Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Proposed Text of DL Control Structure for IEEE 802.16m Amendment**
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Re:	802.16m amendment working document: IEEE 802.16m-08/053r1, "Call for Comments and Contributions on Project 802.16m Amendment working document". Target topic: DL PHY control structure, especially mapping
Abstract	The contribution proposes the text of DL Control Structure section to be included in 802.16m amendment.
Purpose	To be discussed and adopted by TGm for the 802.16m amendment.
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Proposed Text of DL Control Structure for the IEEE 802.16m Amendment

1. Introduction

The contribution proposes the text of DL control section to be included in the 802.16m amendment. The proposed text is developed so that it can be readily combined with IEEE P802.16 Rev2/D8 [1], it is compliant to the 802.16m SRD [2] and the 802.16m SDD [3], and it follows the style and format guidelines in [4].

2. Modifications to the SDD text

The text proposed in this contribution is based on subclauses 11.7 in the IEEE 802.16m SDD [3]. The modifications to the SDD text are summarized below:

- DL control information classification is not included
  - DL control information classification serves as the basis for DL control channel design, and the detailed DL control channel design will be covered in different sections with detailed control information. It is not necessary to discuss about which information belongs to which category.
- Synchronization Channel (SCH)
  - In the latest SDD [3], many places in Section 11.7.2.1 are left as TBD/FFS; especially there is no agreement on the SCH symbols and location. In this contribution the agreed items about P-SCH and S-SCH are included. All other parts will be filled in after the relevant SDD text is filled.
- Broadcast Channel
  - In Broadcast channel section, the following items are covered: information content in BCH, resource allocation of BCH, transmission format for PBCH/SBCH.
- Unicast Service Control Channel (USCCH)
  - In USCCH section, the following items are covered: information content in non-user specific/user specific USCCH, USCCH resource allocation and transmission format, while some parts are left as FFS.
- Multicast Service Control Channel (MSCCH)
  - Prefer to work on this after completing unicast control channel design. Leave as TBD.
- Multicarrier Control Channel
  - Prefer to work on this after completing single carrier control channel design. Leave as TBD.

3. References

[1] IEEE P802.16 Rev2/D8, “Draft IEEE Standard for Local and Metropolitan Area Networks: Air Interface for Broadband Wireless Access,” Dec. 2008.

[2] IEEE 802.16m-07/002r7, “802.16m System Requirements”

[3] IEEE 802.16m-08/003r6, “The Draft IEEE 802.16m System Description Document”

[4] IEEE 802.16m-08/043, “Style guide for writing the IEEE 802.16m amendment”

4. Text proposal for inclusion in the 802.16m amendment

---------- Text Start ----------

3. Definitions

Insert the following at the end of section 3:

4. Abbreviations and acronyms

Insert the following at the end of section 4:

BCH	Broadcast Channel
P-SCH	Primary Synchronization Channel
SCH	Synchronization Channel
S-SCH	Secondary Synchronization Channel

Insert a new section 15.xxx:

15. Advanced Air Interface

15.3. Physical layer

15.3.x DL Control Structure

15.3.x.1 SCH

The synchronization channel (SCH) is a DL physical channel that provides a reference signal for time, frequency, and frame synchronization, RSSI estimation, channel estimation, and ABS identification.

15.3.x.1.1 SCH Structure

Two levels of synchronization hierarchy exist:

- Primary synchronization channel (P-SCH)
- Secondary synchronization channel (S-SCH).

The P-SCH is used for initial acquisition and superframe synchronization. The S-SCH is used for fine synchronization and carries cell/sector identification (ID).

P-SCH and S-SCH are time division multiplexed in one superframe.

15.3.x.1.2 Location of synchronization symbols

In the mixed deployment scenario that includes legacy WirelessMAN-OFDMA, the presence of the WirelessMAN-OFDMA preamble in the first symbol of the WirelessMAN-OFDMA frame is implicit. The location of SCH symbol(s) of the Advanced Air Interface is fixed within the superframe.

One symbol per frame is used for SCH. The Advanced Air Interface P-SCH is transmitted at the beginning of superframe. The Advanced Air Interface S-SCH is transmitted at the beginning of each following radio frames in the superframe.

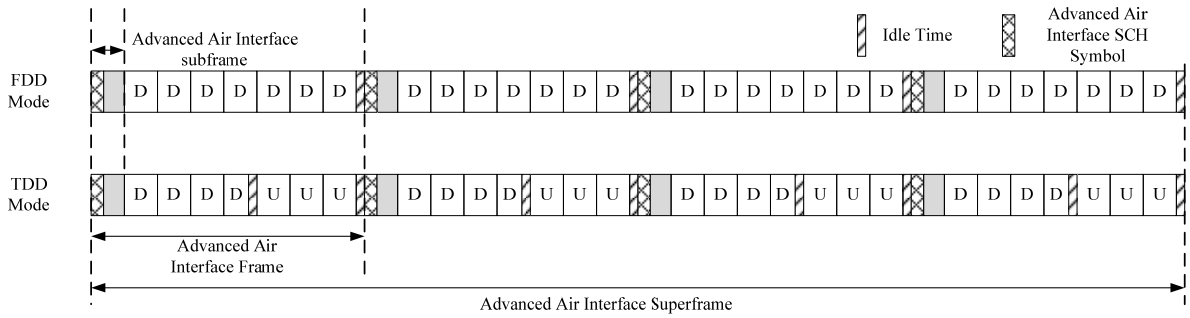

Figure XXX Location of SCH symbols in Advanced Air Interface-only mode

15.3.x.1.3 Description of legacy support

Advanced Air Interference system supports both greenfield and mixed (coexisting WirelessMAN-OFDMA and Advanced Air Interference equipments) deployments. In mixed deployments the WirelessMAN-OFDMA preamble shall be present.

15.3.x.1.4 P-SCH/S-SCH Sequences

TBD.

15.3.x.2 BCH

The Broadcast Channel (BCH) carries essential system parameters and system configuration information. The BCH is divided into two channels: Primary Broadcast Channel (PBCH) and Secondary Broadcast Channel (SBCH).

15.3.x.2.1 Primary Broadcast Channel (PBCH) and Secondary Broadcast Channel (SBCH)

The Primary Broadcast Channel (PBCH) and the Secondary Broadcast Channel (SBCH) carry essential system parameters and system configuration information. PBCH shall be transmitted in every superframe. The SBCH may also be transmitted. Parameters that have constant size shall be present in PBCH; the parameters that have variable size may be present in SBCH, e.g. the size of PHY subchannelization configuration may be variable due to different number of frequency partitions. The parameters transmitted in PBCH and SBCH are defined in Table xxx and Table yyy, respectively.

Table xxx Information Transmitted in PBCH

Syntax	**Size**	**Notes**
PBCH Information {		
Superframe number	8 bits	
SBCH Size	3 bits	The SBCH size in unit of LRU. [Note: The meaning of the values (000 – 111) are FFS.]
Duplex mode	1bit	0:TDD 1:FDD, including HFDD operation

If (Duplex mode==0) {		
TTG	2bits	TTG size in the unit of OFDM symbols. 00: no TTG. 01: 1 OFDMA symbol for TTG 10: 2 OFDMA symbols for TTG 11: Reserved
DL/UL ratio	3 bits	000: 4 DL subframes : 4 UL subframes 001: 5:3 010: 6:2 011: 7:1 100: 8:0 others: Reserved
} else {		
UL central Frequency	5 bits	Paired UL central frequency
}		
DL bandwidth	2 bits	00:5Mhz 01:10Mhz 10: 20Mhz 11: Reserved [Notes: Whether to indicate 7 and 8.75 Mhz is FFS.]
PHY configuration counter	4 bits	Whenever PHY configuration changed, this counter should ++ Could be common in whole network
Paging information presence	1 bit	Indication of the paging information presence in the channel of SBCH.
Traffic indication presence	1 bit	Indication of the traffic indication presence in the channel of additional broadcast information.
PBCH CRC	16 bits	
}		

Table yyy Information Transmitted in SBCH

Syntax	**Size**	**Notes**
SBCH format {		
ABS_ERIP	3 bits	ABS transmitting power
Ranging Power config.	3 bits	To configure the power management method for initial ranging.

		[Note: The meaning of the values are FFS.]
DL Frequency Partition Configuration{		
Frequency Partition Count (FPC)	2 bits	the number of frequency partitions 00: Reserved; 01: 1; 10: 3; 11: 4;
Subband Allocation Count (SAC)	FFS	The number of reserved subbands obtained in the subband allocation [Notes, the size of SAC could be constant (5 bits), or be determined by bandwidth]
If (FPC=10 or 11) {		
Frequency Partition Size (FPS)	FFS	The number of PRUs allocated to FPi in the number of minibands (N2), i>0. [Note: the size of FPS could be constant (6 bits), or be determined by bandwidth and SAC]
Frequency Partition Subband Count (FPSC)	FFS	the number of subbands allocated to FPi, i>0 [Note: the size of FPS could be constant (6 bits), or be determined by bandwidth and SAC]
}		
for (i=0; i<the number of frequency partitions; i++) {		
CRU Allocation Size (CAS)	FFS	The number of CRU in one FP. This number is in the unit of sub-band. It's FP specific [Note: the size of CAS could be constant (4 bits), or be determined by FPS and FPSC for FPi]
}		
}		
UL Frequency Partition Configuration{		
Frequency Partition Count (FPC)	2 bits	the number of frequency partitions 00: Reserved; 01: 1; 10: 3; 11: 4;
Subband Allocation Count (SAC)	FFS	The number of reserved subbands obtained in the subband allocation [Notes, the size of SAC could be constant (5 bits), or be determined by bandwidth]

If (FPC=10 or 11) {		
Frequency Partition Size (FPS)	FFS	The number of PRUs allocated to FPi in the number of minibands (N2), i>0. [Note: the size of FPS could be constant (6 bits), or be determined by bandwidth and SAC]
Frequency Partition Subband Count (FPSC)	FFS	the number of subbands allocated to FPi, i>0 [Note: the size of FPS could be constant (6 bits), or be determined by bandwidth and SAC]
}		
for (i=0; i<the number of frequency partitions; i++) {		
CRU Allocation Size (CAS)	FFS	The number of CRU in one FP. This number is in the unit of sub-band. It's FP specific [Note: the size of CAS could be constant (4 bits), or be determined by FPS and FPSC for FPi]
}		
}		
If (Paging information presence==1){		Paging information presence is transmitted in PBCH.
Hashed MAC address	24 bits(FFS)	Hashed MAC address to indicate AMS to perform paging. AMS shall select one UL ranging channel in current super-frame according to its Mac address or other factor.
Further paging	1 bit	1: there is some further paging message in data region, all awake idle AMS shall decode the next USCCH to find that paging message. 0: there is no further paging message in data region, idle AMS doesn't need to decode USCCH in this super-frame.
}		
If (Traffic indication presence==1) {		
Format	1 bit	
If (Format==0) {		The two-level bitmap traffic indication method is used.
SLPID Group Indication Bitmap	32 bits	N-th bit of SLPID-Group Indication Bitmap [MSB corresponds to N = 0] is allocated to SLPID Group that includes MS with SLPID values from N*32 to N*32+31. Meaning of this bit 0: There is no traffic for all the 32 MS that belong to the SLPID-Group 1: There is traffic for at least one MS in SLPID-Group.

[Traffic Indication Bitmap]	[FFS]	The Traffic Indication bitmap comprises the multiples of 32-bit long Traffic Indication unit. A Traffic Indication unit for 32 SLPIDs is added to MOB_TRF-IND message whenever its SLPID Group is set to 1. 32 bits of Traffic Indication Unit (starting from MSB) are allocated to MS in the ascending order of their SLPID values: 0: Negative indication; 1: Positive indication [Note: The inclusion of "Traffic Indication Bitmap" may significantly increase the information transmitted in SBCH. It could also be transmitted in USCCH region or even as a MAC message.]
} else {		The SPLID method is used.
Num_SPLID	3 bits	Number of SLPIDs following
for (i = 0; i < Num_ SPLID; i++) {		
SLPID	10 bits	
}		
}		
SBCH CRC	16 bits	
}		

15.3.x.2.2 Location of the BCH

The SFH includes PBCH and the SBCH, and is located in the first subframe within a superframe. The PBCH and SBCH occupy no more BW than 5 MHz. The physical mapping of PBCH and SBCH is given in 15.3.x.2.5.

15.3.x.2.3 Multiplexing of the PBCH and SBCH with other control channels and data channels

The PBCH/SBCH is TDM with the SCH.

If SFH occupies narrower BW than system BW, the PBCH and SBCH in SFH are FDM with data within the same subframe.

The PBCH is FDM with the SBCH within the first subframe.

15.3.x.2.4 Transmission format

The PBCH and SBCH are transmitted using predetermined modulation and coding schemes. The modulation for the PBCH and the SBCH is QPSK.

The coding rate for PBCH and SBCH is FFS.

SFBC is used to transmit PBCH/SBCH.

15.3.x.2.5 Resource allocation

PBCH and SBCH are transmitted in a predefined frequency partition. The PRUs of the frequency partition locate in the center 5 MHz, for any bandwidth.

There are totally 24 PRUs in the center 5 MHz BW. The 24 PRUs [or a subset of the 24 PRUs, FFS] in the 1st subframe of a superframe are pre-defined as the frequency partition to transmit BCH. To avoid unnecessary complexity, no CRUs are allocated in the frequency partition. The whole frequency partition is mapped to be distributed LRUs. The two stream pilot pattern, as defined in section XXX [TBD, in the section of DL PHY structure], is used in the frequency partition. The first M1 distributed LRUs are allocated for PBCH transmission. [Note: The value of M1 need to be decided based on the size of PBCH information and MCS] The following M2 distributed LRUs are allocated for SBCH, if SBCH is present. M2 is indicated in PBCH by the field "SBCH size". The other distributed LRUs (if any) are allocated for data transmission. The resource allocation for BCH in 10MHz BW is illustrated in Figure yyy.

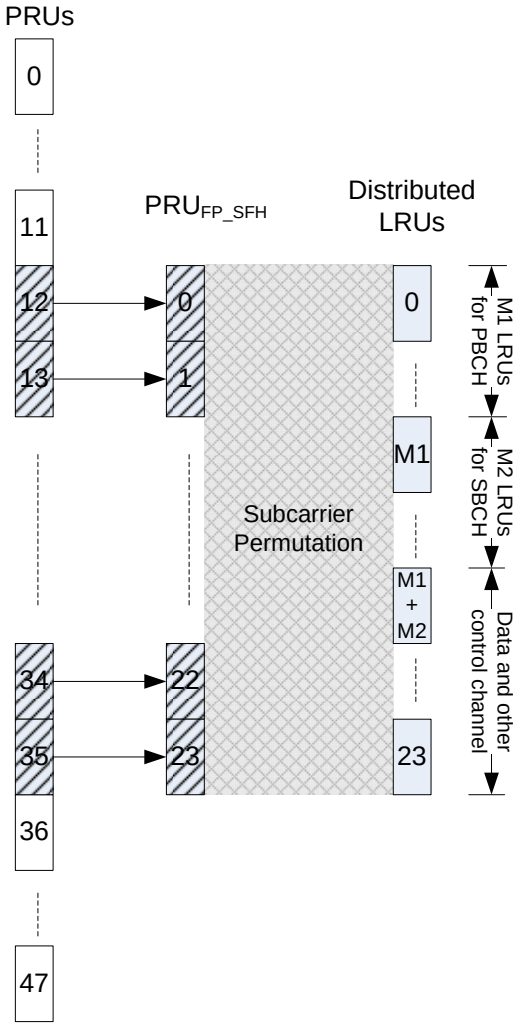

Figure yyy Resource allocation for BCH in 10MHz BW

15.3.x.3 USCCH

15.3.x.3.1 Unicast service control information/content

Unicast service control information consists of both user-specific control information and non-user-specific control information.

15.3.x.3.1.1 Non-user-specific control information

Non-user-specific control information consists of information that is not dedicated to a specific user or a specific group of users. It includes information required to decode the user-specific control. Non-user-specific control information that is not carried in the BCH may be included in this category.

The size of the USCCH region is indicated in the Non-user-specific control information, in the unit of LRU. The detailed information included in non-user specific information is FFS.

CRC of Non-user-specific control information elements are masked by a pre-defined ID so that AMS is able to identify it out during blind decoding procedure. Non-user-specific control IE is located starting from the lowest LRU index and with multiple size options, e.g. 1,2,4,8 MRBs, as specified in 15.3.x.3.4.

The size and number of Non-user-specific control information elements are variable, and AMS could detect the format out by blind decoding.

15.3.x.3.1.2 User-specific control information

User specific control information consists of information intended for one user or more users. It includes resource allocation, power control information, HARQ ACK/NACK information. HARQ ACK/NACK information for uplink data transmission is carried by DL ACK channel which is separated from control blocks for other user specific control information.

Resources can be allocated persistently to AMSs. The periodicity of the allocation may be configured.

Group control information is used to allocate resources and/or configure resources to one or multiple mobile stations within a user group. Each group is associated with a set of resources. The group message contains bitmaps to signal resource assignment, MCS, resource size etc. VoIP is an example of the subclass of services that use group messages.

15.3.x.3.1.2.1 Resource allocation information in USCCH IE

Resource allocation information in USCCH IE is FFS.

15.3.x.3.2 Multiplexing scheme for data and unicast service control

Within a subframe, control and data channels are multiplexed using FDM. Both control and data channels are transmitted on logical resource units (LRU) that span all OFDM symbols in a sub-frame.

15.3.x.3.3 Location of control blocks

The first Advanced Air Interference DL subframe of each frame contains at least one USCCH region. A USCCH region can include both non-user specific and user specific control information. In case of multiple frequency partitions defined, each frequency partition may contain one USCCH region. As specified in 15.3.5, the frequency reuse factor of FP0 is 1, and the frequency reuse factors of FP1~3 are 3. If an AMS is not sensitive to interference, the USCCH for the AMS could be transmitted in FP0 to improve efficiency; otherwise, it could be put in FPi (i>0) to reduce interference. The size information of each USCCH region is transmitted in the beginning of each USCCH region.

To reduce the blind-detection complexity, ABS could use explicit or implicit method to allow some AMSs only decode the USCCH region in a single frequency partition and ignore the rest frequency partitions. The “switching” between FPs relies on ABS’s observation on AMS’ channel quality (or SINR). E.g., when an AMS is in high-interference scenario, according to ABS’ observation, ABS could indicate that AMS only needs to decode the

USCCH and data in FPi. Then, AMS does not need to decode FP0 until ABS's further indication. The "switching" could be performed by simple handshake signaling between ABS and AMS, and could be initiated by either ABS or AMS.

USCCH regions are located 'n' subframes apart. If subframe N contains USCCH region(s), the next subframe which contains USCCH region(s) is the subframe N+n of the same frame. DL data allocations corresponding to the USCCH region can correspond to resources in any subframes between successive USCCH regions. The values of n can be 1 or 2. Other values of n (3 and 4) are FFS. For example, for n=2, USCCH region in subframe N can point to resource allocation in subframe N or N+1 and the next USCCH region is in subframe N+2. If a USCCH region is allocated in subframe N and contains the specification for UL data allocations, the corresponding UL data allocations occur in subframe TBD.

In the FDD mode, the first IEEE 802.16m DL subframe of each frame contains user-specific control information. In the TDD mode, the first IEEE 802.16m DL subframe after each UL to DL transition contains user-specific control information.

15.3.x.3.4 USCCH mini-RB

USCCH Mini-RB (MRB) is defined as the basic PHY resource unit in USCCH region. Each LRU is consist of multiple MRBs. The size of MRB is FFS. Each USCCH may contain 1,2,4 or 8 MRBs.

15.3.x.3.5 Transmission format

Non-user-specific control information is encoded separately from the user-specific control information.

For user-specific control information elements intended for a single user or a group of users, multiple information elements are coded separately. The modulation and coding scheme (fixed/variable) of each information element is FFS.

Non-user-specific control information in a USCCH region is transmitted at a fixed MCS for a given system configuration.

The modulation scheme used for USCCH non-user-specific control information is QPSK. And the channel coding rate could be variable according to different messages but no larger than 2/3 [TBD] where channel coding rate is defined as number of USCCH IE payload bits (including CRC) divided by the number of physical channel bits on the USCCH.

15.3.x.3.6 Resource allocation (physical to logical mapping, pilots, block size*)*

FFS.

15.3.x.3.7 AMS Blind Decoding Procedure on USCCH

AMS shall start blind decoding procedure on the USCCH regions in all FPs whenever it is in active mode or available duration in sleep mode. With ABS's explicitly indication, AMS may ignore some USCCH regions in particular FPs.

For USCCH region in each FP, AMS shall firstly decode the 1st USCCH which indicates the size of this USCCH region, $N_{\mathrm{MRB},k,n}$ for FP n subframe k. The payload bit number is 4 [TBD] in 1st USCCH. And the transmission format of 1st USCCH is the same to that of PBCH. Hence the number of MRB used for the 1st USCCH is pre-known by all AMSs, the detail number is FFS.

The USCCH region in any particular FP consists of a set of MRBs, numbered from 0 to $N_{\mathrm{MRB},k,n}-1$. The MRB used for 1st USCCH is excluded from the numbering. AMS shall monitor a number of USCCH candidates for control information, where monitoring means attempting to decode each of the USCCH in the set according to all types of USCCH IE. The maximum coding rate of any USCCH is no larger than 2/3.

The number of USCCH candidates to monitor is defined in terms of search spaces, where a search space $S_{k,n}^{(L)}$ at aggregation level $L \in \{1,2,4,8\}$ is defined by a set of USCCH candidates for FP n and subframe k. The MRBs corresponding to USCCH candidate m of the search space $S_{k,n}^{(L)}$ are given by

$$L\left\{\left(Y_{k,n}+m\right)\bmod\left\lfloor N_{MRB,k,n}/L\right\rfloor\right\}+i$$

where $Y_{k,n}$ is defined below, $i=0,\cdots,L-1$ and $m=0,\cdots,M^{(L)}-1$. $M^{(L)}$ is the number of USCCH candidates to monitor in the given search space $S_{k,n}^{(L)}$. The detail number of $M^{(L)}$ is FFS.

For the non-user specific USCCH IE search spaces, $Y_{k,n}$ is set to 0 for the two aggregation levels $L=4$ and $L=8$. Notice that non-user specific USCCH IE is not allowed in FP0.

For the user specific USCCH IE search spaces $S_k^{(L)}$ at aggregation level L, the variable Y_k is defined by

$$Y_{k,n}=\left(AY_{k-1,n}\right)\bmod D$$

where $Y_{-1,n}=\left(MSID+nA\right)\bmod D$, $A=39749$ and $D=65537$, n is the frequency partition index.

If AMS is in a group, to detect Group Resource Allocation, the user specific search spaces $S_k^{(L)}$ shall be expanded to:

$$\left\{L\left\{\left(Y_{k,n}+m\right)\bmod\left\lfloor N_{MRB,k,n}/L\right\rfloor\right\}+i\right\}\cup\left\{L\left\{\left(Y_{k,n}'+m'\right)\bmod\left\lfloor N_{MRB,k,n}/L\right\rfloor\right\}+i'\right\}$$

where $Y_{k,n}'=\left(AY_{k-1,n}'\right)\bmod D$, and $Y_{-1,n}'$ is assigned by ABS which is same to all AMSs within the group in a particular subframe, $i'=0,\cdots,L-1$ and $m=0,\cdots,M^{(L)}'-1$. $M^{(L)}'$ is the number of USCCH candidates to monitor in the given search space $S_{k,n}^{(L)}$, which is assigned by ABS while adding the AMS into that group.

The search space for non-user and user specific USCCH IE could be overlapped with each other, which is illustrated in Figure 1.

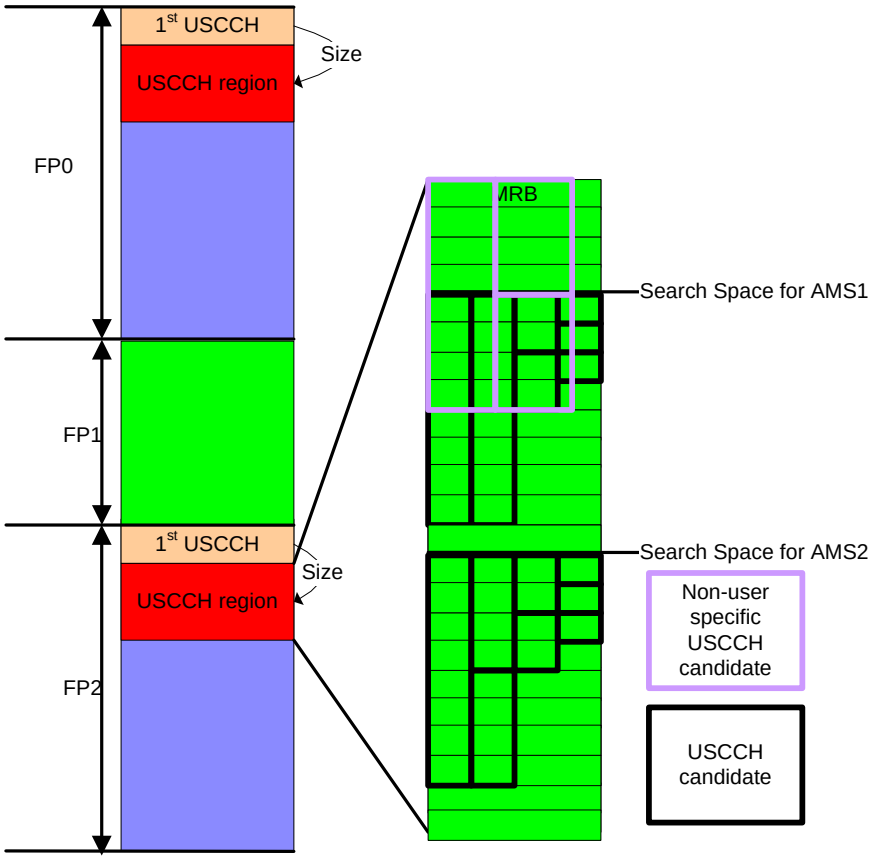

Figure 1 Search Space for USCCH blind decoding

15.3.x.4 MSCCH

<Note: this section will be filled after USCCH design is agreed.>

15.3.x.5 Transmission of additional broadcast information

<Note: this section will be filled after PBCH/SBCH design is agreed.>

15.3.x.5 Multicarrier Control

<Note: We suggest to define Multicarrier control after single carrier control is defined.>

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