If the AMS fails to perform CDMA HO ranging successfully until the expiration of Ranging Initiation Deadline, it shall stop using the dedicated code but randomly pick a ranging code if further ranging is necessary. The T-ABS shall select the dedicated ranging code from the group of codes that are allocated for dedicated handover ranging purpose.

Upon reception of the AAI-HO-CMD message, the AMS should pre-update STID and AK to be used in the T-ABS. Any mismatched system information between AMS and the T-ABS, if detected, may be provided to the AMS by the S-ABS during HO preparation. For AMS-initiated HO, the S-ABS may detect an S-SFH mismatch between SFH information of a candidate T-ABS as known to the AMS and the SFH information of the candidate T-ABS as known to the S-ABS by referring to the AAI-NBR-ADV change count of AMS included in AAI-HO-REQ message. In such case, the ABS should include mismatching delta SFH information in AAI-HO-CMD, or it should reject the HO.

For ABS-initiated HO, the AMS may detect an SFH mismatch by referring to the S-SFH change count included in the AAI-HO-CMD message. The AMS should not select a T-ABS with mismatched SFH information. If the AMS does not have the latest SFH for any of the T-ABSs included in AAI-HO-CMD, the AMS should cancel the HO by sending AAI-HO-IND with HO event code 0b11 and SFH mismatch indication 0b1. When the S-ABS receives the AAI-HO-IND with HO event code 0b11 and SFH mismatch indication 0b1, it may send another AAI-HO-CMD message that includes all up-to-date delta SFH information of each recommended T-ABS. If pre-allocated at T-ABS, the S-ABS shall include an STID to be used at T-ABS in the AAI-HO-CMD message. The pre-allocated STID shall be used in the T-ABS by the AMS to communicate with the T-ABS. The FIDs that are used to distinguish different connections are not updated during the handover procedure. If the network decides that certain service flow will not exist at the T-ABS, this shall also be indicated in the AAI-HO-CMD message.

If HO_Reentry_Mode is set to 1, the S-ABS shall negotiate with the T-ABS the relevant HO parameters, hereby referred to as the “EBB HO parameters”. In the single carrier handover case, the EBB HO parameters include HO_Reentry_Interleaving_Interval, HO_Reentry_Interval, and HO_Reentry_Iteration for the AMS to communicate with the S-ABS during network reentry, in which case HO_Reentry_Interleaving_Interval and HO_Reentry_Interval must be no less than the minimal values defined in AMS capability. The HO_Reentry_Interval defines the period during which an AMS performs network reentry at the T-ABS; whereas, the HO_Reentry_Interleaving_Interval defines the period during which an AMS performs normal data communication at the S-ABS

after the HO_Reentry_Interval. In the multicarrier handover case, the EBB HO parameters include the carrier information in the T-ABS for the AMS performing network reentry while continuing communication with the S-ABS concurrently.

The ABS shall not set HO_Reentry_Mode to 1 unless EBB Support was declared (set to 1) by the AMS in AAI-REG-REQ. When only one T-ABS is included in the AAI-HO-CMD message, the HO preparation phase completes when S-ABS informs the AMS of its handover decision via an AAI-HO-CMD message. When multiple T-ABSs are included in the AAI-HO-CMD message, the HO preparation phase completes when the AMS informs the ABS of its T-ABS selection via an AAI-HO-IND message with HO Event code 0b00. The AAI-HO-CMD message shall include Action Time of each T-ABS for the AMS to start network reentry. The AAI-HO-CMD message shall also include a Disconnect Time Offset for each AMS to calculate disconnect time for each candidate T-ABS. Disconnect time is the time when the S-ABS expects the AMS to switch to a T-ABS. At disconnect time the S-ABS will stop sending DL data and stop providing any regular UL allocations to the AMS. When HO_Reentry_Mode is set to 0, the Disconnect Time will be (Action time - Disconnect Time Offset). For HO_Reentry_Mode = 1, Disconnect time will be (Action time + Disconnect Time Offset).

The S-ABS may reject an AMS-initiated handover by transmitting the AAI-HO-CMD message with mode set to 0b10. In this case, the S-ABS shall not include any candidate T-ABS if the T-ABS is unavailable as described in 16.2.6.3.4. If the ABS requested as a candidate T-ABS, which is available but the ABS does not have MS information, ABS list may be included in AAI-HO-CMD message with REQ-Duration. After REQ-Duration expires, AMS is allowed to perform handover. After transmitting the AAI-HO-CMD message, S-ABS may transmit MS information to the ABS via backbone network or relay link. If the ABS chooses to accept the handover, it shall set Mode in the AAI-HO-CMD to 0b00. If the ABS sets Mode to 0b00, it may include zero, one, or more T-ABS in the AAI-HO-CMD message. The ABS may include candidate T-ABSs requested by the AMS in the AAI-HO-REQ message and/or alternate candidate ABSs not requested by the AMS. If the serving ABS and those candidate T-ABSs do not share the MS information, the serving ABS may transmit MS information to candidate T-ABSs via backbone network or relay link when either serving infrastructure station or target infrastructure station has no backhaul connection but they communicate each other via relay link. When MS information is transmitted via relay link, AAI-L2-XFER message including MS information is used in DL/UL relay zone.

The AAI-HO-CMD message indicates if the static and/or dynamic context and its components of the AMS are available at the T-ABS.

All on-going DSx transaction during HO shall be cancelled, and shall be re-started after HO completion. After an ABS receives the AAI-HO-REQ message from an AMS, the ABS shall not send any DSx message to the AMS until HO completion. After an ABS sends the AAI-HO-CMD message to an AMS, the ABS shall not send any DSx message to the AMS until HO completion.

16.2.7 Persistent Scheduling in the Advanced Air Interface

16.2.8 Multicarrier operation

16.2.9 Group Resource Allocation

16.2.10 Connection Management

[Insert the following text before the last paragraph of 16.2.10:]

Multicast connections are intended for reception by some specific MSs as a group. Messages sent over multicast connections are distinguished by the 16-bit CRC masking in the HR-Multicast DL Assignment A-MAP IE as specified in 17.3.9.2.1.

16.2.11 Bandwidth Request and Allocation Mechanism
16.2.12 Quality of Service (QoS)
16.2.13 ARQ mechanism
16.2.14 HARQ functions
16.2.15 Network entry and initialization
16.2.15.7 Network entry and initialization for machine to machine operation
16.2.16 Periodic ranging
16.2.17 Sleep mode
16.2.18 Idle mode
16.2.19 Deregistration with context retention (DCR) mode
16.2.20 Co-located coexistence (CLC)
16.2.21 Interference mitigation mechanism
16.2.22 MAC control reliability
16.2.23 Power management for active mode
16.2.24 Update of S-SFH IEs
16.2.25 Short Message Service
16.2.25.1 Small burst transmission for machine to machine application
16.2.26 Coverage Loss Detection and Recovery from Coverage Loss
16.2.27 AMS deregistration
16.2.28 Support for Multicast Service
16.2.28.4 Multicast operation for machine to machine application
16.2.29 MAC Support for M2M Application
16.2.29.1 Introduction
16.2.29.2 Addressing
16.2.29.3 Security
16.2.29.4 Network (Re-)entry
16.2.29.5 Idle Mode

16.2.29.6 Support of Multicast Service

16.2.29.7 Support of M2M short packet transmission

16.2.29.8 Group Resource Allocation

16.2.29.9 Device Collaboration

16.3 Physical layer

[Change section 16.3.5.5.2.4 as indicated:]

16.3.5.5.2.4 Assignment A-MAP IE

Table 848 describes Assignment A-MAP IE Types.

Table 848 – Assignment A-MAP IE Types

A-MAP IE Type	Usage	Property
0b0000	DL Basic Assignment A-MAP IE	Unicast
0b0001	UL Basic Assignment A-MAP IE	Unicast
0b0010	DL Subband Assignment A-MAP IE	Unicast
0b0011	UL Subband Assignment A-MAP IE	Unicast
0b0100	Feedback Allocation A-MAP IE	Unicast
0b0101	UL Sounding Command A-MAP IE	Unicast
0b0110	CDMA Allocation A-MAP IE	Unicast
0b0111	DL Persistent Allocation A-MAP IE	Unicast
0b1000	UL Persistent Allocation A-MAP IE	Unicast
0b1001	Group Resource Allocation A-MAP IE	Multicast
0b1010	Feedback Polling A-MAP IE	Unicast
0b1011	BR-ACK A-MAP IE	Multicast
0b1100	Broadcast Assignment A-MAP IE	Broadcast/Multicast
0b1101	~~Reserved~~ HR-Multicast DL Assignment A-MAP IE	~~NA.~~ Multicast
0b1110	Reserved	NA.
0b1111	Extended Assignment A-MAP IE	NA.

CRC Mask

A 16-bit CRC is generated based on the randomized contents of assignment A-MAP IE and is masked by 16-bit CRC mask using the bitwise XOR operation.

The 16-bit masked CRC is constructed using a 1 bit masking prefix, a 3 bit message type indicator, and 12 bit Masking Code as described in Table 849.

Table 849 – Description of CRC Mask

Masking Prefix (1 bit MSB)	**Remaining 15 bit LSBs**	
0b0	*Type Indicator*	*Masking Code*
	0b000	12 bit STID or TSTID
	0b001	Refer to Table 850
	0b010	Refer to Table 851
0b1	15 bit RA-ID: The RA-ID is derived from the AMS' random access attributes (i.e., superframe number (LSB 5bits), frame_index (2 bits), preamble code index for ranging or BR (6 bits) and opportunity index for ranging or BR (2 bits)) as defined below: RA-ID = (LSB 5bits of superframe number | frame_index | preamble_code_index | opportunity_index)	

……

Table 851 – Description of Masking Code for type indicator 010

Decimal Value	**Description**
4095	Used to mask Broadcast A-MAP IE for multicast assignment
Others	~~Reserved~~ 12 bit MGID is used to make HR-Multicast DL Assignment A-MAP IE for high reliable multicast assignment

16.3.11 Global Values

16.4 Support for Femto ABS

16.4.1 General description

16.4.2 Femto base station subscription types

16.4.3 Femto ABS state diagram

16.4.4 PHY and MAC level identifier

16.4.4.1 PHY level cell identifier

16.4.4.2 CSG white list

16.4.5 Femto ABS initialization and de-attachment
16.4.6 Network synchronization
16.4.7 Network entry
16.4.8 Handover (HO)
16.4.9 Idle mode
16.4.10 Low-duty operation mode
16.4.11 Interference avoidance and interference mitigation
16.4.12 Power control
16.4.13 Femto ABS reliability
16.5 Multi-BS MIMO
16.6 Support for Relay
16.6.1 Relay Modes and General Description
16.6.2 Medium access control
16.6.2.1 Addressing
16.6.2.2 MAC PDU Formats
16.6.2.3 Construction and Transmission of MPDUs
16.6.2.4 Security
16.6.2.5 Handover
16.6.2.6 Scheduling and QoS
16.6.2.7 Bandwidth Request and Grant Management
16.6.2.8 ARQ
16.6.2.9 HARQ
16.6.2.10 Network Entry
16.6.2.11 Ranging
16.6.2.12 Sleep Mode
16.6.2.13 Idle Mode
16.6.2.14 ARS Configuration
16.6.2.15 ARS De-registration
16.6.2.16 Update of SFH
16.6.3 Physical Layer for TTR relay mode
16.6.3.1 Basic frame structure supporting ARS
16.6.3.2 Frame structure
16.6.3.3 Relay Downlink PHY Structure
16.6.3.4 Downlink Control Structure
16.6.3.5 Relay Uplink physical structure
16.6.3.6 Uplink Control Structure

16.6.4 Physical Layer for STR relay mode

16.7 Support for Self-organization

16.8 Support for Location Based Services (LBS)

16.9 Support for Enhanced Multicast Broadcast Service

16.10 Support for Advanced Air Interface in LZone

16.10.11 Global Values

[Insert the following clause:]

17. WirelessMAN-High Reliability Network

17.1 Overview

17.1.1 Operating frequencies

17.1.2 Operating bandwidths

17.1.3 Duplex

17.1.4 Backward compatibility

17.2 WirelessMAN HR-OFDMA air interface

[Dummy Figure 800]

[Dummy Table 1000]

17.2.1 Multi-mode operation

17.2.1.1 Relay function for HR-BS

An HR-BS (affected HR-BS) may operate as a relay station to communicate with another HR-BS (serving HR-BS) that has connection to backhaul.

An HR-BS acting as RS mode operates in either TTR mode or STR mode.

17.2.1.1.1 STR mode for HR-BS acting as HR-RS

To support STR mode, the affected HR-BS maintains base station functionality.

The procedures for RS mode change consist of following activities:

a) establish a relay link with a serving HR-BS

b) if necessary, inform some subordinate stations to perform handover

c) if necessary, reconfigure the physical frame and commence operation in relay mode

17.2.1.1.2 TTR mode for HR-BS acting as HR-RS

To support TTR mode, the affected HR-BS can maintain connectivity with subordinate HR-RS. How to maintain is FFS.

The procedures for RS mode change consist of following activities:

a) establish a relay link with a serving HR-BS

b) if necessary, inform some subordinate stations to perform handover

c) if necessary, reconfigure the physical frame and commence operation in relay mode

17.2.1.2 Relay function for HR-MS

An HR-MS may operate as an HR-RS to provide connectivity for multiple out-of-coverage HR-MSs. During basic capability negotiation at network entry, an HR-MS that is capable of role change to HR-RS shall report such capability to the super-ordinate HR-BS/HR-RS.

While operating as HR-RS, the station may maintain certain HR-MS functionalities. A mode switch to HR-RS shall be commanded by its superordinate HR-BS.

If the HR-MS is released from its role as a relay, HR-MS may perform handover to the any infrastructure station.

17.2.1.2.1 Relay link establishment

To support relay function for HR-MS, HR-MS capable of relay function may establish relay link with HR-BS.

An HR-MS acting as HR-RS is operated in either TTR mode or STR mode and its relay mode is determined by HR-BS.

To request subordinate HR-MS to change its role as HR-RS, HR-BS transmits MMRS-REQ message described in 6.3.2.3.x1 including relay mode (i.e., either TTR or STR mode).

In response to MMRS-REQ, the HR-MS transmits MMRS-RSP message described in 6.3.2.3.x2.

During establishing relay link, HR-BS transmits RS_Config-CMD message described in 6.3.2.3.63 to configure the operation parameters of HR-RS.

17.2.1.2.2 Relay link configuration

While HR-MS is acting as relay mode, the superordinate HR-BS may send an RCD message to configure the Relay operation parameters as specified in 6.3.9.18.

17.2.1.3 Base station function for HR-MS

An HR-MS may operate as an HR-BS to provide connectivity for itself and other HR-MSs. During basic capability negotiation at network entry, an HR-MS that is capable of role change to HR-BS shall report such capability to the super-ordinate HR-BS/HR-RS.

While operating as an HR-BS, the station may maintain certain HR-MS functionalities

The HR-MS may start operating as an HR-BS in a Proactive operation or a Reactive operation. For proactive operation, the mode switch is directed by the superordinate HR-BS of the HR-MS; In reactive operation, the mode switch is initiated by the HR-MS itself.

17.2.1.3.1 Proactive Operation

A superordinate HR-BS may select a target HR-MS among its subordinate HR-MSs which are capable of role changing to HR-BS, according to the measured signal power at HR-BS and/or subordinate HR-MS' status information such as the battery level. The subordinate HR-MS capable of role changing to HR-BS may report its status information to the superordinate HR-BS via MM-STAT-REP MAC control message. The triggering condition for reporting status information may be configured by the superordinate HR-BS.

After selecting the target HR-MS, the superordinate HR-BS requests the target HR-MS to change its mode to HR-BS by exchanging HRBS-REQ/RSP message. If the target HR-MS accepts the request from the superordinate HR-BS to change the mode to HR-BS, the superordinate HR-BS may transmit HRBS-CONFIG-CMD message to request the target HR-MS to set the configuration parameters and the trigger conditions for operating as HR-BS.

17.2.1.3.2 Reactive Operation

The HR-MSs which are capable of role changing to HR-BS may contend for operating at BS mode when the superordinate HR-BS fails. The HR-MSs may initiate a mode switch to HR-BS after expiration of a random backoff timer to avoid potential collision among adjacent HR-MSs trying to perform a mode switch to HR-BS at the same time.

After completion of mode switch, the HR-MS acting as HR-BS may request mode change to one of its subordinate HR-MSs in order to hand HR-BS role over. In this case, it follows the procedure for Proactive operation as described in 17.2.1.3.1.

17.2.2 Direct communication between HR-MSs

17.2.2.1 General Description

In HR-MS direct communication, the two communicating HR-MSs are the source and the sink of data. The data packets are passed from upper layers to MAC at the source HR-MS and back to upper layers at the sink HR-MS. Data packets are exchanged between the two HR-MSs directly or by passing through another HR-MS.

HR-MS direct communication is applicable when 1) the two HR-MSs are in coverage of and are directly associated to an HR infrastructure station; 2) one HR-MS is in coverage of and directly associated to an HR infrastructure station, while the other HR-MS is out of coverage of any HR infrastructure stations; 3) the two HR-MSs are out of coverage of any HR infrastructure stations.

Resource for HR-MS direct communication can be allocated by the HR infrastructure station for cases (1) and (2).

For case-3, direct communications between HR-MSs shall satisfy:

- The operation of HR-MSs shall not interfere with any existing infrastructure stations. When HR-MS cannot receive any BS preamble from any infrastructure station and HR-MS direct communication without infrastructure is permitted by device configuration, HR-MSs are allowed to communicate with each other in the same band without getting permission from infrastructure stations.
- A Coordinator is selected for the coordination of transmission among HR-MSs. Until a coordinator is selected, an HR-MS is only allowed to transmit signals necessary to enable coordinator selection. To avoid collisions among HR-MSs in coordinator selection, the HR-MS follow a collision avoidance procedure. The procedure is defined in 17.2.2.5.
- A coordinator shall function as a simplified HR-BS except it may not support handover. How to select a coordinator among HR-MSs shall follow the operation described in TBD.
- A coordinator supports the following topologies:
    - HR-MS linked to the coordinator and the pair is the source and sink of data. This topology is implemented through the local source and sink capability of the HR-MS.
    - Two HR-MS linked to the coordinator and the two HR-MS are the source and sink of data. This topology is implemented through the local forwarding capability of the HR-BS.
    - A forwarding HR-MS forwards data of a forwarded HR-MS to the coordinator. This topology is implemented through the HR-BS capability to support HR-MS forwarding operation.
    - Two HR-MS are linked (DC) and are the source and sink of data to each other under the control of the coordinator. This topology is implemented through the HR-BS ability to support DC between its subordinates.
- The coordinator and any HR-MS that are communicating through the coordinator shall continue cell search operation and shall cease DC operation as soon as the criteria for DC and prevention of interference above are not met.

HR-MS direct communication using distributed resource allocation among nearby HR-MSs, that is called talk-around direct communication, is described in 17.2.2.6.

17.2.2.2 Frame Structure and Resource Allocation

Resources for HR-MS Direct Communications and HR-MS Forwarding to Network shall be scheduled by the serving HR-BS/RS when one exists. Serving HR-BS/RS can schedule direct communication in an on-demand and dynamic manner, and can multiplex this with transmissions between HR-MS and HR-BS / HR-RS.

To optimize the signaling and switching cost and improve QoS provisioning to HR-MS direct communication, serving HR-BS / HR-RS can schedule resource for DC/FTN zone

for multiplexing DC/FTN transmissions. An HR-MS DC / FTN Zone is an area of continuous OFDMA resources in time and logical subchannels or resource units. The size and location of DC/FTN zone is dynamically or semi-stationary determined by the serving HR-BS.

When an infrastructure node doesn't exist, one of the HR-MS shall fulfill this coordinating role. It is understood that the coordinating HR-MS needs to take on some of the functionality of a HR-BS and may also require new functionality.

All resource scheduling shall be conveyed through MAP or DL control messages from serving HR-BS/RS or a coordinating HR-MS. In the case of HR-MS Forwarding to Network, the scheduling messages shall be forwarded by the forwarding HR-MS.

Random access channels may be used for bandwidth request. For case-1, bandwidth request are sent directly to the serving HR-BS /HR-RS. For case 2, bandwidth requests are forwarded by the forwarding HR-MS.

17.2.2.3 Synchronization between HR-MSs involving in HR-MS DC/FTN

This section describes the process of maintaining synchronization between two HR-MSs that communicate directly with each other under HR-MS DC and FTN. The process is employed after HR-MS DC/FTN has been setup, and therefore should be differentiated from the discovery process described in 17.3.7.1.2. Synchronization between HR-MSs is classified into two levels:

- The frame-level should allow HR-MSs to share a common understanding of frame and/or superframe timing and configuration.

- The symbol-level should allow reliable (i.e. received within the appropriate reception threshold) bi-directional transmissions between HR-MSs.

Synchronization mechanisms are specified for three different use cases as follows.

17.2.2.3.1 Use case 1: Both HR-MSs are within the coverage of HR-BS/RS

The following synchronization mechanisms are used for HR-MS DC/FTN scheduled in uplink area of a frame.

Frame-level Synchronization:

When both HR-MSs are able to receive preambles and DL control signals from a common serving HR-BS/HR-RS, they shall use these to achieve frame-level synchronization (with respect to HR-BS/HR-RS and between themselves). When both HR-MSs involved in DC or FTN are within the coverage of HR-BS/HR-RS, frame-level synchronization means the HR-MSs acquire DL synchronization with the serving HR-BS/HR-RS and are able to achieve system configuration and control messages.

Symbol-level Synchronization:

When the HR-MS/HR-MS direct link is scheduled in a UL area of a frame, the transmitting HR-MS shall follow the same timing advance as has been adjusted and agreed with the serving HR-BS/HR-RS. This means the transmitting HR-MS shall time its direct transmissions as if these are normal UL transmissions toward the serving HR-BS/HR-RS.

It is the responsibility of the receiving HR-MS to adjust its receive timing to match the time of arrival (TOA) of the signal transmitted by the other HR-MS. This time adjustment shall be achieved by the serving HR-BS/HR-RS scheduling the HR-MSs to transmit ranging sequences to each other. Based on a received ranging sequence, an HR-MS can estimate and correct its time offset with the transmitting HR-MS. To facilitate this process, the serving HR-BS/HR-RS shall assign dedicated ranging sequences and ranging channels in UL area of a frame for HR-MS/HR-MS direct ranging.

To enhance bi-directional communication between HR-MSs, the serving HR-BS/HR-RS can allocate ranging resources to both involved HR-MSs in a single assignment. This allows the receiving HR-MS to transmit back a ranging sequence right after successfully processing the ranging sequence transmitted by the other HR-MS.

The serving HR-BS/RS schedules ranging between two HR-MSs through HR-DCV-CMD message.

17.2.2.3.2 Use case 2: one HR-MS is inside and the other is outside the coverage of HR-BS/RS

The following synchronization mechanisms are used for HR-MS DC/FTN scheduled in uplink area of a frame.

Frame-level Synchronization:

When two HR-MSs need to achieve frame-level synchronization and only one of them is within the coverage of the serving HR-BS/HR-RS, the inside-of-coverage HR-MS shall first acquires DL synchronization with the serving HR-BS/HR-RS (based on preambles and control messages from the serving HR-BS/HR-RS). The inside-of-coverage HR-MS shall subsequently broadcast preambles and possibly network configuration information (NCI) for the outside-of-coverage HR-MS to co-synchronize.

The registered HR-MS shall transmit preambles either at the first OFDMA symbol or the last OFDMA symbol of the frame. The NCI shall be transmitted in an UL area. The location of the NCI, relative to the transmitted preambles, shall be determinable by the outside-of-coverage HR-MS.

Symbol-level Synchronization:

Using the preambles and NCI transmitted by the inside-of-coverage HR-MS, the outside-of-coverage HR-MS shall adjust its timing to receive messages transmitted from the inside-of-coverage HR-MS. To further improve synchronization in this direction, the inside-of-coverage HR-MS can transmit ranging signal toward the outside-of-coverage HR-MS so that this node can estimate and correct its time/frequency offsets. Symbol-level synchronization in the opposite direction, i.e., from the outside-of-coverage of HR-MS toward the inside-of-coverage HR-MS shall be achieved by the outside-of-coverage HR-MS transmitting ranging signal toward the inside-of-coverage HR-MS. Upon processing the received ranging signal, the inside-of-coverage HR-MS can either adjust its own receive timing or request the outside-of-coverage HR-MS to adjust the transmit timing.

The serving HR-BS/RS schedules ranging between two HR-MSs through HR-DCV-CMD message.

17.2.2.3.1 Use case 3: MS-MS direct communications; there is no HR-BS/RS

- The first level synchronization should be carried out in a Master-slave manner. It is understood that the master needs to take on some of the functionality of a BS and may also require new functionality.

- The second level of synchronization can be achieved by HR-MSs exchanging ranging signals.

An example of this scenario is when HR-MS1 and HR-MS2 are having direct communications in an infrastructure-less deployment (or due to single point of failure). For this, an HR-MS (which can be HR-MS1, HR-MS2, or another node) should first be elected as the network coordinator. It is assumed that either one or both HR-MS1 and HR-MS2 then are within the coverage of the elected coordinator. After being elected, the coordinator shall periodically broadcast preambles for frame-level synchronization. With this, the control is back to one of the two earlier scenarios.

17.2.2.4 HR-MS Direct Communication with Infrastructure Stations

HR-BS/HR-RS shall check DSA_REQ messages received from HR-MS and determine whether HR-MS direct communication can be adopted for a flow. The HR-BS/HR-RS may help the source and destination HR-MSs setting up a direct communication link through DSA signaling.

HR-BS knows the possibility of setting up a direct communication between two HR-MSs by checking the HR-MS neighbor tables. If the two nodes are neighbor, HR-MS may schedule the two HR-MSs to do channel measurement and determine whether a direct communication link should be setup.

Before a service flow can be conveyed over the link between source and destination HR-MSs, a direct communication link shall be setup first if it has not been setup yet.

A direct communication link is a link between a pair of HR-MS. It is identified by a CID. A security association may be setup between the two HR-MS linked by the direct communication. HR-BS manages the link by referring to the CID assigned to this link.

There are a few steps to setup a direct communication link between two HR-MS. The first step is that the two HR-MS need to do a channel measurement. After the channel measurement, the two HR-MSs shall report the measurement results to the HR-BS and HR-BS shall make a decision whether it will setup a direct communication link between the two HR-MSs. If HR-BS decides to setup a direct communication link, it shall assign a CID to the target link. After that, it may help the two sides setup a security association between the two HR-MSs. Once a security association is setup, then the communication link is considered being established between the two HR-MSs and service flows can be carried on the link. Figure 801 shows the procedure to setup a direct communication link between HR-MSs.

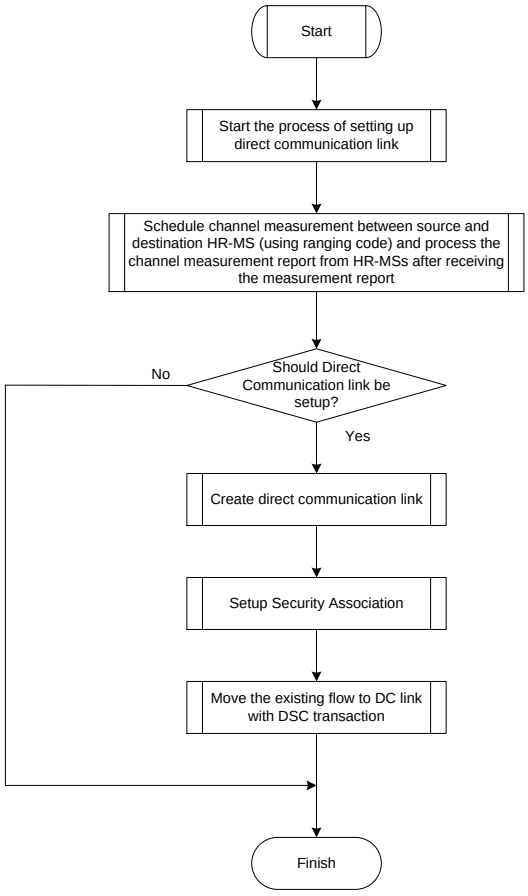


Figure 801— The overall procedure to setup direct communication

17.2.2.4.1 Direct Communication Management

17.2.2.4.1.1 Direct Communication Link Creation

When HR-BS creates direct communication link between two HR-MSs. It shall allocate a CID for the direct communication link and send link creation message to both source and destination HR-MSs. Direct communication link creation can only be initiated by the HR-BS.

Table 1001— Direct Communication Link Creation Request

Syntax	Size (bit)	Notes
DC-LINK-CREATE-REQ () {		
Management Message Type = [TBD]	8	—
CID of source HR-MS	16	
CID of destination HR-MS	16	
CID assigned to DC link	16	
}		

The HR-MSs shall send back a response once they receive the direct communication link creation request.

Table 1002— Direct Communication Link Creation Response

Syntax	Size (bit)	Notes
DC-LINK-CREATE-ACK () {		
Management Message Type = [TBD]	8	—
CID assigned to DC link	16	—
Confirmation Code	4	0x00: accept 0x01: reject 0x02 – 0x0f: reserved
Reserved	4	—
}		

Once the HR-BS receives responses from both HR-MSs, it can continue on other steps of direct communication setup.

17.2.2.4.1.2 Direct Communication Link Deletion

When HR-BS wants remove a direct communication link, it shall send deletion request to both HR-MS and wait for responses from the HR-MSs.

Table 1003-- Direct Communication Deletion Request

Syntax	Size (bit)	Notes
DC-LINK-DEL () {		
Management Message Type = [TBD]	8	—
CID of DC link	16	
}		

The HR-MS shall reply with reasons to HR-BS when it receives the link deletion request from HR-BS.

Table 1004—Direct Communication Deletion Response

Syntax	Size (bit)	Notes
DC-LINK-DEL-ACK () {		
Management Message Type = [TBD]	8	—
CID of DC link	16	
Confirmation Code	4	0x00: accept 0x01: reject 0x02 – 0x0f: reserved
Reserved	4	—
}		

17.2.2.4.1.3 Direct Communication Link Report

HR-BS may require the HR-MS report the status of the direct communication link by sending a request to the relative HR-MS.

Table 1005—Direct Communication Link Report Request

Syntax	Size (bit)	Notes
DC-LINK-REPORT-REQ () {		
Management Message Type = [TBD]	8	—
CID of DC link	16	
}		

HR-MS shall send back report regarding the direct communication link when it receives a link report request from HR-BS.

Table 1006—Direct Communication Link Report

Syntax	Size (bit)	Notes
DC-LINK-REPORT-REQ () {		

Management Message Type = [TBD]	8	—
CID of DC link	16	
Link state	3	0x00: active 0x01: no link found 0x02 – 0x07: reserved
reserved	5	—
}		

17.2.2.4.2 Direct communication service flow management

17.2.2.4.2.1 Service flow creation over direct communication link

After a direct communication link has been setup between the source and destination HR-MS, the source HR-MS can setup flows over the direct communication link.

A direct communication setup protocol is illustrated in Figure 802 and described in detail in **17.2.2.4. 2.3**.

When HR-BS receives DSA-REQ from HR-MS, it checks whether a direct communication can be setup between the source and destination. If direct communication can be setup, HR-BS sends back a DSX_RVD to source HR-MS with indication of direct communication link. If direct communication is possible, the HR-BS holds on the transmission of DSA-RSP to source HR-MS until it finishes DSA negotiation with the destination HR-MS.

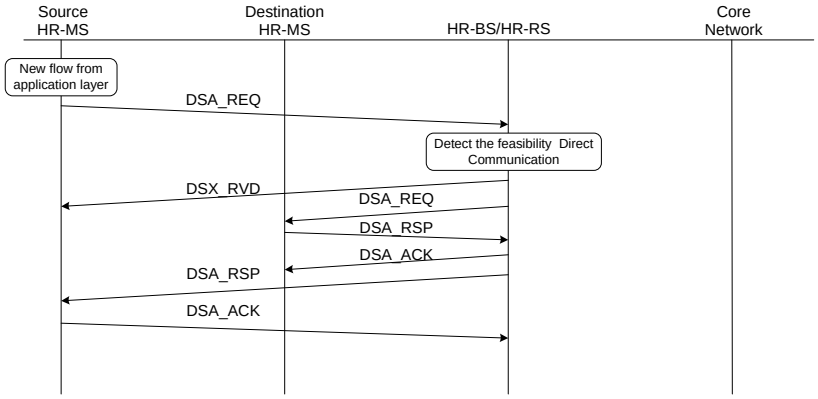


Figure 802—The establishment of direct communication between HR-MS

17.2.2.4.2.2 Modification and Deletion of Dynamic Service Flow over direct communication link

In addition to the methods presented in **17.2.2.4.2.3** for creating service flows, protocols are defined for modifying and deleting service flows; see **17.2.2.4.2.4** and **17.2.2.4.2.5**.

The modification of parameters of a service flow over direct communication link also involves both the source and destination HR-MS.

If the modification is initiated by one HR-MS, then if and only if the HR-BS and the other HR-MS agree with the modification, then the modification can be applied. If the modification is initiated by the HR-BS, then if and only if both HR-MSs agrees with the change then the modification can be applied.

17.2.2.4. 2.3 Dynamic Service Addition

When HR-BS receives a DSA_REQ from an HR-MS and find that direct communication can be setup between the source and destination HR-MSs by checking the source and destination addresses after testing the integrity. If direct communication can be setup, the Confirmation Code in DSX_RVD message shall be set to **direct-comm-setup** as defined in table 607 so that the source HR-MS knows that a direct communication link is going to be setup between the source and destination HR-MSs and Timer 74 instead of timer T7. Else, the HR-BS processes the DSA_REQ as a normal request.

HR-BS creates a flow_id based on the QOS requirement in the DSA_REQ.

Before sending DSA_RSP back to the source HR-MS, the HR-BS shall finish the DSA transaction with destination HR-MS with indication of direct communication. The process is illustrated in the Table 1007.

Table 1007—DSA Process for the direct communication

Source SS	Destination SS		BS
New service flow needed Check if resources are available			
Send DSA-REQ Set Timers T7 and T14		---DSA-REQ-->	Receive DSA-REQ DSA-REQ integrity valid
Timer T14 Stops; If direct communication is feasible, Timer T7 stops; Set Timer T74.			Check whether source and destination SS can support direct communication.
		<-- DSX-RVD--	Check whether source and destination are neighbors. Check whether SS is authorized for service Check whether service flow QoS can be Supported Create SFID
	Receive DSA-REQ Confirm that SS can support service flow Add DL SFID (if present) Enable reception on any new DL	<-- DSA-REQ--	Send DSA-REQ Set Timer T7

	service flow Send DSA-RSP	---DSA-RSP-->	Receive DSA-RSP Timer T7 Stops Enable transmission (DL) or reception (UL) of data on new service flow
	Receive DSA-ACK Enable transmission on new UL service Flow	<-- DSA-ACK--	Send DSA-ACK
Receive DSA-RSP Timer T74 Stops If ActiveQoSParamSet is non-null, Enable transmission or reception of data on new service flow		<--DSA-RSP---	Send DSA-RSP
Send DSA-ACK		---DSA-ACK-->	Receive DSA-ACK If DL ActiveQoSParamSet is non-null, Enable transmission of data on new DL service flow

17.2.2.4.2.4 Dynamic Service Change

With direct communication, the data flow is uni-direction, from source to destination HR-MS. Only source HR-MS and HR-BS are allowed to change the service flow parameters.

Source HR-MS initiated DSC procedure

When receving DSC-REQ from source HR-MS, the HR-BS shall delay the DSC-RSP to the source HR-MS and finish the DSC transaction with destination HR-MS first. Once the DSC transaction with destination HR-MS is finished, then the HR-MS sends a DSC-RSP to the source HR-MS and wait for the ACK. The process is illustrated in the Table 1008.

Table 1008—HR-MS initiated DSC procedure for direct communication

Source HR-MS	**Destination HR-MS**		**HR-BS**
Service flow requires modifying Send DSC-REQ Set Timers T74 and T14		--- DSC-REQ ---->	Receive DSC-REQ
Timer T14 Stops		<-- DSX-RVD ---	DSC-REQ integrity valid Validate Request
	Receive DSC-REQ	<-- DSC-REQ ---	Set Timers T7

	Validate request Modify service flow Send DSC-RSP	--- DSC-RSP ---->	Receive DSC-RSP Timer T7 Stops Increase Channel Bandwidth if Required
	Receive DSC-ACK	<-- DSC-ACK ---	Send DSC-ACK
Receive DSC-RSP Timer T74 Stops Reduce Payload Bandwidth if Required		<-- DSC-RSP ----	Send DSC-RSP
Send DSC-ACK Increase Payload Bandwidth if Required		--- DSC-ACK ---->	Decrease channel Bandwidth if Required

HR-BS Initiated

HR-BS can do the modification over DSC transaction with source and destination HR-MSs separately but with certain order.

In case bandwidth allocated to the direct communication link will be increased, the HR-BS should finish the transaction with destination HR-MS first and followed by the DSC transaction with source HR-MS.

In case bandwidth allocated to the direct communication link will be reduced, the HR-BS should finish the transaction with source HR-MS first and followed by the DSC transaction with destination HR-MS.

17.2.2.4.2.5 Dynamic Service Deletion

An HR-MS wishing to delete a service flow over HR-MS direct communication link generates a delete request to the HR-BS using a DSD-REQ message. The HR-BS finds the other HR-MS that also associates to the service flow first and then removes the service flow. After that, the HR-BS generates a response using a DSD-RSP message to the HR-MS who sends DSD_REQ. At the same time, the HR-BS also generates DSD-REQ to the other HR-MS who also associates to this service flow.

A BS wishing to delete a dynamic service flow over HR-MS direct communication link generates two delete requests to the associated HR-MSs respectively using DSD-REQs. The HR-MSs removes the service flows and generate responses using DSD-RSPs. This process is illustrated in Table xxx.

17.2.2.4.2.6 Management Messages

17.2.2.4.2.6.1 DSA_REQ

When HR-BS establishes direct communication between the source and destination HR-MSs, the DSA_REQ from HR-BS to the destination HR-MS shall contain a TLV that indicates of direct communication link setting up.

The TLV for direct communication is defined in 11.13.46.

17.2.2.4.2.6.2 DSA_RSP

When HR-BS establishes service flow over direct communication between the source and destination HR-MSs setting up direct communication, the DSA_RSP from HR-BS to the source HR-MS shall indicate by a TLV that a direct communication link should be used for the coming flow.

17.2.2.4.2.6.3 DSA_ACK

After receiving the DSA_ACK from the destination HR-MS, the HR-BS shall send DSA_RSP to the source HR-MS.

17.2.2.4.2.6.4 DSX_RVD

When setting up a direct communication link between source and destination HR-MSs, HR-BS should set the confirmation code in DSX_RVD to direct-com-setup as defined in table 607.

17.2.2.5 HR-MS Discovery for Direct Communication without Infrastructure

When HR-MS cannot receive any BS preamble from any infrastructure station or an HR-MS that is associated with an infrastructure station, and HR-MS direct communication without infrastructure is permitted by device configuration, then HR-MSs are allowed to transmit network discovery signals to the network.

When HR-MS sends out network discovery messages, to avoid collision with other HR-MSs, it should follow a random-back off mechanism as follows:
1) A back-off timer shall be started.
2) When the timer is timeout, HR-MS should sense the channel for the presence of preambles first. If no preambles detected, then the HR-MS should transmit the discovery message. If a preamble has been detected, then node should hold the transmission and restart the timer.
3) HR-MS should get the value for the duration of back-off from a window, for example, from a window of [w_{min}, w_{max}], the size of window can be adjusted based on the traffic of networks. The value of W_{min} and W_{max} are TBD.

The network discovery message shall take the following format: a frame preamble shall be transmitted first followed by control and discovery information. The control information includes FCH, DL-MAP. UL-MAP shall be omitted. Discovery information

should follow the DL-MAP. A data packet may be transmitted as part of the discovery information.

For the FCH, it takes the same format as defined in 8.4.4.4.

For the DL-MAP, the DCD messages transmitted in the PHY Synchronization Field shall set the value of frame duration code to 255. The value indicates that the message is not from a BS, it is from an HR-MS for the discovery purpose. DCD count shall be set to zero. The base station ID shall be set to the MAC address of the current HR-MS.

17.2.2.5.1 DC_DISCOV_Message

The discovery message follows the DL-MAP and shall take the following encoding format:

Table 1009—DC discovery message encodings

Syntax	Size (bit)	Notes
DC_DISCOV_Message() {	—	—
Length	16	The length of the message
NBR Count	8	Number of neighboring HR-MSs
for(i=0;i<n;i++){		
DC_DISCOV_IE();		
}		
}		

MAC Address

MAC address is the 48 bit address assigned to the HR-MS device. It shall be used as unique identity of the HR-MS in network discovery.

NBR Count

The value indicates the number of neighboring HR-MSs that the current HR-MS discovered via the neighbor discovery process.

DC_DISCOV_IE

Various information such as name of the HR-MS, MAC address of the neighboring node, invitation for communication etc is contained in the IEs.

17.2.2.5.2 Encoding of DC_DISCOV_IEs

The IEs contained in discovery message has a common encoding format as follows:

Table 1010—DC discovery IE encodings

Syntax	Size (bit)	Notes
DC_DISCOV_IE() {	—	—
Type	8	—
Length	8	The length of data contained in the value field
Value	variable	
}		

A few type of IE has been defined in Table 1011 [number TBD].

Table 1011—DC discovery IE types

Type	**Name**
0x01	DC_DISCOV_NODE_NAME
0x02	DC_DISCOV_NBR_ADDR
0x03	DC_DISCOV_INVITE
0x04	DC_DISCOV_INVITE_ACCEPT
0x05	DC_DISCOV_INVITE_REJECT
0x06 – 0xfe	Reserved
0xff	DC_DISCOV_DATA

17.2.2.5.2.1 DC_DISCOV_NODE_NAME

The node name is an ASCII string. The maximum length is 16 bytes.

Table 1012—DC HR-MS Name

Type (1 byte)	**Length (1 byte)**	**Value (variable length)**
0x01	**1 – 16**	**A name given by the user of HR-MS**

17.2.2.5.2.2 DC_DISCOV_NBR_ADDR

It contains MAC addresses of neighboring HR-MSs discovered by the current HR-MS. Each MAC address takes six bytes. Multiple MAC addresses can be transmitted in the same DC_DISCOV_NBR_ADDR IE.

Table 1013—DC Neighbor Address IE

Type (1 byte)	**Length (1 byte)**	**Value (variable length)**

0x02	**variable**	**MAC Address of the HR-MSs**

17.2.2.5.2.3 DC_DISCOV_INVITE

The IE contains MAC address of the HR-MS that the current HR-MS want to setup connections. Multiple MAC addresses can be contained in the IE.

Table 1014—DC Invitation IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0x03	**variable**	**MAC address of the invited HR-MS**

17.2.2.5.2.4 DC_DISCOV_INVITE_ACCEPT

The current HR-MS decided to accept the invitation. It intends to join the HR-MS network once the HR-MS become a coordinator.

Table 1015—DC Accept IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0x04	**6**	**MAC address**

The MAC address belongs to the HR-MS who sends out a DC_DISCOV_INVITE_ACCEPT message

17.2.2.5.2.4 DC_DISCOV_INVITE_REJECT

The current HR-MS rejects the invitation from the HR-MS. The IE contains the MAC address of the HR-MS who sends out a DC_DISCOV_INVITE message. It indicates that the current HR-MS declines to communicate with the other HR-MS.

Table 1016—DC Reject IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0x05	**6**	**MAC address of the inviting HR-MS**

17.2.2.5.2.6 DC_DISCOV_DATA

A short data packet is contained in the IE. The interpretation of the data is up to application.

Table 1017—DC Data IE

Type (1 byte)	Length (1 byte)	Value (variable length)

0xff	1 – 255	First 6 bytes is the MAC address of intended HR-MS and follows by the data from upper layer.

17.2.2.6 Talk-around Direct Communication

HR-MSs by themselves synchronize and perform contention-based transmission. The synchronization and the contention-based transmission are performed among those HR-MSs on a dedicated resource unused by HR-BSs if at least one of the HR-MSs are under HR-BS coverage.

17.2.2.6.1 Key management for talk-around direct communication

Talk-around direct communication key is managed as described in 17.2.10.1.2.

17.2.2.7 Power control for mobile to mobile communication

17.2.2.7.1 Power control for two HR-MS associated with an HR-BS

When two HR-MS that are associated with an HR-BS are transmitting to each other their power control related commands are generated by their serving HR-BS.

The HR-BS may define measurements to be performed by the HR-MS on resources used for MS-MS communications and on the desired MS-MS signal to be reported to the HR-BS.

Definition of power control procedure is TBD.

17.2.2.7.2 Power control for one HR-MS associated with an HR-BS

The transmission power of a forwarding HR-MS transmitting to forwarded HR-MS is controlled by messages from the forwarded HR-MS that are derived from HR-BS controls

The transmission power of a forwarded HR-MS is controlled by messages from the forwarding HR-MS that are derived from HR-BS controls

Power control procedure details TBD.

17.2.2.7.3 Power control for no HR-MS associated with an HR-BS

If a coordinator is used then it controls transmission power for the pair in the same way as a baseline HR-BS would.

17.2.3 HR-MS Forwarding to Network

17.2.3.1 General Description

In HR-MS Forwarding to Network, an HR-MS forwards user data and control signaling between an HR-MS and an HR infrastructure station. The user data and control signaling do not go through higher layer at the forwarding HR-MS. The origination and termination of the user data and control signaling are at the forwarded HR-MS and the HR infrastructure station respectively and vice versa.

HR-MS Forwarding to Network is applicable when 1) the forwarded HR-MS and the forwarding HR-MS are in coverage of and directly associated to an infrastructure station; 2) the forwarding HR-MS is in coverage of and directly associated to an HR infrastructure station, while the forwarded HR-MS is out of coverage of any HR infrastructure stations.

Resource for HR-MS Forwarding to Network can be allocated by the HR infrastructure station with which the forwarding HR-MS is associated.

17.2.3.2 Frame structure and resource allocation

See 17.2.2.2

17.2.3.3 Synchronization (this section is identical to 17.2.2.3)

See 17.2.2.3

17.2.3.4 Bandwidth Requests sent from Forwarded HR-MS

For use case 2, an out-of-coverage forwarded HR-MS can request bandwidth by transmitting some known sequences (Bandwidth Request (BR) preambles) toward the forwarding HR-MS.

The process can be described as follows.

- Serving HR-BS/RS schedules resources in an uplink subframe for forwarded HR-MSs to transmit BR messages to their corresponding forwarding HR-MS.
- The resource allocation information is conveyed to the forwarded HR-MS.
- The forwarding HR-MS listens to bandwidth requests at times and resources indicated by the HR-BS. The forwarded HR-MS may transmit bandwidth requests using these resources.
- The forwarding HR-MS, upon receiving BR messages from one of its forwarded HR-MS, forwards the requests to serving HR-BS/RS.
- Any resource assignment from the HR-BS is forwarded to the forwarding HR-MS.

17.2.4 Standalone network

For WirelessMAN HR-OFDMA air interface, when the HR-BS loses connectivity to the

backbone network and the neighboring HR-BSs, the network stations under the coverage of this HR-BS shall form a standalone network. The local connectivity shall be provided for the HR-MS within the coverage of affected HR-BS. The established service flow between HR-MS within the coverage of the affected HR-BS shall be maintained.

17.2.4.1 Maintenance of Local Connectivity

For maintenance of local connectivity, all the HR-BSs shall maintain a network topology table of HR-MS/HR-RS within its coverage area. The network topology table shall be updated periodically by broadcasting STN-REQ message from HR-BS and receiving acknowledgement message STN-ACK from HR-MS or HR-RS within its coverage area.

17.2.4.2 Entry Process for Standalone Network

The HR standalone network with WirelessMAN HR-OFDMA air interface shall allow the entry of an unassociated HR-MS into the standalone network and establish the connection with standalone network HR-BS. The unassociated HR-MS is referred to the HR-MS which is not associated with any Base Station.

17.2.4.3 Recovery Process of Standalone Network

When a standalone network HR-BS recovers the backbone connection, the standalone network shall be incorporated to the backbone connected network. Neighbor HR-BSs transmit information to the HR-BS which has recovered the backbone connection. The specification on how to transmit is out of scope of this standard. The subordinate stations may remain the association or re-associate with the HR-BS that has recovered the backbone connection.

17.2.5 Relaying operation

In order to provide great reliability in a degraded network, the relay function described in this subsection shall be supported.

In order to support local forwarding in an HR-Rs, the HR-Rs shall follow operation as defined in Section 17.2.6.

17.2.6 Local Forwarding

17.2.7 Path Discovery and Management

17.2.7.1 HR-MS Neighbor Discovery

HR-MS neighbor discovery is a key functionality to enable other 16n features such as path discovery and management, HR-MS direct communications (with or without presence of infrastructure), and HR-MS forwarding to network. HR-MS neighbor discovery procedures are specified for two scenarios: i) when HR-MSs associated with a

common super-ordinate station (HR-BS/RS or a coordinating HR-MS) attempt to discovery each other and ii) when an out-of-coverage HR-MS attempts to discover an HR-MS in order to connect through it to network infrastructure.

17.2.7.1.1 Neighbor Discovery among associated HR-MSs (Use Case 1)

For associated HR-MSs to discover each other, the serving HR-BS/HR-RS shall schedule some HR-MSs to broadcast predefined self-advertizing (PSA) signals so that other HR-MSs can try to receive and verify their neighbor relationship. Ranging preambles shall be used as PSA signals.

The process of neighbor discovery for registered HR-MSs is as follows:

- The serving HR-BS/HR-RS sends HR-DCV-CMD message to schedule one or multiple associated HR-MSs to broadcast ranging sequences in assigned channels. Multiple HR-MSs may share the same ranging sequence or the same assigned channel.
- In the same HR-DCV-CMD message, the serving HR-BS/HR-RS also schedules some other HR-MSs to listen on those channels scheduled for ranging signals.
- Each HR-MS that is scheduled to receive ranging sequences shall determine what sequences it can properly decode, together with related information such as estimations of time/frequency offsets and signal strength.
- The receiving HR-MSs may report their measurements to the serving HR-BS/HR-RS using HR-DCV-REP message. Whether a receiving HR-MS shall report its measurements or not may be based on a threshold.

The transmission of HR-DCV-CMD can be described as follows. The HR-BS unicasts HR-DCV-CMD message to a single HR-MS or multicasts the message to a group of HR-MSs that are supposed to broadcast the ranging signal. The HR-BS unicasts HR-DCV-CMD message to a single HR-MS or multicasts the message to a group of HR-MSs that are supposed to attempt to receive the ranging signal. The HR-BS can also broadcast the HR-DCV-CMD message to all of its subordinates HR-MS. In such a case, all HR-MS that are not involved in UL transmission during the ranging opportunity index shall attempt to receive the ranging signal.

17.2.7.1.2 HR-MS Discover Network Infrastructure

For use case 2, The HR-BS may instruct HR-MS that are associated with it to transmit access information at pre-defined resources relative to the preambles transmitted by the HR-MS. The access information defines resources for access by the HR-MS that is not under HR-BS coverage. Access information may be omitted. If access information is omitted then access resources are defined by the index and the sub-carrier set index of the SA-Preamble. All or a group of the directly associated HR-MS may or may not transmit the same access information on the same or different resources.

An unassociated HR-MS that detects the associated HR-MS preamble(s) shall

subsequently receive access information to determine the access resource. If access information is omitted then access resources are determined from the SA-Preamble. The unassociated HR-MS transmits a CDMA preamble.

The associated HR-MS that received the CDMA preamble responds with sufficient access information to complete the association procedure.

17.2.7.2 Robustness against SPOF

The HR-MS may transmit/receive data to/from any one infrastructure station at any given time. The HR-MS may forward previously received data to other infrastructure stations at other times.

17.2.7.2.1 Preparation for SPOF

In order to support Preparation for SPOF, alternative path described in this subsection shall be supported.
An alternative path may include HR-MS that switches mode to RS or BS.

Network entry including handover as described in 6.3.21 shall be supported in the event of SPOF. An indication of whether MAC context information of the subordinate HR-MS is being shared by infrastructure stations shall be transmitted to HR-MS.

HR-MSs capable of forwarding to the network and/or multimode operation shall share the MAC context information with the HR-MS performing local forwarding to the network.

If necessary, another path can be selected, if available, among alternative paths.

17.2.7.2.2 Preparation for SPOF with fast network reentry

To support switching to alternative path with fast network reentry, the serving HR-BS transmits MOB_BSHO-REQ message with mode = 0b111 to the HR-MS.

The target HR-BS of the alternative path can request MS context information from the serving HR-BS and recommend a ranging code and slot from the ranging region to facilitate fast network reentry and reduce contention during ranging. However, how to request and recommend is out of this specification. The serving HR-BS indicates to the HR-MS whether an optimized network reentry should be carried out by setting “HO process optimization” bitmap in the MOB_BSHO-REQ message.

The alternative path information may be updated with a new MOB_BSHO-REQ message.

When the trigger condition specified in the TLV of the last MOB_BSHO-REQ is met, the alternative path is activated and fast network reentry is performed by an HR-MS. If the action time is non-zero, the HR-MS shall perform the fast network reentry after the action time expires.

17.2.7.2.3 Recovery from SPOF

Network reentry including handover as described in 6.3.21 shall be supported in the event of SPOF. Whether MAC context information of the subordinate HR-MS is shared by the infrastructure stations shall be transmitted to HR-MS.

If role change was indicated in MOB_BSHO-REQ, subordinate HR-MS shall establish relay link described in 17.2.1.2.1 after fast network reentry as described in 17.2.7.2.2. This is to support other HR-MS which are affected by the SPOF.

Alternative path may be selected during the role change or release the mode as described in 17.2.1.

17.2.7.3 Preparation for Alternative path to support fast network reentry to the neighbor HR-MS

HR-MSs capable of forwarding to the network and/or multimode operation shall share the MAC context information with the HR-MS performing local forwarding to the network.

To support fast network reentry to the neighbor HR-MSs, either HR-BS or HR-MS may prepare the alternative path.
To prepare the alternative path by an HR-BS, the HR-BS shall perform operation as follows:

a) neighbor discovery as described in 17.2.7.1.1
b) collecting HR-MS' neighbor information as described in 17.2.7.1.1
c) determines the alternative path for HR-MS
d) informs HR-MS about its alternative path information

To prepare the alternative path by an HR-MS, following operation shall be performed by HR-MS and HR-BS:

a) An HR-MS transmit AP-NBR-REQ to the HR-BS to initiate the neighbor discovery process
b) HR-BS received AP-NBR-REQ, performs the neighbor discovery as described in 17.2.7.1.1
c) HR-BS collects the neighbor information of requesting HR-MS as described in 17.2.7.1.1
d) HR-BS transmits AP-NBR-REP message to HR-MS which includes the neighbor information of requesting HR-MS.
e) HR-MS determines alternative path by itself based on its received neighbor information, but how to determine is out of scope of this specification

17.2.8 Priority Access Operation

17.2.9 Multicast support

Each HR-BS capable of providing multicast communication belongs to a certain multicast group zone. A multicast zone defined as a set of HR-BSs where the same HR Multicast CID is used for transmitting the content of certain service flow(s).

An HR-BS may provide the HR-MS with multicast content locally within its coverage and independently of other HR-BSs. The single HR-BS provision of multicast is therefore a configuration where a Multicast Zone is configured to consist of a single HR-BS only. In this case, the HR-BS uses any CID providing multicast service, independently of other HR-BSs, so the HR-MS received the multicast data from its serving HR-BS, and the HR-MS should not expect the service flow for this multicast connection to continue when the HR-MS leaves the serving HR-BS' coverage. However, if the HR-MS moves to an HR-BS that is transmitting the same multicast flow in another HR Multicast Group Zone, HR-MS may update its service flow management encodings to continue to receive the same multicast flows.

To ensure proper multicast operation on networks of HR-BS employing multicast, the HR Multicast CID used for common multicast content and service shall be the same for all HR-BSs within the same HR Multicast Group Zone. This allows the HR-MS which has already registered with a service to be seamlessly synchronized with multicast transmissions within an HR Multicast Group Zone without communicating in the UL or re-registering with other HR-BS within that HR Multicast Group Zone.

The Multicast Group Zone identifier shall not be "0."

When the Multicast Group Zone identifier list appears in DCD setting TLV in MOB_NBR-ADV message with only one value of "0," then the neighbor BS is not affiliated with any Multicast zone. An Multicast zone that is adjacent to another Multicast zone is a neighbor multicast zone to that multicast zone.

17.2.9.1 Multicast communication operation

An HR-BS establishes a DL multicast service by creating a multicast connection with each HR-MS to be associated with the service. Multicast service flows are not dedicated to the specific HR-MS and are maintained even though the HR-MS is either connected mode or idle mode. When an HR-MS is registered at an HR-BS for receiving multicast service, multicast service flows shall be instantiated as multicast connections. An HR-MS regardless of what mode the HR-MS is currently in may receive data of multicast service flows transmitted from HR-BS. Any available HR Multicast CID is used for the multicast service (i.e., there are no dedicated CIDs for multicast transport connections). To ensure proper multicast operation, the HR multicast CID used for the service shall be the same for all HR-MSs on the same channel that participate in the connection in a multicast zone. Mapping of multicast service flows to corresponding HR multicast CIDs shall be known and be the same for all HR-BSs belonging to the same HR Multicast Group Zone.

17.2.9.1.1 Multicast communication establishment

The procedure of multicast communication establishment includes capacity exchange, establishment multicast connection, transmission and receiving the HR-multicast control channel as shown in Figure 803. The procedure includes

- Capacity exchange using REG-REQ/RSP
- DSx procedure containing relevant multicast parameter to establish multicast connection
- Transmission and receiving the HR multicast control channel

To discover multicast service, HR-MS will inform HR-BS of support of multicast transmission by REG-REQ message and the HR-BS will indicate if it supports multicast for that HR-MS through REG-RSP message. The basic multicast capability exchange in REG-REQ/RSP message is described in 6.3.2.3.7 and 6.3.2.3.8.

When an HR-MS registers to receive multicast services, the serving HR-BS or the HR-MS may initiate the DSA procedure for multicast connections. The HR-MS' discovery and registration of multicast services with the HR-BS through upper layer signaling are outside the scope of this standard.

The DSA, DSC and DSD messages are used to establish, change, and delete multicast service flows respectively. The HR-BS shall send the DSA-REQ/RSP to the HR-MS with the relevant multicast parameters including Multicast Group ID.

To receive multicast data, an HR-MS receives the multicast allocation information in the multicast control channel (i.e., multicast assignment MAP).

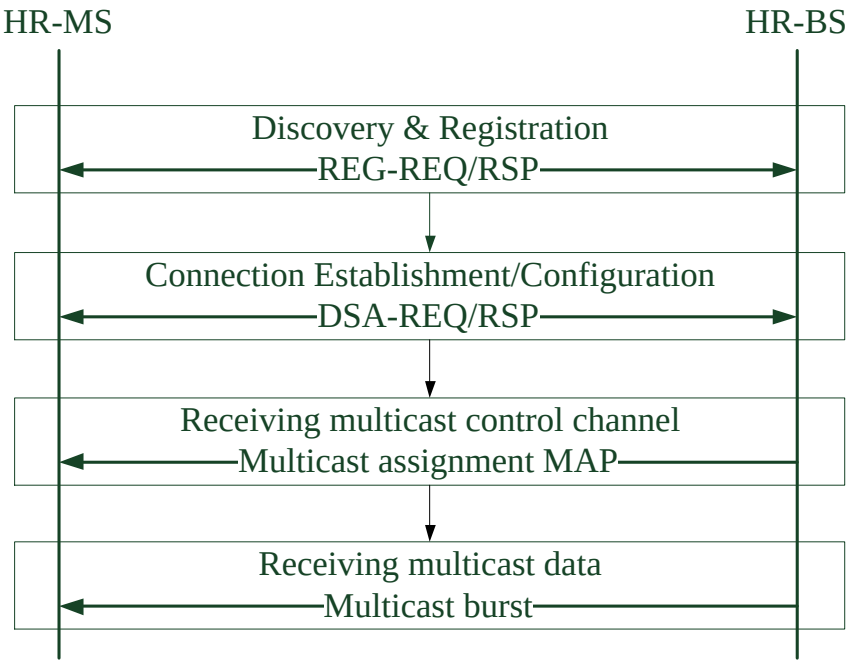


Figure 803 – Procedure of multicast communication establishment

17.2.9.1.2 Multicast communication in normal operation mode

When an HR-MS moves across Multicast zone boundaries in Active Mode or Sleep Mode, the HR-MS performs the handover procedure as described in 6.3.21.

When the HR-MS transits to a new Multicast Zone while in Active Mode or Sleep Mode, the HR-MS shall send RNG-REQ message described in 6.3.2.3.5 with Ranging Purpose Indication Bit 5 setting to 1 at the target HR-BS. In response to the request for multicast service flow update, the HR-BS shall transmit RNG-RSP message described in 6.3.2.3.6, which may include multicast service flow update mapping info to provide updated service flow management encodings for any affected multicast flow as part of the handover procedure.

17.2.9.1.3 Multicast communication operation in idle mode

When an HR-MS in Idle mode moves to an HR-BS which does not belong to HR-MS' previous Multicast Group Zone, the HR-MS is expected to update the multicast service flow management encodings at that HR-BS to provide continuous reception of multicast content. The HR-MS may obtain the multicast information in the target Multicast zone through MOB_NBR-ADV message described in 6.3.2.3.42 in the Multicast Zone of the service HR-BS. If the idle mode HR-MS has not received such information from the serving Multicast Zone, the HR-MS shall use location update procedure to acquire updated multicast service flow management encodings. In order to perform the multicast location update process, the HR-MS shall transmit RNG-REQ message described in 6.3.2.3.5 with the Ranging Purpose Indication Bit 5 setting to 1. In response to the request for multicast location update, the HR-BS shall transmit RNG-RSP message

described in 6.3.2.3.6, which may include the Multicast Group Zone identifier and HR Multicast CID to provide update service flow management encodings for any affected multicast flow(s).

17.2.9.2 Multicast protocol features and functions

17.2.9.2.1 Downlink control channel for multicast communication

HR-multicast control channel (i.e., HR-Multicast DL MAP IE) carries configuration information (including allocation/change/releasement) for multicast communication for one multicast zone in an HR-BS. In HR-Multicast DL MAP, allocation period indicates a period of persistent allocation of multicast resource and Lifetime is a timer indicating the next instance of HR-Multicast DL MAP IE. Unless the Lifetime expires, this HR-Multicast DL MAP does not change during the allocation duration. At the time the Lifetime expires, the HR-Multicast DL MAP shall change or release the allocation.

Table 1018—HR-Multicast DL MAP IE

Syntax	Size (bit)	Notes
HR-Multicast DL MAP IE {		
Extended-2 DIUC	4	HR Multicast DL Map IE() = 0xF (Extended-3 DIUC)
Length	8	Length in bytes
Extended-3 DIUC	4	0x01
Region ID Indicator	1	0: not use Region_ID 1: use Region_ID
If (Region_ID use indicator == 0) {		
OFDMA symbol offset	8	Offset from the start of DL subframe
Subchannel offset	7	
Number of OFDMA symbols	7	
Number of subchannels	7	
Rectangular subburst Indication	1	Indicates subburst allocations are time-first rectangular. The duration field in each subburst IE specifies the number of subchannels for each rectangular allocation. This is only valid for AMC allocations and all allocations with dedicated pilots. When this field is clear, subbursts shall be allocated in frequency-first manner and the duration field reverts to the default operation.
Reserved	2	
} else		
Region_ID	8	Index to the DL region defined in DL region definition TLV in DCD
}		
HR_Multicast_DL_Subburst_IE()	*variable*	Table xx+1
Padding	*variable*	Padding to byte for the unspecified portion of this

		IE (i.e. not including the first two fields, "Extended-2 DIUC" and "Length"); shall be set to 0.
}		

Table 1019—HR Multicast DL subburst IE format

Syntax	Size (bit)	Notes
HR_Multicast_DL_Subburst_IE() {		
N subburst	4	Number of subbursts in the 2D rectangular region is this field value plus 1.
Resource shifting indicator	1	0 = No Resource shifting 1= Resource shifting
For(j=0;j<Number of subbursts;j++){		
Allocation Flag	1	1 = allocate 0 = de-allocate
Group Indicator	1	TDD mode: *Reserved*, set to 0. Used for FDD/H-FDD case only; to indicate the group assignment of the MS (see 8.4.4.2 and 8.4.4.2.1) 0b0: Group #1 0b1: Group #2
If (Allocation Flag == 0) {		// deallocate
HR Multicast CID	16	
If (Resource shifting indicator == 1) {		
Duration	*variable*	Duration in slots. OFDMA Frame duration dependent 7 bits – 2.5 ms frame 8 bits – 5 ms frame 9 bits – 10 ms frame 10 bits – 20 ms frame
Slot Offset	*variable*	Indicates the start of this persistent allocation in OFDMA slots, with respect to the lowest numbered OFDM symbol and the lowest numbered subchannel in the region. OFDMA Frame duration dependent 7 bits – 2.5 ms frame 8 bits – 5 ms frame 9 bits – 10 ms frame 10 bits – 20 ms frame
}		
} else if (Allocation Flag == 1) {		// allocate
HR Multicast CID	16	
Persistent Flag	1	0 = Non-persistent 1 = Persistent

if(Power boost per subburst == 1){		
Boosting	1	0b000: Normal (not boosted) 0b001: +6dB 0b010: –6dB 0b011: +9dB 0b100: +3dB 0b101: –3dB 0b110: –9dB 0b111: –12dB; Note that if the Persistent flag is set, the boosting value applies to each instance of the persistent allocation
}		
Duration	*variable*	Duration in slots. OFDMA Frame duration dependent 7 bits – 2.5 ms frame 8 bits – 5 ms frame 9 bits – 10 ms frame 10 bits – 20 ms frame
Slot Offset	*variable*	Indicates the start of this persistent allocation in OFDMA slots, with respect to the lowest numbered OFDM symbol and the lowest numbered subchannel in the region. OFDMA Frame duration dependent 7 bits – 2.5 ms frame 8 bits – 5 ms frame 9 bits – 10 ms frame 10 bits – 20 ms frame
If (Persistent Flag == 1) {		
Allocation Period (ap)	5	Period of the persistent allocation is this field value plus 1 (unit is frame)
Lifetime(L)	4	Indicates the time to transmit the information of this allocation and the information does not change until lifetime expires. The next transmission of information is at the frame whose frame number, N_{frame}, satisfies the following condition. N_{frame} modulo L + 1 = 0
} else		
Next allocation offset	5	5LSBs of frame number and it indicates next allocation of the allocation of this field
}		
DIUC	4	
Repetition Coding Indication	2	0b00: No Repetition coding 0b01: Repetition coding of 2 used 0b10: Repetition coding of 4 used

		0b11: Repetition coding of 6 used
}		
}		
Padding	*variable*	Padding to nibble; shall be set to 0.
}		

17.2.9.3 Multicast key management

Multicast key is managed as described in 17.2.10.2.

17.2.10 Security

17.2.10.1 Security Procedure for Direct Communication Data Security

17.2.10.1.1 Security Procedure for BS-coordinated Secure Direct Communication

17.2.10.1.1.1 BS-coordinated Key Management Procedure for Secure Direct Communication

In order to support BS-coordinated secure direct communication, the security procedure described in this subsection shall be executed between HR-MS, HR-BS, Authenticator, and AAA Server. Upon successful completion of the security procedure, HR-MSs received the security key from the HR-BS and use this security key for secure direct communication between/among HR-MSs. This security key may be used as the pre-established shared key for secure direct communications in Section 17.2.10.1.1.1.1.

The HR-BS/Authenticator is used to denote that the HR-BS may pass the messages to the AAA-server via the Authenticator for verification and the AAA-server may compute the direct communication security key DMK and send it to the HR-BS via the Authenticator. The flow diagram is shown in Figure 804.

The BS-coordinated security procedure includes the following steps:

Step 1: Once it is determined that secure direct communications is allowed between HR-MS1 and HR-MS2, HR-BS/Authenticator generates the security key DMK, selects N_{HR-BS} and encrypts E_{HR-MS1_KEK}(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr) and computes $\theta_{HR-BS} = MAC_{CMAC1}$("DC_REPLY_OK_BS"|$T_{HR-BS}$|$N_{HR-BS}$|$E_{HR-MS1\_KEK}$(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr)|HR-MS1Addr|HR-MS2Addr) and sends Key-Transfer-MSG#1 message to HR-MS1, where Key-Transfer-MSG#1 = "DC_REPLY_OK_BS"|T_{HR-BS}|N_{HR-BS}|E_{HR-MS1_KEK}(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr)|HR-MS1Addr|HR-MS2Addr|θ_{HR-BS}. HR-BS/Authenticator also encrypts E_{HR-MS2_KEK}(DMK, key_lifetime, HR-MS2Addr, HR-MS1Addr) and computes $\theta_{HR-BS} = MAC_{CMAC2}$("DC_REPLY_OK_BS"|$T_{HR-BS}$|$N_{HR-BS}$|$E_{HR-MS2\_KEK}$(DMK, key_lifetime, HR-MS2Addr, HR-MS1Addr)|HR-MS2Addr|HR-MS1Addr) and sends Key-Transfer-MSG#2 message to HR-MS2, where Key-Transfer-MSG#2 = "DC_REPLY_OK_BS"|T_{HR-BS}|N_{HR-}

$_{BS}|E_{HR\text{-}MS2\_KEK}$(DMK, key_lifetime, HR-MS2Addr, HR-MS1Addr)|HR-MS2Addr|HR-MS1Addr|$\theta_{HR\text{-}BS}$.

Step 2a: If HR-MS1 received Key-Transfer-MSG#1 message from HR-BS/Authenticator, HR-MS1 first checks $T_{HR\text{-}BS}$, $N_{HR\text{-}BS}$ for freshness and $\theta_{HR\text{-}BS}$ for message authentication. If the verifications fail, then HR-MS1 shall ignore Key-Transfer-MSG#1 message. If the verifications are correct, then HR-MS1 decrypts $E_{HR\text{-}MS1\_KEK}$(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr) and obtains the security key DMK and its lifetime key_lifetime.

Step 2b: Upon receiving the Key-Transfer-MSG#2 message, HR-MS2 first checks $T_{HR\text{-}BS}$, $N_{HR\text{-}BS}$ for freshness and $\theta_{HR\text{-}BS}$ for message authentication. If the verifications fail, HR-MS2 shall ignore the Key-Transfer-MSG#2 message. If the verifications are correct, then HR-MS2 decrypts $E_{HR\text{-}MS2\_KEK}$(DMK, key_lifetime, HR-MS2Addr, HR-MS1Addr) and obtains the security key DMK and its lifetime key_lifetime.

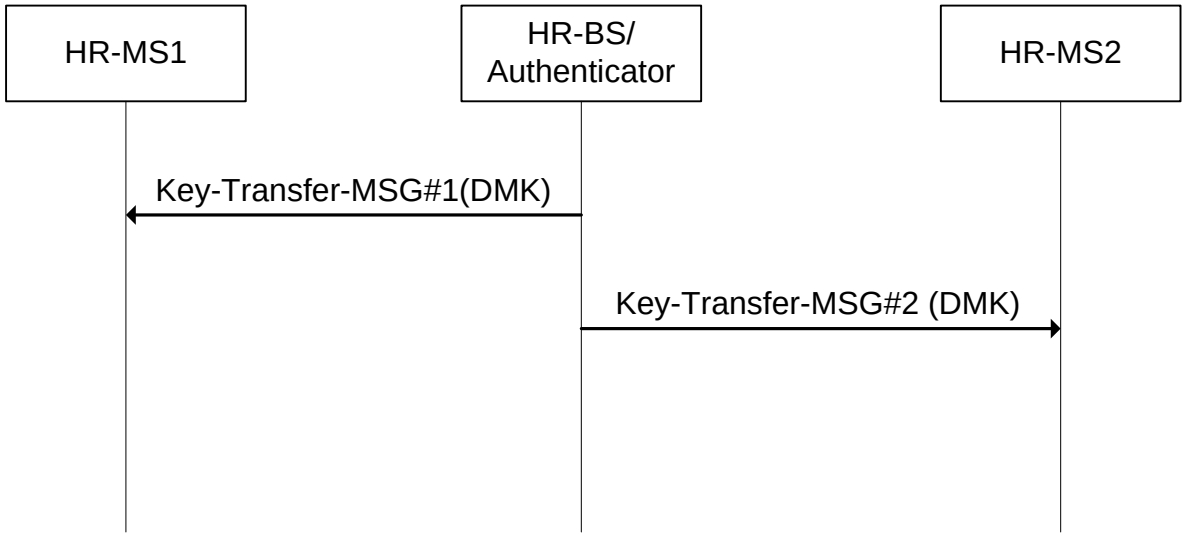


Figure 804—Flow Diagram of Authentication and Key Establishment of Network Aided Direct Communication scenario.

17.2.10.1.1.1.1 Message Type

Table 1020 —Message Type

Code	Message Type	MAC control message name
a	Key-Transfer-MSG#1	AAI-PKM-RSP
b	Key-Transfer-MSG#2	AAI-PKM-RSP

17.2.10.1.1.1.2 Message Attributes

Table 1021—Key-Transfer-MSG#1 message attribute

Attribute	Contents
"DC_REPLY_OK_BS"	HR-BS response to HR-MS1 that HR-MS2 accepted direct communications
T_{HR-BS}	Timestamp generated by HR-BS
N_{HR-BS}	Freshly generated random number of 64bits by HR-BS
E_{HR-MS1_KEK}(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr)	Encryption of DMK, key lifetime by HR-BS using HR-MS1's KEK
HR-MS1Addr	Address of HR-MS1
HR-MS2Addr	Address of HR-MS2
θ_{HR-BS}	Message digest calculated using CMAC key by HR-BS

Table 1022—Key-Transfer-MSG#2 message attribute

Attribute	Contents
"DC_REPLY_OK_BS"	HR-BS response to HR-MS1 that HR-MS2 rejected direct communications
T_{HR-BS}	Timestamp generated by HR-BS
N_{HR-BS}	Nonce generated by HR-BS
E_{HR-MS2_KEK}(DMK, key_lifetime, HR-MS2Addr, HR-MS1Addr)	Encryption of DMK, key lifetime by HR-BS using HR-MS2's KEK
HR-MS2Addr	Address of HR-MS2
HR-MS1Addr	Address of HR-MS1
θ_{HR-BS}	Message digest calculated using CMAC key by HR-BS

17.2.10.1.1.2 Autonomous Mutual Authentication of HR-MS and data security for Direct Communications

17.2.10.1.1.2.1 Secure direct communication using pre-established shared key

In order to support secure direct communication between two or among more HR-MSs, pre-established shared key is used.

The pre-established shared key is established prior to the start of this direct communications.

The pre-established shared key may be established using the procedure mentioned in Section 17.2.10.1.1.

The key agreement handshake procedure described below shall be used for HR-MSs to mutually authenticate themselves (without access to a security server) using the pre-established shared key and to derive data security keys for secure direct communications. Figure 805 shows the flow diagram while Figure 806 shows the flow chart for this scenario.

The key agreement handshake procedure using pre-established shared key includes the following steps:

Step 1: HR-MS1 selects nonce $N_{HR\text{-}MS1}$ and uses the pre-established shared key DMK to compute DAK, DCMAC key and $\theta_{HR\text{-}MS1} = MAC_{DCMAC}(N_{HR\text{-}MS1}|DMK\_Sequence\_No|DAKID|Key\_lifetime)$. Finally, HR-MS1 sends the DirectComms_KeyAgreement_MSG_#1 message to HR-MS2, where DirectComms_KeyAgreement_MSG_#1 = $N_{HR\text{-}MS1}|DMK\_Sequence\_No|DAKID|Key\_lifetime|\theta_{HR\text{-}MS1}$.

Step 2: HR-MS2 first verifies the received nonce is fresh and uses the pre-established shared key DMK to compute DAK =Dot16KDF (DMK, HR-MS1Addr|HR-MS2Addr|"DAK", 160), the DCMAC key and uses DCMAC key to checks $\theta_{HR\text{-}MS1}$. If the verification fails, HR-MS2 shall ignore the DirectComms_KeyAgreement_MSG_#1 message. If the verification is correct, HR-MS2 selects $N_{HR\text{-}MS2}$ and computes $\theta_{HR\text{-}MS2} = MAC_{DCMAC}(N_{HR\text{-}MS1}|N_{HR\text{-}MS2}|DAKID|DMK\_Sequence\_No|DC\_Security\_Parameters)$. Finally, HR-MS2 sends DirectComms_KeyAgreement_MSG_#2 message to HR-MS1, where DirectComms_KeyAgreement_MSG_#2 = $N_{HR\text{-}MS1}|N_{HR\text{-}MS2}|DAKID|DMK\_Sequence\_No|DC\_Security\_Parameters|\theta_{HR\text{-}MS2}$.

Step 3: HR-MS1 receives the DirectComms_KeyAgreement_MSG_#2 message from HR-MS2 and checks the received nonces for freshness and also checks DAKID and $\theta_{HR\text{-}MS2}$. If the verifications fail, HR-MS1 shall ignore the DirectComms_KeyAgreement_MSG_#2 message. If the verifications are correct, HR-MS1 computes $\theta_{HR\text{-}MS1}' = MAC_{DCMAC}(N_{HR\text{-}MS1}|N_{HR\text{-}MS2}|DMK\_Sequence\_No|DC\_SAID|DC\_Security\_Parameters)$. Finally, HR-MS1 sends DirectComms_KeyAgreement_MSG_#3 message to HR-MS2, where DirectComms_KeyAgreement_MSG_#3 = $N_{HR\text{-}MS1}|N_{HR\text{-}MS2}|DMK\_Sequence\_No|DC\_SAID|$ DC_Security_Parameters$|\theta_{HR\text{-}MS1}'$. If HR-MS1 does not receive DirectComms_KeyAgreement_MSG_#2 message from HR-MS2 within DirectComms_KeyAgreement_MSG_#1 Timeout, it shall resend the DirectComms_KeyAgreement_MSG_#1 message up to DirectComms_KeyAgreement_MSG_#1 MaxResends times. If HR-MS1 reaches its

maximum number of resends, it shall initiate another authentication or drop the request.

Step 4: Upon receiving the DirectComms_KeyAgreement_MSG_#3 message, HR-MS2 checks the received nonces for freshness and $\theta_{HR\text{-}MS1}$'. If the verifications are invalid, then HR-MS2 shall ignore the DirectComms_KeyAgreement_MSG_#3 message. If the verifications are correct, HR-MS2 applies the negotiated security parameters. Otherwise, if $\theta_{HR\text{-}MS1}$' is invalid, then HR-MS2 shall ignore the DirectComms_KeyAgreement_MSG_#3 message. If HR-MS2 does not receive DirectComms_KeyAgreement_MSG_#3 message from HR-MS1 within DirectComms_KeyAgreement_MSG_#2 Timeout, it shall resend the DirectComms_KeyAgreement_MSG_#2 message up to DirectComms_KeyAgreement_MSG_#2 MaxResends times. If HR-MS2 reaches its maximum number of resends, it shall initiate another authentication or drop the request. HR-MS1 and HR-MS2 can now derive DTEK and commence secure direct communications.

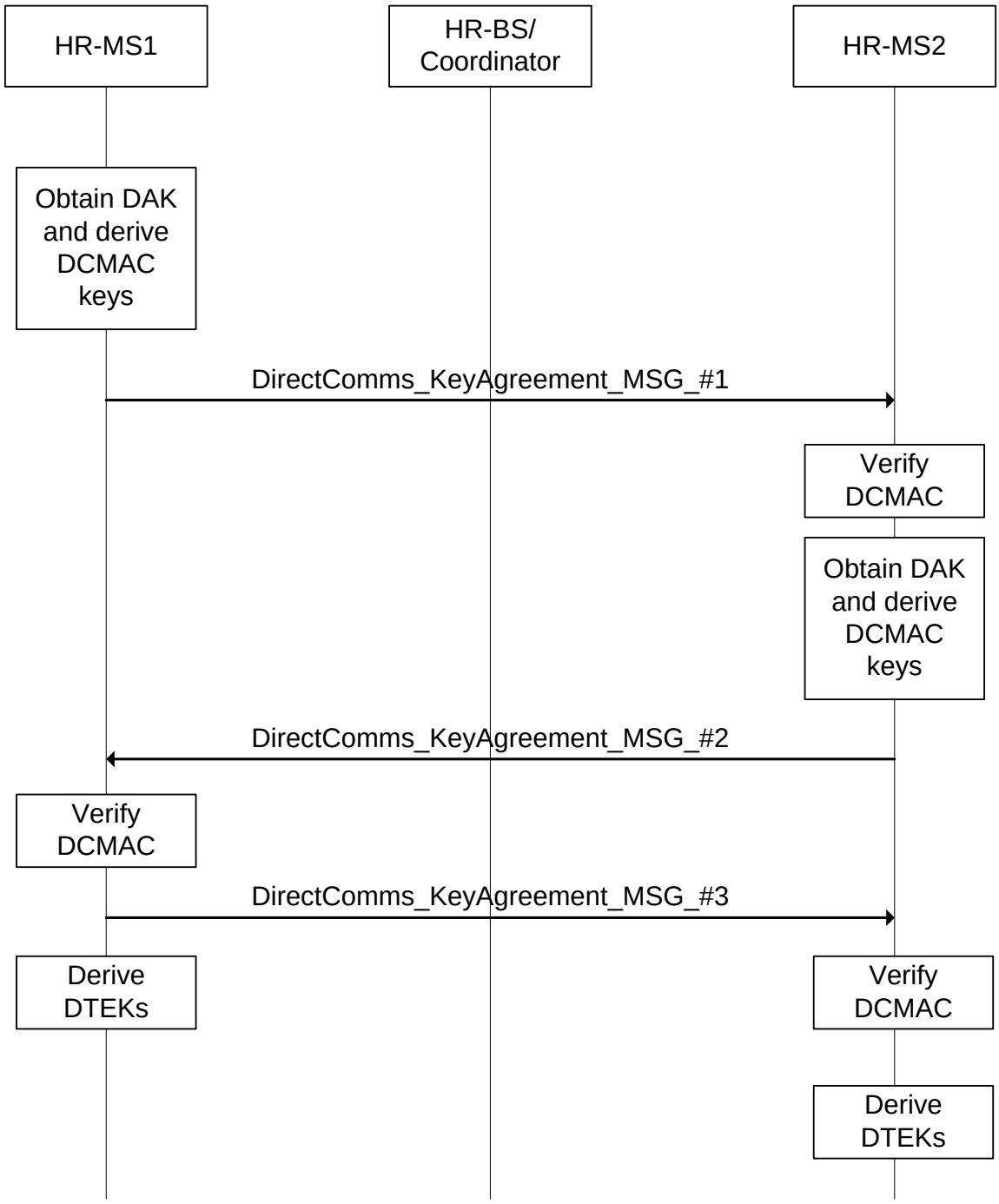


Figure 805—Flow Diagram of Authentication and Key Establishment of Direct Communication without Infrastructure (Pre-shared key case).

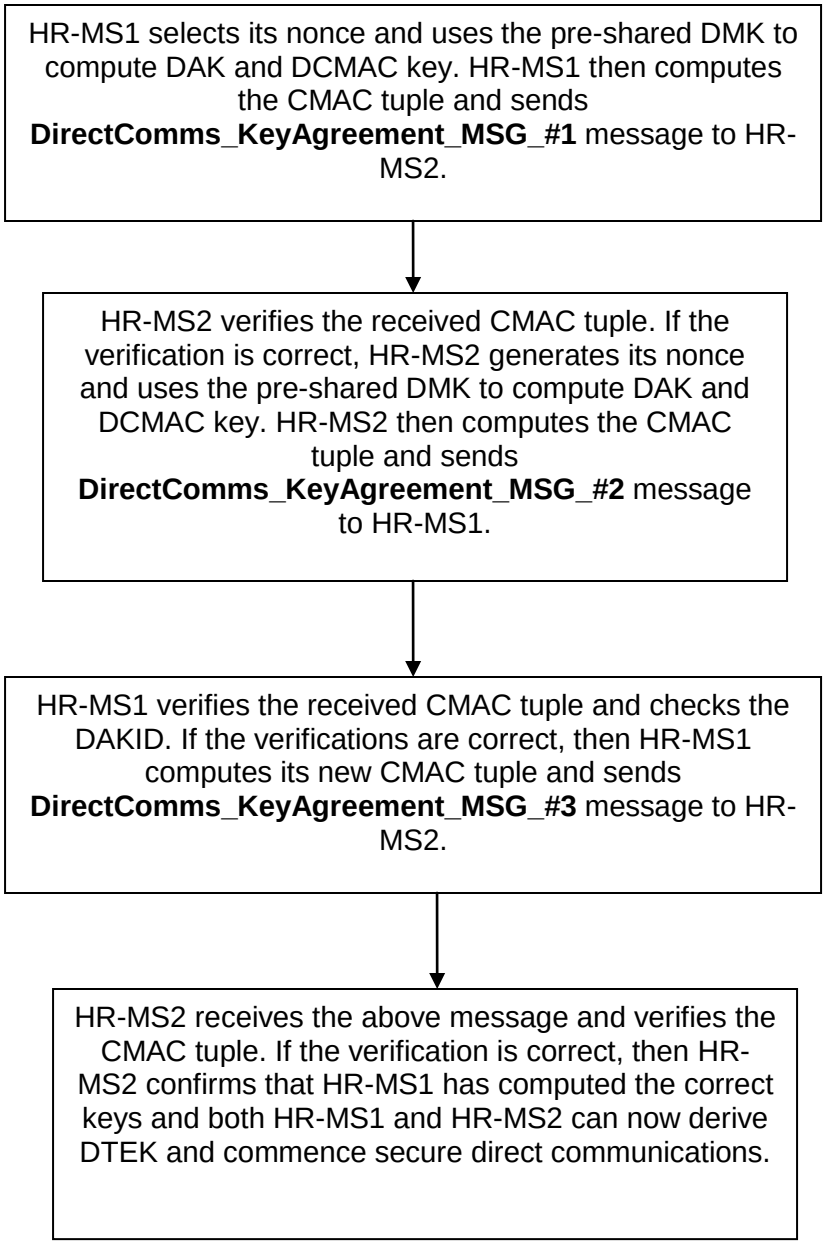


Figure 806—Flow Chart of Pre-shared key-based Autonomous Direct Communication Authentication and Key Establishment Security Procedure.

17.2.10.1.1.2.1.1 Message Type

Table 1023—DC_Request_MSG#1 message attribute

Code	Message Type	MAC control message name
	DirectComms_KeyAgreement_MSG #1	AAI-PKM-RSP
	DirectComms_KeyAgreement_MSG #2	AAI-PKM-REQ

	DirectComms_KeyAgreement_MSG #3	AAI-PKM-RSP

17.2.10.1.1.2.1.2 Message Attributes

Table 1024—DirectComms_KeyAgreement_MSG_#1 message attribute

Attribute	Contents
N_{HR-MS1}	Freshly generated random number of 64bits by HR-MS1
DMK_Sequence_No	new DMK sequence number
DAKID	identifies the direct communications authorization key
Key_lifetime	DMK key lifetime
θ_{HR-MS1}	Message digest calculated using DCMAC key

Table 1025—DirectComms_KeyAgreement_MSG_#2 message attribute

Attribute	Contents
N_{HR-MS1}	Nonce generated by HR-MS1 in DirectComms_KeyAgreement_MSG_#1 message
N_{HR-MS2}	Freshly generated random number of 64bits by HR-MS2
DAKID	identifies the direct communications authorization key
DMK_Sequence_No	new DMK sequence number
DC_Security_Parameters	The requesting HR-MS's security capabilities
θ_{HR-MS2}	Message digest calculated using DCMAC key

Table 1026 —DirectComms_KeyAgreement_MSG_#3 message attribute

Attribute	Contents
N_{HR-MS1}	Nonce generated by HR-MS1 in DirectComms_KeyAgreement_MSG_#1 message
N_{HR-MS2}	Nonce generated by HR-MS1 in DirectComms_KeyAgreement_MSG_#2 message
DMK_Sequence_No	new DMK sequence number
DC_SAID	identifies the direct communications authorization key for protecting this message
DC_Security_Parameters	The supporting HR-MS's security capabilities

$\theta_{HR\text{-}MS1}'$	Message digest calculated using DCMAC key

17.2.10.1.1.2.2 Secure direct communication using Public Key Infrastructure

When pre-established shared key is not used for direct communication, Public Key Infrastructure shall be used.

Each HR-MS has a public/private key pair and digital certificate (e.g. X.509) issued by a certification authority for mutual authentication and key exchange prior to the start of this direct communications.

The key agreement handshake procedure described below shall be used for HR-MSs to mutually authenticate themselves (without access to a security server) using Public Key Infrastructure and to derive data security keys for secure direct communications. The flow diagram for this scenario is depicted in Figure 807 and the Flow Chart for this scenario is shown in Figure 808.

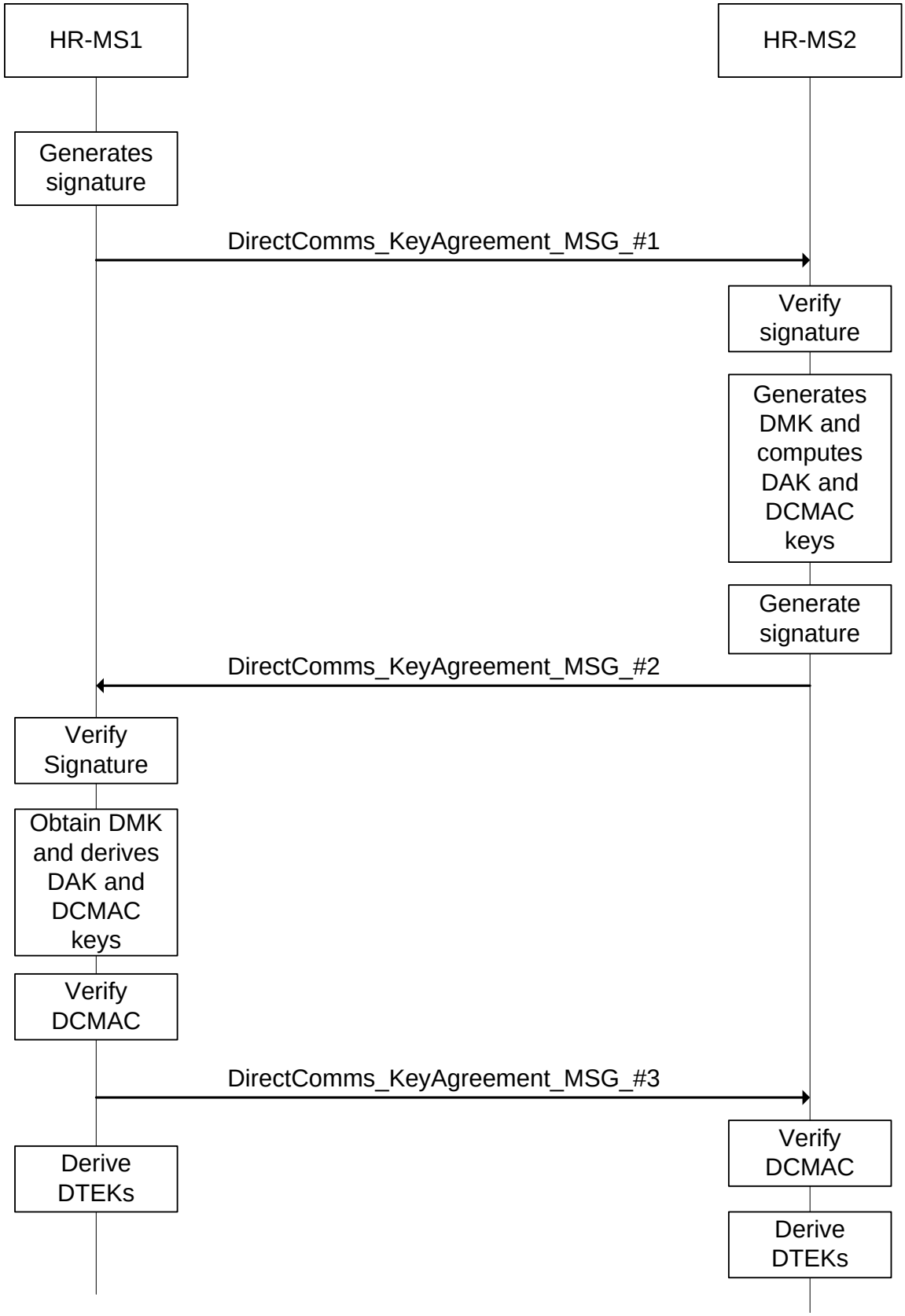
The key agreement handshake procedure using Public Key Infrastructure includes the following steps:

Step 1: HR-MS1 first generates nonce $N_{HR\text{-}MS1}$. Next, HR-MS1 computes the signature $\sigma_{HR\text{-}MS1}$ = SIGN($T_{HR\text{-}MS1}|N_{HR\text{-}MS1}|$HR-MS2Addr|HR-MS1Addr) and sends DirectComms_KeyAgreement_MSG_#1 message to HR-MS2, where DirectComms_KeyAgreement_MSG_#1 = $T_{HR\text{-}MS1}|N_{HR\text{-}MS1}|$HR-MS2Addr|HR-MS1Addr|$\sigma_{HR\text{-}MS1}|$Cert(HR-MS1).

Step 2: HR-MS2 first verifies the received timestamp and nonce for freshness and the certificate Cert(HR-MS1) and signature $\sigma_{HR\text{-}MS1}$. If the verifications fail, then HR-MS2 ignores the DirectComms_KeyAgreement_MSG_#1 message. If the verifications are correct, then HR-MS2 generates nonce $N_{HR\text{-}MS2}$ and security key DMK and computes DAK =Dot16KDF (DMK, HR-MS1Addr|HR-MS2Addr| "DAK", 160) and the DCMAC key and $\theta_{HR\text{-}MS2}$ = $MAC_{DCMAC}(N_{HR\text{-}MS2}|N_{HR\text{-}MS1}|$HR-MS2Addr|HR-MS1Addr). HR-MS2 then uses HR-MS1's public key to encrypt and obtain $E_{HR\text{-}MS1\_PK}$(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr). Finally, HR-MS2 computes signature $\sigma_{HR\text{-}MS2}$ = SIGN($T_{HR\text{-}MS2}|N_{HR\text{-}MS2}|$HR-MS1Addr|HR-MS2Addr|$N_{HR\text{-}MS1}|E_{HR\text{-}MS1\_PK}$(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr)|$\theta_{HR\text{-}MS2}$) and sends DirectComms_KeyAgreement_MSG_#2 message to HR-MS1, where DirectComms_KeyAgreement_MSG_#2 = $T_{HR\text{-}MS2}|N_{HR\text{-}MS2}|$HR-MS1Addr|HR-MS2Addr|$N_{HR\text{-}MS1}|E_{HR\text{-}MS1\_PK}$(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr)|$\theta_{HR\text{-}MS2}|\sigma_{HR\text{-}MS2}|$Cert({HR-MS2).

Step 3: HR-MS1 first verifies the received timestamp and nonces for freshness and the certificate Cert(HR-MS2) and signature $\sigma_{HR\text{-}MS2}$. If the verification is invalid, then HR-MS1 ignores the DirectComms_KeyAgreement_MSG_#2 message. If the verifications are correct, then HR-MS1 decrypts $E_{HR\text{-}MS1\_PK}$(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr) and obtains security key DMK and key_lifetime. Next, HR-MS1 computes DAK and DCMAC keys and verifies $\theta_{HR\text{-}MS2}$. If the verification is invalid, then HR-MS1 ignores the DirectComms_KeyAgreement_MSG_#2 message. If the verification is correct, then HR-MS1 computes $\theta_{HR\text{-}MS1} = MAC_{DCMAC}(N_{HR\text{-}MS1}|N_{HR\text{-}MS2}|$HR-MS1Addr|HR-MS2Addr) and sends DirectComms_KeyAgreement_MSG_#3 message to HR-MS2, where DirectComms_KeyAgreement_MSG_#3 = $N_{HR\text{-}MS2}$|HR-MS2Addr|HR-MS1Addr| $\theta_{HR\text{-}MS1}$. If HR-MS1 does not receive DirectComms_KeyAgreement_MSG_#2 message from HR-MS2 within DirectComms_KeyAgreement_MSG_#1 Timeout, it shall resend the DirectComms_KeyAgreement_MSG_#1 message up to DirectComms_KeyAgreement_MSG_#1 MaxResends times. If HR-MS1 reaches its maximum number of resends, it shall initiate another authentication or drop the request.

Step 4: HR-MS2 receives the DirectComms_KeyAgreement_MSG_#3 message and verifies received nonce and the CMAC tuple. If the verification fails, then HR-MS2 ignores DirectComms_KeyAgreement_MSG_#3 message. If the verification is correct, then HR-MS2 confirms that HR-MS1 has computed the correct keys and commence secure direct communications. If HR-MS2 does not receive DirectComms_KeyAgreement_MSG_#3 message from HR-MS1 within DirectComms_KeyAgreement_MSG_#2 Timeout, it shall resend the DirectComms_KeyAgreement_MSG_#2 message up to DirectComms_KeyAgreement_MSG_#2 MaxResends times. If HR-MS2 reaches its maximum number of resends, it shall initiate another authentication or drop the request. HR-MS1 and HR-MS2 can now derive DTEK and commence secure direct communications.


HR-MS1
HR-MS2
Generates signature
DirectComms_KeyAgreement_MSG_#1
Verify signature
Generates DMK and computes DAK and DCMAC keys
Generate signature
DirectComms_KeyAgreement_MSG_#2
Verify Signature
Obtain DMK and derives DAK and DCMAC keys
Verify DCMAC
DirectComms_KeyAgreement_MSG_#3
Verify DCMAC
Derive DTEKs
Derive DTEKs

1

Figure 807—Flow Diagram of Authentication and Key Establishment of Direct Communication without Infrastructure (HR-MS becomes HR-BS*case).

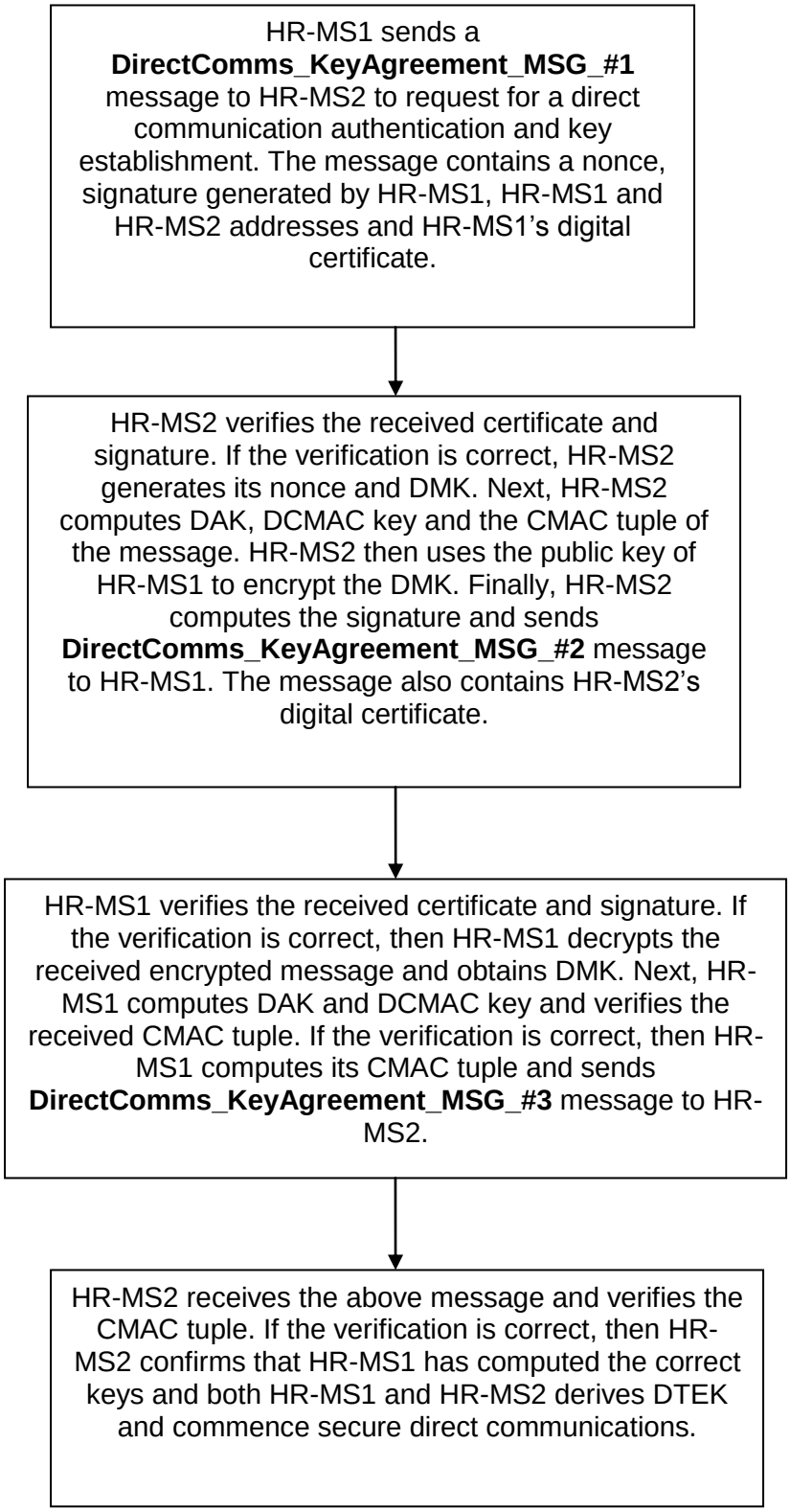


Figure 808—Flow Chart of PKI-based Autonomous Direct Communication Authentication and Key Establishment Security Procedure.

17.2.10.1.1.2.2.1 Message Type

Table 1027—DC_Request_MSG#1 message attribute

Code	Message Type	MAC control message name
	DirectComms_KeyAgreement_ MSG #1	AAI-PKM-RSP
	DirectComms_KeyAgreement_ MSG #2	AAI-PKM-REQ
	DirectComms_KeyAgreement_ MSG #3	AAI-PKM-RSP

17.2.10.1.1.2.2.2 Message Attribute

Table 1028—DirectComms_KeyAgreement_MSG_#1 message attribute

Attribute	Contents
$T_{HR\text{-}MS1}$	Timestamp generated by HR-MS1
$N_{HR\text{-}MS1}$	Freshly generated random number of 64bits by HR-MS1
HR-MS2Addr	Address of HR-MS2
HR-MS1Addr	Address of HR-MS1
$\sigma_{HR\text{-}MS1}$	Signature of message generated by HR-MS1 using its RSA private key
Cert(HR-MS1)	Digital certificate of HR-MS1

Table 1029—DirectComms_KeyAgreement_MSG_#2 message attribute

Attribute	Contents
$T_{HR\text{-}MS2}$	Timestamp generated by HR-MS2
$N_{HR\text{-}MS2}$	Freshly generated random number of 64bits by HR-MS2
HR-MS1Addr	Address of HR-MS1
HR-MS2Addr	Address of HR-MS2
$N_{HR\text{-}MS1}$	Nonce generated by HR-MS1 in DirectComms_KeyAgreement_MSG_#1 message
$E_{HR\text{-}MS1\_PK}$(DMK, key_lifetime, HR-MS1Addr, HR-MS2Addr)	Public key encryption using HR-MS1's Public key where DMK = DirectComms Master Key generated by HR-MS and key_lifetime = lifetime of DMK

$\theta_{HR\text{-}MS2}$	Message digest calculated using DCMAC key by HR-MS2
$\sigma_{HR\text{-}MS2}$	Signature of message generated by HR-MS2 using its RSA private key
Cert(HR-MS2).	Digital certificate of HR-MS2

Table 1030—DirectComms_KeyAgreement_MSG_#3 message attribute

Attribute	Contents
$N_{HR\text{-}MS2}$	Nonce generated by HR-MS2 in DirectComms_KeyAgreement_MSG_\#2 message
HR-MS2Addr	Address of HR-MS2
HR-MS1Addr	Address of HR-MS1
$\theta_{HR\text{-}MS1}$	Message digest calculated using DCMAC key by HR-MS1

17.2.10.1.1.3 Security Context for BS-coordinate Secure Direct Communication

The direct communications security context describes the set of parameters that links the direct communication security keys for BS-coordinate secure direct communications.

17.2.10.1.1.3.1 DMK context

The DMK context includes all parameters associate with the DMK. This context is created when the DMK is derived.

The DMK context is described in Table 1031.

Table 1031—The DMK context

Parameter	Size (bit)	Usage
DMK	160	Multicast Master Key shared by HR-BS and HR-MSs in a multicast group
DMK SN	4	DMK sequence number
DMK Lifetime	32	MMK Lifetime
DAK_COUNT	16	Counter to ensure freshness of computed CMAC key and prevent replay attacks.

17.2.10.1.1.3.2 DAK context

The DAK context includes all parameters associate with the DAK. This context is created whenever a new DAK is derived. This context shall be deleted when the DAK is not in used.

The DAK context is described in Table 1032.

Table 1032—The DAK context

Parameter	Size (bit)	Usage
DAK	160	Direct Communications Authentication Key derived from DMK.
DAK Lifetime	32	DAK Lifetime
DAKID	64	Identifies the DAK key.
DCMAC_KEY	128	Key which is used for signing Direct Communications MAC control messages.
DCMAC_PN	24	Used to avoid multicast replay attack on the control connection. The initial value of DCMAC_PN is zero.
DAK_COUNT	16	Counter to ensure freshness of computed CMAC key and prevent replay attacks.

17.2.10.1.1.3.3 DSA context

The DSA context is the set of parameters managed by each DSA in order to ensure DTEK management and usage in a secure way for BS-coordinated secure direct communications.

The DSA holds the DTEK context and additional information that belongs to the DSA itself.

17.2.10.1.1.3.4 DTEK context

The DTEK context includes all parameters of the DTEK and is described in Table 1033.

Table 1033—The DTEK context

Parameter	Size (bit)	Usage
DTEK	128	Key used for encryption or decryption of direct communications messages
DMK SN	4	DMK sequence number
COUNTER_DTEK	16	The counter used to derive this DTEK
DTEK lifetime	32	DTEK lifetime=DMK lifetime
DTEK_PN	22	The PN used for encrypting multicast packets. After each Multicast MAC PDU transmission, the value shall be increased by 1. (0x000000-0x1FFFFF)

17.2.10.1.1.3.5 DSA context

The DSA context is described in Table 1034.

Table 1034—The DSA context

Parameter	Size (bit)	Usage
DSAID	8	The identifier of this DSA, which decribes the applied encryption/decryption method and DTEK contexts.
DTEK context	Sizeof(DTEK context)	DTEK context for encryption and decryption

17.2.10.1.1.4 Key Derivation for BS-coordinated Secure Direct Communication

The key hierarchy defines what keys are present in the system for BS-coordinated secure direct communication and how the keys are generated.

17.2.10.1.1.4.1 DMK Derivation

The DMK is the security key/pre-established shared key that is randomly generated by HR-BS or HR-MS or a network entity (e.g. an AAA Server etc). The DMK is a 160-bit key.

The DMK may be used as a source for keying materials required by upper layers.

The DMK is used to derive the Direct Communication Authentication Key (DAK).

17.2.10.1.1.4.2 DAK Derivation

DAK is derived from DMK and belongs to a pair of HR-MSs. The DAK is used for BS-coordinated Direct Communications in the event of failure in the backbone.

The DAK derivation is as follows:

DAK =Dot16KDF (DMK, HR-MS1Addr|HR-MS2Addr|”DAK”, 160)

where: HR-MS1Addr and HR-MS2Addr are the addresses of HR-MS1 and HR-MS2 respectively.

The DCMAC-DTEK prekey is derived from DAK and is used to derive other keys:

- Direct Communication Cipher-based Message Authentication Code (DCMAC) key
- Direct Communication Traffic Encryption (DTEK) Key

The DCMAC-DTEK prekey derivation is done as follows:

DCMAC-DTEK prekey = Dot16KDF (DAK, DAK_COUNT|"DCMAC-DTEK prekey", 160)

17.2.10.1.1.4.3 DCMAC Key Derivation

DCMAC key is derived from DAK and used for message authentication for the messages sent during BS-coordinated secure direct communications.

DCMAC key is derived as follows:

DCMAC key = Dot16KDF(DCMAC-DTEK prekey, "DCMAC_KEYS", 128)

17.2.10.1.1.4.4 DTEK Derivation

DTEK is the transport encryption key used to encrypt data in BS-coordinated secure direct communications.

DTEK is derived as follows:

DTEK = Dot16KDF(DCMAC-DTEK prekey,
DSAID|COUNTER_DTEK|"DTEK_KEY", 128)

Where

SAID is the security association to which the TEK belongs.

COUNTER_DTEK is a counter used to derive different TEKs for the same SAID, the value of the counter is changed everytime a new DTEK needs to be derived within the same AK and AK_COUNT pair is valid. Everytime a new DCMAC-DTEK prekey is derived, this counter is reset.

17.2.10.1.2 Security Procedure for Secure talk-around Direct Communication using dedicated resource

In order to support secure direct communication between two or among more HR-MSs, pre-established shared key is used.

PKMv3 provides HR-MSs with strong protection from theft of service by encrypting talk-around direct connections between two or among HR-MSs.

If a talk-around direct communication connection is to be encrypted, each HR-MS

participating in the connection shall have an additional security association (SA) (i.e., talk-around direct communication SA), allowing that connection to be encrypted using keys that are independent of those used for other encrypted transmissions between HR-MSs.

Talk-around direct communication traffic can be encrypted using talk-around direct communication specific key management based on PKMv3.

17.2.10.2 Security Procedure for Multicast Operation

17.2.11 Self-Coexistence

17.2.11.1 Self-coexistence cycle

A self-coexistence cycle (SCC) consists of TBD frames as shown in Figure 809. A frame is identified by frame identification number (FIN), which is in range between 0 to TBD-1. Location of a frame identification number is TBD.

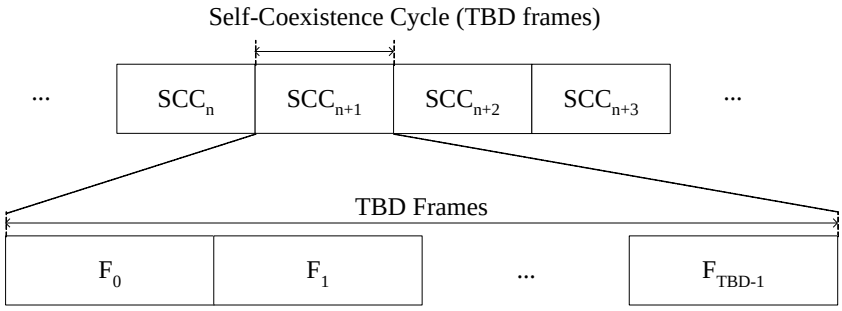


Figure 809—Self-coexistence cycle for WirelessMAN OFDMA air interface.

17.2.11.2 Frame Structure

A self-coexistence zone can be allocated in a frame for transmission preamble and self-coexistence beacons for self-coexistence of multiple HR cells overlapped in coverage and have to operate on the same frequency channel.

As shown in Figure 810, a self-coexistence zone occupies the last 3 symbols of a frame. The first symbol is used as guard time. In the second symbol, preamble shall be transmitted, and in the last symbol self-coexistence beacon protocol (SCBP) MAC PDU shall be transmitted.

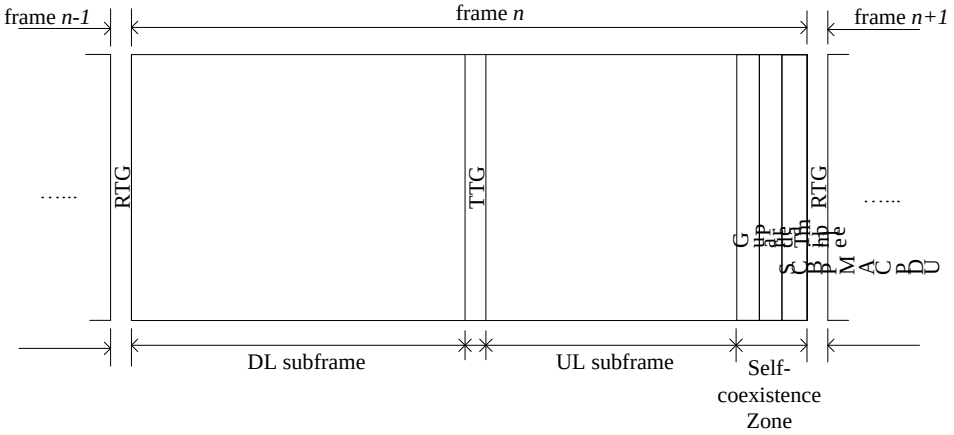


Figure 810—TDD frame structure with self-coexistence zone.

17.2.11.3 Operation Modes

HR network can operate in two modes: normal mode and self-coexistence mode. In normal mode, a HR network occupies one frequency channel and operates on all frames of a self-coexistence cycle. In self-coexistence mode, multiple HR cells share the same frequency channel and operate on different frames. A HR cell operates in normal mode by default and transits to self-coexistence mode when the HR cell receives self-coexistence beacon from an adjacent HR cell on its operating channel.

17.2.11.4 Self-coexistence Beacon Protocol (SCBP)

TBD

17.2.11.5 Mechanism for self-coexistence of multiple HR cells

TBD

17.2.12 Support of Downlink High Reliability and Uplink Heavy Data Service

For HR-network operating in VHF band, it may use VHF mode of HR OFDMA air interface to support uplink heavy data service.

VHF mode of HR OFDMA air interface is OFDMA PHY-based with operating frequency in VHF band. The DL and UL tile structure specified in Figures 247a and 249a may be used in VHF mode. The modified DL tile structure is able to provide higher reliability of data link compared to DL PUSC cluster structure specified in 8.4.6.1.2.1. The modified tile structure for UL has lower pilot occupation rate which allows higher data rate compared to UL PUSC cluster structure specified in 8.4.6.2.1.

17.3 WirelessMAN HR Advanced air interface

[Dummy Figure 900]
[Dummy Table 1200]

17.3.1 Multi-mode operation

17.3.1.1 Relay function for HR-BS

An HR-BS (affected HR-BS) may operate as a relay station to communicate with another HR-BS (serving HR-BS) that has connection to backhaul.

An HR-BS acting as RS mode operates in either TTR mode or STR mode.

The procedure for mode change consists of following activities:

a) establishing a relay link with a serving HR-BS

b) if necessary, informing some of its subordinate stations to perform handover

c) if necessary, reconfiguring the physical frame

d) commencing the new operation.

The affected HR-BS establishes relay link with a serving HR-BS as described in 17.3.1.1.1. The procedure applies to both STR and TTR relay modes.

When supporting STR relay mode, the affected HR-BS maintains base station functionality.

When supporting TTR relay mode, the affected HR-BS maintains connectivity with its subordinate HR-RS by performing a dual-role BS/RS operation described in 17.3.1.1.2.2.

17.3.1.1.1 Relay link establishment

The HR-BS having no connection to backhaul transmits MM-ADV message with action type = 0b100 described in 16.2.3.70 including expected time of backhaul link available. Based on the expected time, HR-MS handovers to neighbor infrastructure station or staying in the HR-BS until restarting service with available backhaul link.

To establish relay link with a serving HR-BS, the HR-BS having no connection to backhaul follows network entry and initialization for relay link described in 16.2.15 and 16.6.2.10. In addition, the HR-BS shall perform the relay link establishment procedure as follows:

a) Scan for DL channel and establish synchronization with the HR-BS having connection to backhaul

b) Obtain DL/UL parameters (from SuperFrameHeader)

c) Perform ranging

d) Basic capability negotiation, if needed

e) Authorization, authentication, and key exchange, if needed

f) Registration with the HR-BS, if needed

g) Configuration operational parameters including initiating relay link using AAI-MMRS-REQ/RSP and AAI-ARS-CONFIG-CMD messages

To establish relay link with another HR-BS (serving HR-BS), HR-BS having no connection to backhaul transmits AAI-MMRS-REQ message described in 16.2.3.71 including relay mode, i.e., either TTR or STR mode. In response to AAI-MMRS-REQ, the serving HR-BS transmits AAI-MMRS-RSP message described in 16.2.3.72 to inform whether the request is accepted or rejected. Upon receiving the AAI-MMRS-RSP message, the affected HR-BS starts establishing the relay link with serving HR-BS immediately or retransmits AAI-MMRS-REQ message at the action time expires. If the serving HR-BS rejects the request, the serving HR-BS informs the HR-BS having no connection to backhaul the rejection of the request. Upon receiving the AAI-MMRS-RSP message with rejection information, the HR-BS either tries to establish relay link with another HR-BS or follows standalone network operation described in 17.3.4.

To support handover as a part of robustness against SPOF as described in 17.3.7.2, an indication of whether MAC context information of the subordinate HR-MS is being shared by infrastructure stations shall be transmitted to HR-MS.

For the case of affected HR-BS establishing a TTR relay link with a serving HR-BS, the following actions shall be carried out:

- In the AAI-MMRS-REQ message, the affected HR-BS reports its required switching gaps *BSTTG* and *BSRTG* to the serving HR-BS. Here, *BSTTG* is the minimum transmit-to-receive turnaround gap while *BSRTG* is the minimum receive-to-transmit turnaround gap required at the affected HR-BS. Based on the values of *BSTTG* and *BSRTG*, the two HR-BSs agree on the timing advance T_a of the frame boundary of the affected HR-BS, relative to that of the serving HR-BS. The affected HR-BS can propose a value for T_a in the AAI-MMRS-REQ message, and the serving HR-BS can reply with a confirmed T_a value in the AAI-MMRS-RSP message. With the values of *BSTTG*, *BSRTG*, and T_a, the two HR-BSs calculate shared values for the switching time *R-TTI* and *R-RTI*, based on the following equations:

  $$R\text{-}TTI = 0 \text{ if } RTD/2 + T_a > BSTTG \text{ and } R\text{-}TTI = T_s \text{ if } RTD/2 + T_a < BSTTG$$

  and

  $$R\text{-}RTI = 0 \text{ if } T_a - RTD/2 > BSRTG \text{ and } R\text{-}RTI = T_s \text{ if } T_a - RTD/2 < BSRTG,$$

  where *RTD* is the round trip delay between the affected HR-BS and the serving HR-BS and T_s is the OFDMA symbol duration.

- Also included in the AAI-MMRS-REQ message sent by affected HR-BS is the proposed dual-mode switching pattern (T_{bs}, T_{rs}), as described in 17.3.1.1.2.2. This pattern shall be confirmed in the corresponding AAI-MMRS-RSP message sent by the serving HR-BS.

As an alternative to what described above, certain parts of the signaling between the two HR-BSs can be carried out through backhaul, i.e., prior to (and in preparation for) the backhaul failure at affected HR-BS.

17.3.1.1.2 Maintaining connectivity for subordinate HR-RS

17.3.1.1.2.1 Affected HR-BS supporting STR relay mode

When supporting STR relay mode, the affected HR-BS maintains its base station functionality and therefore continues to support its subordinate HR-RS.

17.3.1.1.2.2 Affected HR-BS supporting TTR relay mode

The affected HR-BS shall be able to switch between BS Operation and RS Operation in a frame-by-frame basis. The role switching pattern shall be periodic, with the dual-role HR-BS assuming BS Operation for T_{bs} consecutive frames, followed by RS Operation for T_{rs} consecutive frames. T_{bs} can be set to 0. The values of T_{bs} , T_{rs} shall be negotiated between the affected/dual-role HR-BS and its serving HR-BS. This negotiation can happen when the affected/dual-role HR-BS starts associating with the serving HR-BS, e.g., through AAI-MMRS-REQ/RSP and AAI-ARS-CONFIG-CMD messages. The configuration can be altered during operation, e.g., through AAI-MMRS-REQ/RSP, AAI-ARS-CONFIG-CMD. The dual-role operation of affected HR-BS is illustrated in Figure 901.

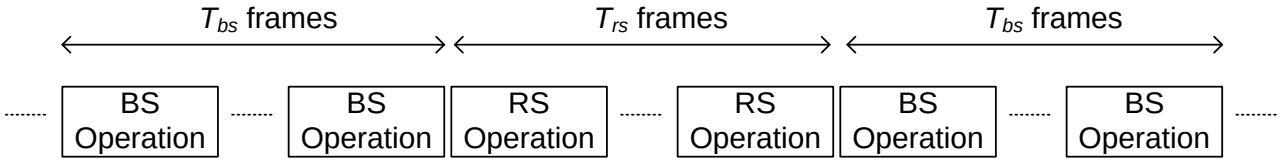


Figure 901—Affected/dual-role HR-BS performs BS/RS role-switching in a frame-by-frame basis.

The operation of affected HR-BS in each mode, i.e., BS Operation and RS Operation, depends on the value of switching interval *R-TTI* and is specified in 17.3.1.1.2.2.1 and 17.3.1.1.2.2.2.

17.3.1.1.2.2.1 When *R-TTI = 0*

When *R-TTI = 0*, the affected HR-BS shall keep its original PHY-layer configuration, including *IDCell*, frame configuration, and FFR pattern. In addition, the affected HR-BS shall set the *AAI_Relay_zone_AMS_allocation_indicator* field in AAI-SCD and AAI-ARS-CONFIG-CMD messages to 0b0. The operation of the affected/dual-role HR-BS can be described as follows.

In BS Operation Mode:

- The affected/dual-role HR-BS shall only communicate with its subordinate MS/AMS/HR-MS/HR-RS stations and shall not be available to receive from or transmit to its serving HR-BS.

- The manner in which the affected/dual-role HR-BS control and communicate with its subordinate HR-MSs/HR-RSs shall be the same as that of a normal HR-BS. The serving HR-BS is not expected to know the specific configuration of the dual-role HR-BS during BS Operation. When the affected/dual-role HR-BS transmits to or receives from its subordinate MS/AMS/HR-MS/HR-RS during BS Operation, it does so independently to the serving HR-BS.

- The affected/dual-role HR-BS transmits control messages regarding its role-switching behaviors toward its subordinate HR-RSs. Essentially, these role-switching messages tell the subordinate HR-RSs when the HR-BS will switch to RS Operation and what are the specific behaviors of the HR-BS during RS Operation.

In RS Operation Mode:

- The affected/dual-role HR-BS shall communicate with the serving HR-BS and with the subordinate MS/AMS/HR-MS. It may or may not communicate with its subordinate HR-RS during this mode of operation. The frame structure of the affected HR-BS is divided into DL Access zone, DL Relay zone, UL Access zone, and UL Relay zone. Note that as *R-TTI = 0*, no time gap need to be inserted into the last OFDM symbol of the last subframe in the DL Access zone.

- As the affected HR-BS still transmits the same SA-Preamble, the subordinate MS/AMS/HR-MS are oblivious to the mode change of the affected HR-BS. The affected HR-BS continue to transmit to its subordinate MS/AMS/HR-MS in the DL Access zone, and receive from its subordinate MS/AMS/HR-MS in the UL Access zone.

- The affected/dual-role HR-BS receives from and transmits to its serving HR-BS during the DL Relay zone and UL Relay zone, respectively. The PHY-layer configuration for DL/UL Relay zones shall be sent by the serving HR-BS toward the affected HR-BS in the AAI-ARS-CONFIG-CMD message.

- The affected/dual-role HR-BS can communicate with its subordinate HR-RSs in the following ways:

- The affected/dual-role HR-BS can instruct its subordinate HR-RSs to transmit UL data during the DL Relay zone, i.e., when the affected/dual-role HR-BS also receives from the serving HR-BS. While doing so, the affected/dual-role HR-BS shall instruct the transmitting HR-RSs to use the same PHY-layer configuration as used in the DL Relay zone of the serving HR-BS.

- The affected/dual-role HR-BS can instruct its subordinate HR-RSs to receive DL messages during the UL Relay zone, i.e., when the affected/dual-role HR-BS also transmits to the serving HR-BS. While doing so, the HR-BS shall instruct the transmitting HR-RSs to use the same PHY-layer configuration as used in the UL Relay zone of the serving HR-BS. Furthermore, if an *R-RTI* = T_s is inserted in the first OFDMA symbol of the first subframe of the UL Relay zone, the dual-role HR-BS shall let its subordinate HR-RSs to be aware of this insertion.

17.3.1.1.2.2.2 When *R-TTI* = T_s

When *R-TTI* = T_s, the affected HR-BS shall change its *IDCell*, i.e., it shall pick one of the SA-Preamble sequences (and possibly new preamble carrier index) that are allocated for TTR ARS. The operation of the affected/dual-role HR-BS can be described as follows.

In BS Operation Mode:

- The affected/dual-role HR-BS shall only communicate with its subordinate AMS/HR-MS/HR-RS stations and shall not be available to receive from or transmit to its serving HR-BS.

- The affected/dual-role HR-BS shall behave like a normal HR-RS for its subordinate AMS/HR-MS. The subordinate AMS/HR-MS detect the SA-preamble transmitted by the affected/dual-role HR-BS and classify the HR-BS as a TTR HR-RS. In response, the affected HR-BS shall only transmit DL data toward its subordinate AMS/HR-MS in the DL Access zone and receive UL data from its subordinate AMS/HR-MS in the UL Access zone. Furthermore, as *R-TTI* = T_s, the affected HR-BS shall not transmit on the last OFDM symbol of the last subframe in the DL Access zone. The information regarding *R-TTI* = T_s shall be transmitted in the SFH SP2 toward subordinate AMS/HR-MS.

- The affected HR-BS shall behave like a normal HR-BS for its subordinate HR-RS. That means the affected HR-BS shall transmit to its subordinate HR-RS in the DL Relay zone, and receive from its subordinate HR-RS in the UL Relay zone.

In RS Operation Mode:

- The affected HR-BS shall communicate with its serving HR-BS. It may or may not communicate with its subordinate HR-RS in the mode of operation, and the specifications are as described in 17.3.1.1.2.2.

- The affected/dual-role HR-BS shall behave like a normal HR-RS for its subordinate AMS/HR-MS. The subordinate AMS/HR-MS detect the SA-preamble transmitted by the affected/dual-role HR-BS and classify the HR-BS as a TTR HR-RS. In response, the affected HR-BS shall only transmit DL data toward its subordinate AMS/HR-MS in the DL Access zone and receive UL data from its subordinate AMS/HR-MS in the UL Access zone. Furthermore, as $R\text{-}TTI = T_s$, the affected HR-BS shall not transmit on the last OFDM symbol of the last subframe in the DL Access zone. The information regarding $R\text{-}TTI = T_s$ shall be transmitted in the SFH SP2 toward subordinate AMS/HR-MS.

17.3.1.1.3 Relay link configuration

During establishing relay link, serving HR-BS transmits AAI-ARS-CONFIG-CMD message described in 16.2.3.57 to configure PHY layer parameter set including superframe number indicating the time to establish relay link.

While HR-BS is maintaining relay link, the serving HR-BS shall send AAI-ARS-ESI message described in 16.2.3.58 in the DL relay zone when the essential system information in SFH is changed. The HR-BS also shall send AAI-ARS-CONFIG-CMD message in the DL relay zone when PHY layer parameter needs to be reconfigured.

HR-BS acting as relay may transmit AAI-MM-ADV message with action type described in 16.2.3.70 to update PHY/MAC layer parameter after receiving AAI-ARS-ESI or AAI-ARS-CONFIG-CMD message.

17.3.1.1.4 Relay link release

If the HR-BS recovers from failure of backhaul, it may inform network or notify the current serving HR-BS of the HR-BS having recovered backhaul link through the backhaul network interface. The superordinate serving HR-BS may then initiate HR-MS handover back to the HR-BS in which the recovered HR-BS should be listed in the first priority. The HR-BS having recovered backhaul may store MAC context information of the serving MSs (basic capabilities, security capabilities, etc.). Such context information allows HR-MS to perform optimized network reentry when returning back to the HR-BS upon its recovery.

HR-BS transmits AAI-MM-ADV message with action type = 0b101 described in 16.2.3.70 including expected time of backhaul link up. When receiving the AAI-MM-ADV message, HR-MS performs either handover to neighbor infrastructure station and returns to the HR-BS at the expected time or waiting in the HR-BS until restarting service with available backhaul link.

17.3.1.2 Relay function for HR-MS

An HR-MS may operate as an HR-RS to provide connectivity for multiple out-of-coverage HR-MSs. During basic capability negotiation at network entry, an HR-MS that

is capable of role change to HR-RS shall report such capability to the super-ordinate HR-BS/HR-RS.

While operating as HR-RS, the station may maintain certain HR-MS functionalities. A mode switch to HR-RS shall be commanded by its superordinate HR-BS.

17.3.1.2.1 Relay link establishment

To support relay function for HR-MS, HR-MS capable of relay function shall establish relay link with HR-BS.

An HR-MS acting as HR-RS is operated in either TTR mode or STR mode and its relay mode is determined by HR-BS.

To request subordinate HR-MS to change its role as HR-RS, HR-BS transmits AAI-MMRS-REQ message described in 16.2.3.71 including relay mode (i.e., either TTR or STR mode).

In response to AAI-MMRS-REQ, the HR-MS transmits AAI-MMRS-RSP message described in 16.2.3.72.

During establishing relay link, HR-BS transmits AAI-ARS-CONFIG-CMD message described in 16.2.3.57 to configure PHY layer parameter set including superframe number indicating the time to start acting as HR-RS.

To support handover as a part of robustness against SPOF as described in 17.3.7.2, an indication of whether MAC context information of the subordinate HR-MS is being shared by infrastructure stations shall be transmitted to HR-MS.

17.3.1.2.2 Relay link configuration

While HR-MS is acting as relay mode, the superordinate HR-BS shall send AAI-ARS-ESI message described in 16.2.3.58 in the DL relay zone when the essential system information in SFH is changed. The HR-BS also shall send AAI-ARS-CONFIG-CMD message in the DL relay zone when PHY layer parameter needs to be reconfigured.

While an HR-MS operating as HR-BS, any communication is performing with superordinate HR-BS in DL/UL relay zone to maintain HR-MS functionalities.

HR-MS acting as relay mode may transmit AAI-MM-ADV message described in 16.2.3.70 to update PHY/MAC layer parameter after receiving AAI-ARS-ESI or AAI-ARS-CONFIG-CMD message.

17.3.1.2.3 Relay link release

An HR-MS acting as RS may end its relay service and remove the relay link from the HR-BS. During the HR-MS' relay mode release process, all subordinate HR-MSs of the HR-MS acting as RS shall be transferred to another infrastructure station prior to HR-MS' relay mode release. The HR-MS acting as RS sets Cell Bar bit to 1 in order to prevent HR-MS (re)entry and transmits AAI-MM-ADV message to transfer all

subordinate HR-MSs to another infrastructure station. An HR-MS acting as RS may transmit an AAI-MMRL-REQ message described in 16.2.3.73 in UL relay zone to an HR-BS so that it initiates the release procedure and requests handover of all its subordinate HR-MSs. Upon receiving the AAI-MMRL-REQ message, the HR-BS decides whether it allows the HR-MS' relay mode release. If the request is accepted, the HR-BS may transmit the AAI-MMRL-RSP message described in 16.2.3.74 in DL relay zone to inform the acceptance and start BS-initiated handover process for the requested HR-MSs. After handover procedures between the HR-BS and HR-MS acting as RS' subordinate HR-MSs are completed, the HR-BS informs the HR-MS acting as RS that handover is completed by transmitting an AAI-MMRL-RSP message in DL relay zone. Upon receiving the AAI-MMRL-RSP message, the HR-MS acting as RS starts relay mode release process immediately or at action time expires. If the HR-BS rejects the request, the HR-BS informs the HR-MS acting as RS the rejection of the request by transmitting the AAI-MMRL-RSP message in DL relay zone. Upon receiving the AAI-MMRL-RSP message with rejection information, the HR-MS acting as RS continues operating in relay mode. After action time expires, the HR-MS acting as RS retransmits an AAI-MMRL-REQ message in UL relay zone to the HR-BS.

The mode release process may be initiated by an HR-BS through transmitting an unsolicited AAI-MMRL-RSP message in DL relay zone.

After mode release process, all the relay-related connections and resource are released between the HR-BS and the HR-MS.

17.3.1.3 Base station function for HR-MS

An HR-MS may operate as an HR-BS to provide connectivity for itself and other HR-MSs. During basic capability negotiation at network entry, an HR-MS that is capable of role change to HR-BS shall report such capability to the super-ordinate HR-BS/HR-RS.

While operating as an HR-BS, the station may maintain certain HR-MS functionalities

The HR-MS may start operating as an HR-BS in a Proactive operation or a Reactive operation. For proactive operation, the mode switch is directed by the superordinate HR-BS of the HR-MS; In reactive operation, the mode switch is initiated by the HR-MS itself.

17.3.1.3.1 Proactive Operation

A superordinate HR-BS may select a target HR-MS among its subordinate HR-MSs which are capable of role changing to HR-BS, according to the measured signal power at HR-BS and/or subordinate HR-MS' status information such as the battery level. The subordinate HR-MS capable of role changing to HR-BS may report its status information to the superordinate HR-BS via MM-STAT-REP MAC control message and/or AMS Battery Level Report header as described in 16.2.2.1.3.5. The triggering condition for reporting status information may be configured by the superordinate HR-BS.

After selecting the target HR-MS, the superordinate HR-BS requests the target HR-MS to change its mode to HR-BS by exchanging HRBS-REQ/RSP message. If the target HR-

MS accepts the request from the superordinate HR-BS to change the mode to HR-BS, the superordinate HR-BS may transmit HRBS-CONFIG-CMD message to request the target HR-MS to set the configuration parameters and the trigger conditions for operating as HR-BS.

17.3.1.3.2 Reactive Operation

The HR-MSs which are capable of role changing to HR-BS may contend for operating at BS mode when the superordinate HR-BS fails. The HR-MSs may initiate a mode switch to HR-BS after expiration of a random backoff timer to avoid potential collision among adjacent HR-MSs trying to perform a mode switch to HR-BS at the same time.

After completion of mode switch, the HR-MS acting as HR-BS may request mode change to one of its subordinate HR-MSs in order to hand HR-BS role over. In this case, it follows the procedure for Proactive operation as described in 17.3.1.3.1.

17.3.2 Direct communication between HR-MSs

17.3.2.1 General Description

In HR-MS direct communication, the two communicating HR-MSs are the source and the sink of data. The data packets are passed from upper layers to MAC at the source HR-MS and back to upper layers at the sink HR-MS. Data packets are exchanged between the two HR-MSs directly or by passing through another HR-MS.

HR-MS direct communication is applicable when 1) the two HR-MSs are in coverage of and are directly associated to an HR infrastructure station; 2) one HR-MS is in coverage of and directly associated to an HR infrastructure station, while the other HR-MS is out of coverage of any HR infrastructure stations; 3) the two HR-MSs are out of coverage of any HR infrastructure stations.

Resource for HR-MS direct communication can be allocated by the HR infrastructure station for cases (1) and (2).

For case-3, direct communications between HR-MSs shall satisfy:

- The operation of HR-MSs shall not interfere with any existing infrastructure stations. When HR-MS cannot receive any BS preamble from any infrastructure station and HR-MS direct communication without infrastructure is permitted by device configuration, HR-MSs are allowed to communicate with each other in the same band without getting permission from infrastructure stations.
- A Coordinator is selected for the coordination of transmission among HR-MSs. Until a coordinator is selected, an HR-MS is only allowed to transmit signals necessary to enable coordinator selection. To avoid collisions among HR-MSs in coordinator selection, the HR-MS follow a collision avoidance procedure. The procedure is defined in 17.3.2.5.

- A coordinator shall function as a simplified HR-BS except it may not support handover. How to select a coordinator among HR-MSs shall follow the operation described in TBD.
- A coordinator supports the following topologies:
    - HR-MS linked to the coordinator and the pair is the source and sink of data. This topology is implemented through the local source and sink capability of the HR-MS.
    - Two HR-MS linked to the coordinator and the two HR-MS are the source and sink of data. This topology is implemented through the local forwarding capability of the HR-BS.
    - A forwarding HR-MS forwards data of a forwarded HR-MS to the coordinator. This topology is implemented through the HR-BS capability to support HR-MS forwarding operation.
    - Two HR-MS are linked (DC) and are the source and sink of data to each other under the control of the coordinator. This topology is implemented through the HR-BS ability to support DC between its subordinates.
- The coordinator and any HR-MS that are communicating through the coordinator shall continue cell search operation and shall cease DC operation as soon as the criteria for DC and prevention of interference above are not met.

Resource for HR-MS direct communication may be allocated in a distributed manner among nearby HR-MSs independent of infrastructure node deployment for cases (1), (2), and (3).

HR-MS direct communication using distributed resource allocation among nearby HR-MSs, that is called talk-around direct communication, is described in 17.3.2.6.

17.3.2.2 Frame Structure and Resource Allocation

Resources for HR-MS Direct Communications and HR-MS Forwarding to Network shall be scheduled by the serving HR-BS/RS when one exists. Serving HR-BS/RS can schedule direct communication in an on-demand and dynamic manner, and can multiplex this with transmissions between HR-MS and HR-BS / HR-RS.

To optimize the signaling and switching cost and improve QoS provisioning to HR-MS direct communication, serving HR-BS / HR-RS can schedule resource for DC/FTN zone for multiplexing DC/FTN transmissions. An HR-MS DC / FTN Zone is an area of continuous OFDMA resources in time and logical subchannels or resource units. The size and location of DC/FTN zone is dynamically or semi-stationary determined by the serving HR-BS.

When an infrastructure node doesn’t exist, one of the HR-MS shall fulfill this coordinating role. It is understood that the coordinating HR-MS needs to take on some of the functionality of a HR-BS and may also require new functionality.

All resource scheduling shall be conveyed through MAP or DL control messages from serving HR-BS/RS or a coordinating HR-MS. In the case of HR-MS Forwarding to Network, the scheduling messages shall be forwarded by the forwarding HR-MS.

Random access channels may be used for bandwidth request. For case-1, bandwidth request are sent directly to the serving HR-BS /HR-RS. For case 2, bandwidth requests are forwarded by the forwarding HR-MS.

17.3.2.3 Synchronization between HR-MSs involving in HR-MS DC/FTN

This section describes the process of maintaining synchronization between two HR-MSs that communicate directly with each other under HR-MS DC and FTN. The process is employed after HR-MS DC/FTN has been setup, and therefore should be differentiated from the discovery process described in 17.3.7.1.2. Synchronization between HR-MSs is classified into two levels:

- The frame-level should allow HR-MSs to share a common understanding of frame and/or superframe timing and configuration.
- The symbol-level should allow reliable (i.e. received within the appropriate reception threshold) bi-directional transmissions between HR-MSs.

Synchronization mechanisms are specified for three different use cases as follows.

17.3.2.3.1 Use case 1: Both HR-MSs are within the coverage of HR-BS/RS

The following synchronization mechanisms are used for HR-MS DC/FTN scheduled in uplink area of a frame.

Frame-level Synchronization:

When both HR-MSs are able to receive PA/SA-Preambles and DL control signals from a common serving HR-BS/HR-RS, they shall use these to achieve frame-level synchronization (with respect to HR-BS/HR-RS and between themselves). When both HR-MSs involved in DC or FTN are within the coverage of HR-BS/HR-RS, frame-level synchronization means the HR-MSs acquire DL synchronization with the serving HR-BS/HR-RS and are able to achieve system configuration and control messages.

Symbol-level Synchronization:

When the HR-MS/HR-MS direct link is scheduled in a UL area of a frame, the transmitting HR-MS shall follow the same timing advance as has been adjusted and agreed with the serving HR-BS/HR-RS. This means the transmitting HR-MS shall time its

direct transmissions as if these are normal UL transmissions toward the serving HR-BS/HR-RS.

It is the responsibility of the receiving HR-MS to adjust its receive timing to match the time of arrival (TOA) of the signal transmitted by the other HR-MS. This time adjustment shall be achieved by the serving HR-BS/HR-RS scheduling the HR-MSs to transmit ranging sequences to each other. Based on a received ranging sequence, an HR-MS can estimate and correct its time offset with the transmitting HR-MS. To facilitate this process, the serving HR-BS/HR-RS shall assign dedicated ranging sequences and ranging channels in UL area of a frame for HR-MS/HR-MS direct ranging.

To enhance bi-directional communication between HR-MSs, the serving HR-BS/HR-RS can allocate ranging resources to both involved HR-MSs in a single assignment. This allows the receiving HR-MS to transmit back a ranging sequence right after successfully processing the ranging sequence transmitted by the other HR-MS.

The serving HR-BS/RS schedules ranging between two HR-MSs through HR-DCV-CMD message.

17.3.2.3.2 Use case 2: one HR-MS is inside and the other is outside the coverage of HR-BS/RS

The following synchronization mechanisms are used for HR-MS DC/FTN scheduled in uplink area of a frame.

Frame-level Synchronization:

When two HR-MSs need to achieve frame-level synchronization and only one of them is within the coverage of the serving HR-BS/HR-RS, the inside-of-coverage HR-MS shall first acquires DL synchronization with the serving HR-BS/HR-RS (based on PA/SA-Preambles and control messages from the serving HR-BS/HR-RS). The inside-of-coverage HR-MS shall subsequently broadcast preambles and possibly network configuration information (NCI) for the outside-of-coverage HR-MS to co-synchronize.

The inside-of-coverage HR-MS shall transmit PA/SA preambles at the first OFDMA symbols of 2^{nd} and 3^{rd} frames within each superframe. The NCI shall be transmitted in an UL area. The location of the NCI, relative to the transmitted preambles, shall be determinable by the outside-of-coverage HR-MS.

Symbol-level Synchronization:

Using the preambles and NCI transmitted by the inside-of-coverage HR-MS, the outside-of-coverage HR-MS shall adjust its timing to receive messages transmitted from the inside-of-coverage HR-MS. To further improve synchronization in this direction, the inside-of-coverage HR-MS can transmit ranging signal toward the outside-of-coverage

HR-MS so that this node can estimate and correct its time/frequency offsets. Symbol-level synchronization in the opposite direction, i.e., from the outside-of-coverage of HR-MS toward the inside-of-coverage HR-MS shall be achieved by the outside-of-coverage HR-MS transmitting ranging signal toward the inside-of-coverage HR-MS. Upon processing the received ranging signal, the inside-of-coverage HR-MS can either adjust its own receive timing or request the outside-of-coverage HR-MS to adjust the transmit timing.

The serving HR-BS/RS schedules ranging between two HR-MSs through HR-DCV-CMD message.

17.3.2.3.3 Use case 3: MS-MS direct communications; there is no HR-BS/RS

- The first level synchronization should be carried out in a Master-slave manner. It is understood that the master needs to take on some of the functionality of a BS and may also require new functionality.

- The second level of synchronization can be achieved by HR-MSs exchanging ranging signals.

An example of this scenario is when HR-MS1 and HR-MS2 are having direct communications in a infrastructure-less deployment (or due to single point of failure). For this, an HR-MS (which can be HR-MS1, HR-MS2, or another node) should first be elected as the network coordinator. It is assumed that either one or both HR-MS1 and HR-MS2 then are within the coverage of the elected coordinator. After being elected, the coordinator shall periodically broadcast preambles for frame-level synchronization. With this, the control is back to one of the two earlier scenarios.

17.3.2.4 HR-MS Direct Communication with Infrastructure Stations

HR-BS/HR-RS shall check DSA_REQ messages received from HR-MS and determine whether HR-MS direct communication can be adopted for a flow. The HR-BS/HR-RS may help the source and destination HR-MSs setting up a direct communication link through DSA signaling.

HR-BS knows the possibility of setting up a direct communication between two HR-MSs by checking the HR-MS neighbor tables. If the two nodes are neighbor, HR-MS may schedule the two HR-MSs to do fine channel measurement and determine whether a direct communication link should be setup or not.

Before a service flow can be conveyed over the link between source and destination HR-MS, a direct communication link shall be setup first if it has not been setup yet.

A direct communication link is a link between a pair of HR-MS. It is identified by a STID. A security association may be setup between the two HR-MS linked by the direct communication. HR-BS manages the link by referring to the STID assigned to this link.

There are a few steps to setup a direct communication link between two HR-MS. The first step is that the two HR-MS need to do a channel measurement. After the channel measurement, the two HR-MSs shall report the measurement results to the HR-BS and HR-BS shall make a decision whether it will setup a direct communication link between the two HR-MSs. If HR-BS decides to setup a direct communication link, it shall assign a STID to the target link. After that, it may help the two sides setup a security association between the two HR-MSs. Once a security association is setup, then the communication link is considered being established between the two HR-MSs and service flows can be carried on the link. Figure 902 shows the procedure.

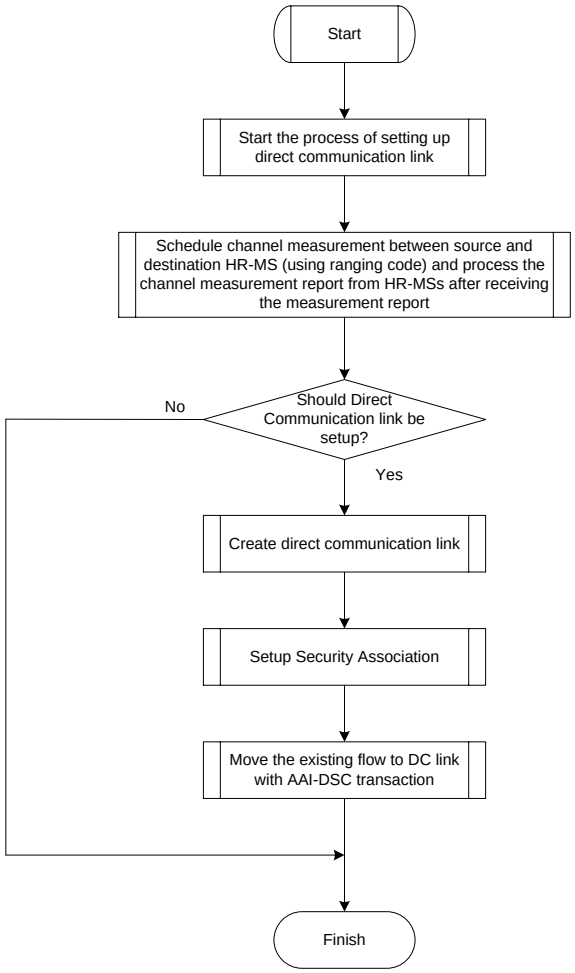


Figure 902—The overall procedure to setup direct communication

17.3.2.4.1 Direct Communication Link Management

17.3.2.4.1.1 Direct Communication Link Creation

When HR-BS creates direct communication link between two HR-MSs. It shall send link creation message to both source and destination HR-MSs. Direct communication link creation can only be initiated by the HR-BS.

Table 1201—Direct Communication Link Creation Request

Syntax	Size (bit)	Notes
DC-LINK-CREATE-REQ () {		
FID	4	—
Type	5	
STID of source/destination HR-MS	12	
STID	12	STID assigned to DC link
}		

The HR-MSs shall send back a response once they receive the direct communication link creation request.

Table 1202—Direct Communication Link Creation Response

Syntax	Size (bit)	Notes
DC-LINK-CREATE-ACK () {		
FID	4	—
Type	5	
STID	12	STID assigned to DC link
Confirmation Code	4	0x00: accept 0x01: reject 0x02 – 0x0f: reserved
Reserved	4	—
}		

Once the HR-BS receives responses from both HR-MSs, it can continue on other steps of direct communication setup.

17.3.2.4.1.2 Direct Communication Link Deletion

When HR-BS wants remove a direct communication link, it shall send deletion request to both HR-MS and wait for responses from the HR-MSs.

Table 1203—Direct Communication Deletion Request

Syntax	Size (bit)	Notes
DC-LINK-DEL () {		
FID	4	—
Type	5	
STID	12	STID assigned to DC link
}		

The HR-MS shall reply with reasons to HR-BS when it receives the link deletion request from HR-BS.

Table 1204—Direct Communication Deletion Response

Syntax	Size (bit)	Notes
DC-LINK-DEL-ACK () {		
FID	4	—
Type	5	
STID	12	STID assigned to DC link
Confirmation Code	4	0x00: accept 0x01: reject 0x02 – 0x0f: reserved
Reserved	4	—
}		

17.3.2.4.1.3 Direct Communication Link Report

HR-BS may require the HR-MS report the status of the direct communication link by sending a request to the relative HR-MS.

Table 1205—Direct Communication Link Report Request

Syntax	Size (bit)	Notes
DC-LINK-REPORT-REQ () {		
FID	8	—
Type	5	
STID	12	STID assigned to DC link
}		

HR-MS shall send back report regarding the direct communication link when it receives a link report request from HR-BS.

Table 1206—Direct Communication Link Report

Syntax	Size (bit)	Notes
DC-LINK-REPORT-REQ () {		
FID	4	—
Type	5	
STID	12	STID assigned to DC link
Link state	3	0x00: active 0x01: no link found 0x02 – 0x07: reserved
reserved	5	—
}		

17.3.2.4.2 Direct communication service flow management

17.3.2.4.2.1 Direct communication service flow

After a direct communication link has been setup between the source and destination HR-MS, the source HR-MS can setup flows over the direct communication link.

A direct communication setup protocol is illustrated in Figure 903 and described in detail in 17.3.2.1.2.

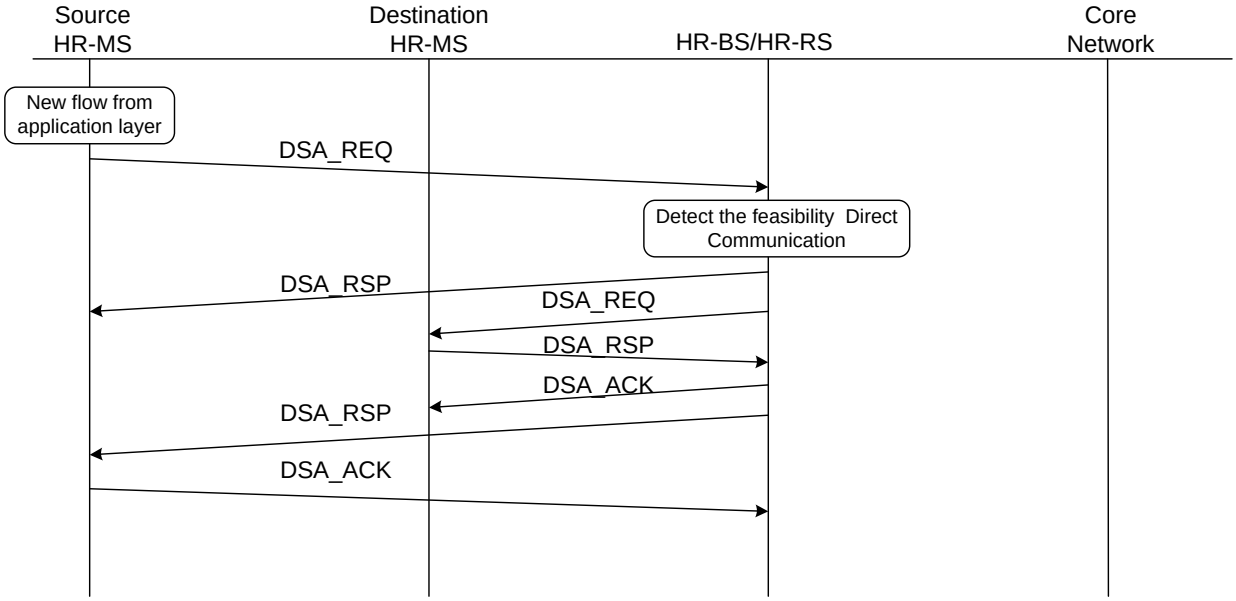


Figure 903—The establishment of direct communication between HR-MS

When receive AAI-DSA-REQ from HR-MS, if the BS already setup a direct communication link between the source and destination HR-MS and it intends to setup the flow over the direct communication link, then the HR-MS shall send an AAI-DSA_RSP to source HR-MS with CC equals to ***direct-comm-setup*** as defined in table 607 and STID of the direct communication link. At the same time, the HR-BS shall send AAI-DSA_REQ to the destination HR-MS with an indication of the direct communication flag and STID of direct communication link as specified in the table 734. The destination HR-MS shall send back a AAI-DSA-RSP with indication of accept/reject of direct communication and the HR-BS sends an AAI-DSA_ACK back to the destination HR-MS. The HR-BS shall send an AAI-DSA-RSP to the source HR-MS with indication of accept/reject of flow setup with indication of type. If direct communication setup is rejected, the flow shall be setup on the uplink in a normal way.

17.3.2.4.2.2 Dynamic Service Flow Modification and Deletion

When HR-MS initiates the service flow modification, if the modification increases the resource allocated to a flow over direct communication, then the HR-BS should hold on

the transaction with source HR-MS and finish the transaction with destination and then finish the transaction with source. If the modification reduces the resource allocated to a flow, the HR-BS should finish the transaction with source and then finish the transaction with destination.

When HR-BS initiates the service flow deletion and the target flow is over a direct communication link, it should send AAI-DSD to the two HR-MS respectively. When source/destination HR-MS initiates the service flow deletion and the target flow is over a direct communication link, HR-BS should also send a AAI-DSD to the destination/source HR-MS also.

17.3.2.5 HR-MS Discovery for Direct Communication without Infrastructure

When HR-MS cannot receive any BS preamble from any infrastructure station or an HR-MS that is associated with an infrastructure station, and HR-MS direct communication without infrastructure is permitted by device configuration, then HR-MSs are allowed to transmit network discovery signals to the network.

When HR-MS sends out network discovery messages, to avoid collision with other HR-MSs, it should follow a random-back off mechanism as follows:
1) A back-off timer shall be started.
2) When the timer is timeout, HR-MS should sense the channel for the presence of preambles first. If no preambles detected, then the HR-MS should transmit the discovery message. If a preamble has been detected, then node should hold the transmission and restart the timer.
3) HR-MS should get the value for the duration of back-off from a window, for example, from a window of [w_{min}, w_{max}], the size of window can be adjusted based on the traffic of networks. The value of W_{min} and W_{max} are TBD.

The network discovery message shall take following format: frame preambles, PA-Preamble and SA-Preamble shall be transmitted first, and then followed by the discovery information.

Based on the preamble pattern, HR-MS knows the signals are from a BS or from HR-MSs. The discovery message shall be transmitted after the SA-Preamble and use radio resource specified by SA-Preamble. The radio resource is TBD.

17.3.2.5.1 DC_DISCOV_Message

The discovery message shall take the following encoding format:

Table 1207—DC discovery message encodings

Syntax	Size (bit)	Notes
DC_DISCOV_Message() {	—	—

MAC Address	48	MAC address of the device
Length	16	The length of the message
NBR Count	8	Number of neighboring HR-MSs
for(i=0;i<n;i++){		
DC_DISCOV_IE();		
}		
}		

MAC Address

MAC address is the 48 bit address assigned to the HR-MS device. It shall be used as unique identity of the HR-MS in network discovery.

NBR Count

The value indicates the number of neighboring HR-MSs that the current HR-MS discovered via the neighbor discovery process.

DC_DISCOV_IE

Various information such as name of the HR-MS, MAC address of the neighboring node, invitation for communication etc is contained in the IEs.

17.3.2.5.2 Encoding of DC_DISCOV_IEs

The IEs contained in discovery message has a common encoding format as follows:

Table 1208—DC discovery IE encodings

Syntax	Size (bit)	Notes
DC_DISCOV_IE() {	—	—
Type	8	—
Length	8	The length of data contained in the value field
Value	variable	
}		

A few type of IE has been defined in table [number TBD]

Table 1209—DC discovery IE types

Type	**Name**
0x01	DC_DISCOV_NODE_NAME

0x02	DC_DISCOV_NBR_ADDR
0x03	DC_DISCOV_INVITE
0x04	DC_DISCOV_INVITE_ACCEPT
0x05	DC_DISCOV_INVITE_REJECT
0x06 – 0xfe	Reserved
0xff	DC_DISCOV_DATA

17.3.2.5.2.1 DC_DISCOV_NODE_NAME

The node name is an ASCII string. The maximum length is 16 bytes.

Table 1210—DC HR-MS Name

Type (1 byte)	Length (1 byte)	Value (variable length)
0x01	1 – 16	A name given by the user of HR-MS

17.3.2.5.2.2 DC_DISCOV_NBR_ADDR

It contains MAC addresses of neighboring HR-MSs discovered by the current HR-MS. Each MAC address takes six bytes. Multiple MAC addresses can be transmitted in the same DC_DISCOV_NBR_ADDR IE.

Table 1211—DC Neighbor Address IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0x02	variable	MAC Address of the HR-MSs

17.3.2.5.2.3 DC_DISCOV_INVITE

The IE contains MAC address of the HR-MS that the current HR-MS want to setup connections. Multiple MAC addresses can be contained in the IE.

Table 1212—DC Invitation IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0x03	variable	MAC address of the invited HR-MS

17.3.2.5.2.4 DC_DISCOV_INVITE_ACCEPT

The current HR-MS decided to accept the invitation. It intends to join the HR-MS network once the HR-MS become an HR-BS.

Table 1213—DC Accept IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0x04	6	MAC address of the inviting HR-MS

The MAC address belongs to the HR-MS who sends out a DC_DISCOV_INVITE_ACCEPT message

17.3.2.5.2.4 DC_DISCOV_INVITE_REJECT

The IE contains the MAC address of the HR-MS who sends out a DC_DISCOV_INVITE_ACCEPT message and the current HR-MS reject the invitation. It intends to not join the HR-MS network when the HR-MS become an HR-BS.

Table 1214—DC Reject IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0x05	6	MAC address of the inviting HR-MS

17.3.2.5.2.6 DC_DISCOV_DATA

A short data packet is contained in the IE. The interpretation of the data is up to application.

Table 1215—DC Data IE

Type (1 byte)	Length (1 byte)	Value (variable length)
0xff	1 – 255	First 6 bytes is the MAC address of intended receving HR-MS and followed by data packets from upper layer

17.3.2.6 Talk-around Direct Communication mode

HR-MSs by themselves synchronize and perform contention-based transmission. The synchronization and the contention-based transmission are performed among those HR-MSs on a dedicated resource unused by HR-BSs if at least one of the HR-MSs is under HR-BS coverage.

17.3.2.6.1 Medium access control

17.3.2.6.1.1 Addressing

The HR-MS has unique addresses and logical address that identify HR-MS and connections during unicast and multicast transmission operations of talk-round direct communication.

17.3.2.6.1.1.1 DC terminal identifier (DCTID)

Each HR-MS shall have a 24-bit value that identifies a HR-MS uniquely.

17.3.2.6.1.1.2 DC group identifier (DCGID)

Each direct communication group shall have a 24-bit value that identifies a multicast group of HR-MSs uniquely for direct communication.

17.3.2.6.1.1.3 Flow identifier (FID)

Each connection is assigned a 4-bit FID that uniquely identifies the connection within the HR-MS or multicast group. FIDs are used along with a DCTID to identify a unicast control connection and unicast transport connections. FIDs are used along with a DCGID to identify a multicast control connection and multicast transport connections.

17.3.2.6.1.2 MAC PDU formats

MAC PDU formats shall be the same as described as in section 16.2.2*[with the exception of MAC PDU formats described in this section*].

17.3.2.6.1.3 MAC control messages

The peer-to-peer protocols of MAC layers in two HR-MSs communicate using the MAC control messages to perform the control plane function. MAC control messages shall be carried in a MAC PDU to be transported in a unicast control connection. In addition, the point-to-multipoint protocols of MAC layers in a multicast group of HR-MSs communicate using MAC control messages to perform the control plane functions. Table 1216 lists the MAC control messages that shall be defined in the ASN.1 format.

Table 1216—MAC control messages

No.	Functional Areas	Message names	Message description	Secuirty	Connection
n+1	Link Establishment	DM-LEST-REQ	Link Establishment Request		Unicast

n+2	Link Establishment	DM-LEST-RSP	Link Establishment Response		Unicast
n+3	Link Release	DM-LREL-REQ	Link Release Request		Unicast
n+4	Link Release	DM-LREL-RSP	Link Release Response		Unicast
n+5	Flow Management	DM-DSA-REQ	Dynamic Service Addition Request		Unicast
n+6	Flow Management	DM-DSA-RSP	Dynamic Service Addition Response		Unicast
n+7	Flow Management	DM-DSA-ACK	Dynamic Service Addition Acknowledgement		Unicast
n+8	Flow Management	DM-DSC-REQ	Dynamic Service Change Request		Unicast
n+9	Flow Management	DM-DSC-RSP	Dynamic Service Change Response		Unicast
n+10	Flow Management	DM-DSC-ACK	Dynamic Service Change Acknowledgement		Unicast
n+11	Flow Management	DM-DSD-REQ	Dynamic Service Deletion Request		Unicast
n+12	Flow Management	DM-DSD-RSP	Dynamic Service Deletion Response		Unicast
n+13	Flow Management	DM-DSD-ACK	Dynamic Service Deletion Acknowledgement		Unicast
n+14	Measurement	DM-MES-REQ	Measurement Request		Unicast
n+15	Measurement	DM-MES-RSP	Measurement Response		Unicast
n+16	Measurement	DM-MES-REP	Measurement Report		Unicast
n+17	Resource Management	DM-RCHG-REQ	Resource Change Request		Unicast
n+18	Resource Management	DM-RCHG-	Resource Change Response		Unicast

		RSP			
n+19	Token Management	DM-TKN-REQ	Token Request		Unicast
n+20	Token Management	DM-TKN-RSP	Token Response		Unicast
n+21	Token Management	DM-TKN-HO	Token Handover		Unicast or Multicast
n+22	Link Establishment	DM-LEST-CMD	Link Establishment Command		Multicast
n+23	Link Release	DM-LREL-CMD	Link Release Command		Multicast
n+24	Flow Management	DM-DSA-CMD	Dynamic Service Addition Command		Multicast
n+25	Flow Management	DM-DSC-CMD	Dynamic Service Change Command		Multicast
n+26	Flow Management	DM-DSD-CMD	Dynamic Service Delete Command		Multicast
n+27	Measurement	DM-MES-CMD	Measurement Command		Multicast
n+28	Resource Management	DM-RCHG-CMD	Resource Change Command		Multicast
n+29	Token Management	DM-TKN-ADV	Token Advertisement		Multicast

17.3.2.6.1.3.1 DM-LEST-REQ

An HR-MS transmits a DM-LEST-REQ message to establish a peer-to-peer link.

Table 1217— DM-LEST-REQ message field description

Field	Size (bits)	Value/Description	Condition
Link Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, Link Change Count is incremented by one (modulo 16) by the sender.	Shall always be present
For (i=0; i<N_Flow_Est; i++) {		N_Flow_Est is the number of flows on which the receiver of this message sends MAC PDUs. Range [0..1]	
FID	4	Flow identifier assigned by the sink of packets on the flow	
Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	

CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
MAC Header Type	1	Indicates whether AGMH or SPMH is presented at the start of MAC PDUs of the service flow. 0 : AGMH (Advanced Generic MAC Header) 1 : SPMH (Short-Packet MAC header) default value is 0.	
}			
For (i=0; i<N_Flow_Req; i++) {		N_Flow is the number of flows which the sender requests the receiver to establish. Range [0..1]	
Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	
CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
}			
Reserved			

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2 **17.3.2.6.1.3.2 DM-LEST-RSP**

3 An HR-MS transmits a DM-LEST-RSP message in response to a received DM-LEST-
4 REQ.

5 **Table 1218— DM-LEST-RSP message field description**

Field	Size (bits)	Value/Description	Condition
Link Change Count	4	Link Change Count from corresponding the DM-LEST-REQ	Shall always be present
Confirmation Code	4	Zero indicates the request was successful. Nonzero indicates failure	Shall always be present
For (i=0; i<N_Flow_Est; i++) {		N_Flow_Est is the number of flows on which the receiver of this message sends MAC PDUs. Range [0..1]	
FID	4	Flow identifier assigned by the sink of packets on the flow	
Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	
CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
MAC Header Type	1	Indicates whether AGMH or SPMH is presented at the start of MAC PDUs of the service flow. 0 : AGMH (Advanced Generic MAC Header) 1 : SPMH (Short-Packet MAC header) default value is 0.	
}			
Reserved			

17.3.2.6.1.3.3 DM-LREL-REQ

An HR-MS transmits a DM-LREL-REQ message to release either a peer-to-peer link or a point-to-multipoint link.

Table 1219— DM-LREL-REQ message field description

Field	Size (bits)	Value/Description	Condition
Link Release Request Code	8	Used to indicate the purpose of this message 0x00: Link release request. 0x01–0xff: *Reserved*	Shall always be present

17.3.2.6.1.3.4 DM-LREL-RSP

An HR-MS transmits a DM-LREL-RSP message in response to a received DM-LREL-REQ.

Table 1220— DM-LREL-RSP message field description

Field	Size (bits)	Value/Description	Condition
Link Release Confirm Code	8	Used to indicate the purpose of this message 0x00: Link release confirm. All the established flows including traffic flows are terminated immediately. 0x01: The sender of this message rejects to release the established link. 0x02–0xff: *Reserved*	Shall always be present

17.3.2.6.1.3.5 DM-DSA-REQ

An HR-MS transmits a DM-DSA-REQ message to create a new service flow.

Table 1221— DM-DSA-REQ message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present
For (i=0; i<N_Flow_Est; i++) {		N_Flow_Est is the number of flows on which the receiver of this message sends MAC PDUs. Range [0..1]	
FID	4	Flow identifier assigned by the sink of packets on the flow	
Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	
CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
MAC Header Type	1	Indicates whether AGMH or SPMH is	

		presented at the start of MAC PDUs of the service flow. 0 : AGMH (Advanced Generic MAC Header) 1 : SPMH (Short-Packet MAC header) default value is 0.	
}			
For (i=0; i<N_Flow_Req; i++) {		N_Flow is the number of flows which the sender requests the receiver to establish. Range [0..1]	
Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	
CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
MAC Header Type	1	Indicates whether AGMH or SPMH is presented at the start of MAC PDUs of the service flow. 0 : AGMH (Advanced Generic MAC Header) 1 : SPMH (Short-Packet MAC header) default value is 0.	
}			
Reserved			

17.3.2.6.1.3.6 DM-DSA-RSP

An HR-MS transmits a DM-DSA-RSP message in response to a received DM-DSA-REQ.

Table 1222— DM-DSA-RSP message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	FID Change Count from corresponding the DM-DSA-REQ	Shall always be present
Confirmation Code	4	Zero indicates the request was successful. Nonzero indicates failure	Shall always be present
For (i=0; i<N_Flow_Est; i++) {		N_Flow_Est is the number of flows on which the receiver of this message sends MAC PDUs. Range [0..1]	
FID	4	Flow identifier assigned by the sink of packets on the flow	
Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	
CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
MAC Header Type	1	Indicates whether AGMH or SPMH is presented at the start of MAC PDUs of the service flow. 0 : AGMH (Advanced Generic MAC Header) 1 : SPMH (Short-Packet MAC header)	

		default value is 0.	
}			
Reserved			

17.3.2.6.1.3.7 DM-DSA-ACK

An HR-MS may transmit a DM-DSA-ACK message in response to a received DM-DSA-RSP.

Table 1223— DM-DSA-ACK message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	FID Change Count from corresponding the DM-DSA-REQ	Shall always be present
Confirmation Code	4	Zero indicates the request was successful. Nonzero indicates failure	Shall always be present

17.3.2.6.1.3.8 DM-DSC-REQ

An HR-MS transmits a DM-DSC-REQ message to change the parameters of an existing service flow

Table 1224— DM-DSC-REQ message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present

17.3.2.6.1.3.9 DM-DSC-RSP

An HR-MS transmits a DM-DSC-RSP message in response to a received DM-DSC-REQ.

Table 1225— DM-DSC-RSP message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present

17.3.2.6.1.3.10 DM-DSC-ACK

An HR-MS may transmit a DM-DSC-ACK message in response to a received DM-DSC-RSP.

Table 1226— DM-DSC-ACK message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	FID Change Count from corresponding the DM-DSA-REQ	Shall always be present
Confirmation Code	4	Zero indicates the request was successful. Nonzero indicates failure	Shall always be present

17.3.2.6.1.3.11 DM-DSD-REQ

An HR-MS transmits a DM-DSD-REQ message to delete an existing service flow.

Table 1227— DM-DSD-REQ message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present
For (i=0; i<N_Flow_Rel; i++) {		N_Flow_Rel is the number of flows which the sender of this message is to release. Range [0..12]	
FID	4	Flow identifier assigned by the sink of packets on the flow	
}			
For (i=0; i<N_Flow_Req; i++) {		N_Flow is the number of flows which the sender requests the receiver to release. The sender of this message is used to send MAC PDUs on the flow. Range [0..12]	
FID	4	Flow identifier assigned by the sink of packets on the flow	
}			

17.3.2.6.1.3.12 DM-DSD-RSP

An HR-MS transmits a DM-DSD-RSP message in response to a received DM-DSD-REQ.

Table 1228— DM-DSD-RSP message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present
For (i=0; i<N_Flow_Rel; i++) {		N_Flow_Rel is the number of flows which the sender of this message is to release. Range [0..12]	
FID	4	Flow identifier assigned by the sink of packets on the flow	
}			

17.3.2.6.1.3.13 DM-DSD-ACK

An HR-MS may transmit a DM-DSD-ACK message in response to a received DM-DSD-RSP.

Table 1229— DM-DSD-ACK message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	FID Change Count from corresponding the DM-DSD-REQ	Shall always be present
Confirmation Code	4	Zero indicates the request was successful. Nonzero indicates failure	Shall always be present

17.3.2.6.1.3.14 DM-MES-REQ

An HR-MS transmits a DM-MES-REQ message to request a radio measurement and reporting the measurement results.

Table 1230— DM-MES-REQ message field description

Field	Size (bits)	Value/Description	Condition

17.3.2.6.1.3.15 DM-MES-RSP

An HR-MS transmits a DM-MES-RSP message in response to a received DM-MES-REQ.

Table 1231— DM-MES-RSP message field description

Field	Size (bits)	Value/Description	Condition

17.3.2.6.1.3.16 DM-MES-REP

An HR-MS transmits a DM-MES-REP message to report the measurement results if a report trigger condition is met.

Table 1232— DM-MES-REP message field description

Field	Size (bits)	Value/Description	Condition

17.3.2.6.1.3.17 DM-RCHG-REQ

An HR-MS transmits a DM-RCHG-REQ message to change radio resource for dedicated channel.

Table 1233— DM-RCHG-REQ message field description

Field	Size (bits)	Value/Description	Condition
For (i=0; i<N_Resource_Change; i++) {		N_Resource_Change is the number of dedicated channels Range [0..12]	
Old DC Frame Number	4	Indicates a DC frame number with the dedicated channel is on the frame.	
Old Dedicated Channel Number	4	Indicates a number of dedicated channel with DC Frame Number.	
New DC Frame Number	4	Indicates a DC frame number with the dedicated channel is on the frame.	
New Dedicated Channel Number	4	Indicates a number of dedicated channel with DC Frame Number.	

}			

17.3.2.6.1.3.18 DM-RCHG-RSP

An HR-MS transmits a DM-RCHG-RSP message in response to a received DM-RCHG-REQ.

Table 1234— DM-RCHG-REQ message field description

Field	Size (bits)	Value/Description	Condition
Confirmation Code	4	Zero indicates the request was successful. Nonzero indicates failure	Shall always be present

17.3.2.6.1.3.19 DM-TKN-REQ

An HR-MS transmits a DM-TKN-REQ message to change a token for half duplex communication.

Table 1235— DM-TKN-REQ message field description

Field	Size (bits)	Value/Description	Condition
DC Frame Number	4	Indicates a DC frame number with the dedicated channel is on the frame.	
Dedicated Channel Number	4	Indicates a number of dedicated channel with DC Frame Number.	

17.3.2.6.1.3.20 DM-TKN-RSP

An HR-MS transmits a DM-TKN-RSP message in response to a received DM-TKN-REQ.

Table 1236— DM-TKN-RSP message field description

Field	Size (bits)	Value/Description	Condition
Confirmation Code	4	Zero indicates the request was successful. Nonzero indicates failure	Shall always be present

17.3.2.6.1.3.21 DM-TKN-HO

An HR-MS transmits a DM-TKN-HO message to handover a token for half duplex communication

Table 1237— DM-TKN-HO message field description

Field	Size (bits)	Value/Description	Condition
DCTID	24	DC Terminal Identifier. Indicate the HR-MS which takes a PTT token.	Shall always be present
DC Superframe Number	4	Indicates a DC Superframe number in which the HR-MS sends packets on the flows	

17.3.2.6.1.3.22 DM-LEST-CMD

An HR-MS transmits a DM-LEST-CMD message to establish a point-to-multipoint link.

Table 1238— DM-LEST-CMD message field description

Field	Size (bits)	Value/Description	Condition
Link Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, Link Change Count is incremented by one (modulo 16) by the sender.	Shall always be present
For (i=0; i<N_Flow_Est; i++) {		N_Flow_Est is the number of flows on which the sender of this message sends MAC PDUs. Range [0..1]	
FID	4	Flow identifier assigned by the source of packets on the flow	
Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	
CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
MAC Header Type	1	Indicates whether AGMH or SPMH is presented at the start of MAC PDUs of the service flow. 0 : AGMH (Advanced Generic MAC Header) 1 : SPMH (Short-Packet MAC header) default value is 0.	
}			

17.3.2.6.1.3.23 DM-LREL-CMD

An HR-MS transmits a DM-LREL-CMD message to release a point-to-multipoint link.

Table 1239— DM-LREL-CMD message field description

Field	Size (bits)	Value/Description	Condition
Link Release Command Code	8	Used to indicate the purpose of this message 0x00: Link release command. 0x01–0xff: *Reserved*	Shall always be present

17.3.2.6.1.3.24 DM-DSA-CMD

An HR-MS transmits a DM-DSA-CMD message to create a new service flow on a point-to-multipoint link.

Table 1240— DM-DSA-CMD message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present
For (i=0; i<N_Flow_Est; i++) {		N_Flow_Est is the number of flows on which the sender of this message sends MAC PDUs. Range [0..1]	
FID	4	Flow identifier assigned by the source of packets on the flow	

Traffic priority	3	0 to 7: Higher numbers indicate higher priority Default: 0	
CS Specification Parameters	8	0–15: *Reserved* 16: Voice Codec G.729A 17–255: *Reserved*	
MAC Header Type	1	Indicates whether AGMH or SPMH is presented at the start of MAC PDUs of the service flow. 0 : AGMH (Advanced Generic MAC Header) 1 : SPMH (Short-Packet MAC header) default value is 0.	
}			
Reserved			

17.3.2.6.1.3.25 DM-DSC-CMD

An HR-MS transmits a DM-DSC-CMD message to change the parameters of an existing service flow on a point-to-multipoint link

Table 1241— DM-DSC-CMD message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present

17.3.2.6.1.3.26 DM-DSD-CMD

An HR-MS transmits a DM-DSD-CMD message to delete an existing service flow on a point-to-multipoint link.

Table 1242— DM-DSD-CMD message field description

Field	Size (bits)	Value/Description	Condition
FID Change Count	4	The change count of this transaction assigned by the sender. If new transaction is started, FID Change Count is incremented by one (modulo 16) by the sender.	Shall always be present
For (i=0; i<N_Flow_Rel; i++) {		N_Flow_Rel is the number of flows which the sender of this message is to release. Range [0..12]	
FID	4	Flow identifier assigned by the source of packets on the flow	
}			

17.3.2.6.1.3.27 DM-MES-CMD

An HR-MS transmits a DM-MES-CMD message to request a radio measurement and reporting the measurement results on a point-to-multipoint link.

Table 1243— DM-MES-CMD message field description

Field	Size (bits)	Value/Description	Condition

17.3.2.6.1.3.28 DM-RCHG-CMD

An HR-MS transmits a DM-RCHG-CMD message to change communication resource on a point-to-multipoint link.

Table 1244— DM-RCHG-CMD message field description

Field	Size (bits)	Value/Description	Condition
For (i=0; i<N_Resource_Change; i++) {		N_Resource_Change is the number of dedicated channels Range [0..12]	
Old DC Frame Number	4	Indicates a DC frame number with the dedicated channel is on the frame.	
Old Dedicated Channel Number	4	Indicates a number of dedicated channel with DC Frame Number.	
New DC Frame Number	4	Indicates a DC frame number with the dedicated channel is on the frame.	
New Dedicated Channel Number	4	Indicates a number of dedicated channel with DC Frame Number.	
}			

17.3.2.6.1.3.29 DM-TKN-ADV

An HR-MS transmits a DM-TKN-ADV message to advertise status of a token for half duplex communication on a point-to-multipoint link

Table 1245— DM-TKN-REQ message field description

Field	Size (bits)	Value/Description	Condition
DC Frame Number	4	Indicates a DC frame number with the dedicated channel is on the frame.	
Dedicated Channel Number	4	Indicates a number of dedicated channel with DC Frame Number.	
PTT Token Status	4	Zero indicates that the PTT token is available. Nonzero indicates unavailable	

17.3.2.6.1.4 Security

Talk-around direct communication key is managed as described in 17.3.10.1.2.

17.3.2.6.1.5 Connection management

A peer-to-peer connection is a mapping between two MAC peers of HR-MSs, which is defined as a unicast connection. The unicast connection is defined in one way and identified by an UTID and an FID.

A point-to-multipoint connection is a mapping among MAC peers of a group of HR-MSs, which is defined as a multicast connection. HR-MSs in a multicast group share the multicast connection. When an HR-MS has a right to send a packet on the multicast connection, all the other HR-MSs in the multicast group shall receive the packet from the

sending HR-MS.

Two types of connections are used: control connections and transport connections. Control connections are used to carry MAC control messages. Transport connections are used to carry user data packet. These two types of connections are applicable to both unicast and multicast connections.

17.3.2.6.1.5.1 Control connections

One pair of bi-directional unicast control connections are automatically established when two HR-MSs perform unicast link establishment with two-way handshake of control messages.

One multicast control connection is established when HR-MSs perform multicast link establishment multicasting one-way control message.

17.3.2.6.1.5.2 Transport connections

A unicast transport connection is unidirectional and identified by an FID between two HR-MSs. The unicast transport connection is established during the service flow creation procedure.

One multicast transport connection is established and identified by an FID among a group of HR-MSs. The FID is assigned during the service flow creation procedure.

17.3.2.6.1.6 Link management

HR-MS establishes a unicast link of direct communication between two peer-to-peer HR-MSs.

HR-MS establishes a multicast link of direct communication among a multicast group of HR-MSs.

17.3.2.6.1.6.1 Synchronization

Before link establishment, all the HR-MSs involved in direct communication shall be synchronized. The HR-MS shall acquire the PHY synchronization of direct communication on Synchronization channel. The detail synchronization procedure is described in section 17.3.2.6.2.x.

17.3.2.6.1.6.2 Link establishment

When HR-MSs need to communicate directly, the HR-MSs shall establish a unicast or multicast link of direct communication. During link establishment, a transport connection shall be established so that HR-MSs communicate directly. During link establishment, multiple transport connections may be established.

Two HR-MSs establish a unicast link with two-way handshake of DM-LEST-REQ/RSP

messages.

HR-MSs establish a multicast link with one-way DM-LEST-CMD message.

The radio resource for a dedicated channel is allocated during link establishment. A sending HR-MS shall send QoS parameters of traffic connection and the receiving HR-MS selects radio resources of a dedicated channel.

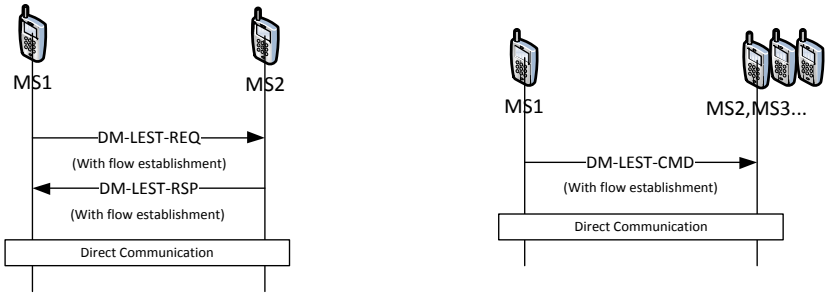


Figure 904—Message procedures of link establishment for unicast and multicast links

17.3.2.6.1.6.2 Link release

The unicast or multicast link is terminated with link release. On link release, all the connections built on a direct communication link are terminated automatically.

Two HR-MSs release a unicast link using DM-LREL-REQ/RSP messages.

HR-MSs release a multicast link using DM-LREL-CMD message.

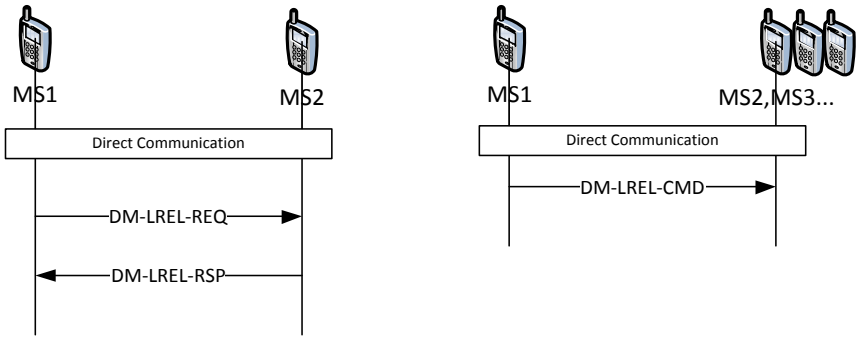


Figure 905—Message procedures of link release for unicast and multicast links

17.3.2.6.1.7 QoS management

QoS concept of direct communication shall be the same as described as in section 16.2.12 with the exception of QoS described in this section.

17.3.2.6.1.7.1 Service Flow Management

Service flows may be created, changed, or deleted. This is accomplished through a series of MAC management messages referred to as DM-DSA, DM-DSC, and DM-DSD. The DM-DSA messages create a new service flow. The DM-DSC messages change an

existing service flow. The DM-DSD messages delete an existing service flow.

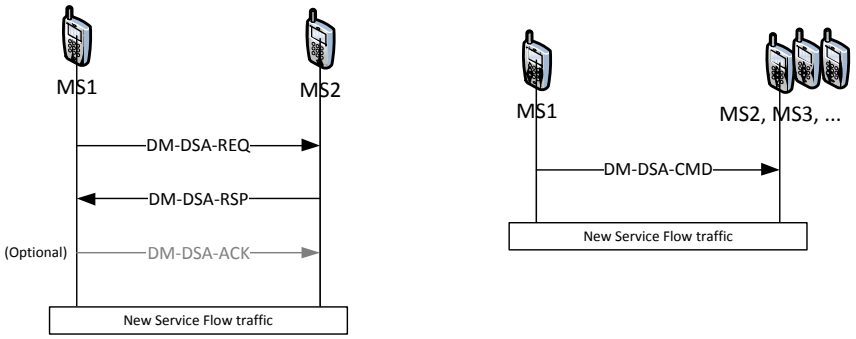


Figure 906—Message procedures of dynamic service flow addition for unicast and multicast links

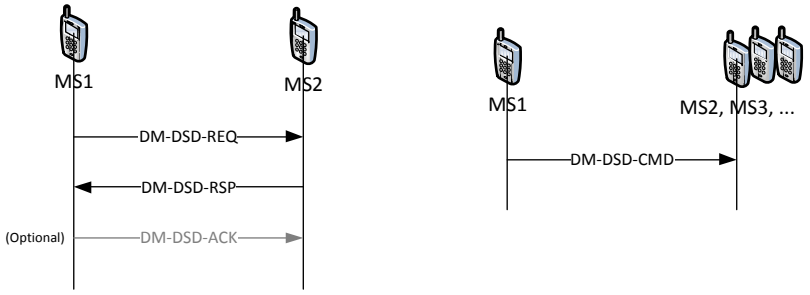


Figure 907—Message procedures of dynamic service flow deletion for unicast and multicast links

17.3.2.6.1.8 Token management

When an HR-MS has a token, the HR-MS sends packets on a shared link for half-duplex transmission. The DM-TKN-HO message passes the token over to other HR-MS. The DM-TKN-REQ message makes a request of token handover. The DM-TKN-RSP message makes a response to the DM-TKN-REQ message.

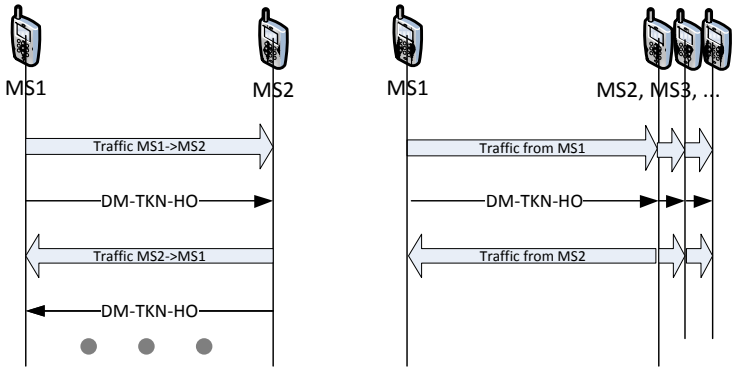


Figure 908—Message procedures of token management for unicast and multicast links

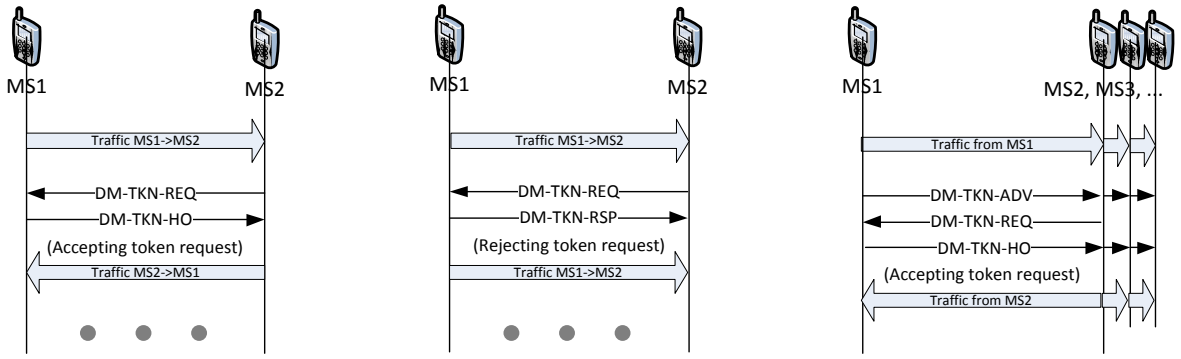


Figure 909—Message procedures of token management with token request for unicast and multicast links

17.3.2.6.1.9 Resource management

When a receiving HR-MS needs to change resource, the HR-MS requests it to the sending HR-MS. The receiving HR-MS recommends a candidate resource at least and the sending HR-MS may use new resource to send packets toward the receiving HR-MS.

When a receiving HR-MS needs to change transmission modulation, the HR-MS requests it to the sending HR-MS.

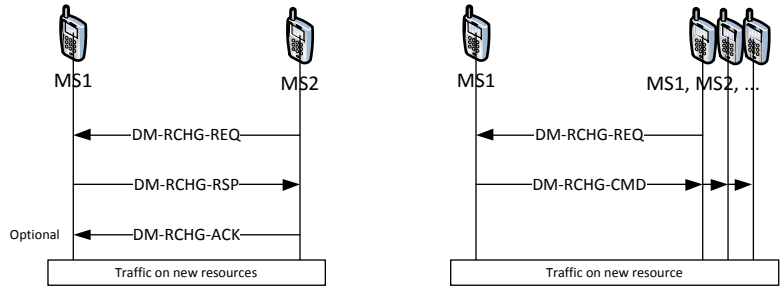


Figure 910—Message procedures of resource management for unicast and multicast links

17.3.2.6.1.10 Measurement

An HR-MS requests that the receiving HR-MS measures signals and interferences on resources and the measured values are reported periodically or at a trigger event. The sending HR-MS sends the DM-MES-REQ messages. The receiving HR-MS sends the DM-MES-RSP message in response and the DM-MES-REP message.

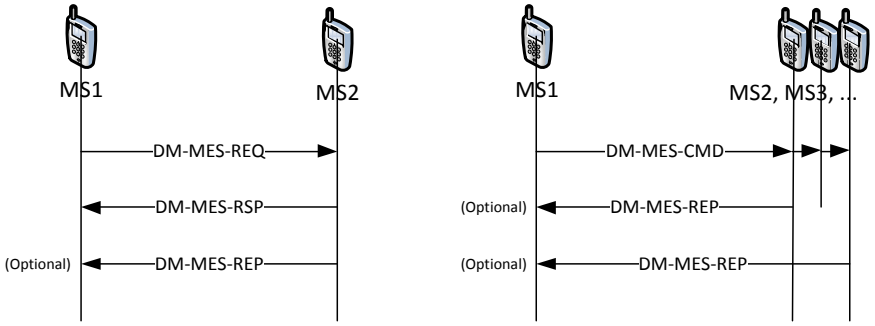


Figure 911—Message procedures of measurement for unicast and multicast links

17.3.2.6.11 Support for two hop communication

17.3.2.6.2 Physical layer

17.3.2.6.2.1 Frame structure

For talk-around direct communication, two types of infra-structure communication resources are dedicatedly assigned:

- Common Direct Mode Zone (CDMZ): set of PRUs with fixed size and positions which are commonly assigned to all cells (must be CRU)
- Cell Specific Direct Mode Zone (CSDMZ): additionally assigned direct-mode resource blocks independently assigned by each HR-BS (CRU or DRU) and information to receive cell specific direct mode region can be obtained from common direct mode zone

Figure 912 shows an example of talk-around direct communication resource allocation. In the figure, some part of uplink infra structure resources are assigned for common direct mode zone, and some part of uplink and downlink infra structure communication resources are assigned for cell specific direct mode zone. By assigning the same physical resources for common direct mode zone the following benefits can be obtained:

- Reduce the overhead of control channels to transmit allocation information of resources for direct-mode communication
- Reduce the computation complexity and power to obtain synchronization for direct communication, specially for the HR-MSs in the outside of HR-BS coverage

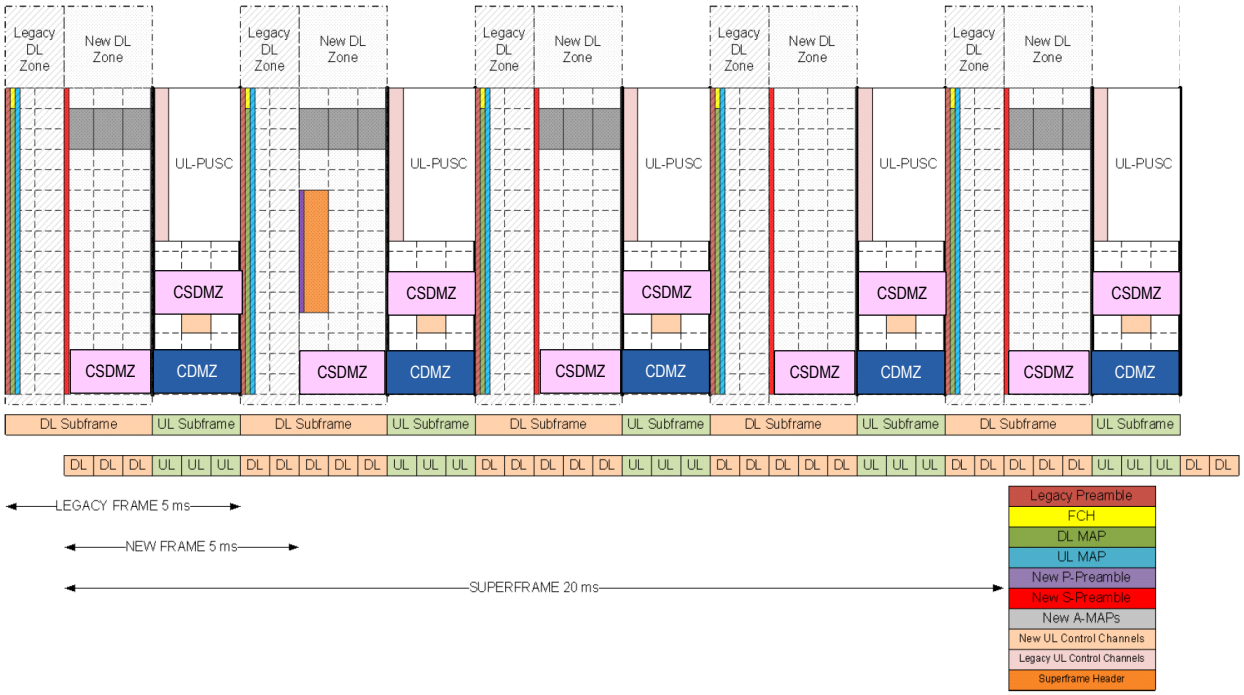


Figure 912—An example of talk-around direct communication resource allocation

The highest four PRUs of uplink resources are assigned for Common Direct Mode Zone (CDMZ). For FFT size = 512, PRU 20, 21, 22, 23 are assigned for CDMZ, for FFT size = 1024, PRU 44, 45, 46, 47 are assigned for CDMZ, and for FFT size = 2048, PRU 92, 93, 94, 95 are assigned for CDMZ. The resources for Cell Specific Direct Mode Zone (CSDMZ) are determined by each HR-BS independently and the assignment information is transmitted in the CDMZ.

Logical frame of common direct mode zone is composed by collecting all resources of CDMZ in a superframe as shown in Figure 913. In the example, there are three uplink subframes for each 5msec frame. Frame structure of cell specific direct mode zone is extension of common direct mode frame structure and the details are FFS.

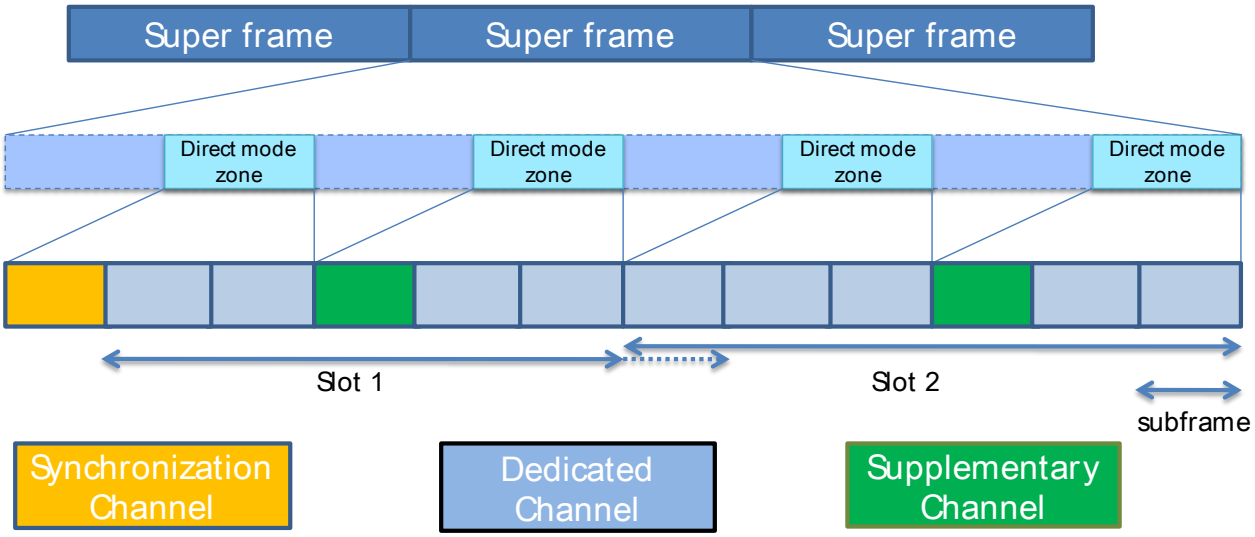


Figure 913—An example of common direct mode logical frame construction

There are three physical channels for talk-around direct communication:

- Synchronization Channel (Sync-CH)
- Dedicated Channel(Ded-CH)
- Supplementary Channel(Sup-CH)

The first subframe of the common direct mode frame is occupied by synchronization channel. All the HR-MSs receives the synchronization signal on the Synchronization channel except HR-MSs transmitting the synchronization signals. The HR-MSs are synchronized to the received synchronization signal if the signal timing has priority to HR-MS's synchronization timing itself. The details of timing priority is FFS. Some HR-MSs sends the synchronization signal on the Synchronization channel at selected subframes. HR-MS selects its slots for sending synchronization timing in distributed way. The details of how to select is FFS. The synchronization channel is composed of two parts: synchronization channel preamble part and synchronization message part. The synchronization channel preamble part is used for acquiring time and frequency synchronization, and synchronization sequence part is used for transmitting some information including frame structure information, hop count, transmitter ID et. al. The detailed design of synchronization channel is described in 17.3.2.6.2.3.1

Resources excluding the first subframe assigned for synchronization channel are assigned for dedicated channels and supplementary channels. A Dedicated channel is a resource to send direct communication packets for two HR-MSs or a group of HR-MSs. An HR-MS sends a packet on one or more than one subchannels of dedicated channel and the other HR-MSs receives the packet on it. If two HR-MSs and a group of HR-MSs are involved, the transmissions are unicast and multicast, respectively. How to configure the resource of dedicated channel is discussed in described in 17.3.2.6.2.3.2. The resources for dedicated channel is divided into small size sub-blocks (mRB: mini-Resource Block), as shown in Figure 914. One mRB is composed of 6 subcarriers-by-6

OFDM symbols, and there are 12 mRBs for each subframe (4PRU/ 1/3 PRU = 12). A dedicated subchannel is composed of a collection of 9 mRBs distributed across the entire frequency region in the slot.

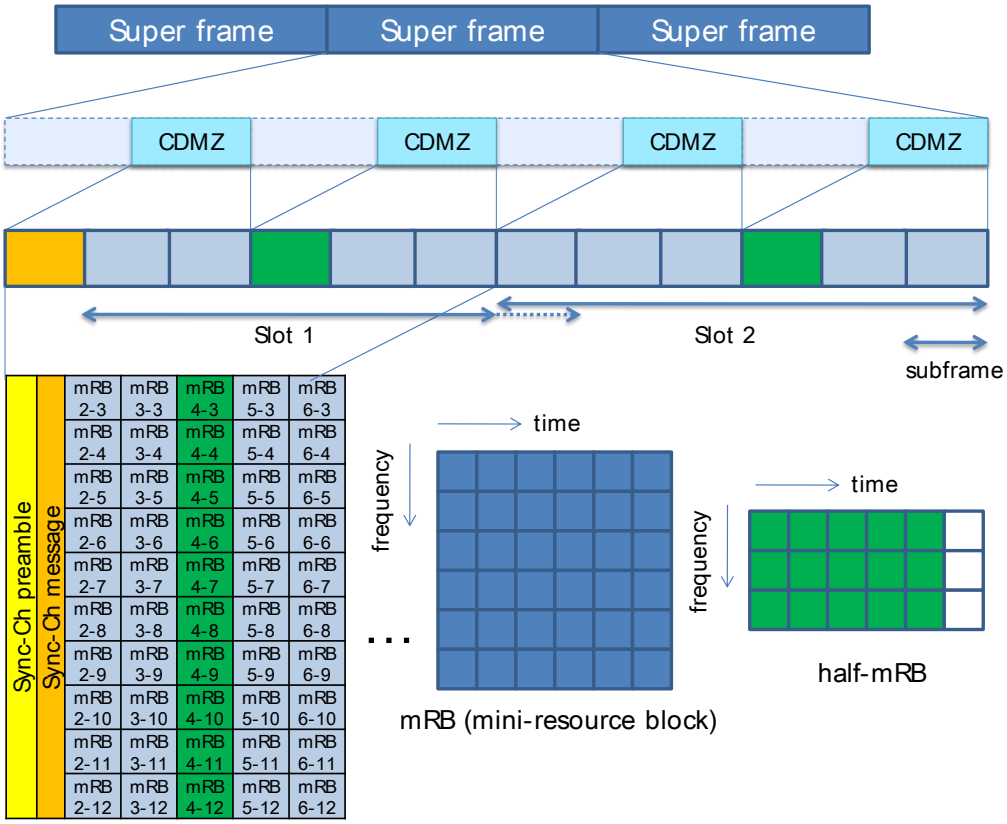


Figure 914—An example of common direct mode zone resource segmentation and construction of mRB

A supplementary sub-channel is one-to-one mapped with each dedicated sub-channel. By using the supplementary sub-channel, the following MAC messages, PHY signalings and short feedback messages related with the corresponding dedicated subchannel are transmitted.

- MAC messages: RTS, CTS for corresponding dedicated subchannel, MCS information, ranging response et. al.

- PHY signalings: periodic ranging sequence, sounding signal et. al.

- Short feedback messages: ACK, NACK, CQI, CSI, RI (rank information) et. al.

An mRB for supplementary sub-channel is divided into two half-mRB as shown in Figure zzz, and a half mRB is composed of 3 subcarriers-by- 5 OFDM symbols. Since all HR-MSs should listen the supplementary channels, to obtain Tx. And Rx. Switching time, no signal is transmitted in the last OFDM symbol of supplementary channel (6th OFDM symbol). The details of supplementary channel design are discussed in described in *17.3.2.6.2.3.3*.

17.3.2.6.2.2 Physical structure

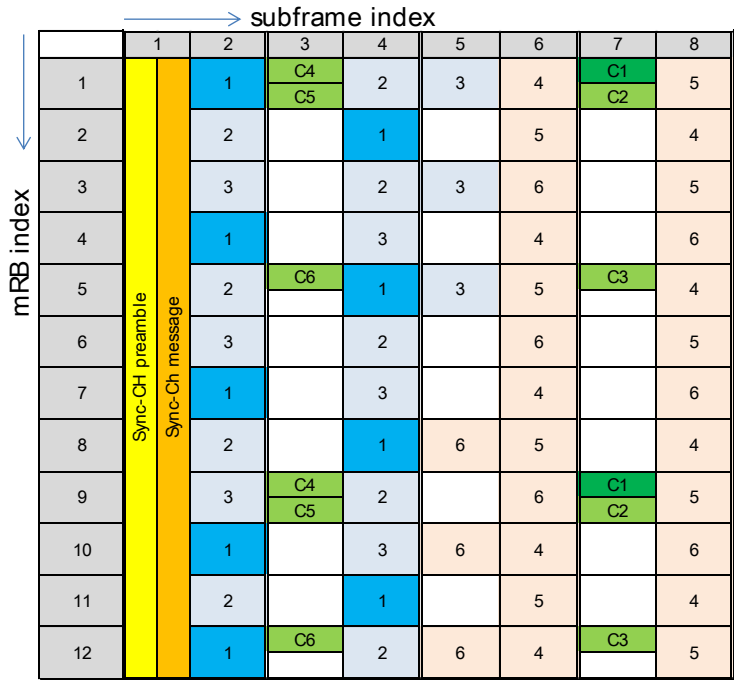
17.3.2.6.2.2.3.2 Dedicated Channel

Resources excluding the first subframe assigned for synchronization channel are assigned for dedicated channels and supplementary channels. A dedicated sub-channel is composed of a collection of nine mRBs distributed across the entire frequency region in the same slot. There are two slots for dedicated sub-channels. The subframes in the first and second frame are assigned for slot 1, and the subframes in the third and fourth frame are assigned for slot 2. For the case the number of uplink subframes is two and five, the first subframe of the third frame is allocated for both slot 1 and slot 2 simultaneously. Table 1246 summarizes the number of dedicated sub-channels for the various number of uplink subframes in a frame.

Table 1246—The number of dedicated sub-channels according to the number of uplink subframes in a frame

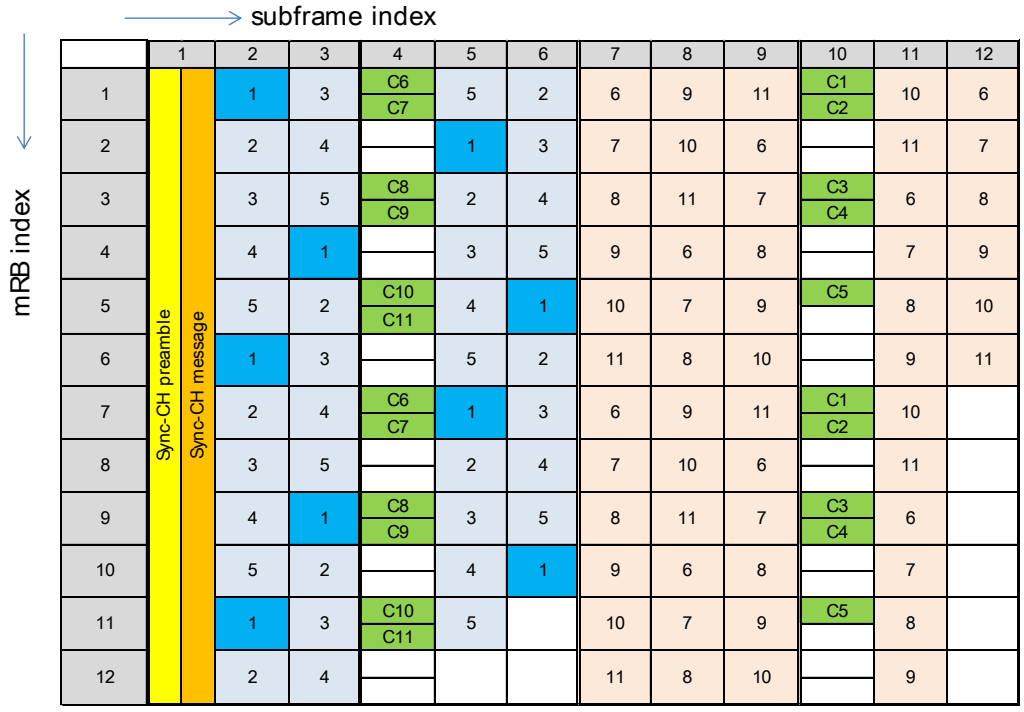
The number of uplink subframes in a 5msec frame	The number of dedicated sub-channel in the slot 1	The number of dedicated sub-channel in the slot 2	Total number of dedicated sub-channels
2	3	3	6
3	5	6	11
4	8	9	17
5	11	11	22

Figure 915 ~ Figure 918 show the frame structure of talk-around direct communication channels. In the figures, each block indicates mRB, and the number inside each mRB is the index of the dedicated sub-channel. For example, the dedicated sub-channel 1 is composed of nine mRBs in subframe in slot 1.



	1	2	3	4	5	6	7	8
1	Sync-CH preamble	1	C4 C5	2	3	4	C1 C2	5
2	Sync-Ch message	2		1		5		4
3		3		2	3	6		5
4		1		3		4		6
5		2	C6	1	3	5	C3	4
6		3		2		6		5
7		1		3		4		6
8		2		1	6	5		4
9		3	C4 C5	2		6	C1 C2	5
10		1		3	6	4		6
11		2		1		5		4
12		1	C6	2	6	4	C3	5

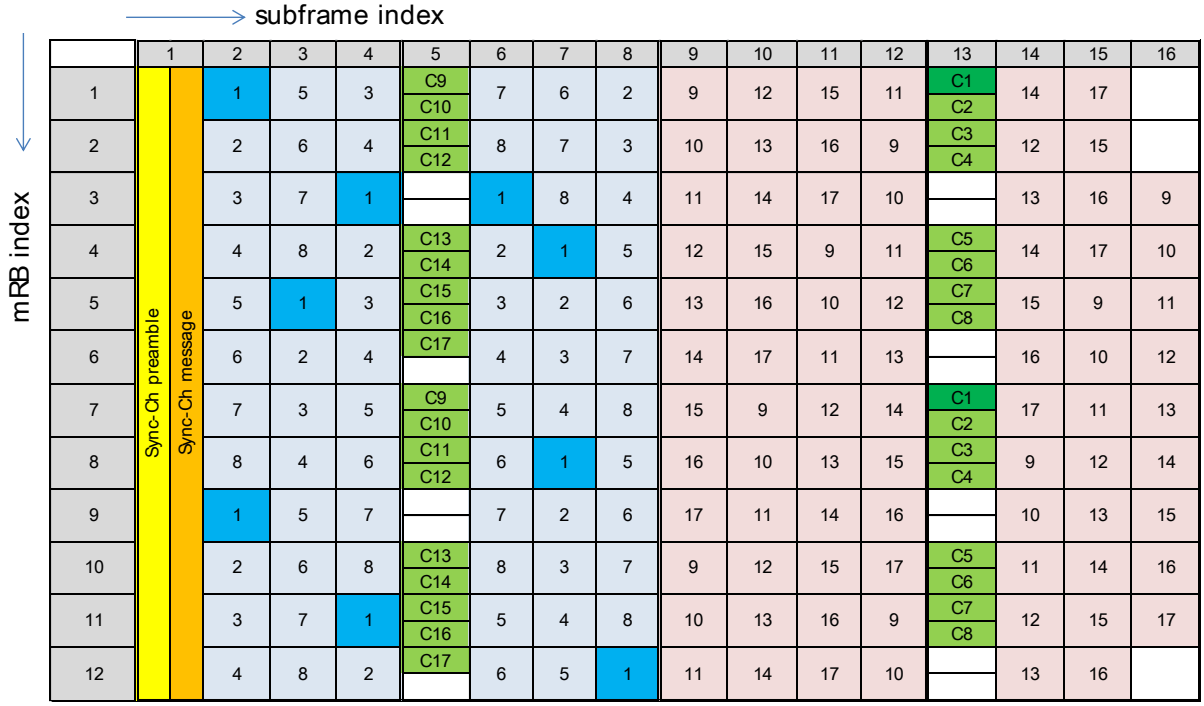
Figure 915—Frame structure of talk-around direct communication when the number of uplink subframe per 5msec frame is two. In the figure, each block indicates mRB, and the number inside each mRB is the index of the dedicated sub-channel. For example, the dedicated sub-channel 1 is composed of nine mRBs in subframe two and four (in blue color). C_i is the *i*-th supplementary sub-channel corresponding to the *i*-th dedicated sub-channel



	1	2	3	4	5	6	7	8	9	10	11	12
1	Sync-CH preamble	1	3	C6 C7	5	2	6	9	11	C1 C2	10	6
2	Sync-CH message	2	4		1	3	7	10	6		11	7
3		3	5	C8 C9	2	4	8	11	7	C3 C4	6	8
4		4	1		3	5	9	6	8		7	9
5		5	2	C10 C11	4	1	10	7	9	C5	8	10
6		1	3		5	2	11	8	10		9	11
7		2	4	C6 C7	1	3	6	9	11	C1 C2	10	
8		3	5		2	4	7	10	6		11	
9		4	1	C8 C9	3	5	8	11	7	C3 C4	6	
10		5	2		4	1	9	6	8		7	
11		1	3	C10 C11	5		10	7	9	C5	8	
12		2	4				11	8	10		9	

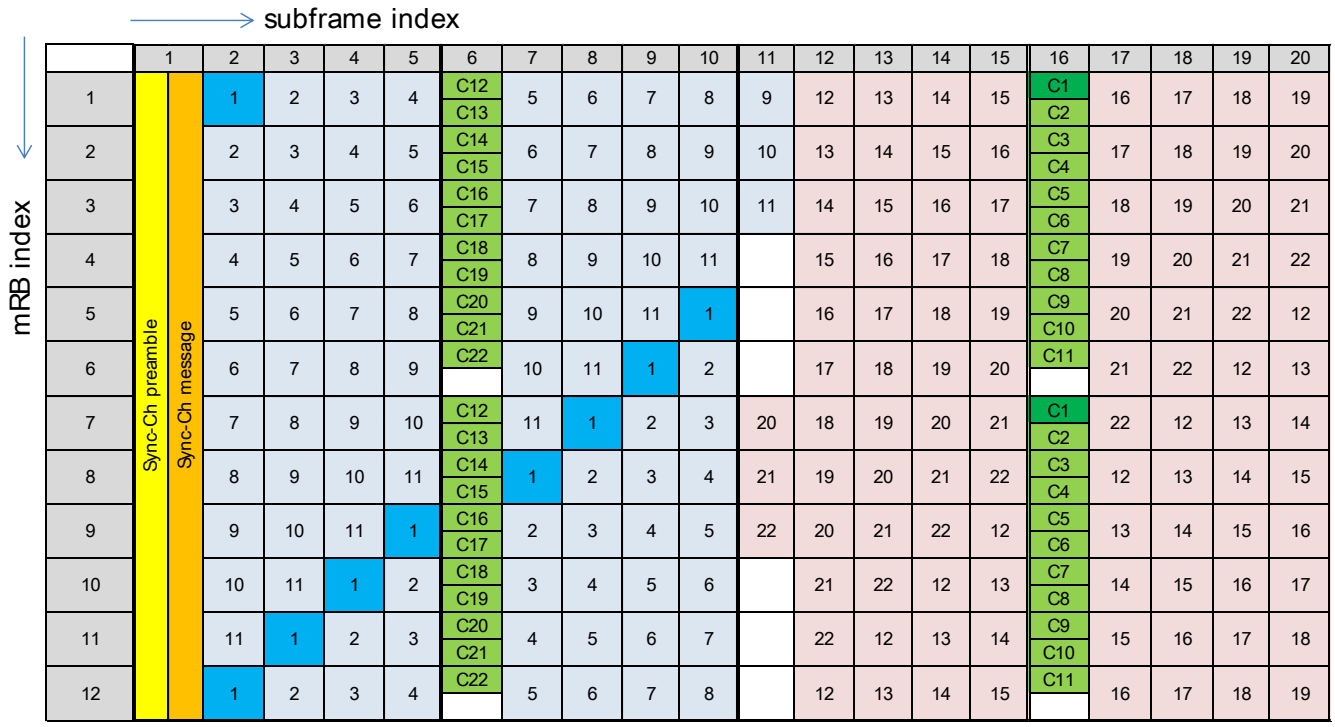
Figure 916—Frame structure of talk-around direct communication when the number of uplink subframe per 5msec frame is three. In the figure, each block indicates mRB, and the number inside each mRB is the index of the dedicated sub-channel. For example, the dedicated sub-channel 1 is composed of nine mRBs in subframe two, three, five and six (in

blue color). C_i is the *i*-th supplementary sub-channel corresponding to the *i*-th dedicated sub-channel



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		1	5	3	C9 / C10	7	6	2	9	12	15	11	C1 / C2	14	17	
2		2	6	4	C11 / C12	8	7	3	10	13	16	9	C3 / C4	12	15	
3		3	7	1		1	8	4	11	14	17	10		13	16	9
4		4	8	2	C13 / C14	2	1	5	12	15	9	11	C5 / C6	14	17	10
5		5	1	3	C15 / C16	3	2	6	13	16	10	12	C7 / C8	15	9	11
6		6	2	4	C17	4	3	7	14	17	11	13		16	10	12
7		7	3	5	C9 / C10	5	4	8	15	9	12	14	C1 / C2	17	11	13
8		8	4	6	C11 / C12	6	1	5	16	10	13	15	C3 / C4	9	12	14
9		1	5	7		7	2	6	17	11	14	16		10	13	15
10		2	6	8	C13 / C14	8	3	7	9	12	15	17	C5 / C6	11	14	16
11		3	7	1	C15 / C16	5	4	8	10	13	16	9	C7 / C8	12	15	17
12		4	8	2	C17	6	5	1	11	14	17	10		13	16	

Figure 917—Frame structure of talk-around direct communication when the number of uplink subframe per 5msec frame is four. In the figure, each block indicates mRB, and the number inside each mRB is the index of the dedicated sub-channel. For example, the dedicated sub-channel 1 is composed of nine mRBs in subframe two, three, four, six, seven and eight (in blue color). C_i is the *i*-th supplementary sub-channel corresponding to the *i*-th dedicated sub-channel



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		1	2	3	4	C12 C13	5	6	7	8	9	12	13	14	15	C1 C2	16	17	18	19
2		2	3	4	5	C14 C15	6	7	8	9	10	13	14	15	16	C3 C4	17	18	19	20
3		3	4	5	6	C16 C17	7	8	9	10	11	14	15	16	17	C5 C6	18	19	20	21
4		4	5	6	7	C18 C19	8	9	10	11		15	16	17	18	C7 C8	19	20	21	22
5		5	6	7	8	C20 C21	9	10	11	1		16	17	18	19	C9 C10	20	21	22	12
6		6	7	8	9	C22	10	11	1	2		17	18	19	20	C11	21	22	12	13
7		7	8	9	10	C12 C13	11	1	2	3	20	18	19	20	21	C1 C2	22	12	13	14
8		8	9	10	11	C14 C15	1	2	3	4	21	19	20	21	22	C3 C4	12	13	14	15
9		9	10	11	1	C16 C17	2	3	4	5	22	20	21	22	12	C5 C6	13	14	15	16
10		10	11	1	2	C18 C19	3	4	5	6		21	22	12	13	C7 C8	14	15	16	17
11		11	1	2	3	C20 C21	4	5	6	7		22	12	13	14	C9 C10	15	16	17	18
12		1	2	3	4	C22	5	6	7	8		12	13	14	15	C11	16	17	18	19

Figure 918—Frame structure of talk-around direct communication when the number of uplink subframe per 5msec frame is five. In the figure, each block indicates mRB, and the number inside each mRB is the index of the dedicated sub-channel. For example, the dedicated sub-channel 1 is composed of nine mRBs in subframe two, three, four, five, seven, eight, nine and ten (in blue color). C_i is the *i*-th supplementary sub-channel corresponding to the *i*-th dedicated sub-channel

17.3.2.6.2.2.3.3 Supplementary Channel

There are two subframes to transmit supplementary channel in a super frame. One subframe for supplementary channel is located in the first uplink subframe of the second frame, and the other subframe for supplementary channel is located in the first uplink subframe of the fourth frame. A supplementary sub-channel is one-to-one mapped with each dedicated sub-channel. By using the supplementary sub-channel, the following MAC messages, PHY signalings and short feedback messages related with the corresponding dedicated sub-channel are transmitted.

- MAC messages: RTS, CTS, MCS information, ranging response et. al.
- PHY signalings: periodic ranging sequence, sounding signal et. al.
- Short feedback messages: ACK, NACK, CQI, CSI, RI (rank information) et. al.

As shown in Figure 2 ~ Figure 5, C_i is the *i*-th supplementary sub-channel corresponding to the *i*-th dedicated sub-channel. A supplementary sub-channel is composed of two sub-blocks distributed in the frequency domain. Since all HR-MSs should listen the supplementary channels, to obtain Tx. And Rx. Switching time, no signal is transmitted in the last OFDM symbol of supplementary channel (6-th OFDM symbol). The sub-block of supplementary sub-channel is composed of 3 subcarriers-by- 5 OFDM symbols. The supplementary sub-channels corresponding to the dedicated sub-channels in slot 1 are located in slot 2, and the supplementary

sub-channels corresponding to the dedicated sub-channels in slot 2 are located in slot 1. By assigning a dedicated sub-channel and the corresponding supplementary sub-channel in a cross way, the setup time of communication link and the retransmission latency can be minimized. For example, if an HR-MS transmits a packet by using the dedicated sub-channel 1 in slot 1, because the corresponding supplementary sub-channel is located in slot 2, the receiving HR-MS can transmit ACK/NACK signal by using the supplementary sub-channel in the same superframe, and the retransmission packet can be transmitted in the next superframe.

17.3.2.6.2.3 Control structure

17.3.2.6.3.1 Synchronization channel

The Synchronization channel is used for frequency and time synchronization among HR-MSs involved in direct communications. The location of the synchronization is located at fixed position within dedicated resource reserved by HR-BS.

When an HR-MS transmits any channels for direct communication between HR-MSs, the transmitting HR-MS shall pre-compensate the frequency offset according to the frequency difference between the HR-MS and HR-BS. An HR-MS within the coverage of the HR-BS estimates frequency offset with the frequency of the serving HR-BS. Some HR-MSs can transmit some reference signals to spread the reference frequency of the HR-BS. The HR-MSs outside of HR-BS coverage can estimate frequency reference by using the propagated reference signals. If no propagated reference signal can be received, the HR-MS outside of coverage pre-compensate frequency offset according to the previously estimated offset value which was used when that HR-MS is inside of HR-BS coverage.

In addition to the frequency synchronization, the synchronization channel is used for acquiring time synchronization. Synchronization channel shall be used to estimate the transmission timing of the direct communication channels to prevent timing offset between the desired signals and interference signals at the receiver.

17.3.2.6.3.1.1 Synchronization channel structure

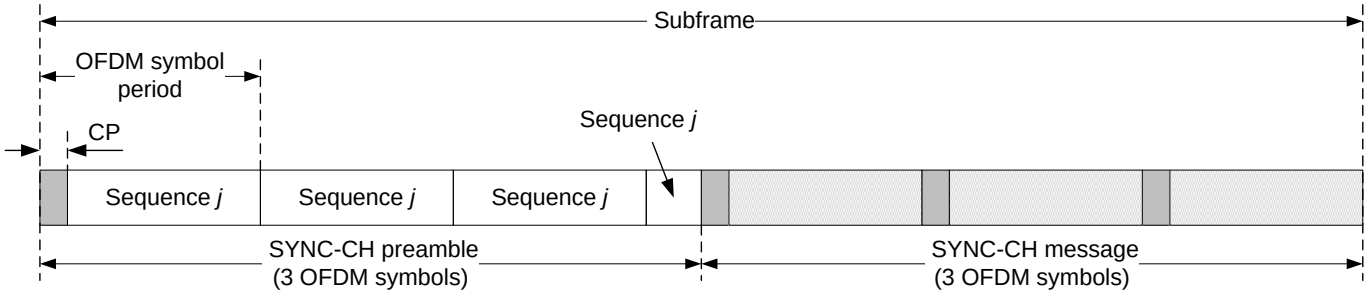


Figure 919—Synchronization channel for direct communication

Figure 919 describes the synchronization channel structure for direct communication in the time domain. One synchronization channel occupies one subframe composed of six OFDM symbols. The first three OFDM symbols are used for Sync-CH preamble transmission and the last three OFDM symbols include the Sync-CH message. In the frequency domain, 72 contiguous subcarriers are assigned to transmit the synchronization channel for direct communication. The Sync-CH preamble is used for preamble detection, timing offset estimation, frequency offset estimation, and channel estimation. A preamble sequence with 72 binary codes is mapped to the 72 subcarriers and the same preamble sequence is repeated during each symbol. The time domain preamble sequence is obtained by taking IFFT of the sequence mapped to 72 subcarriers. The first Sync-CH symbol is defined by the CP and the time domain preamble sequence. Second and third Sync-CH symbols are defined by the repetition of the time domain preamble sequence without the CP. To limit the preamble length to three OFDM symbols, the time domain preamble sequence is repeated by (2+α) times, where α is given by

$$\alpha = 2N_{CP} / N_{FFT}$$

where N_{CP} is the CP length and N_{FFT} is the FFT size.

17.3.2.6.3.1.2 Preamble sequences for synchronization channel

The preamble sequences are defined by the pseudonoise binary codes produced by the PRBS used for ranging code generation. The generator polynomial of the PRBS is $1+X^1+X^4+X^7+X^{15}$. The PRBS generator is initialized by the seed b14 … b0 = 1,1,0,1,0,1,0,0,0,0,0,0,0,0,0, where b0 is the LSB of the PRBS seed. The preamble sequences are subsequences of the pseudonoise binary sequence C_k generated by the PRBS. The length of each preamble sequence is 72 bits and the number of preamble sequences is 4. Suppose that the first bit of the PRBS output is C_0. Then, the preamble sequences are defined as follows.

$$S_k^0 = 1 - 2 \times C_k, \quad 0 \le k \le 71$$

$$S_k^1 = 1 - 2 \times C_k, \quad 72 \le k \le 143$$

$$S_k^2 = \begin{cases} 0, & 144 \le k \le 146 \\ 1 - 2 \times C_k, & 147 \le k \le 215 \end{cases}$$

$$S_k^3 = \begin{cases} 0, & 216 \le k \le 218 \\ 1 - 2 \times C_k, & 219 \le k \le 287 \end{cases}$$

where S_k^j is the *k*-th bit of the *j*-th preamble sequence. When the HR-MS transmitting the synchronization channel is within the coverage of the serving HR-BS, S_k^0 or S_k^1 shall be used. When the HR-MS transmitting the synchronization channel is outside of the HR-BS coverage, S_k^2 or S_k^3 shall be used.

17.3.2.6.3.1.3 Synchronization channel message

Synchronization channel message is transmitted after channel encoding. The pilot pattern

and channel coding method for the resources for synchronization channel message is FFS. The synchronization channel message is composed of the fields in Table 1247.

Table 1247—Synchronization channel message

Field name	Field size
Transmitter HR-MS ID	TBD
Hop count	4
Frame structure information	4
CRC	16

[note: the feature of the synchronization follows:

- *Distributed transmission (The MS decide to transmit the synchronization packet itself)*
- *Frame Timing and frequency reference by BS is propagated to the MSs out of the service coverage (using synchronization hop counter as an example)]*

17.3.2.7 Power control for mobile to mobile communication

17.3.2.7.1 Power control for two HR-MS associated with an HR-BS

When two HR-MS that are associated with an HR-BS are transmitting to each other their power control related commands are generated by their serving HR-BS.

The HR-BS may define measurements to be performed by the HR-MS on resources used for MS-MS communications and on the desired MS-MS signal to be reported to the HR-BS.

Definition of power control procedure is TBD.

17.3.2.7.2 Power control for one HR-MS associated with an HR-BS

The transmission power of a forwarding HR-MS transmitting to forwarded HR-MS is controlled by messages from the forwarded HR-MS that are derived from HR-BS controls

The transmission power of a forwarded HR-MS is controlled by messages from the forwarding HR-MS that are derived from HR-BS controls

Power control procedure details TBD.

17.3.2.7.3 Power control for no HR-MS associated with an HR-BS

If a coordinator is used then it controls transmission power for the pair in the same way as a baseline HR-BS would.

17.3.3 HR-MS Forwarding to Network

17.3.3.1 General Description

In HR-MS Forwarding to Network, an HR-MS forwards user data and control signaling between an HR-MS and an HR infrastructure station. The user data and control signaling do not go through higher layer at the forwarding HR-MS. The origination and termination of the user data and control signaling are at the forwarded HR-MS and the HR infrastructure station respectively and vice versa.

HR-MS Forwarding to Network is applicable when 1) the forwarded HR-MS and the forwarding HR-MS are in coverage of and directly associated to an infrastructure station; 2) the forwarding HR-MS is in coverage of and directly associated to an HR infrastructure station, while the forwarded HR-MS is out of coverage of any HR infrastructure stations.

Resource for HR-MS Forwarding to Network can be allocated by the HR infrastructure station with which the forwarding HR-MS is associated.

Using talk-around direct communication described in 17.3.2.6, HR-MS forwarding to network is described in 17.3.3.5.

17.3.3.2 Frame structure and Resource Allocation

See 17.3.2.2

17.3.3.3 Synchronization

See 17.3.2.3

17.3.3.4 Bandwidth Requests sent from Forwarded HR-MS

For use case 2, an out-of-coverage forwarded HR-MS can request bandwidth by transmitting some known sequences (Bandwidth Request (BR) preambles) toward the forwarding HR-MS.

The process can be described as follows.

- Serving HR-BS/RS schedules resources in an uplink subframe for forwarded HR-MSs to transmit BR messages to their corresponding forwarding HR-MS.
- The resource allocation information is conveyed to the forwarded HR-MS.

- The forwarding HR-MS listens to bandwidth requests at times and resources indicated by the HR-BS. The forwarded HR-MS may transmit bandwidth requests using these resources.
- The forwarding HR-MS, upon receiving BR messages from one of its forwarded HR-MS, forwards the requests to serving HR-BS/RS.
- Any resource assignment from the HR-BS is forwarded to the forwarding HR-MS.

17.3.3.5 HR-MS forwarding to network using talk-around direct communication

17.3.3.5.1 HR-MS discoveries

A forwarding HR-MS shall maintain a list of HR-MSs that are in communication range using talk-around direct communication.

An HR-BS shall maintain a list of HR-MSs that are collected from forwarding HR-MSs for HR-MS forwarding. An HR-BS broadcast the HR-MS list for HR-MS forwarding to forwarding HR-MSs using AAI-DMMS-ADV message. When new HR-MS is added or HR-MSs are deleted, the forwarding HR-MS shall update the HR-MS list by an exchange of MAC Management messages with HR-BS such as AAI-DMLU-REQ/RSP.

17.3.3.5.2 Forwarding connection management

A unicast forwarding connection between HR-BS and forwarding HR-MS is a unicast transport connection established to forward data traffic in one-way from HR-BS to forwarding HR-MS or vice versa.

A multicast forwarding connection between HR-BS and forwarding HR-MS is a multicast transport connection established to forward data traffic in one-way from HR-BS to forwarding HR-MSs.

Each unicast or multicast forwarding connection, which is established for supporting HR-MS forwarding, carries forwarding data packets. When HR-BS sends data packets on a unicast or multicast forwarding connection, forwarding HR-MS discriminates the data packets with type of transport connection and forwards the data packets on a direct communication link. When a forwarding HR-MS receives data packets on a direct communication link, the forwarding HR-MS discriminates the data packets and forwards the data packets on a unicast forwarding connection toward HR-BS.

17.3.3.5.2.1 Forwarding connection establishment

When a forwarding HR-MS is requested to establish a forwarding connection from HR-MSs out of BS’s coverage, the forwarding HR-BS establishes a unicast or multicast forwarding connection. The unicast or multicast forwarding connection between HR-BS and forwarding HR-MS is established by exchanges of MAC Management messages such as AAI-DSA-REQ/RSP/ACK.

17.3.3.5.2.2 Forwarding connection release

The forwarding connection is terminated with forwarding connection release. On forwarding connection release, the context of forwarding connection are removed at both HR-BS and forwarding HR-MSs.

An HR-BS and a forwarding HR-MS release a unicast or multicast forwarding connection by exchanges of MAC Management messages such as AAI-DSD-REQ/RSP/ACK.

17.3.3.5.3 QoS management

QoS concept of forwarding connections shall be the same as described as in section 16.2.12 with the exception of QoS described in this section.

17.3.4 Standalone network

For WirelessMAN HR Advanced air interface, when HR-BS lost the connectivity to the backbone network and the neighboring HR-BSs, the network nodes under the coverage of this HR-BS shall form a standalone network. The local connectivity shall be provided for the mobile stations within the coverage of Base station. When the Base Station loses the backbone connection, the established service flow between mobile stations within the coverage of the base station shall be maintained.

When backbone connectivity is lost, the MAC connectivity is provided among HR-MSs within BS’s coverage

17.3.4.1 Backbone status management

17.3.4.1.1 Backbone Enable notification

When backbone connectivity is available, the HR-BS shall notify HR-MSs of its availability. The transport connections may be recovered from their unavailable status.

An HR-BS exchanges the BBE-REQ/RSP message with HR-MSs on unicast control connections.

An HR-BS broadcasts the BBE-CMD message to all the HR-MSs under BS’s coverage.

17.3.4.1.2 Backbone Disable notification

When backbone connectivity is not available, the HR-BS shall notify HR-MSs of its unavailability. After backbone disables, all the transport connections on which packets transfer to network are not available.

An HR-BS exchanges the BBD-REQ/RSP message with HR-MSs on unicast control

connections.

An HR-BS broadcasts the BBD-CMD message to all the HR-MSs under BS coverage.

17.3.4.2 Maintenance of Local Connectivity

For maintenance of local connectivity, all the HR-BSs shall maintain a network topology table of HR-MS/HR-RS within its coverage area. The network topology table shall be updated periodically by broadcasting a STN-REQ message from HR-BS and receiving acknowledgement message STN-ACK from HR-MS or HR-RS within its coverage area.

The maintenance of local connectivity for standalone network with WirelessMAN HR Advanced air interface shall according to the process defined in section 17.2.4.1

17.3.4.3 Entry Process for Standalone Network

The HR standalone network with WirelessMAN HR Advanced air interface shall allow the entry of an unassociated HR-MS into the standalone network and establish the connection with standalone network HR-BS. The unassociated HR-MS is referred to the HR-MS which is not associated with any Base Station.

The entry process is as defined in Section 17.2.4.2.

17.3.5 Relaying operation

In order to provide great reliability in a degraded network, the relay function described in this subsection shall be supported.

In order to support local forwarding in an HR-RS, the HR-RS shall follow operation as defined in Section 17.3.6.

17.3.5.1 Relaying connection notifications over an alternative interface

An alternative interface is an interface between two stationary HR-MSs that is not an IEEE 802.16 air interface. It may be an air interface on an unlicensed spectrum such as WLAN, or a wired interface on a power line.

When an HR-BS has downlink data for a HR-MS that has powered down or in an extended sleep mode (Such as a DCR mode) from the 802.16 network, the HR-BS may send a multicast Connection Notification message to the multicast group to which the target HR-MS belongs. In the multicast message, the identity of the target HR-MS is included. When HR-MS in the multicast group that is currently connected to the network receives the notification, the HR-MS is assumed to relay the notification to the target HR-MS identified in the Connection Notification message over the alternative interface. Upon receipt of this notification, the target HR-MS shall enter the network and receive any pending messages from the HR-BS.

17.3.6 Local Forwarding

HR-RS/BS should detect the local forwarding opportunity and be able to bind together the uplink flow ID from the source and the downlink flow ID to the destination for two communicating HR-

MSs within its control during connection establishment or connection re-establishment for handover, if it is allowed by HR-BS. After the binding HR-RS is able to forward the data from the source to the destination without going through HR-BS and may optionally forward to HR-BS one copy of the data that is being locally forwarded, if required.

17.3.7 Path Discovery and Management

17.3.7.1 HR-MS Neighbor Discovery

HR-MS neighbor discovery is a key functionality to enable other 16n features such as path discovery and management, HR-MS direct communications (with or without presence of infrastructure), and HR-MS forwarding to network. HR-MS neighbor discovery procedures are specified for two scenarios: i) when HR-MSs associated with a common super-ordinate station (HR-BS/RS or a coordinating HR-MS) attempt to discovery each other and ii) when an out-of-coverage HR-MS attempts to discover an HR-MS in order to connect through it to network infrastructure.

To enable neighbor discovery among directly associated HR-MSs (use case 1), the super-ordinate station shall instruct these directly associated HR-MSs to transmit and receive predefined signals.

17.3.7.1.1 Neighbor Discovery among associated HR-MSs (Use Case 1)

For associated HR-MSs to discover each other, the serving HR-BS/HR-RS shall schedule some HR-MSs to broadcast predefined self-advertizing (PSA) signals so that other HR-MSs can try to receive and verify their neighbor relationship. Ranging preambles shall be used as PSA signals.

The process of neighbor discovery for registered HR-MSs is as follows:

- The serving HR-BS/HR-RS sends HR-DCV-CMD message to schedule one or multiple registered HR-MSs to broadcast ranging sequences in assigned channels. Multiple HR-MSs may share the same ranging sequence or the same assigned channel.
- In the same HR-DCV-CMD message, the serving HR-BS/HR-RS also schedules some other HR-MSs to listen on those channels scheduled for ranging signals.
- Each HR-MS that is scheduled to receive ranging sequences shall determine what sequences it can properly decode, together with related information such as estimations of time/frequency offsets and signal strength.
- The receiving HR-MSs may report their measurements to the serving HR-BS/HR-RS using HR-DCV-REP message. Whether a receiving HR-MS shall report its measurements or not may be based on a threshold.

The transmission of HR-DCV-CMD can be described as follows. The HR-BS unicasts HR-DCV-CMD message to a single HR-MS or multicasts the message to a group of HR-MSs that are supposed to broadcast the ranging signal. The HR-BS unicasts HR-DCV-

CMD message to a single HR-MS or multicasts the message to a group of HR-MSs that are supposed to attempt to receive the ranging signal. The HR-BS can also broadcast the HR-DCV-CMD message to all of its subordinates HR-MS. In such a case, all HR-MS that are not involved in UL transmission during the ranging opportunity index shall attempt to receive the ranging signal.

17.3.7.1.2 HR-MS Discover Network Infrastructure

To enable coverage extension, a serving HR-BS/HR-RS shall schedule some of its directly-associated HR-MSs to transmit PA/SA-Preamble signals so that an outside-of-coverage HR-MS can detect and start network entry. The directly-associated HR-MS shall transmit PA-Preamble at the first OFDM symbol of the 2nd frame and SA-Preamble at the first OFDM symbol of the 3rd frame (of a super-frame).

Any new HR-MS scanning for DL preambles for possible network entry shall be able to differentiate between preambles transmitted by normal infrastructure stations (HR-BS/HR-RS) and those transmitted by a coverage-extending HR-MS. For that, the last [TBD] SA-Preamble sequences in each segment are reserved for transmission by coverage-extending HR-MS.

The HR-BS may instruct HR-MS that are associated with it to transmit network configuration information (NCI) at pre-defined resources relative to the preambles transmitted by the HR-MS. The NCI, when transmitted, defines resources for access by the HR-MS that is not under HR-BS coverage. This corresponds to the coverage extension procedure defined in 17.3.7.1.2.1. If NCI is omitted then access resources are defined by the index and the sub-carrier set index of the SA-Preamble. This corresponds to the coverage extension procedure defined in 17.3.7.1.2.2.

17.3.7.1.2.1 Coverage Extension with NCI Preceding Initial Ranging

The procedure starts when serving HR-BS/RS transmits an HR-CEX-CMD message to instruct one or a group of its directly-associated HR-MS to carry out a coverage-extending process. The format of HR-CEX-CMD message is defined in Table 780 and includes the following information:

- *Idx* and *n*: the index of the SA-Preamble and index of SA-Preamble carrier set, respectively, to be transmitted by the scheduled HR-MS (or group of HR-MS). The scheduled HR-MS shall also transmit PA-Preamble, however this preamble is the same as that transmitted by serving HR-BS and therefore need not be specified.
- t_{adv}: the timing advance that should be used by the scheduled HR-MS (or group of HR-MS) when transmitting PA/SA-Preambles. This offset is with respect to the DL frame timing as seen by the scheduled HR-MS.
- n_{start} : the superframe number in which the new coverage-extending process should be started.
- m_{prep}: the number of superframes, counting from the superframe with number n_{start}, that the scheduled HR-MS (or group of HR-MS) shall transmit PA/SA-Preambles without transmitting NCI. The value of m_{prep} shall not be greater than a

system parameter N_{prep_max}.

- m_{nci}: the number of superframes in which NCI is to be transmitted, i.e., the NCI shall be transmitted in superframes $(n_{start} + m_{prep})$ to $(n_{start} + m_{prep} + m_{nci} - 1)$.
- m_{rng}: the number of ranging opportunities, together with their particular configurations.
- The location of the channel used to feedback to the new HR-MS (if pre-allocated).
- The power setting to be used by scheduled HR-MS (or group of HR-MS) when transmitting preambles and NCI.
- Other information to be transmitted in NCI (see Table 1248 and Table 1249).

Upon receiving the HR-CEX-CMD message, the scheduled HR-MS (or group of HR-MS), from now on simply referred to as forwarding HR-MS, shall start transmitting PA/SA-Preambles in superframe $n_{start.}$ The forwarding HR-MS transmits PA-Preamble in the first symbol of the 2nd frame and SA-Preamble in the first symbol of the 3rd frame of every superframe with superframe number from $n_{start.}$ to $(n_{start} + m_{prep.} - 1)$.

Next, the forwarding HR-MS transmits NCI in superframes with number from $(n_{start} + m_{prep})$ to $(n_{start} + m_{prep} + m_{nci} - 1)$. During these m_{nci} superframes, the forwarding HR-MS continue to transmit PA/SA-Preambles as specified above. The transmission of NCI can be described as follows:

- NCI partitioning: The NCI is divided into two subpackets, i.e., Initial Network Configuration Information (I-NCI) and Supplementing Network Configuration Information (S-NCI). I-NCI is transmitted first, with its location determinable from the SA-Preamble index, *Idx,* and subcarrier set index, *n*, of the SA-Preamble transmitted by the forwarding HR-MS. The content of I-NCI is described in Table xx2. The content of S-NCI is described in Table xx3. The location of S-NCI is specified in the I-NCI.

- Transmission of I-NCI: The I-NCI shall be transmitted in the $N_{I\text{-}NCI}$ Distirubted LRUs (DLRUs) in the first subframe of a superframe, with the particular resource index being determinable from the SA-Preamble transmitted by the forwarding HR-MS. Within the selected subframe, the I-NCI shall occupy the last 5 OFDM symbols, i.e., effectively forming a Type-3 subframe.

- Transmission of S-NCI: the resource allocated for S-NCI shall be defined in I-NCI (see Table xx2). In general, this allocation depends on the *IDCell* and the frame configuration of the serving HR-BS/RS.

When a new HR-MS detects PA/SA-Preambles and I/S-NCI transmitted by the forwarding HR-MS and decides to start initial ranging through the forwarding HR-MS, the following process shall be carried out:

- The new HR-MS, after acquiring downlink synchronization and uplink transmission parameters shall pick one of the ranging codes specified in S-NCI using a uniform random process. The HR-MS shall send the selected ranging code on the first allocated ranging channel specified in S-NCI.

- Upon receiving the ranging code from the new HR-MS, the forwarding HR-MS is supposed to respond with an HR-CEX-RNG-ACK message. As specified in S-NCI, m_{rng} ranging opportunities shall be allocated. If the new HR-MS has previously transmitted a ranging code in a ranging opportunity which is not the last opportunity, the HR-MS shall expect to receive an HR-CEX-RNG-ACK message from the forwarding HR-MS before the next ranging opportunity. If the new HR-MS does not receive such an HR-CEX-RNG-ACK message, it shall pick another ranging code using a uniform random process and transmit on the coming ranging opportunity. The new HR-MS may ramp-up its transmit power as specified in S-NCI. If the new HR-MS transmits a ranging code in the last ranging opportunity specified in S-NCI, it shall expect to receive an HR-CEX-RNG-ACK message within Tx1 Timer.

- The HR-CEX-RNG-ACK message provides responses to all the successfully received and detected ranging preamble codes in the ranging opportunity preceding its transmission. There are four possible ranging status responses from the forwarding HR-MS to the new HR-MS in the HR-CEX-RNG-ACK message, i.e.,
    - Continue: The forwarding HR-MS informs the new HR-MS of needed adjustments (e.g., time, power, and possibly frequency corrections) and a status notification of "continue".
    - Success: The forwarding HR-MS informs the new HR-MS of status "success", but may have adjustment suggestions to the new HR-MS if necessary. With status success, the forwarding HR-MS shall inform the new HR-MS of a BW allocation in the uplink for the new HR-MS to send HR-CEX-RNG-REQ message.
    - Abort: The forwarding HR-MS informs the new HR-MS to abort the current initial ranging process.
    - Continue with 2nd Phase: This status notification is only applicable if the current coverage extension process follows the Two-Phase approach, as specified in HR-CEX-CMD message. The forwarding HR-MS informs the new HR-MS to prepare to receive post-access preambles and post-access S-NCI. This status shall only be sent once, i.e., it shall not be given when the new HR-MS has already been carrying out ranging using post-access preambles and post-access S-NCI from forwarding HR-MS.

- Based on the received response of ranging status, the new HR-MS perform the following:
    - Upon receiving a Continue status notification and parameter adjustments in HR-CEX-RNG-ACK message, the new HR-MS shall adjust its parameters accordingly and continue the ranging process by randomly select one ranging code and transmit in the next available ranging opportunity, or as instructed in the HR-CEX-RNG-ACK message.
    - Upon receiving a Success status notification, the new HR-MS shall wait for the forwarding HR-MS to inform it of a BW allocation in the UL to send HR-CEX-RNG-REQ message. The BW shall be allocated to fit the

size of HR-CEX-RNG-REQ. The forwarding HR-MS forwards the corresponding request to the serving HR-BS, and subsequently acts on behalf of the HR-BS in sending an HR-CEX-RNG-RSP message to the new HR-MS. If the new HR-MS does not receive BW allocation for HR-CEX-RNG-REQ within Tx or the HR-CEX-RNG-REQ/RSP is not completed in [TBD] frames, it stops the process and try to associate with another HR-MS or a HR-BS/RS.

- Upon receiving an Abort status notification, the new HR-MS shall stop the ranging process. It shall not attempt to restart initial ranging with a forwarding HR-MS transmitting the same SA-Preamble in the next n_{closed} coverage extending process.
- Upon receiving Continue with 2nd Phase status notification, the new HR-MS waits for post-access PA/SA-Preambles and post-access S-NCI to be transmitted by forwarding HR-MS. Upon receiving post-access PA/SA-Preambles and S-NCI, the new HR-MS start a new round of initial ranging as follows steps as described above. and carries out ranging process as described above. The initial transmission power for the ranging is determined based on the last ranging prior to detection of post-access SA-Preamble and S-NCI.

- HR-BS assigns and transfers a TSTID by AAI-RNG-RSP message when ranging status is Success. Initial ranging process is over after receiving the HR-CEX-RNG-RSP message. The TSTID is used until STID is newly assigned and received at successful registration.

In the above procedure, the transmission of initial ranging code by the new HR-MS shall follow:

- For frame configuration without FDM-based UL PUSC zone support:

  - In the time domain, the S-RCH allocation is specified by the subframe offset O_{SF} transmitted in S-NCI, i.e., ranging opportunity is located at $mod(O_{SF} + 1, NUL)^{th}$ uplink AAI subframe of a particular frame. The information for ranging frequency resource allocation, i.e., the subband index for ranging resource allocation is determined by the *IDcell* of the superordinate HR-BS (transmitted in I-NCI) and the allocated number of subbands R_{SB} according to the following equation, where *IDcell* is defined in 16.3.5.1.2 and R_{SB} is $L_{SB\text{-}CRU,FPi}/4$, where $L_{SBCRU,\,FPi}$ is the number of allocated subband CRUs as defined in 16.3.7.3 for FP_i corresponding to reuse 1 partition or power-boosted reuse 3 partition only if there is no reuse 1 partition.

    $$I_{SB,s} = mod(IDcell + 1, R_{SB}),$$

    where $I_{SB,\,s}$ denotes the subband index $(0, \ldots, R_{SB} - 1)$ for ranging resource allocation among R_{SB} subbands.

- For frame configuration with FDM-based UL PUSC zone support:
    - The un-associated HR-MS shall transmit ranging preamble in a similar way to what specified in 16.3.8.2.4.3.

After a successful initial ranging, the forwarding HR-MS shall assist HR-BS and the new HR-MS to exchange control messages to complete basic capability negotiation, HR-MS authorization and key exchange, and registration.

The behavior of the forwarding HR-MS and serving HR-BS/RS during initial ranging of the new HR-MS shall be as follows.

- After transmitting NCI (i.e., in I/S-NCI messages), the forwarding HR-MS shall monitor the specified ranging opportunities for any initial-ranging attempt by new HR-MS. If no such ranging attempt is detected, the coverage extension process terminates.

- When the forwarding HR-MS detects one or more ranging codes transmitted on the allocated ranging opportunities, it shall calculate signal strength and necessary adjustments (time, power, frequency corrections). An HR-CEX-RNG-ACK message shall be transmitted to the new HR-MS.

- If resource in the uplink area has been pre-allocated by HR-BS for the forwarding HR-MS to transmit HR-CEX-RNG-ACK message, the forwarding HR-MS shall transmit an HR-CEX-RNG-ACK message to the new HR-MS, with corresponding status and adjustments (if necessary). The HR-BS shall also monitor the pre-allocated resource for the HR-CEX-RNG-ACK in order to carry out any further proactive resource allocation for the coverage extending process.

- If resource has not been pre-allocated for the forwarding HR-MS to transmit HR-CEX-RNG-ACK message, the forwarding HR-MS shall transmit an HR-CEX-RNG-REP report to the HR-BS. The HR-CEX-RNG-REP message contains signal strength and possibly necessary adjustments for the new HR-MS. The HR-BS may receive HR-CEX-RNG-REP messages from multiple scheduled forwarding HR-MS. The HR-BS is supposed to follow up with an HR-CEX-FLU message before the next allocated ranging opportunity of the coverage extending process if there is any. Otherwise, if this is the last ranging opportunity as specified in S-NCI, the HR-CEX-FLU message is supposed to be transmitted within *Tx2* Timer, where $Tx2 < Tx1$. The HR-CEX-FLU message specifies the forwarding HR-MS that shall transmit an HR-CEX-RNG-ACK message to the new HR-MS (if such a message need to be transmitted). The resource to transmit such an HR-CEX-RNG-ACK message has been pre-specified in the original HR-

CEX-CMD message, and has been made known to the new HR-MS through the S-NCI.

- After the ranging status has become Success, HR-BS shall allocate bandwidth in the uplink to allow the new HR-MS to transmit HR-CEX-RNG-REQ message. The forwarding HR-MS shall recognize this allocation IE in the A-MAP and inform the new HR-MS accordingly (using a CDMA Allocation IE). The resource allocation for HR-CEX-RNG-REQ message shall be preceded by HR-UL-RCV-IE which allocates uplink resource for the forwarding HR-MS to relay ranging, registration, capability negotiation, security exchanges from the new HR-MS to serving HR-BS.

- The HR-BS may request the forwarding HR-MS to report any ranging attempt, whether they have crossed the response threshold or not, for management purposes.

Table 1248—I-NCI IE format

Syntax	**Size (bits)**	**Notes**
BS *IDcell*	10	
Frame Configuration Index	6	The mapping between value of this index and frame configuration is listed in Table 806, Table 807, and Table 808
If (WirelessMAN-OFDMA with FDM-based UL PUSC Zone Support){		True if Frame configuration index is equal to – 5, 7, 9, 11, 13, 15, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 for 5/10 MHz channel bandwidth according to Table 806; – 4, 6, 8 or 10 for 8.75 MHz channel bandwidth according to Table 807; – 3 or 5 (with CP=1/8) for 7 MHz channel bandwidth according to Table 808. False if Frame configuration index is something else
UL_Permbase	7	Indicates UL_Permbase used in WirelessMAN-OFDMA system with FDM-based UL PUSC Zone.
Reserved	[TBD]	
}else{		
USAC	5/4/3	Indicates the number of subbands K_{SB} as defined in Table 903 to Table 905 in 16.3.7.2.1 For 2048 FFT size, 5 bits For 1024 FFT size, 4 bits For 512 FFT size, 3 bits

UFPC	4/3/3	Indicate the frequency partition configuration as defined in Table 906 to Table 908 in 16.3.7.2.3 For 2048 FFT size, 4 bits For 1024 FFT size, 3 bits For 512 FFT size, 3 bits
UFPSC	3/2/1	Indicate the number of subbands allocated to *FPi* ($i > 0$) in 16.3.7.2.3 For 2048 FFT size, 3 bits For 1024 FFT size, 2 bits For 512 FFT size, 1 bits
$UCAS_{SB0}$	5/4/3	Indicates the number of subband-based CRUs in FP0 in 16.3.7.3.1 For 2048 FFT size, 5 bits For 1024 FFT size, 4 bits For 512 FFT size, 3 bits
$UCAS_{MB0}$	5/4/3	Indicates the number of miniband-based CRUs in FP0 in 16.3.7.3.1 For 2048 FFT size, 5 bits For 1024 FFT size, 4 bits For 512 FFT size, 3 bits
Resource Index for S-NCI	[TBD]	
Reserved	[TBD]	
}		

Table 1249—S-NCI IE format

Syntax	**Size (bits)**	**Notes**
If (Support of WirelessMANOFDMA with FDM-based UL PUSC Zone){		
Subframe offset of the RCH	2	Indicates the subframe offset (O_{SF}) of the RCH allocation. The range of values is $0 \leq O_{SF} \leq 3$
Start RP code information of the RCH	4	Indicates the k_{ns}, which is the parameter for start of the RP code group (r_{ns0}). $r_{ns0}(k_{ns}) = 16 \times k_{ns} + 1$, $k_{ns} = 0,1, ...,15$
Number of RP codes allocated for coverage extension ranging	2	Indicates the number of RP codes and the particular codes that can be used for ranging with the forwarding HR-MS.
}else{		
Subframe offset of the S-RCH	2	Indicates the subframe offset (O_{SF}) of the S-RCH allocation

Start RP code information of the S-RCH		Indicates the *ks* that is the parameter controlling the start root index of the RP codes (r_{s0}). $r_{s0} = 6 \times k_s + 1$ The range of values is $0 \leq k_s \leq 15$
Transmission timing offset of SRCH	3	Indicates N_{RTO}, which is the parameter used for the calculation of the sample number, T_{RTO}, which is applied to advance the ranging signal transmission timing relative to the defined uplink transmission timing point based on the frame structure from AMS perspective when AMS conducts initial or handover ranging in a femtocell. $T_{RTO} = \text{floor}(N_{RTO} \times (T_g - 2) \times F_S)$(samples) where $N_{RTO} = min(RTD / (T_g - 2) , 7)$, and *RTD* is the round trip delay from the femto-ABS to the overlay macro-ABS. The range of values is $0 \leq N_{RTO} \leq 7$.
}		
UCASi	3/2/1	Indicates the number of total allocated CRUs, in a unit of a subband, for FP*i* ($i \geq 0$) in 16.3.7.3.1 For 2048 FFT size, 3 bits For 1024 FFT size, 2 bits For 512 FFT size, 1 bits
Forwarding EIRP	5	Unsigned integer from 1 to 31 in units of 1 dBm, where 0b00000=1 dBm and 0b11111=31 dBm.
HR-MS Transmit Power Limitation Level	5	Unsigned 5-bit integer. Specifies the maximum allowed HR-MS transmit power. Values indicate power levels in 1 dB steps starting from 0 dBm.
EIRxPIR,min	5	Unsigned integer from –133 to –102 in units of 1 dBm, where 0b00000 = –133 dBm and 0b11111 = –102 dBm.
Pre-access S-NCI Indicator	1	Indicates whether this is a pre-access S-NCI that is used for Group Discovery mode 0b0: not a pre-access S-NCI 0b1: pre-access S-NCI

17.3.7.1.2.2 Coverage Extension with Initial Ranging Preceding NCI

The procedure starts when serving HR-BS (or serving HR-RS) transmits an HR-CEX-CMD message to instruct one or a group of its directly-associated HR-MS to carry out a coverage-extending process.

Upon receiving the HR-CEX-CMD message, the scheduled HR-MS (or group of HR-MS), from now on simply referred to as forwarding HR-MS, shall start transmitting pre-access PA/SA-Preambles.

Both pre-access and post-access SA-Preamble are assigned by the serving HR-BS. The HR-BS may assign same SA-Preamble to multiple forwarding HR-MS. The HR-BS should assign pre-access SA-Preamble to groups of HR-MS based on their service characteristics. The HR-BS should assign post-access SA-Preamble ~~and NCI~~ such that they will be unique within physical proximity.

When a new HR-MS detects PA/SA-Preamble sequences transmitted by the forwarding HR-MS and decides to start initial ranging through the forwarding HR-MS, the process can be described as follows:

- The new HR-MS, after acquiring downlink synchronization and uplink transmission parameters shall pick one of the ranging codes derived from the SA-Preamble ID using a uniform random process. The HR-MS shall send the selected ranging code on the first allocated ranging channel.

- Upon receiving the ranging code from the new HR-MS, the forwarding HR-MS is supposed to respond with post-access SA-Preamble and NCI. If the new HR-MS does not receive, a post access SA-Preamble and NCI it may ramp-up the transmit power for the next ranging attempt, if necessary.

- The forwarding HR-MS responds to ranging that has exceeded a threshold determined by the HR-BS.

- If the new HR-MS detects a post-access SA-Preamble and NCI it shall pick one of the ranging codes (specified in NCI) using a uniform random process. The HR-MS shall send the selected ranging code on the first allocated ranging channel. The initial transmission power for the ranging is determined based on the last ranging prior to detection of post-access SA-Preamble and NCI.

- There are three possible ranging status responses from the forwarding HR-MS to the new HR-MS in the HR-CEX-RNG-ACK message, i.e.,
    - Continue: The forwarding HR-MS informs the new HR-MS of needed adjustments (e.g., time, power, and possibly frequency corrections) and a status notification of “continue”.
    - Success: The forwarding HR-MS informs the new HR-MS of status “success”, but may have adjustment suggestions to the new HR-MS if necessary. With status success, the forwarding HR-MS shall inform the new HR-MS of a BW allocation in the uplink for the new HR-MS to send HR-CEX-RNG-REQ message.
    - Abort: The forwarding HR-MS informs the new HR-MS to abort the current initial ranging process.

- Based on the received response of ranging status, the new HR-MS perform the following:
    - Upon receiving a Continue status notification and parameter adjustments in HR-CEX-RNG-ACK message, the new HR-MS shall adjust its parameters accordingly and continue the ranging process by randomly

select one ranging code and transmit in the next available ranging opportunity, or as instructed in the HR-CEX-RNG-ACK message.
    - Upon receiving a Success status notification, the new HR-MS shall wait for the forwarding HR-MS to inform it of a BW allocation in the UL to send HR-RNG-REQ message.
    - Upon receiving an Abort status notification, the new HR-MS shall stop the ranging process.

- HR-BS assigns and transfers a TSTID by AAI-RNG-RSP message when ranging status is success. Initial ranging process is over after receiving the HR-RNG-RSP message. The TSTID is used until STID is newly assigned and received at successful registration.

After a successful initial ranging, the forwarding HR-MS shall assist HR-BS and the new HR-MS to exchange control messages to complete basic capability negotiation, HR-MS authorization and key exchange, and registration.
The behavior of the forwarding HR-MS and serving HR-BS/RS during initial ranging of the new HR-MS shall be as follows.

- After transmitting NCI, the forwarding HR-MS shall monitor the specified ranging opportunities for any initial-ranging attempt by new HR-MS until told to stop by the HR-BS.

- When the forwarding HR-MS detects one or more ranging codes transmitted on the allocated ranging opportunities, it shall calculate signal strength and necessary adjustments (time, power, frequency corrections). An HR-CEX-RNG-ACK message shall be transmitted to the new HR-MS.

- After the ranging status has become Success, HR-BS shall allocate bandwidth in the uplink to allow the new HR-MS to transmit HR-CEX-RNG-REQ message. The forwarding HR-MS shall recognize this allocation IE in the A-MAP and inform the new HR-MS accordingly.

- The HR-BS may request the forwarding HR-MS to report any ranging attempt (whether they have crossed the response threshold or not).

17.3.7.2 Robustness against SPOF

The HR-MS may transmit/receive data to/from any one infrastructure station at any given time. The HR-MS may forward previously received data to other infrastructure stations at other times.

17.3.7.2.1 Preparation for SPOF

In order to support preparation for SPOF, alternative path described in this subsection shall be supported.

An alternative path may include HR-MS that switches mode to RS or BS.

Network entry including handover as described in 16.2.6 and 16.2.8.2.9 shall be supported in the event of SPOF. An indication of whether MAC context information of the subordinate HR-MS is being shared by infrastructure stations shall be transmitted to HR-MS.

HR-MSs capable of forwarding to the network and/or multimode operation shall share the MAC context information with the HR-MS performing local forwarding to the network.

If necessary, another path can be selected, if available, among alternative paths.

17.3.7.2.2 Preparation for SPOF with fast network reentry

To support switching to alternative path with fast network reentry, the serving HR-BS transmits AAI-HO-CMD message with mode = 0b11, HO Reentry Mode = 0b0 and CDMA_RNG_FLAG = 1 to the HR-MS.

The target HR-BS of the alternative path can request MS context information from the serving HR-BS and recommend a ranging code and slot from the ranging region to facilitate fast network reentry and reduce contention during ranging. However, how to request and recommend is out of this specification. The serving HR-BS may indicate to the HR-RS that an optimized network reentry should be carried out by setting “Reentry process optimization” bitmap in the AAI-HO-CMD message.

The alternative path information may be updated with a new AAI-HO-CMD message.

When the trigger condition specified in the TLV of the last AAI-HO-CMD is met, the alternative path is activated and fast network reentry is performed by an HR-MS. If the action time is non-zero, the HR-MS shall perform the fast network reentry after the action time expires.

17.3.7.2.3 Recovery from SPOF

Network reentry including handover as described in 16.2.6 and 16.2.8.2.9 shall be supported in the event of SPOF. Whether MAC context information of the subordinate HR-MS is shared by the infrastructure stations shall be transmitted to HR-MS.

If role change was indicated in AAI-HO-CMD, subordinate HR-MS shall establish relay link described in 17.3.1.2.1 after fast network reentry as described in 17.3.7.2.2. This is to support other HR-MS which are affected by the SPOF.

Alternative path may be selected during the role change or release the mode as described in 17.3.1.

17.3.7.3 Preparation for Alternative path to support fast network reentry to the neighbor HR-MS

HR-MSs capable of forwarding to the network and/or multimode operation shall share the MAC context information with the HR-MS performing local forwarding to the network.

To support fast network reentry to the neighbor HR-MSs, either HR-BS or HR-MS may prepare the alternative path.
To prepare the alternative path by an HR-BS, the HR-BS shall perform operation as follows:

a) neighbor discovery as described in 17.3.7.1.1
b) collecting HR-MS' neighbor information as described in 17.3.7.1.1
c) determines the alternative path for HR-MS
d) informs HR-MS about its alternative path information

To prepare the alternative path by an HR-MS, following operation shall be performed by HR-MS and HR-BS:

a) An HR-MS transmit AP-NBR-REQ to the HR-BS to initiate the neighbor discovery process
b) HR-BS received AP-NBR-REQ, performs the neighbor discovery as described in 17.3.7.1.1
c) HR-BS collects the neighbor information of requesting HR-MS as described in 17.3.7.1.1
d) HR-BS transmits AP-NBR-REP message to HR-MS which includes the neighbor information of requesting HR-MS
e) HR-MS determines alternative path by itself based on its received neighbor information, but how to determine is out of scope of this specification

17.3.8 Priority Access Operation

17.3.9 Multicast support

Each HR-BS capable of providing multicast communication belongs to a certain multicast group zone. A multicast zone defined as a set of HR-BSs where the same Multicast Group ID and FID is used for transmitting the content of certain service flow(s).

An HR-BS may provide the HR-MS with multicast content locally within its coverage and independently of other HR-BSs. The single HR-BS provision of multicast is therefore a configuration where a Multicast Zone is configured to consist of a single HR-BS only. In this case, the HR-BS uses any Multicast Group ID and FID for providing multicast service, independently of other HR-BSs, so the HR-MS received the multicast data from its serving HR-BS, and the HR-MS should not expect the service flow for this multicast connection to continue when the HR-MS leaves the serving HR-BS' coverage. However, if the HR-MS moves to an HR-BS that is transmitting the same multicast flow

in another HR Multicast Group Zone, HR-MS may update its service flow management encodings to continue to receive the same multicast flows.

To ensure proper multicast operation on networks of HR-BS employing multicast, the Multicast Group IDs and FIDs used for common multicast content and service shall be the same for all HR-BSs within the same HR Multicast Group Zone. This allows the HR-MS which has already registered with a service to be seamlessly synchronized with multicast transmissions within an HR Multicast Group Zone without communicating in the UL or re-registering with other HR-BS within that HR Multicast Group Zone.

The Multicast Group Zone identifier shall not be "0."
When the Multicast Group Zone identifier appears in AAI-NBR-ADV message with only one value of "0," then the neighbor BS is not affiliated with any Multicast zone. An Multicast zone that is adjacent to another Multicast zone is a neighbor multicast zone to that multicast zone.

17.3.9.1 Multicast communication operation

An HR-BS establishes a DL multicast service by creating a multicast connection with each HR-MS to be associated with the service. Multicast service flows are not dedicated to the specific HR-MS and are maintained even though the HR-MS is either connected state or idle state. When an HR-MS is registered at an HR-BS for receiving multicast service, multicast service flows shall be instantiated as multicast connections. An HR-MS regardless of what mode the HR-MS is currently in may receive data of multicast service flows transmitted from HR-BS. Any available FID is used for the multicast service (i.e., there are no dedicated FIDs for multicast transport connections). To ensure proper multicast operation, the Multicast Group ID and FID used for the service shall be the same for all HR-MSs on the same channel that participate in the connection in a multicast zone. Mapping of multicast service flows to corresponding Multicast Group IDs and FIDs shall be known and be the same for all HR-BSs belonging to the same HR Multicast Group Zone.

17.3.9.1.1 Multicast communication establishment

The procedure of multicast communication establishment includes capacity exchange, establishment multicast connection, transmission and receiving the HR-multicast control channel as shown in Figure 920. The procedure includes

- Capacity exchange using AAI-REG-REQ/RSP
- DSx procedure containing relevant multicast parameter to establish multicast connection
- Transmission and receiving the HR multicast control channel

To discover multicast service, HR-MS will inform HR-BS of support of multicast transmission by AAI-REG-REQ message and the HR-BS will indicate if it supports

multicast for that HR-MS through AAI-REG-RSP message. The basic multicast capability exchange in AAI_REG-REQ/RSP message is described in 16.2.3.8 and 16.2.3.9.

When an HR-MS registers to receive multicast services, the serving HR-BS or the HR-MS may initiate the DSA procedure for multicast connections. The HR-MS's discovery and registration of multicast services with the HR-BS through upper layer signaling are outside the scope of this standard.

The AAI-DSA, AAI-DSC and AAI-DSD messages are used to establish, change, and delete multicast service flows respectively. The HR-BS shall send the AAI-DSA-REQ/RSP to the HR-MS with the relevant multicast parameters including Multicast Group ID.

To receive multicast data, an HR-MS receives the multicast allocation information in the multicast control channel (i.e., multicast assignment MAP).

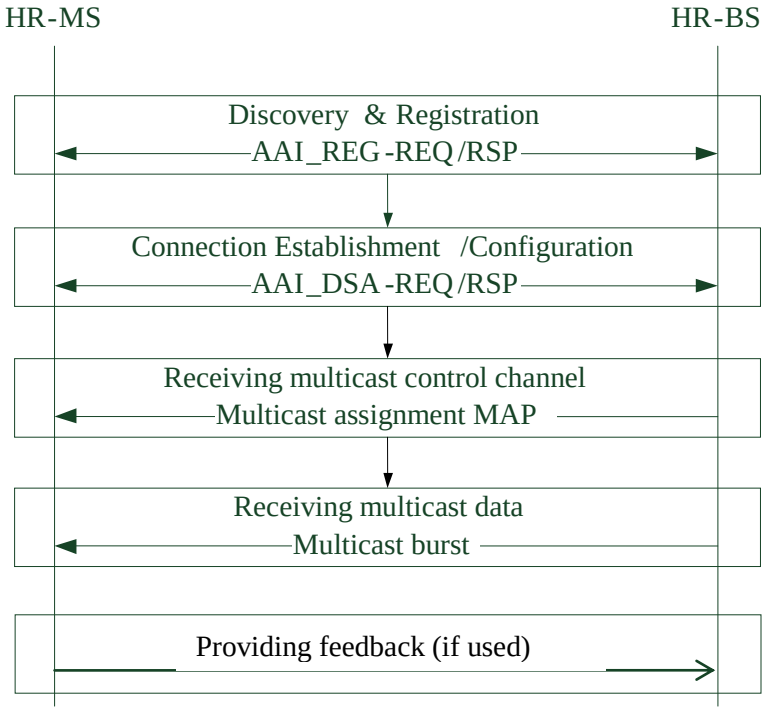


Figure 920—Procedure of multicast communication establishment

17.3.9.1.2 Multicast communication operation in connected state

When an HR-MS moves across Multicast zone boundaries in Active Mode or Sleep Mode, the HR-MS performs the handover procedure as described in 16.2.6.3.

When the HR-MS transits to a new Multicast Zone while in Active Mode or Sleep Mode, the HR-MS shall send AAI-RNG-REQ message described in 16.2.3.1 with Ranging Purpose Indication = 0b1110 at the target HR-BS. In response to the request for multicast service flow update, the HR-BS shall transmit AAI-RNG-RSP message described in 16.2.3.2, which may include Multicast Group Zone Identifier, Multicast Group ID, FID Update, and feedback parameters if used, to provide updated service flow management encodings for any affected multicast flow(s) as part of the handover procedure.

17.3.9.1.3 Multicast communication operation in idle state

When an HR-MS in Idle state moves to an HR-BS which does not belong to HR-MS' previous Multicast Group Zone, the HR-MS is expected to update the multicast service flow management encodings at that HR-BS to provide continuous reception of multicast content. The HR-MS may obtain the multicast information in the target Multicast zone through broadcast messages in the Multicast Zone of the service HR-BS. If the idle HR-MS has not received such information from the serving Multicast Zone, the HR-MS shall use location update procedure to acquire updated multicast service flow management encodings. In order to perform the multicast location update process, the HR-MS shall transmit AAI-RNG-REQ message with Ranging Purpose Indication = 0b1110. In response to the request for multicast location update, the HR-BS shall transmit AAI-RNG-RSP message which may include the Multicast Group Zone identifier, Multicast Group ID, and FID and feedback parameters if used to provide update service flow management encodings for any affected multicast flow(s).

17.3.9.2 Multicast protocol features and functions

17.3.9.2.1 Downlink control channel for multicast communication

HR-multicast control channel (i.e., HR-Multicast DL Assignment A-MAP IE) carries configuration information (including allocation/change/release) for multicast communication for one multicast zone in an HR-BS. In HR-Multicast DL Assignment A-MAP, allocation period indicates a period of persistent allocation of multicast resource and Lifetime is a timer indicating the next instance of HR-Multicast DL-Assignment A-MAP IE. Unless the Lifetime expires, this HR-Multicast DL Assignment A-MAP does not change during the allocation duration. At the time the Lifetime expires, the HR-Multicast DL Assignment A-MAP shall change or release the allocation.

Table 1250—HR-Multicast DL Assignment A-MAP IE*

Syntax	Size (bit)	Description/Notes
HR-Multicast_DL_Assignment_A-MAP_IE() {		

A-MAP IE Type	4	HR-Multicast DL Assignment A-MAP IE
Allocation period	2	Period of persistent allocation of multicast resource. If (Allocation Period==0b00), it indicates the deallocation of persistent resource. 0b00: deallocation 0b01: 2 frames 0b10: 4 frames 0b11: 6 frames
If (Allocation Period == 0b00) {		
Resource Index	11	5 MHz: 0 in first 2 MSB bits + 9 bits for resource index 10 MHz: 11 bits for resource index 20 MHz: 11 bits for resource index Resource index includes location and allocation size.
Long TTI Indicator	1	Indicates number for AAI subframes spanned by the allocated resource. 0b0: 1 AAI subframe (default TTI) 0b1: 4 DL AAI subframe for FDD or all DL AAI subframes for TDD (long TTI)
Reserved	22	
} else if(Allocation Period != 0b00) {		
Isizeoffset	5	Offset used to compute burst size index
MEF	2	MIMO encoder format 0b00: SFBC 0b01: Vertical encoding 0b10: Multi-layer encoding 0b11: CDR
If (MEF ==0b01) {		Parameter for vertical encoding
M_t	3	Number of streams in transmission $M_t <= N_t$ N_t: Number of transmit antennas at the HR-BS 0b000: 1 stream 0b001: 2streams 0b010: 3streams 0b011: 4streams 0b100: 5streams

		0b101: 6streams 0b110: 7streams 0b111: 8streams
Reserved	1	
} else if (MEF == 0b10) {		Parameters for multi-layer encoding
Si	4	Index to identify the combination of the number of streams and the allocated pilot stream index in a transmission with MU-MIMO, and the modulation constellation of paired user in the case of 2 stream transmission 0b0000: 2 streams with PSI=stream1 and other modulation = QPSK 0b0001: 2 streams with PSI=stream1 and other modulation = 16QAM 0b0010: 2 streams with PSI=stream1 and other modulation = 64QAM 0b0011: 2 streams with PSI=stream1 and other modulation information not available 0b0100: 2 streams with PSI=stream2 and other modulation =QPSK 0b0101: 2 streams with PSI=stream2 and other modulation =16QAM 0b0110: 2 streams with PSI=stream2 and other modulation =64QAM 0b0111: 2 streams with PSI=stream2 and other modulation information not available 0b1000: 3 streams with PSI=stream1 0b1001: 3 streams with PSI=stream2 0b1010: 3 streams with PSI=stream3 0b1011: 4 streams with PSI=stream1 0b1100: 4 streams with PSI=stream2 0b1101: 4 streams with PSI=stream3 0b1110: 4 streams with PSI=stream4 0b1111: n/a
}		
Resource Index	11	5 MHz: 0 in first 2 MSB bits + 9 bits for resource index 10 MHz: 11 bits for resource index 20 MHz: 11 bits for resource index Resource index includes location and allocation size.
Long TTI Indicator	1	Indicates number for AAI subframes

		spanned by the allocated resource. 0b0: 1 AAI subframe (default TTI) 0b1: 4 DL AAI subframe for FDD or all DL AAI subframes for TDD (long TTI)
Lifetime(L)	4	Indicates the time to transmit next HR-Multicast DL Assignment A-MAP and the information of this HR-Multicast DL Assignment A-MAP does not change during the allocation duration. The next HR-Multicast DL Assignment A-MAP is at the superframe whose superframe number, Nsuperframe, satisfies the following condition. Nsuperframe modulo L+1 = 0
Reserved	7	
}		
}		

*A 16bit CRC is generated based on the randomized contents of the HR-Multicast DL Assignment A-MAP IE. The CRC is masked by the 16-bit CRC mask (with masking prefix = 0b0 and message type indicator = 0b010) generated according to Table 849 as describe in 16.3.5.5.2.4.

17.3.9.2.2 Feedback operation for multicast

To ensure robust multicast and provide the network operator with specific or statistical information of its reception a feedback operation is defined between an HR-MS that is an addressee of a multicast transmission and its serving HR-BS or HR-RS.

The conditions for providing feedback are defined by the network per each multicast channel and include positive feedback only (logical ACK), negative feedback only (logical NAK) or both (logical ACK/NAK). It is expected that all intended recipients of a multicast channel obey the same rules but those can be changed by the network. UL resources for the feedback are also provided by the HR-BS. Feedback parameters may be unicast or multicast.

Feedback operation is supported by multicast addressees in connected as well as in idle states.

The procedure for providing the feedback is TBD**.**

17.3.9.3 Multicast key management

Multicast key is managed as described in 17.3.10.2.

17.3.10 Security

17.3.10.1 Security Procedure for Direct Communication Data Security

17.3.10.1.1 Security Procedure for BS-coordinated Secure Direct Communication

Refer to Section 17.2.10.1.1.

17.3.10.1.1.x Security Context for BS-coordinated Secure Direct Communication

Refer to Section 17.2.10.1.1.x

17.3.10.1.1.y Key Derivation for BS-coordinated Secure Direct Communication

Refer to Section 17.2.10.1.1.y

17.3.10.1.2 Security Procedure for Secure talk-around Direct Communication

Refer to Section 17.2.10.1.2.

17.3.10.2 Security Procedure for Multicast Operation

PKMv3 as described in 16.2.5.2 provides HR-stations with strong protection from theft of service by encrypting connections between HR-MSs and HR-BSs.

PKMv3 also shall provide HR-stations with strong protection from theft of service by encrypting multicast connections between HR-MSs and HR-BSs, as defined in this subsection.

If a DL multicast connection is to be encrypted, each HR-MS participating in the connection shall have an additional security association (SA) (i.e., multicast SA), allowing that connection to be encrypted using keys that are independent of those used for other encrypted transmissions between HR-MSs and the HR-BS.

Similar to unicast key management, multicast traffic can be encrypted using multicast specific key management based on PMKv3 as described in Figure 921. Multicast CMAC (MCMAC) key and Multicast TEK (MTEK) are derived from Multicast AK (MAK). MAK is a pre-established shared key among an HR-BS and a group of HR-MSs in an HR multicast group.

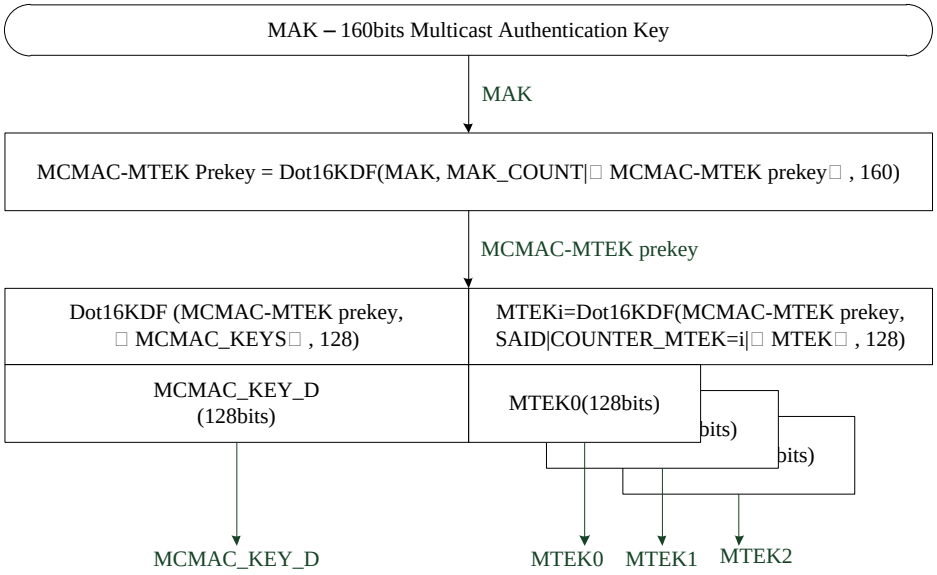


Figure 921—MCMAC Key and MTEK derivation from MAK

Shared security association (i.e., Multicast Security Association; MSA) is an SA for the multicast transport/control flow and it provides keying material. Security key related to parameter to support multicast and the context is secured till the key expires.

17.3.10.2.1 Security context for multicast communication

The multicast security context is a set of parameters linked to a key in each hierarchy that defines the scope while the key usage is considered to be secure.

Examples of these parameters are key lifetime and counters ensuring the same encryption will not be used more than once. When the context of the key expires, a new key should be obtained to continue working. The purpose of this sub clause is to define the context that belongs to each key, how it is obtained and the scope of its usage.

17.3.10.2.1.1 MAK context

The MAK context includes all parameters associated with the MAK. This context is created whenever a new MAK is derived.

This context shall be deleted whenever the MAK is no longer valid or used.

The MAK context is described in Table 1251.

Table 1251—The MAK context

Parameter	Size (bit)	Usage
MAK	160	Shared by HR-MSs in a multicast group
MAK Lifetime	32	MAK Lifetime
MAKID	64	Identifies the authorization key.
MAK_COUNT	16	A value used to derive the MCMAC key and MTEK

MCMAC_KEY_D	128	The key which is used for signing DL MAC control messages.
MCMAC_PN_D	24	Used to avoid DL replay attack on the control connection before this expires, reauthorization is needed. The initial value of MCMAC_PN_D is zero and the value of MCMAC_PN_D is reset to zero whenever MAK_COUNT is increased.
Next available counter_MTEK	16	The counter value to be used in next MTEK derivation, after derivation this is increased by 1.

17.3.10.2.1.2 MSA context

The MSA context is the set of parameters managed by each MSA in order to ensure MTEK management and usage in secure way.

The MSA context holds MTEK context and additional information that belongs to the MSA itself.

17.3.10.2.1.2.1MTEK context

The MTEK context includes all relevant parameters of a single MTEK and is described in Table 1252.

Table 1252—The MTEK context

Parameter	Size (bit)	Usage
MTEK	128	Key used for encryption or decryption of MAC PDUs from FIDs associated with the corresponding MSA
MEKS	2	Encryption key sequence number
COUNTER_MTEK	16	The counter value used to derive this MTEK
MTEK lifetime	32	MTEK lifetime
MTEK_PN_D	22	The PN used for encrypting DL packets. After each MAC PDU transmission, the value shall be increased by 1. (0x000000-0x1FFFFF)
PN Window Size	As negotiated in key agreement	The receiver shall track the PNs received inside PN window

17.3.10.2.1.2.2 MSA context

The MSA context is described in Table 1253.

Table 1253—The MSA context

Parameter	Size (bit)	Usage
MSAID	8	The identifier of this MSA, which describes the

		applied en/ decryption method and MTEK contexts.
$MTEK_{DLE}$ context	Sizeof(MTEK Context)	MTEK context used for downlink encryption and decryption.

17.3.11 Self-Coexistence

17.3.11.1 Self-coexistence cycle

TBD

17.3.11.2 Frame structure

A self-coexistence zone can be allocated in a frame for transmission preamble and self-coexistence beacons for self-coexistence of multiple HR networks overlapped in coverage and have to operate on the same frequency channel.

The structure of self-coexistence zone in WirelessMAN HR Advanced networks is TBD.

17.3.11.3 Operation modes

See 17.2.11.3

17.3.11.4 Self-coexistence Beacon Protocol (SCBP)

TBD

17.3.11.5 Mechanism for self-coexistence of multiple HR cells

TBD