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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.

51 **3.156 HR-station:** An HR-MS, HR-BS, or HR-RS.

52 **3.157 Infrastructure station:** An HR-BS or HR-RS.

53 **3.158 Directly Associated:** An HR-MS is directly associated with an infrastructure  
 54 station if it is effectively controlled directly by it.

55 **3.159 Indirectly Associated:** An HR-MS is indirectly associated with an infrastructure  
 56 station if it is effectively controlled by it through a forwarding HR-MS.

57 **3.160 Coexistence:** Coexistence is a state by which multiple wireless communications  
 58 systems in same vicinity share a same radio frequency channel while minimizing harmful  
 59 interference to each other by appropriate measures.

60 **3.161 Self-coexistence:** In HR network, self-coexistence is coexistence of multiple HR  
 61 cells.

62 **3.162 Self-coexistence mode:** Self-coexistence mode is an operation mode of HR  
 63 network, in which multiple HR cells share the same frequency channel in time.

64

#### 65 **4. Abbreviations and acronyms**

66 *[Insert the following abbreviations:]*

67

68 HR High Reliability

69 PPDR Public Protection and Disaster Relief

70 SPOF Single Point of Failure

71

#### 72 **5. Service Specific CS**

73

#### 74 **6. MAC common part sublayer**

#### 75 **7. Security sublayer**

76

#### 77 **8. Physical layer (PHY)**

78 8.4 WirelessMAN-OFDMA PHY

79 8.4.1 Introduction

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

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

83

84

85 8.4.3 OFDMA basic terms definition

86

## 87 8.4.3.1 Slot and data region

88

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

90

91 — For DL PUSC (defined in 8.4.6.1.2.1), one slot is one subchannel by two OFDMA  
92 symbols. For VHF mode DL PUSC, one slot is one subchannel by four OFDMA  
93 symbols.

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

98

## 99 8.4.4.3 OFDMA Frame Parameters and Operations

100

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

102

103 In VHF mode, subcarrier allocation scheme of PUSC (defined in 8.4.6.1.2.1.1 and  
104 8.4.6.2.2) is used for both UL and DL and duplex method is TDD, and MIMO, STC  
105 scheme are not used.

106

## 107 8.4.4.4 DL frame prefix

108

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

110

111 For VHF mode, CC encoding used on DL-MAP is selected as “Coding Indication” from  
112 DL frame prefix format shown in Table 314. The FFT size of 1024 is selected from Table  
113 315.

114

115

## 116 8.4.6 OFDMA subcarrier allocations

117

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

119

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

123

124

## 125 8.4.6.1.2.1 Symbol structure for PUSC

126

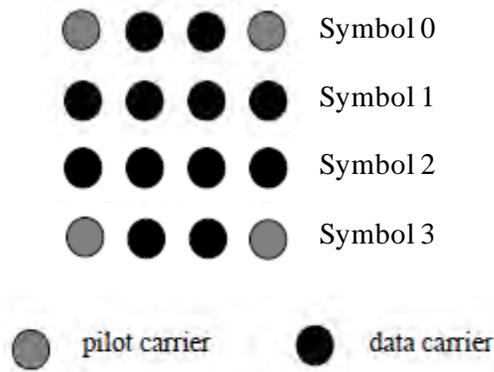
127 *[Insert the following text at the end of Section 8.4.6.1.2.1:]*

128

129 For VHF mode, the symbol is first divided into basic tiles (as defined in Figure 247a) and  
130 zero carriers are allocated. Pilots and data carriers are allocated within each tile. Table  
131 442a summaries the parameters of the symbol structure under this PHY mode.

132

133 A slot in the DL of VHF mode is composed of **four (4)** OFDMA symbols and one  
 134 subchannel. Within each slot, there are **48** data subcarriers and **16** fixed-location pilots as  
 135 shown in Table 247a. The subchannel is constructed from **four(4)** DL tiles. Each tile has  
 136 four successive active subcarriers, and its configuration is illustrated in Figure 247a.

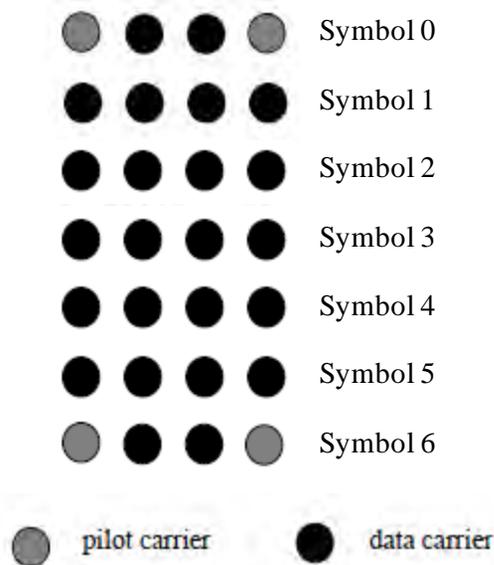


137 **Figure 247a—Description of a DL tile in VHF Mode**

138  
 139  
 140  
 141 8.4.6.2.1 Symbol structure for subchannel (PUSC)

142  
 143 *[Insert the following text at the end of Section 8.4.6.2.1:]*

144  
 145 For VHF mode, a slot in the UL is composed of **seven (7)** OFDMA symbols and one  
 146 subchannel. Within each slot, there are **48** data subcarriers and **8** fixed-location pilots as  
 147 shown in Table 249a. The subchannel is constructed from **two(2)** UL tiles. Each tile has  
 148 four successive active subcarriers, and its configuration is illustrated in Figure 249a.  
 149



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

154 8.4.9.3 Interleaving

155 *[Insert the following text at Section 8.4.9.3 on Page 1061 before the last 2nd*  
 156 *paragraph:]*  
 157

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

160

161 **10. Parameters and constants**

162 **11. TLV encodings**

163 **16. WirelessMAN-Advanced Air Interface**

164 **16.1 Introduction**

165 **16.2 Medium access control**

166 **16.2.1 Addressing**

167 **16.2.1.3 Addressing to support machine to machine application**

168 **16.2.2 MAC PDU formats**

169 **16.2.3 MAC Control messages**

170

171 *[Change Table 677 as indicated (renumbering may be required):]*

172

Table 677 – MAC control messages

<u>No.</u>	<u>Functional Areas</u>	<u>Message names</u>	<u>Message description</u>	<u>Security</u>	<u>Connection</u>
<u>71</u>	<u>Backbone Enable</u>	<u>BBE-REQ</u>	<u>Backbone Enable Request</u>		<u>Unicast</u>
<u>72</u>	<u>Backbone Enable</u>	<u>BBE-RSP</u>	<u>Backbone Enable Response</u>		<u>Unicast</u>
<u>73</u>	<u>Backbone Disable</u>	<u>BBD-REQ</u>	<u>Backbone Disable Request</u>		<u>Unicast</u>
<u>74</u>	<u>Backbone Disable</u>	<u>BBD-RSP</u>	<u>Backbone Disable Response</u>		<u>Unicast</u>
<u>75</u>	<u>Backbone Enable</u>	<u>BBE-CMD</u>	<u>Backbone Enable Command</u>		<u>Broadcast</u>
<u>76</u>	<u>Backbone Disable</u>	<u>BBD-CMD</u>	<u>Backbone Disable Command</u>		<u>Broadcast</u>

173

174

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

176 [16.2.3.64 BBE-REQ](#)

177 [An HR-BS transmits a BBE-REQ message to notify HR-MSs of backbone connection](#)  
 178 [availability on unicast control connection.](#)

179

180 [16.2.3.65 BBE-RSP](#)

181 [An HR-MS transmits a BBE-RSP message in response to a received BBE-REQ.](#)

182

183 [16.2.3.66 BBD-REQ](#)

184 [An HR-BS transmits a BBD-REQ message to notify HR-MSs of backbone connection](#)  
 185 [unavailability on unicast control connection.](#)

186

187 [16.2.3.67 BBD-RSP](#)

188 [An HR-MS transmits a BBD-RSP message in response to a received BBD-REQ.](#)

189

190 [16.2.3.68 BBE-CMD](#)

191 [An HR-BS transmits a BBE-CMD message to broadcast backbone connection](#)  
 192 [availability.](#)

193

194 [16.2.3.69 BBD-CMD](#)

195 [An HR-BS transmits a BBD-CMD message to broadcast backbone connection](#)  
 196 [unavailability.](#)

197

198 ***[Change Table 678 in section 16.2.3.1 as indicated:]***

199

200 **Table 678.—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 <del>0b1110-0b1111 = reserved</del> <a href="#">0b1110 = HR multicast service flow update</a> <a href="#">0b1111 = reserved</a>	
...	...	...	...

201

202

203

204 **16.2.4 Construction and Transmission of MAC PDUs**205 **16.2.5 AAI Security**206 **16.2.5.5 Security mechanisms for machine to machine application**207 **16.2.6 MAC HO procedures**208 **16.2.7 Persistent Scheduling in the Advanced Air Interface**209 **16.2.8 Multicarrier operation**210 **16.2.9 Group Resource Allocation**211 **16.2.10 Connection Management**212 **16.2.11 Bandwidth Request and Allocation Mechanism**213 **16.2.12 Quality of Service (QoS)**214 **16.2.13 ARQ mechanism**215 **16.2.14 HARQ functions**216 **16.2.15 Network entry and initialization**217 **16.2.15.7 Network entry and initialization for machine to machine operation**218 **16.2.16 Periodic ranging**219 **16.2.17 Sleep mode**220 **16.2.18 Idle mode**221 **16.2.19 Deregistration with context retention (DCR) mode**222 **16.2.20 Co-located coexistence (CLC)**223 **16.2.21 Interference mitigation mechanism**224 **16.2.22 MAC control reliability**225 **16.2.23 Power management for active mode**226 **16.2.24 Update of S-SFH IEs**227 **16.2.25 Short Message Service**

228 **16.2.25.1 Small burst transmission for machine to machine application**

229 **16.2.26 Coverage Loss Detection and Recovery from Coverage Loss**

230 **16.2.27 AMS deregistration**

231 **16.2.28 Support for Multicast Service**

232 **16.2.28.4 Multicast operation for machine to machine application**

233 **16.2.29 MAC Support for M2M Application**

234 **16.2.29.1 Introduction**

235 **16.2.29.2 Addressing**

236 **16.2.29.3 Security**

237 **16.2.29.4 Network (Re-)entry**

238 **16.2.29.5 Idle Mode**

239 **16.2.29.6 Support of Multicast Service**

240 **16.2.29.7 Support of M2M short packet transmission**

241 **16.2.29.8 Group Resource Allocation**

242 **16.2.29.9 Device Collaboration**

243 **16.3 Physical layer**

244

245

246 *[Change section 16.3.5.5.2.4 as indicated:]*

247 **16.3.5.5.2.4 Assignment A-MAP IE**

248 Table 842 describes Assignment A-MAP IE Types.

249

250 Table 842 – Assignment A-MAP IE Types

<b>A-MAP IE Type</b>	<b>Usage</b>	<b>Property</b>
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-	Unicast

	MAP IE	
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	<del>Reserved</del> <a href="#">HR-Multicast DL Assignment A-MAP IE</a>	<del>NA.</del> <a href="#">Multicast</a>
0b1110	Reserved	NA.
0b1111	Extended Assignment A-MAP IE	NA.

251

252 **CRC Mask**

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

255 The 16-bit masked CRC is constructed using a 1 bit masking prefix, a 3 bit message  
 256 type indicator, and 12 bit Masking Code as described in Table 843.

257

Table 843 – Description of CRC Mask

Masking Prefix (1 bit MSB)	Remaining 15 bit LSBs	
0b0	<i>Type Indicator</i>	<i>Masking Code</i>
	0b000	12 bit STID or TSTID
	0b001	Refer to Table 844
	0b010	Refer to Table 845
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)	

258

259 .....

260

261

Table 845 – Description of Masking Code for type indicator 010

Decimal Value	Description
4095	Used to mask Broadcast A-MAP IE for multicast assignment
Others	<del>Reserved</del> <a href="#">12 bit MGID is used to make HR-Multicast DL Assignment A-MAP IE for high reliable multicast assignment</a>

262	
263	
264	
265	
266	
267	<b>16.3.11 Global Values</b>
268	<b>16.4 Support for Femto ABS</b>
269	<b>16.4.1 General description</b>
270	<b>16.4.2 Femto base station subscription types</b>
271	<b>16.4.3 Femto ABS state diagram</b>
272	<b>16.4.4 PHY and MAC level identifier</b>
273	<b>16.4.4.1 PHY level cell identifier</b>
274	<b>16.4.4.2 CSG white list</b>
275	<b>16.4.5 Femto ABS initialization and de-attachment</b>
276	<b>16.4.6 Network synchronization</b>
277	<b>16.4.7 Network entry</b>
278	<b>16.4.8 Handover (HO)</b>
279	<b>16.4.9 Idle mode</b>
280	<b>16.4.10 Low-duty operation mode</b>
281	<b>16.4.11 Interference avoidance and interference mitigation</b>
282	<b>16.4.12 Power control</b>
283	<b>16.4.13 Femto ABS reliability</b>
284	<b>16.5 Multi-BS MIMO</b>
285	<b>16.6 Support for Relay</b>
286	<b>16.6.1 Relay Modes and General Description</b>
287	<b>16.6.2 Medium access control</b>
288	<b>16.6.2.1 Addressing</b>
289	<b>16.6.2.2 MAC PDU Formats</b>
290	<b>16.6.2.3 Construction and Transmission of MPDUs</b>
291	<b>16.6.2.4 Security</b>
292	<b>16.6.2.5 Handover</b>
293	<b>16.6.2.6 Scheduling and QoS</b>
294	<b>16.6.2.7 Bandwidth Request and Grant Management</b>
295	<b>16.6.2.8 ARQ</b>
296	<b>16.6.2.9 HARQ</b>
297	<b>16.6.2.10 Network Entry</b>

298	<b>16.6.2.11 Ranging</b>
299	<b>16.6.2.12 Sleep Mode</b>
300	<b>16.6.2.13 Idle Mode</b>
301	<b>16.6.2.14 ARS Configuration</b>
302	<b>16.6.2.15 ARS De-registration</b>
303	<b>16.6.2.16 Update of SFH</b>
304	<b>16.6.3 Physical Layer for TTR relay mode</b>
305	<b>16.6.3.1 Basic frame structure supporting ARS</b>
306	<b>16.6.3.2 Frame structure</b>
307	<b>16.6.3.3 Relay Downlink PHY Structure</b>
308	<b>16.6.3.4 Downlink Control Structure</b>
309	<b>16.6.3.5 Relay Uplink physical structure</b>
310	<b>16.6.3.6 Uplink Control Structure</b>
311	<b>16.6.4 Physical Layer for STR relay mode</b>
312	<b>16.7 Support for Self-organization</b>
313	<b>16.8 Support for Location Based Services (LBS)</b>
314	<b>16.9 Support for Enhanced Multicast Broadcast Service</b>
315	<b>16.10 Support for Advanced Air Interface in LZone</b>
316	<b>16.10.11 Global Values</b>
317	
318	

319 *[Insert the following clause:]*

320

## 321 **17. WirelessMAN-High Reliability Network**

### 322 **17.1 Overview**

#### 323 **17.1.1 Operating frequencies**

#### 324 **17.1.2 Operating bandwidths**

#### 325 **17.1.3 Duplex**

#### 326 **17.1.4 Backward compatibility**

### 327 **17.2 WirelessMAN HR-OFDMA air interface**

#### 328 **17.2.1 Multi-mode operation**

##### 329 **17.2.1.1 Relay function for HR-BS**

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

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

333

##### 334 **17.2.1.1.1 STR mode for HR-BS acting as HR-RS**

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

336 The procedures for RS mode change consist of following activities:

- 337 a) establish a relay link with a serving HR-BS
- 338 b) if necessary, inform some subordinate stations to perform handover
- 339 c) if necessary, reconfigure the physical frame and commence operation in relay mode

340

##### 341 **17.2.1.1.2 TTR mode for HR-BS acting as HR-RS**

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

344 The procedures for RS mode change consist of following activities:

- 345 a) establish a relay link with a serving HR-BS
- 346 b) if necessary, inform some subordinate stations to perform handover
- 347 c) if necessary, reconfigure the physical frame and commence operation in relay mode

348

349

##### 350 **17.2.1.2 Relay function for HR-MS**

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

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

357 If the HR-MS release its role from the relay mode, HR-MS may perform handover to the  
 358 any infrastructure station.

359

### 360 **17.2.1.3 Base station function for HR-MS**

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

365 While operating as an HR-BS, the station may maintain certain HR-MS functionalities. A  
 366 mode switch to HR-BS may be initiated by the HR-MS itself or may be directed by the  
 367 superordinate HR-BS of the HR-MS.

368

## 369 **17.2.2 Direct communication between HR-MSs**

370

### 371 **17.2.2.1 General Description**

372

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

377

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

383

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

386

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

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

397 defined in 17.2.2.5.

- 398 - A coordinator shall function as a simplified HR-BS except it may not support  
 399 handover. How to select a coordinator among HR-MSs shall follow the operation  
 400 described in TBD.
- 401 - A coordinator supports the following topologies:
- 402 1. HR-MS linked to the coordinator and the pair is the source and sink of  
 403 data. This topology is implemented through the local source and sink  
 404 capability of the HR-MS.
  - 405 2. Two HR-MS linked to the coordinator and the two HR-MS are the source  
 406 and sink of data. This topology is implemented through the local  
 407 forwarding capability of the HR-BS.
  - 408 3. A forwarding HR-MS forwards data of a forwarded HR-MS to the  
 409 coordinator. This topology is implemented through the HR-BS capability  
 410 to support HR-MS forwarding operation.
  - 411 4. Two HR-MS are linked (DC) and are the source and sink of data to each  
 412 other under the control of the coordinator. This topology is implemented  
 413 through the HR-BS ability to support DC between its subordinates.
- 414 - The coordinator and any HR-MS that are communicating through the coordinator  
 415 shall continue cell search operation and shall cease DC operation as soon as the  
 416 criteria for DC and prevention of interference above are not met.

417

#### 418 **17.2.2.2 Frame Structure and Resource Allocation**

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

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

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

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

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

### 439 **17.2.2.3 Synchronization**

440 Synchronization between HR-MSs is classified into two levels:

- 441 - The frame-level (first level) should allow HR-MSs to share a common understanding  
 442 of frame and/or superframe timing and configuration.
- 443 - The symbol-level (second level) should allow reliable (i.e. received within cyclic  
 444 prefix) bi-directional transmissions between HR-MSs.

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

446

#### 447 **17.2.2.3.1 Use case 1: Both HR-MSs are within the coverage of HR-BS/RS**

- 448 - The first level of synchronization shall be maintained by common DL signaling (i.e.  
 449 preambles, FCH, MAP...) from HR-BS/RS.
- 450 - The second level of synchronization can be achieved by HR-MSs exchanging ranging  
 451 signals.

452

453 The following synchronization mechanisms are specifically designed for the case when  
 454 HR-MS DC and FTN are scheduled in UL area of a frame.

455 *Frame-level Synchronization:*

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

462 *Symbol-level Synchronization:*

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

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

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

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

479

480 **17.2.2.3.2 Use case 2: one HR-MS is inside and the other is outside the coverage of**  
481 **HR-BS/RS**

482 - The first level of synchronization shall be achieved by the inside-of-coverage HR-MS  
483 transmitting preamble and in some cases network configuration information toward  
484 the outside-of-coverage HR-MS. The locations of these control signals are TBD. HR-  
485 MS that are associated with an HR-BS transmit preambles at known locations. The  
486 preamble location and conditions for transmission are TBD.

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

489

490 The following synchronization mechanisms are specifically designed for the case when  
491 HR-MS DC and FTN are scheduled in UL area of a frame.

492 *Frame-level Synchronization:*

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

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

503 *Symbol-level Synchronization:*

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

515

#### 516 **17.2.2.3.1 Use case 3: MS-MS direct communications; there is no HR-BS/RS**

- 517 - The first level synchronization should be carried out in a Master-slave manner. It is  
518 understood that the master needs to take on some of the functionality of a BS and may  
519 also require new functionality.
- 520 - The second level of synchronization can be achieved by HR-MSs exchanging ranging  
521 signals.

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

528

529

530

#### 531 **17.2.2.4 HR-MS Direct Communication with Infrastructure Stations**

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

536

537

### 538 **17.2.2.5 HR-MS Discovery for Direct Communication without Infrastructure**

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

543 The network discovery message shall take the following format: a frame preamble shall  
544 be transmitted first followed by discovery information.

545 When HR-MS sends out network discovery messages, to avoid collision with other HR-  
546 MSs, it should follow a random-back off mechanism as follows:

547 1) A back-off timer shall be started.

548 2) When the timer is timeout, HR-MS should sense the channel for the presence of  
549 preambles first. If no preambles detected, then the HR-MS should transmit the discovery  
550 message. If a preamble has been detected, then node should hold the transmission and  
551 restart the timer.

552 3) HR-MS should get the value for the duration of back-off from a window, for example,  
553 from a window of  $[w_{\min}, w_{\max}]$ , the size of window can be adjusted based on the traffic of  
554 networks. The value of  $w_{\min}$  and  $w_{\max}$  are TBD.

555

## 556 **17.2.3 HR-MS Forwarding to Network**

557

### 558 **17.2.3.1 General Description**

559

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

565

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

571

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

### 574 **17.2.3.2 Frame structure and resource allocation**

575 See 17.2.2.2

### 576 **17.2.3.3 Synchronization (this section is identical to 17.2.2.3)**

577 See 17.2.2.3

578

### 579 **17.2.3.4 Bandwidth Requests sent from Forwarded HR-MS**

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

583

584 The process can be described as follows.

585

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

594

## 595 **17.2.4 Standalone network**

596 For WirelessMAN HR-OFDMA air interface, when the HR-BS loses connectivity to the  
 597 backbone network and the neighboring HR-BSs, the network stations under the coverage  
 598 of this HR-BS shall form a standalone network. The local connectivity shall be provided  
 599 for the HR-MS within the coverage of affected HR-BS. The established service flow  
 600 between HR-MS within the coverage of the affected HR-BS shall be maintained.

601

### 602 **17.2.4.1 Maintenance of Local Connectivity**

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

607

### 608 **17.2.4.2 Entry Process for Standalone Network**

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

613

## 614 **17.2.5 Relaying operation**

615 Relay operation described in 802.16j-2009 shall be supported.

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

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

620

## 621 **17.2.6 Local Forwarding**

622

623 **17.2.7 Path Discovery and Management**

624

625 **17.2.7.1 HR-MS Neighbor Discovery**

626 HR-MS neighbor discovery is a key functionality to enable other 16n features such as  
 627 path discovery and management, HR-MS direct communications (with or without  
 628 presence of infrastructure), and HR-MS forwarding to network. HR-MS neighbor  
 629 discovery procedures are specified for two scenarios: i) when HR-MSs associated with a  
 630 common super-ordinate station (HR-BS/RS or a coordinating HR-MS) attempt to  
 631 discovery each other and ii) when an out-of-coverage HR-MS attempts to discover an  
 632 HR-MS in order to connect through it to network infrastructure.

633

634 **17.2.7.1.1 Neighbor Discovery between Registered HR-MSs**

635 For registered HR-MSs to discover each other, the serving HR-BS/HR-RS shall schedule  
 636 some HR-MSs to broadcast predefined self-advertizing (PSA) signals so that other HR-  
 637 MSs can try to receive and verify their neighbor relationship. Either ranging preambles or  
 638 frame preambles (FFS) can be used as PSA signals.

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

- 640 - The serving HR-BS/HR-RS schedules one or multiple registered HR-MSs to  
 641 broadcast PSA sequences in assigned channels. Multiple HR-MSs may share the  
 642 same PSA signal or the same channel PSA sequence or the same assigned channel,  
 643 but not both.
- 644 - The serving HR-BS/HR-RS also schedules some other HR-MSs to listen on those  
 645 channels scheduled for PSA signals.
- 646 - Each HR-MS that is scheduled to receive PSA sequences shall determine what  
 647 sequences it can properly decode, together with related information such as  
 648 estimations of time/frequency offsets and signal strength.
- 649 - The receiving HR-MSs may report their measurements to the serving HR-BS/HR-RS.  
 650 Whether a receiving HR-MS shall report its measurements or not may be based on a  
 651 threshold.

652 [Informative text] The serving HR-BS/HR-RS can determine neighbor topology based on  
 653 reported measurements of transmitted PSA signals. The HR-MS is also able to construct  
 654 a one hop neighborhood map that may be used for different purposes. How HR-BS/HR-  
 655 RS/HR-MS construct neighbor topology is outside of the scope of this standard.

656

657 **17.2.7.1.2 HR-MS Discover Network Infrastructure**

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

664 the same access information on the same or different resources.

665 An unassociated HR-MS that detects the associated HR-MS preamble(s) shall  
666 subsequently receive access information to determine the access resource. If access  
667 information is omitted then access resources are determined from the SA-Preamble. The  
668 unassociated HR-MS transmits a CDMA preamble.

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

671

## 672 **17.2.7.2 Robustness against SPOF**

### 673 **17.2.7.2.1 Preparation for SPOF**

674 In order to support Preparation for SPOF, alternative path described in this subsection  
675 shall be supported.

676 An alternative path may include HR-MS that switches mode to RS or BS.

677

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

681

682 To support fast network reentry to the neighbor HR-MSs, HR-MS shall transmit its  
683 neighbor information to HR-BS. HR-MSs capable of forwarding to the network and/or  
684 multimode operation shall share the MAC context information with the HR-MS  
685 performing local forwarding to the network.

686

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

688

689

### 690 **17.2.7.2.2 Recovery from SPOF**

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

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

696

697

## 698 **17.2.8 Priority Access Operation**

### 699 **17.2.9 Multicast support**

### 700 **17.2.10 Security**

#### 701 **17.2.10.1 Security Procedure for Direct Communication Data Security**

702

703

##### 704 **17.2.10.1.1 Security Procedure for BS-coordinated Secure Direct Communication**

705

706 In order to support BS-coordinated secure direct communication, the security procedure  
707 described in this subsection shall be executed between HR-MS, HR-BS, Authenticator,  
708 and AAA Server. HR-MSs received the security key from the HR-BS and use this  
709 security key for secure direct communication between/among HR-MSs.

710

#### 711 **17.2.10.1.1.1 Autonomous Mutual Authentication of HR-MS and data security for** 712 **Direct Communications**

713

##### 714 **17.2.10.1.1.1.1 Secure direct communication using pre-established shared key** 715

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

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

720

##### 721 **17.2.10.1.1.1.2 Secure direct communication using Public Key Infrastructure** 722

723

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

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

728

##### 729 **17.2.10.1.2 Security Procedure for Secure talk-around Direct Communication using** 730 **dedicated resource**

731

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

734

#### 735 **17.2.10.2 Security Procedure for Multicast Operation** 736

737

738

### 738 **17.2.11 Self-Coexistence**

739 HR network shall support self-coexistence mechanism to mitigate co-channel  
740 interference among HR-stations within the same geographical area.

741

#### 742 **17.2.11.1 Operation Modes**

743 HR network can operate in two modes: normal mode and self-coexistence mode. A HR  
744 cell operates in normal mode by default and transits to self-coexistence mode when the

745 HR cell receives self-coexistence beacon from an adjacent HR cell on its operating  
 746 channel.

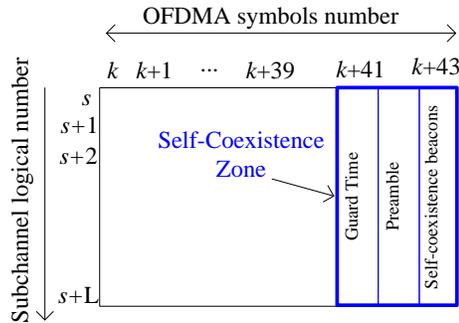
747

748 17.2.11.2 Self-coexistence Zone

749 A self-coexistence zone is a space in a frame for transmission preamble and self-  
 750 coexistence beacons for self-coexistence of multiple HR cells overlapped in coverage and  
 751 have to operate on same frequency channel.

752 In WirelessMAN HR OFDMA networks, a self-coexistence zone occupies the last 3  
 753 symbols of a frame. The first symbol is used as guard time. In the second symbol,  
 754 preamble shall be transmitted, and in the last symbol self-coexistence beacons are  
 755 transmitted.

756



757

758 Figure xx Illustration of self-coexistence zone of WirelessMAN HR OFDMA air  
 759 interface.

760

761

762

763 **17.2.12 Support of Downlink High Reliability and Uplink Heavy Data Service**

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

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

772

773

774 **17.3 WirelessMAN HR Advanced air interface**

775 **17.3.1 Multi-mode operation**

776 **17.3.1.1 Relay function for HR-BS**

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

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

780

781 **17.3.1.1.1 STR mode for HR-BS acting as HR-RS**

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

783 The procedures for RS mode change consist of following activities:

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

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

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

787

788 **17.3.1.1.2 TTR mode for HR-BS acting as HR-RS**

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

791 The procedures for RS mode change consist of following activities:

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

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

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

795

796 **17.3.1.2 Relay function for HR-MS**

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

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

803 If the HR-MS release its role from the relay mode, HR-MS may perform handover to the  
804 any infrastructure station.

805

806 **17.3.1.3 Base station function for HR-MS**

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

811 While operating as an HR-BS, the station may maintain certain HR-MS functionalities. A  
 812 mode switch to HR-BS may be initiated by the HR-MS itself or may be directed by the  
 813 superordinate HR-BS of the HR-MS.

814

815

## 816 **17.3.2 Direct communication between HR-MSs**

817

### 818 **17.3.2.1 General Description**

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

823

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

829

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

832

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

834 - The operation of HR-MSs shall not interfere with any existing infrastructure stations.  
 835 When HR-MS cannot receive any BS preamble from any infrastructure station and  
 836 HR-MS direct communication without infrastructure is permitted by device  
 837 configuration, HR-MSs are allowed to communicate with each other in the same band  
 838 without getting permission from infrastructure stations.

839 - A Coordinator is selected for the coordination of transmission among HR-MSs. Until  
 840 a coordinator is selected, an HR-MS is only allowed to transmit signals necessary to  
 841 enable coordinator selection. To avoid collisions among HR-MSs in coordinator  
 842 selection, the HR-MS follow a collision avoidance procedure. The procedure is  
 843 defined in 17.3.2.5.

844 - A coordinator shall function as a simplified HR-BS except it may not support  
 845 handover. How to select a coordinator among HR-MSs shall follow the operation  
 846 described in TBD.

847 - A coordinator supports the following topologies:

848 5. HR-MS linked to the coordinator and the pair is the source and sink of  
 849 data. This topology is implemented through the local source and sink  
 850 capability of the HR-MS.

851 6. Two HR-MS linked to the coordinator and the two HR-MS are the source  
 852 and sink of data. This topology is implemented through the local

- 853 forwarding capability of the HR-BS.
- 854 7. A forwarding HR-MS forwards data of a forwarded HR-MS to the  
855 coordinator. This topology is implemented through the HR-BS capability  
856 to support HR-MS forwarding operation.
- 857 8. Two HR-MS are linked (DC) and are the source and sink of data to each  
858 other under the control of the coordinator. This topology is implemented  
859 through the HR-BS ability to support DC between its subordinates.
- 860 - The coordinator and any HR-MS that are communicating through the coordinator  
861 shall continue cell search operation and shall cease DC operation as soon as the  
862 criteria for DC and prevention of interference above are not met.

863

864

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

867

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

870

871

#### 872 **17.3.2.2 Frame Structure and Resource Allocation**

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

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

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

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

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

893

894 **17.3.2.3 Synchronization**

895 Synchronization between HR-MSs is classified into two levels:

- 896 - The frame-level (first level) should allow HR-MSs to share a common understanding  
897 of frame and/or superframe timing and configuration.
- 898 - The symbol-level (second level) should allow reliable (i.e. received within cyclic  
899 prefix) bi-directional transmissions between HR-MSs.

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

901

902 **17.3.2.3.1 Use case 1: Both HR-MSs are within the coverage of HR-BS/RS**

- 903 - The first level of synchronization shall be maintained by common DL signaling (i.e.  
904 preambles, FCH, MAP...) from HR-BS/RS.
- 905 - The second level of synchronization can be achieved by HR-MSs exchanging ranging  
906 signals.

907

908 The following synchronization mechanisms are specifically designed for the case when  
909 HR-MS DC and FTN are scheduled in UL area of a frame.

910 *Frame-level Synchronization:*

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

917 *Symbol-level Synchronization:*

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

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

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

934

935 **17.3.2.3.2 Use case 2: one HR-MS is inside and the other is outside the coverage of**  
 936 **HR-BS/RS**

937 - The first level of synchronization shall be achieved by the inside-of-coverage HR-MS  
 938 transmitting preamble and in some cases network configuration information toward  
 939 the outside-of-coverage HR-MS. The locations of these control signals are TBD. HR-  
 940 MS that are associated with an HR-BS transmit preambles at known locations. For  
 941 AAI baseline the PA-Preamble alone or PA-Preamble and SA-Preamble may be used.  
 942 The preamble location and conditions for transmission are TBD.

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

945 The following synchronization mechanisms are specifically designed for the case when  
 946 HR-MS DCm and FTN are scheduled in UL area of a frame.

947 *Frame-level Synchronization:*

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

954 For 16m baseline, the registered HR-MS shall transmit PA/SA preambles at the first  
 955 OFDMA symbols of 2<sup>nd</sup> and 3<sup>rd</sup> frames within each superframe. The NCI shall be  
 956 transmitted in an UL area. The location of the NCI, relative to the transmitted preambles,  
 957 shall be determinable by the outside-of-coverage HR-MS.

958 *Symbol-level Synchronization:*

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

970

#### 971 **17.3.2.3.3 Use case 3: MS-MS direct communications; there is no HR-BS/RS**

- 972 - The first level synchronization should be carried out in a Master-slave manner. It is  
 973 understood that the master needs to take on some of the functionality of a BS and may  
 974 also require new functionality.
- 975 - The second level of synchronization can be achieved by HR-MSs exchanging ranging  
 976 signals.

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

983

984

985

#### 986 **17.3.2.4 HR-MS Direct Communication with Infrastructure Stations**

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

991

992

#### 993 **17.3.2.5 HR-MS Discovery for Direct Communication without Infrastructure**

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

998 The network discovery message shall take following format: frame preambles, PA-  
999 Preamble and SA-Preamble shall be transmitted first followed by the discovery  
1000 information.

1001 When HR-MS sends out network discovery messages, to avoid collision with other HR-  
1002 MSs, it should follow a random-back off mechanism as follows:

1003 1) A back-off timer shall be started.

1004 2) When the timer is timeout, HR-MS should sense the channel for the presence of  
1005 preambles first. If no preambles detected, then the HR-MS should transmit the discovery  
1006 message. If a preamble has been detected, then node should hold the transmission and  
1007 restart the timer.

1008 3) HR-MS should get the value for the duration of back-off from a window, for example,  
1009 from a window of  $[w_{\min}, w_{\max}]$ , the size of window can be adjusted based on the traffic of  
1010 networks. The value of  $W_{\min}$  and  $W_{\max}$  are TBD.

1011

1012

### 1013 **17.3.2.6 Talk-around Direct Communication**

1014

1015 HR-MSs by themselves synchronize and perform contention-based transmission. The  
1016 synchronization and the contention-based transmission are performed among those HR-  
1017 MSs on a dedicated resource unused by HR-BSs if at least one of the HR-MSs are under  
1018 HR-BS coverage.

1019

#### 1020 **17.3.2.6.1 Medium access control**

1021

##### 1022 **17.3.2.6.1.1 MAC control messages**

1023

##### 1024 **17.3.2.6.2 Physical layer**

1025

###### 1026 **17.3.2.6.2.1 Frame structure**

1027

###### 1028 **17.3.2.6.2.2 Physical structure**

1029

###### 1030 **17.3.2.6.2.3 Control structure**

1031

1032

1033

### 1034 **17.3.3 HR-MS Forwarding to Network**

1035

#### 1036 **17.3.3.1 General Description**

1037 In HR-MS Forwarding to Network, an HR-MS forwards user data and control signaling  
1038 between an HR-MS and an HR infrastructure station. The user data and control signaling  
1039 do not go through higher layer at the forwarding HR-MS. The origination and termination  
1040 of the user data and control signaling are at the forwarded HR-MS and the HR  
1041 infrastructure station respectively and vice versa.

1042

1043 HR-MS Forwarding to Network is applicable when 1) the forwarded HR-MS and the  
 1044 forwarding HR-MS are in coverage of and directly associated to an infrastructure station;  
 1045 2) the forwarding HR-MS is in coverage of and directly associated to an HR  
 1046 infrastructure station, while the forwarded HR-MS is out of coverage of any HR  
 1047 infrastructure stations.

1048  
 1049 Resource for HR-MS Forwarding to Network can be allocated by the HR infrastructure  
 1050 station with which the forwarding HR-MS is associated.

1051  
 1052  
 1053 Using talk-around direct communication described in 17.3.2.6, HR-MS forwarding to  
 1054 network is described in 17.3.3.5.

1055

### 1056 **17.3.3.2 Frame structure and Resource Allocation**

1057 See 17.3.2.2

### 1058 **17.3.3.3 Synchronization**

1059 See 17.3.2.3

1060

### 1061 **17.3.3.4 Bandwidth Requests sent from Forwarded HR-MS**

1062 For use case 2, an out-of-coverage forwarded HR-MS can request bandwidth by  
 1063 transmitting some known sequences (Bandwidth Request (BR) preambles) toward the  
 1064 forwarding HR-MS.

1065  
 1066 The process can be described as follows.

1067

- 1068 - Serving HR-BS/RS schedules resources in an uplink subframe for forwarded HR-  
 1069 MSs to transmit BR messages to their corresponding forwarding HR-MS.
- 1070 - The forwarding HR-MS listens to bandwidth requests at times and resources  
 1071 indicated by the HR-BS. The forwarded HR-MS may transmit bandwidth requests  
 1072 using these resources.
- 1073 - The forwarding HR-MS, upon receiving BR messages from one of its forwarded HR-  
 1074 MS, forwards the requests to serving HR-BS/RS.
- 1075 - Any resource assignment from the HR-BS is forwarded to the forwarding HR-MS.

1076

1077

### 1078 **17.3.3.5 HR-MS forwarding to network using talk-around direct communication**

1079

#### 1080 **17.3.3.5.1 HR-MS discoveries**

1081

#### 1082 **17.3.3.5.2 Connection management**

1083

1084 **17.3.3.5.3 Forwarding Link management**

1085

1086 **17.3.3.5.4 QoS management**

1087

1088 **17.3.3.5.5 Paging**

1089

1090

1091 **17.3.4 Standalone network**

1092 For WirelessMAN HR Advanced air interface, when HR-BS lost the connectivity to the  
 1093 backbone network and the neighboring HR-BSs, the network nodes under the coverage of  
 1094 this HR-BS shall form a standalone network. The local connectivity shall be provided for  
 1095 the mobile stations within the coverage of Base station. When the Base Station loses the  
 1096 backbone connection, the established service flow between mobile stations within the  
 1097 coverage of the base station shall be maintained.

1098

1099 When backbone connectivity is lost, the MAC connectivity is provided among HR-MSs  
 1100 within BS's coverage

1101

1102 **17.3.4.1 Backbone status management**1103 **17.3.4.1.1 Backbone Enable notification**

1104 When backbone connectivity is available, the HR-BS shall notify HR-MSs of its  
 1105 availability. The transport connections may be recovered from their unavailable status.

1106 An HR-BS exchanges the BBE-REQ/RSP message with HR-MSs on unicast control  
 1107 connections.

1108 An HR-BS broadcasts the BBE-CMD message to all the HR-MSs under BS's coverage.

1109

1110 **17.3.4.1.2 Backbone Disable notification**

1111 When backbone connectivity is not available, the HR-BS shall notify HR-MSs of its  
 1112 unavailability. After backbone disables, all the transport connections on which packets  
 1113 transfer to network are not available.

1114 An HR-BS exchanges the BBD-REQ/RSP message with HR-MSs on unicast control  
 1115 connections.

1116 An HR-BS broadcasts the BBD-CMD message to all the HR-MSs under BS coverage.

1117

1118 **17.3.4.2 Maintenance of Local Connectivity**

1119 For maintenance of local connectivity, all the HR-BSs shall maintain a network topology  
 1120 table of HR-MS/HR-RS within its coverage area. The network topology table shall be  
 1121 updated periodically by broadcasting a STN-REQ message from HR-BS and receiving  
 1122 acknowledgement message STN-ACK from HR-MS or HR-RS within its coverage area.

1123 The maintenance of local connectivity for standalone network with WirelessMAN HR  
 1124 Advanced air interface shall according to the process defined in section 17.2.4.1

1125

#### 1126 **17.3.4.3 Entry Process for Standalone Network**

1127 The HR standalone network with WirelessMAN HR Advanced air interface shall allow  
 1128 the entry of an unassociated HR-MS into the standalone network and establish the  
 1129 connection with standalone network HR-BS. The unassociated HR-MS is referred to the  
 1130 HR-MS which is not associated with any Base Station.

1131 The entry process is as defined in Section 17.2.4.2.

1132

#### 1133 **17.3.5 Relaying operation**

1134 Relay operation described in Section 16.6 shall be supported.

1135 In order to provide great reliability in a degraded network, the relay function described in  
 1136 this subsection shall be supported.

1137 In order to support local forwarding in an HR-RS, the HR-RS shall follow operation as  
 1138 defined in Section 17.3.6.

1139

#### 1140 **17.3.6 Local Forwarding**

1141 HR-RS/BS should detect the local forwarding opportunity and be able to bind together the uplink  
 1142 flow ID from the source and the downlink flow ID to the destination for two communicating HR-  
 1143 MSs within its control during connection establishment or connection re-establishment for  
 1144 handover, if it is allowed by HR-BS. After the binding HR-RS is able to forward the data from  
 1145 the source to the destination without going through HR-BS and may optionally forward to HR-BS  
 1146 one copy of the data that is being locally forwarded, if required.

1147

#### 1148 **17.3.7 Path Discovery and Management**

1149

##### 1150 **17.3.7.1 HR-MS Neighbor Discovery**

1151 HR-MS neighbor discovery is a key functionality to enable other 16n features such as  
 1152 path discovery and management, HR-MS direct communications (with or without  
 1153 presence of infrastructure), and HR-MS forwarding to network. HR-MS neighbor  
 1154 discovery procedures are specified for two scenarios: i) when HR-MSs associated with a  
 1155 common super-ordinate station (HR-BS/RS or a coordinating HR-MS) attempt to  
 1156 discovery each other and ii) when an out-of-coverage HR-MS attempts to discover an  
 1157 HR-MS in order to connect through it to network infrastructure.

1158 To enable neighbor discovery among directly associated HR-MSs (use case 1), the super-

1159 ordinate station shall instruct these directly associated HR-MSs to transmit and receive  
1160 predefined signals.

1161

1162

### 1163 **17.3.7.1.1 Neighbor Discovery between Registered HR-MSs**

1164 For registered HR-MSs to discover each other, the serving HR-BS/HR-RS shall schedule  
1165 some HR-MSs to broadcast predefined self-advertizing (PSA) signals so that other HR-  
1166 MSs can try to receive and verify their neighbor relationship. Either ranging preambles or  
1167 frame preambles (FFS) can be used as PSA signals.

1168 The process of neighbor discovery for registered HR-MSs is as follows:

- 1169 - The serving HR-BS/HR-RS schedules one or multiple registered HR-MSs to  
1170 broadcast PSA sequences in assigned channels. Multiple HR-MSs may share the  
1171 same PSA signal or the same channel PSA sequence or the same assigned channel,  
1172 but not both.
- 1173 - The serving HR-BS/HR-RS also schedules some other HR-MSs to listen on those  
1174 channels scheduled for PSA signals.
- 1175 - Each HR-MS that is scheduled to receive PSA sequences shall determine what  
1176 sequences it can properly decode, together with related information such as  
1177 estimations of time/frequency offsets and signal strength.
- 1178 - The receiving HR-MSs may report their measurements to the serving HR-BS/HR-RS.  
1179 Whether a receiving HR-MS shall report its measurements or not may be based on a  
1180 threshold.

1181 [Informative text] The serving HR-BS/HR-RS can determine neighbor topology based on  
1182 reported measurements of transmitted PSA signals. The HR-MS is also able to construct  
1183 a one hop neighborhood map that may be used for different purposes. How HR-BS/HR-  
1184 RS/HR-MS construct neighbor topology is outside of the scope of this standard.

1185

### 1186 **17.3.7.1.2 HR-MS Discover Network Infrastructure**

1187 To enable coverage extension, a serving HR-BS/HR-RS shall schedule some of its  
1188 registered HR-MSs to transmit PA/SA preamble signals so that an outside-of-coverage  
1189 HR-MS can detect and start network entry. The registered HR-MS shall transmit PA  
1190 preamble at the beginning of the 2<sup>nd</sup> frame and SA preamble at the beginning of the 3<sup>rd</sup>  
1191 frame (of a super-frame).

1192

1193 Any non-registered HR-MS scanning for DL preambles for possible network entry shall  
1194 be able to differentiate between preambles transmitted by normal infrastructure stations  
1195 (HR-BS/HR-RS) and those transmitted by a coverage-extending HR-MS.

1196

1197 For use case 2, The HR-BS may instruct HR-MS that are associated with it to transmit  
1198 access information at pre-defined resources relative to the preambles transmitted by the  
1199 HR-MS. The access information defines resources for access by the HR-MS that is not

1200 under HR-BS coverage. Access information may be omitted. If access information is  
1201 omitted then access resources are defined by the index and the sub-carrier set index of the  
1202 SA-Preamble. All or a group of the directly associated HR-MS may or may not transmit  
1203 the same access information on the same or different resources.

1204 An unassociated HR-MS that detects the associated HR-MS preamble(s) shall  
1205 subsequently receive access information to determine the access resource. If access  
1206 information is omitted then access resources are determined from the SA-Preamble. The  
1207 unassociated HR-MS transmits a CDMA preamble.

1208 The associated HR-MS that received the CDMA preamble responds with sufficient access  
1209 information to complete the association procedure.

1210

### 1211 **17.3.7.2 Robustness against SPOF**

1212

#### 1213 **17.3.7.2.1 Preparation for SPOF**

1214 In order to support preparation for SPOF, alternative path described in this subsection  
1215 shall be supported.

1216 An alternative path may include HR-MS that switches mode to RS or BS.

1217

1218 Network entry including handover as described in 16.2.6 and 16.2.8.2.9 shall be  
1219 supported in the event of SPOF. An indication of whether MAC context information of  
1220 the subordinate HR-MS is being shared by infrastructure stations shall be transmitted to  
1221 HR-MS.

1222

1223 To support fast network reentry to the neighbor HR-MSs, HR-MS shall transmit its  
1224 neighbor information to HR-BS. HR-MSs capable of forwarding to the network and/or  
1225 multimode operation shall share the MAC context information with the HR-MS  
1226 performing local forwarding to the network.

1227

1228 If necessary, another path can be selected, if available, among alternative paths.

1229

1230

#### 1231 **17.3.7.2.2 Recovery from SPOF**

1232 Network reentry including handover as described in 16.2.6 and 16.2.8.2.9 shall be  
1233 supported in the event of SPOF. Whether MAC context information of the subordinate  
1234 HR-MS is shared by the infrastructure stations shall be transmitted to HR-MS.

1235 Alternative path may be selected during the role change or release the mode as described  
1236 in 17.3.1.

1237

### 1238 **17.3.8 Priority Access Operation**

1239

### 1240 **17.3.9 Multicast support**

1241 Each HR-BS capable of providing multicast communication belongs to a certain  
 1242 multicast group zone. A multicast zone defined as a set of HR-BSs where the same  
 1243 Multicast Group ID and FID is used for transmitting the content of certain service  
 1244 flow(s).

1245 An HR-BS may provide the HR-MS with multicast content locally within its coverage  
 1246 and independently of other HR-BSs. The single HR-BS provision of multicast is  
 1247 therefore a configuration where a Multicast Zone is configured to consist of a single HR-  
 1248 BS only. In this case, the HR-BS uses any Multicast Group ID and FID for providing  
 1249 multicast service, independently of other HR-BSs, so the HR-MS received the multicast  
 1250 data from its serving HR-BS, and the HR-MS should not expect the service flow for this  
 1251 multicast connection to continue when the HR-MS leaves the serving HR-BS' coverage.  
 1252 However, if the HR-MS moves to an HR-BS that is transmitting the same multicast flow  
 1253 in another HR Multicast Group Zone, HR-MS may update its service flow management  
 1254 encodings to continue to receive the same multicast flows.

1255 To ensure proper multicast operation on networks of HR-BS employing multicast, the  
 1256 Multicast Group IDs and FIDs used for common multicast content and service shall be  
 1257 the same for all HR-BSs within the same HR Multicast Group Zone. This allows the HR-  
 1258 MS which has already registered with a service to be seamlessly synchronized with  
 1259 multicast transmissions within an HR Multicast Group Zone without communicating in  
 1260 the UL or re-registering with other HR-BS within that HR Multicast Group Zone.

1261

### 1262 **17.3.9.1 Multicast communication operation**

1263 An HR-BS establishes a DL multicast service by creating a multicast connection with  
 1264 each HR-MS to be associated with the service. Multicast service flows are not dedicated  
 1265 to the specific HR-MS and are maintained even though the HR-MS is either connected  
 1266 state or idle state. When an HR-MS is registered at an HR-BS for receiving multicast  
 1267 service, multicast service flows shall be instantiated as multicast connections. An HR-MS  
 1268 regardless of what mode the HR-MS is currently in may receive data of multicast service  
 1269 flows transmitted from HR-BS. Any available FID is used for the multicast service (i.e.,  
 1270 there are no dedicated FIDs for multicast transport connections). To ensure proper  
 1271 multicast operation, the Multicast Group ID and FID used for the service shall be the  
 1272 same for all HR-MSs on the same channel that participate in the connection in a multicast  
 1273 zone. Mapping of multicast service flows to corresponding Multicast Group IDs and  
 1274 FIDs shall be known and be the same for all HR-BSs belonging to the same HR Multicast  
 1275 Group Zone.

1276

#### 1277 **17.3.9.1.1 Multicast communication establishment**

1278 The procedure of multicast communication establishment includes capacity exchange,  
 1279 establishment multicast connection, transmission and receiving the HR-multicast control  
 1280 channel as shown in Figure xxx. The procedure includes

- 1281 - Capacity exchange using AAI-REG-REQ/RSP
- 1282 - DSx procedure containing relevant multicast parameter to establish multicast

1283 connection

1284 - Transmission and receiving the HR multicast control channel

1285

1286 To discover multicast service, HR-MS will inform HR-BS of support of multicast  
 1287 transmission by AAI-REG-REQ message and the HR-BS will indicate if it supports  
 1288 multicast for that HR-MS through AAI-REG-RSA message. The basic multicast  
 1289 capability exchange in AAI\_REG-REQ/RSP message is described in 16.2.3.8 and  
 1290 16.2.3.9.

1291

1292 When an HR-MS registers to receive multicast services, the serving HR-BS or the HR-  
 1293 MS may initiate the DSA procedure for multicast connections. The HR-MS's discovery  
 1294 and registration of multicast services with the HR-BS through upper layer signaling are  
 1295 outside the scope of this standard.

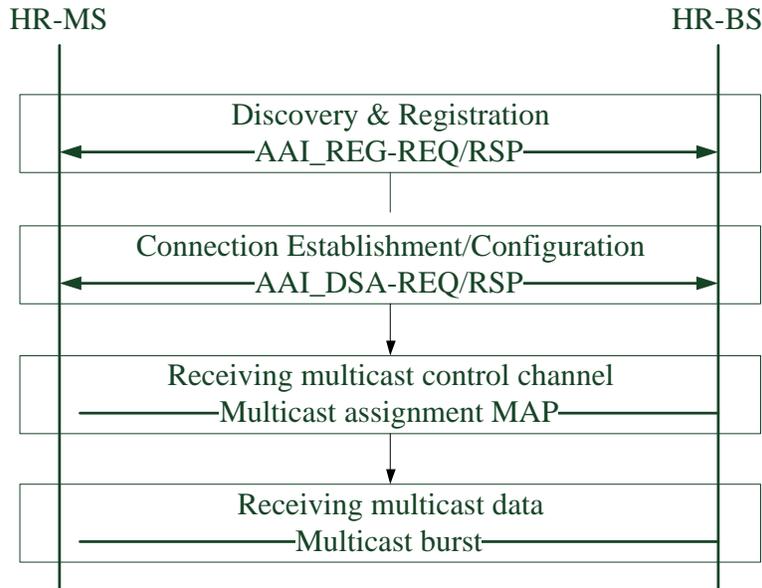
1296

1297 The AAI-DSA, AAI-DSC and AAI-DSD messages are used to establish, change, and  
 1298 delete multicast service flows respectively. The HR-BS shall send the AAI-DSA-  
 1299 REQ/RSP to the HR-MS with the relevant multicast parameters including Multicast  
 1300 Group ID.

1301

1302 To receive multicast data, an HR-MS receives the multicast allocation information in the  
 1303 multicast control channel (i.e., multicast assignment MAP).

1304



1305

1306 **Figure xxx – Procedure of multicast communication establishment**

1307

1308 **17.3.9.1.2 Multicast communication operation in connected state**

1309 When an HR-MS moves across Multicast zone boundaries in Active Mode or Sleep  
1310 Mode, the HR-MS performs the handover procedure as described in 16.2.6.3.

1311 When the HR-MS transits to a new Multicast Zone while in Active Mode or Sleep Mode,  
1312 the HR-MS shall send AAI-RNG-REQ message with Ranging Purpose Indication =  
1313 0b1110 at the target HR-BS and the ABS shall include Multicast Group ID and FID  
1314 Update in AAI-RNG-RSP parameters to provide updated service flow management  
1315 encodings for any affected E-MBS flow as part of the handover procedure.

1316

1317 **17.3.9.1.3 Multicast communication operation in idle state**

1318 When an HR-MS in Idle state moves to an HR-BS which does not belong to HR-MS'  
1319 previous Multicast Group Zone, the HR-MS is expected to update the multicast service  
1320 flow management encodings at that HR-BS to provide continuous reception of multicast  
1321 content. The HR-MS may obtain the multicast information in the target Multicast zone  
1322 through broadcast messages in the Multicast Zone of the service HR-BS. If the idle HR-  
1323 MS has not received such information from the serving Multicast Zone, the HR-MS shall  
1324 use location update procedure to acquire updated multicast service flow management  
1325 encodings. In order to perform the multicast location update process, the HR-MS shall  
1326 transmit AAI-RNG-REQ message with Ranging Purpose Indication = 0b1110. In  
1327 response to the request for multicast location update, the HR-BS shall transmit AAI-  
1328 RNG-RSP message which may include the Multicast Group Zone identifier, Multicast  
1329 Group ID, and FID to provide update service flow management encodings for any  
1330 affected multicast flow(s).

1331

1332 **17.3.9.2 Multicast protocol features and functions**

1333 **17.3.9.2.1 Downlink control channel for multicast communication**

1334 HR-multicast control channel (i.e., HR-Multicast DL Assignment A-MAP IE) carries  
1335 configuration information (including allocation/change/releasement) for multicast  
1336 communication for one multicast zone in an HR-BS. In HR-Multicast DL Assignment A-  
1337 MAP, allocation period indicates a period of persistent allocation of multicast resource  
1338 and Lifetime is a timer indicating the next instance of HR-Multicast DL-Assignment A-  
1339 MAP IE. Unless the Lifetime expires, this HR-Multicast DL Assignment A-MAP does  
1340 not change during the allocation duration. At the time the Lifetime expires, the HR-  
1341 Multicast DL Assignment A-MAP shall change or release the allocation.

1342

1343 Table xx – 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 $M_t \leq N_t$ $N_t$ : 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	<p>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</p> <p>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</p>
}		
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	
}		
}		

1344 \*A 16bit CRC is generated based on the randomized contents of the HR-Multicast DL  
 1345 Assignment A-MAP IE. The CRC is masked by the 16-bit CRC mask (with masking  
 1346 prefix = 0b0 and message type indicator = 0b010) generated according to Table 843 as  
 1347 describe in 16.3.5.5.2.4.

1348

1349 **17.3.9.3 Multicast key management**

1350 Multicast key is managed as described in 17.3.10.2.

1351

1352

1353 **17.3.10 Security**

1354

1355 **17.3.10.1 Security Procedure for Direct Communication Data Security**

1356

1357 **17.3.10.2 Security Procedure for Multicast Operation**

1358

1359

1360 **17.3.11 Self-Coexistence**

1361 HR network shall support self-coexistence mechanism to mitigate co-channel  
 1362 interference among HR-stations within the same geographical area.

1363

1364 **17.3.11.1 Operation Modes**

1365 See 17.2.11.1.

1366

1367 **17.3.11.2 Self-coexistence Zone**

1368 A self-coexistence zone is a space in a frame for transmission preamble and self-  
1369 coexistence beacons for self-coexistence of multiple HR networks overlapped in  
1370 coverage and have to operate one same frequency channel.

1371 The structure of self-coexistence zone in WirelessMAN HR Advanced networks is TBD.

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1373

1374