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Re:	[Call for comment for AWD, session 62, ballot ID: tgmwrkdoc]
Abstract	[Provide detailed rationale for proposed for new IEEE802.16m OFDMA numerology.]
Purpose	[To discuss and accept the proposed solution in this contribution, and adopt the solution text of this contribution into the AWD baseline document 80216m-09_0010r2.doc.]
Notice	
Release	
Patent Policy	

IMT-Advanced Convergence Proposal on OFDM Numerology

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Introduction

The two major competing IMT-Advanced technologies are based on LTE-Advanced and IEEE 802.16m. 3GPP is developing IMT-Advanced specification based on newly completed Long Term Evolution (LTE) standard as to be adopted as 4G standard. The air interface specification of WiMAX has been provided by IEEE 802.16 standard. The IEEE 802.16 Task Group m (TGm) is actively developing evolutionary specification based on existing IEEE 802.16 and WiMAX profile for IMT-Advanced submission. However, LTE and IEEE 802.16 have adopted different values of subcarrier spacing. LTE has fixed its subcarrier spacing to 15 KHz, but IEEE 802.16 has made its subcarrier spacing a variable for different sets of system bandwidths, namely 10.9375 KHz, 7.8125 KHz, 9.765625 KHz, and the list can go on.   It is critical that the design of IEEE 802.16m can satisfy the critical needs for a cost-effective and performance competitive global technology in order to enable IEEE 802.16m to be well into the future.   Meeting these needs will require some balance between how IEEE 802.16m may be constrained by the requirement to support legacy mobile stations while still providing the best solution to expand its ecosystem as a global IMT-Advanced technology. In addition, adapting a fixed subcarrier spacing scheme, will allow 16m to co-exist with other IMT-Advanced technologies.

Problem Statement

In current Amendment text, the subcarrier spacing is kept the same as in legacy systems, namely, it is a variable for different sets of system bandwidths. It is designed to allow backward compatibility to the legacy systems, however, it has the following issues:

- Different system profiles needed to support different BW, which leads to re-design of silican for each BW set and making IOT and certification an impossible task. In addition, global roaming will be problematic if different BWs are used at different regions.
- Lowe spectral efficiency due to unused guard subcarriers (guard bands). This problem exists for current 802.16m design as well as 802.16e and LTE/LTE-Advanced.
- Capacity loss in mutli-carrier deployment due to non-aligned subcarriers in adjacent carriers.
- Lack of mutli-carrier scalability for multi-carrier deployment.
- Frame structure needs to be re-designed to support different CP ratio
- The current 16m frame design based on legacy numerology is not time aligned with LTE subframe design. This will create issues when 16m co-exist with LTE and TD-SCDMA.

Proposed Solution

To address the issues listed in Problem Statement, this contribution proposes to a green field 16m physical layer design based on fixed subcarrier spacing of 12.5kHz. With fixed subcarrier spacing of 12.5kHz, 16m frame structure can be designed to align with LTE-Advance frame structure using 1ms subframes. In addition, the switch points of 16m frames can be flexibly defined to co-exist with LTE-Advance system even in the same frequency band. A reduced subcarrier spacing Δf_{low} = 6.25 kHz can also be supported for low mobility and Multicast Broadcast Services dedicated cell, and an increased subcarrier spacing Δf_{hi} = 25 kHz, for extremely high mobility coverage such as to cover bullet train. Table 1 lists the common set of OFDM numerology proposed by this contribution.

The TDD and FDD channel interference issue remains a very challenging and controversial problem for today's frequency and technology agnostic band plans. The proposed solution in this contribution will be able to address this problem. Since there is no out-of-band interference between the TDD and FDD channels, the RF band filter only needs to handle the receiver desensitization issue. This is a much smaller problem comparing with the traditional out-of-band interferences between the TDD and FDD channels, especially for a receiver with a very high dynamic range. The examples of TDD and FDD coexistence are illustrated in Figure 1 and Figure 2.

Table 1. Proposed common 12.5 KHz subcarrier spacing and sampling frequency

Parameter	Unit	Parameter Values
Sub-carrier Spacing (Δf)	KHz	12.5
Sampling Frequency (Fs)	MHz	25.6
FFT size		2048

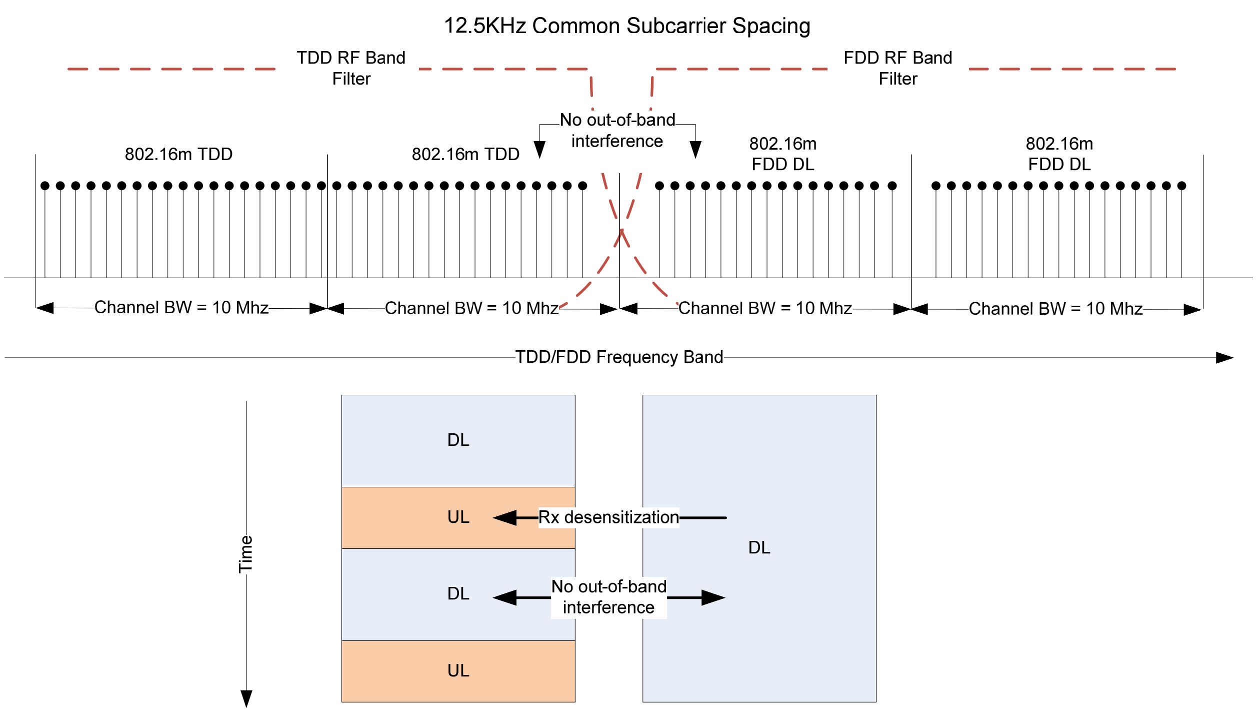

Figure 1. Example of IEEE 802.16m TDD channels coexist with IEEE 802.16m FDD downlink channels

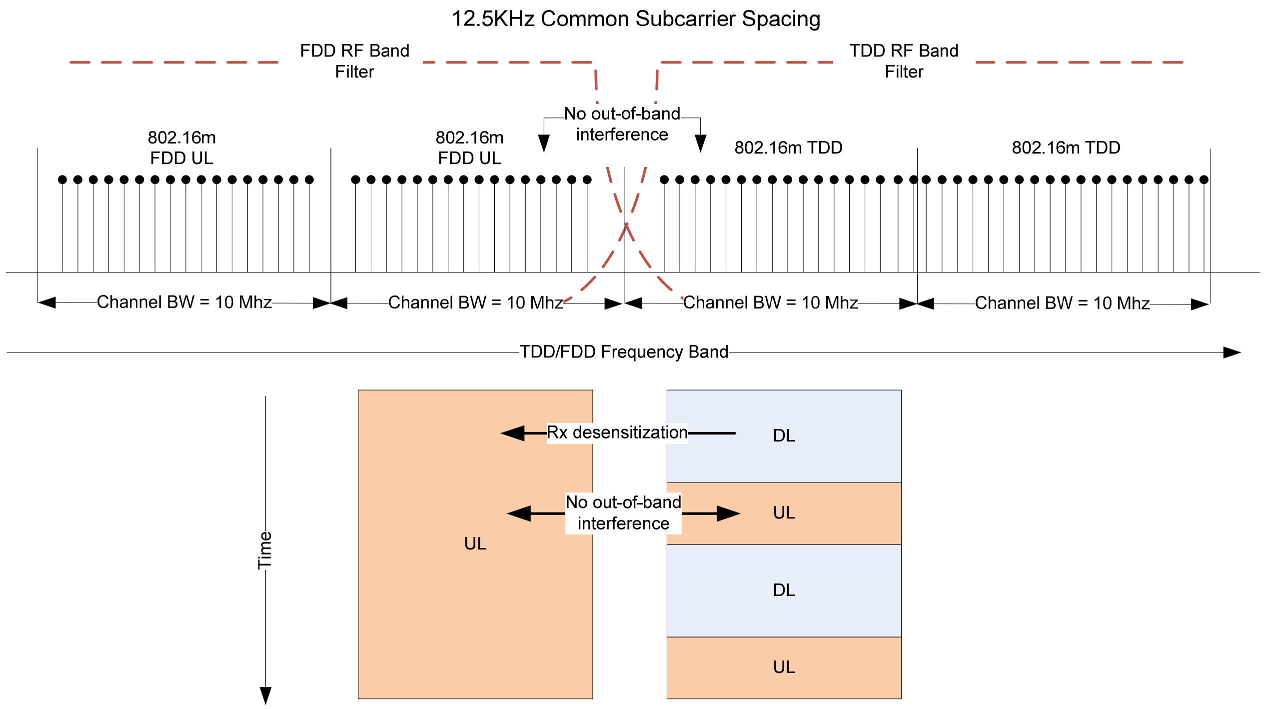

Figure 2. Example of IEEE 802.16m TDD channels coexist with IEEE 802.16m FDD uplink channels

Table 2 below provides a summary comparing how the new 12.5-kHz subcarrier spacing compares with the various options of retaining the current subcarrier spacing(s) in meeting key design considerations for 802.16m.

Table 2. Comparison of 12.5 KHz subcarrier spacing with other solutions

Key Design Considerations	Design Approach for 16m & LTE-Advanced Subcarrier Spacing		
	New 12.5 kHz	Retain Current 16e & LTE Subcarrier Spacings	
		Multiple Spacings 'As Is' (16e)	15 kHz (LTE)
Greenfield (Legacy-free) Considerations			
Lower Hardware Cost	√	X	√
Simplified Global Roaming	√	X	√
Maximize usable bandwidth within carrier adjacent multi-carrier scenarios	√ (1)	X	X (2)
Enable efficient adjacent multicarrier operation with different bandwidths	√	X	X (2)
Enable multicarrier overlay scenarios of different bandwidths	√	X	X
Simplified adaptation to new carrier bandwidths (e.g. 6/12 MHz)	√	X	√-- (3)

Legacy Support Considerations			
Legacy support via TDM multiplexing between 16e and 16m, or between LTE and LTE-Advanced	√	√	√
Legacy support via FDM multiplexing between 16e and 16m	√-- (4)	√- (5)	N/A
16e and 16m or LTE and LTE-Advanced sharing of same freq/time area	√-- (6)	√- (7)	√ (8)
Less hardware re-design	√- (9)	√- (10)	√- (10)
Legacy support of LTE and TD-SCDMA	√	X	√
Inter-RAT Co-existence Considerations			
Ease of co-existence with other IMT-Advanced Technologies (e.g. LTE) with Frame Slot Time Alignment	√	x (11)	x (11)
Reduce interference between TDD and FDD channels within the same frequency band	√	X	X

NOTES

√ indicates is able to satisfy

√- indicates is able to satisfy but with some undesirable constraints

√-- indicates is able to satisfy but not preferred due to significant drawbacks

X indicates is not feasible or not practical

(1) Alignment of subcarrier spacing between adjacent subcarriers allow full carrier bandwidth to be utilized if adjacent carriers are 16m … resulting in >8% improvement in available used bandwidth.

(2) Also results in additional loss due to guard bands required between edges of adjacent carriers since carrier bandwidths are not divisible evenly by the raster. It might have been possible with a change in carrier centering from current assignments based on 200 or 250-kHz raster to new centers based on new raster (e.g. 300 kHz) that is divisible evenly by 15 kHz. However, 300 kHz will not fit any frequency bands in the world, at least it is not a generic channel raster.

(3) Some efficiency loss since 15 kHz subcarrier spacing does not divide most of available carrier bandwidths within spectrum band/block. A channel RF filter is needed to reduce out-of-band emission. On the other hand, the new 12.5 kHz subcarrier can divide any carrier bandwidths in any spectrum band/ block in the world, and no channel RF filters are required.

(4) Can be done with additional hardware for parallel FFTs for different subcarrier spacings, coordinated subcarrier assignment for 16m & 16e, and sufficient guard subcarriers between 16e and 16m used subcarriers. Also, same constraints as (5).

(5) Can be done but can constrain subcarrier arrangement options on 16m subcarriers for 16e distributed subcarrier permutations (e.g. PUSC). The resource blocks are different defined in 16m and 16e, FDM is practically unworkable, not mention 7/14 or 8.75 MHZ bandwidths.

(6) 16e and 16m support via TDM multiplexing between 16e and 16m in the same RF channel.

(7)	Maximizes resource sharing between 16e and 16m but 16m MSs need to operate in a combined 16e/16m mode (tight coupling to 16e). BS has to support both 16e and 16m at the same time. With new releases of 16e and 16m in the future, it make it very challenge to design and support such BS.
(8)	No such requirements, but it can be done via TDM multiplexing.
(9)	Complexity of change depends heavily on current design … designs for multiple subcarrier spacing/sampling freq. are well understood and not complex.
(10)	It is unclear that there won't be hardware changes/upgrades required due to other major PHY and/or MAC design changes for 16m - most likely there will be major hardware changes. The similar reason goes to LTE-Advanced. However LTE-Advanced may expect smaller changes in PHY/MAC.
(11)	Zone and subframe boundaries based on current numerology do not line up well with LTE frame element timings. Major problem expected for TDD mode. Even in FDD, a tight RF channel filter is needed to reduce out-of-band emission. Adopting the same 12.5 kHz subcarrier spacing, No RF channel filters are needed for any two systems in different bandwidths for adjacent channel co-existence.

Proposed Text

[On page 112, line 55, modify the text as following]

The following four primitive parameters characterize the OFDMA symbol except when the optional PHY mode with fixed subcarrier spacing is selected. When optional PHY mode with fixed subcarrier spacing is selected, the primitive parameters are defined in subclause 15.3.2.3.1.

[Page 112, line 65, insert new subclause 15.3.2.3.1 Primitive parameters with fixed subcarrier spacing]

15.3.2.3.1 Primitive parameters with fixed subcarrier spacing

This optional PHY mode should be used for Greenfield deployment. The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 12.5 kHz. In addition there are also a reduced subcarrier spacing Δf_{low} = 6.25 kHz, only for low mobility and Multicast Broadcast Services dedicated cell, and an increased subcarrier spacing Δf_{hi}= 25 kHz, for extremely high mobility coverage such as to cover bullet train.

Table aaa Basic OFDM numerology

Parameter	Unit	Parameter Values
Sub-carrier Spacing (Δf)	KHz	12.5
Optional sub-carrier Spacing (Δf_{low}, Δf_{hi})	KHz	6.25, 25
Sampling Frequency (Fs)	MHz	25.6
Sampling Period (Ts)	µs	0.0390625
Number of Ts for 10ms	Ts	256000
FFT size		2048

[Page 113, line 4, modify text as following]

The following parameters are defined in terms of the primitive parameters of 15.3.2.3 except when the optional PHY mode with fixed subcarrier spacing is selected. When optional PHY mode with fixed subcarrier spacing is selected, the primitive parameters are defined in subclause 15.3.2.4.1

[Page 114, line 24, insert new subclause 15.3.2.4.1 Derived parameters for fixed subcarrier spacing]

15.3.2.4.1 Derived Parameters for fixed subcarrier spacing

In the case of 12.5 kHz sub-carrier spacing there are 4 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 12, 10, 11, and 9 OFDM symbols per subframe respectively.

- Normal cyclic prefix 1: T_{CP1} = 85×Ts (OFDM symbol #0 to #11) = 3.3203125 μs, cyclic postfix = 4×Ts = 0.15625 μs
- Extended cyclic prefix 2: T_{CP2} = 512×Ts (OFDM symbol #0 to #9) = 20 μs
- Cyclic prefix 3: T_{CP3} = 279×Ts (OFDM symbol #0 to #10) = 10.8984375 μs, cyclic postfix = 3×Ts = 0.1171875 μs
- Cyclic prefix 4: T_{CP4} = 796×Ts (OFDM symbol #0 to #8) = 31.09375 μs, cyclic postfix = 4×Ts = 0.15625 μs

where $T_s = 1/(2048 \times \Delta f)$Normal cyclic prefix 1

In the case of 6.25 kHz sub-carrier spacing there are 2 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 6, and 5 OFDM symbols per subframe respectively.

- Low Δf cyclic prefix 1: $T_{CP\text{-}low1}$ = 170×Ts (OFDM symbol #0 to #5) = 6.640625μs, cyclic postfix = 4×Ts = 0.15625 μs
- Low Δf cyclic prefix 2: $T_{CP\text{-}low1}$ = 1024×Ts (OFDM symbol #0 to #4) = 40μs

In the case of 25 kHz sub-carrier spacing there are 2 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 21, and 15 OFDM symbols per subframe respectively.

- High Δf cyclic prefix 1: $T_{CP\text{-}hi1}$ = 195×Ts (OFDM symbol #0 to #20) = 7.6171875μs, cyclic postfix = 1×Ts = 0.0390625 μs
- High Δf cyclic prefix 2: $T_{CP\text{-}hi2}$ = 682×Ts (OFDM symbol #0 to #14) = 26.640625 μs, cyclic postfix = 10×Ts = 0.390625 μs
- High Δf cyclic prefix 3: $T_{CP\text{-}hi3}$ = 89×Ts (OFDM symbol #0 to #22) = 3.4765625μs, cyclic postfix = 1×Ts = 0.0390625 μs
- High Δf cyclic prefix 4: $T_{CP\text{-}hi4}$ = 398×Ts (OFDM symbol #0 to #17) = 15.546875μs, cyclic postfix = 4×Ts = 0.15625 μs

Table bbb OFDMA parameters

Sub-carrier Spacing (Δf, Δf_{low}, Δf_{hi})	**KHz**	**12.5**	**6.25**	**25**
Subframe Duration	**ms**	**1**	**1**	**1**
Number of Ts	**ms**	25600	25600	25600

CP Length (T_{CP})	**Normal CP1**	**T_s**	85	170	195
	Extended CP2	**T_s**	512	1024	682
	CP3	**T_s**	279	-	89
	CP4	**T_s**	796	-	398
Number of OFDM Symbols Per Subframe		**N_{CP1}**	12	6	21
		N_{CP2}	10	5	15
		N_{CP3}	11	-	23
		N_{CP4}	9	-	18
Extra Samples for Subframe Idle Time	**n_{CP1}**	**T_S**	4	4	1
	n_{CP2}		0	0	10
	n_{CP3}		3	-	1
	n_{CP4}		4	-	4

All frequency bandwidths are supported. The following table provides the example of the existing frequency band plans.

Table ccc Example of supported system bandwidths

Parameter		**Unit**	**Parameter Values**							
Channel Bandwidth (BW)		MHz	1.4	2.5	3	3.5	5	6	7	8
Number of Used sub-carriers (Nused)	N_{sc}^{RB} **=16**		112	192	240	272	400	480	560	640

Parameter		**Unit**	**Parameter Values (Continue)**							
Channel Bandwidth (BW)		MHz	8.75	10	11	12	14	15	20	40
Number of Used sub-carriers (Nused)	N_{sc}^{RB} **=16**		688	800	880	960	1120	1200	1600	3200

[On page 115, line 31, insert the following text at beginning of subclause 15.3.3.1.]

This subclause defines the basic frame structure for advance air interface except when the optional PHY mode with fixed subcarrier spacing is selected. When optional PHY mode with fixed subcarrier spacing is selected, the primitive parameters are defined in subclause 15.3.3.1.1

[On page 116, line 26, insert new subclause 15.3.3.1.1 Basic frame structure with fixed subcarrier spacing, and replace it with the following text.]

15.3.3.1.1. Basic Frame structure with fixed subcarrier spacing

The advanced air interface basic frame structure is illustrated in Figure eee for FDD mode and Figure fff for TDD mode. Each 20 ms superframe is divided into four equally-sized 5 ms radio frames. Each 5 ms radio frame further consists five equally-sized 1 ms subframes. According to the different configurations in Table bbb, the number of symbols in a suframe can be different.

In the case of 12.5 kHz sub-carrier spacing there are 4 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 12, 10, 11, and 9 OFDM symbols per subframe respectively.

- Normal cyclic prefix 1: T_{CP1} = 85×Ts (OFDM symbol #0 to #11) = 3.3203125 µs, cyclic postfix = 4×Ts = 0.15625 µs
- Extended cyclic prefix 2: T_{CP2} = 512×Ts (OFDM symbol #0 to #9) = 20 µs
- Cyclic prefix 3: T_{CP3} = 279×Ts (OFDM symbol #0 to #10) = 10.8984375 µs, cyclic postfix = 3×Ts = 0.1171875 µs
- Cyclic prefix 4: T_{CP4} = 796×Ts (OFDM symbol #0 to #8) = 31.09375 µs, cyclic postfix = 4×Ts = 0.15625 µs

  where $T_s = 1/(2048 \times \Delta f)$

In the case of 6.25 kHz sub-carrier spacing there are 2 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 6, and 5 OFDM symbols per subframe respectively.

- Low Δf cyclic prefix 1: $T_{CP\text{-}low1}$ = 170×Ts (OFDM symbol #0 to #5) = 6.640625µs, cyclic postfix = 4×Ts = 0.15625 µs
- Low Δf cyclic prefix 2: $T_{CP\text{-}low1}$ = 1024×Ts (OFDM symbol #0 to #4) = 40µs

In the case of 25 kHz sub-carrier spacing there are 2 cyclic-prefix (CP) lengths. These are CP choices for a 1-ms subframe, corresponding to 21, and 15 OFDM symbols per subframe respectively.

- High Δf cyclic prefix 1: $T_{CP\text{-}hi1}$ = 195×Ts (OFDM symbol #0 to #20) = 7.6171875µs, cyclic postfix = 1×Ts = 0.0390625 µs
- High Δf cyclic prefix 2: $T_{CP\text{-}hi2}$ = 682×Ts (OFDM symbol #0 to #14) = 26.640625 µs, cyclic postfix = 10×Ts = 0.390625 µs
- High Δf cyclic prefix 3: $T_{CP\text{-}hi3}$ = 89×Ts (OFDM symbol #0 to #22) = 3.4765625µs, cyclic postfix = 1×Ts = 0.0390625 µs
- High Δf cyclic prefix 4: $T_{CP\text{-}hi4}$ = 398×Ts (OFDM symbol #0 to #17) = 15.546875µs, cyclic postfix = 4×Ts = 0.15625 µs

Table ddd Parameters of Frame Structure with fixed subcarrier spacing

Sub-carrier Spacing (Δf, Δf_{low}, Δf_{hi})		KHz	12.5	6.25	25
Subframe Duration		ms	1	1	1
Number of Ts		ms	25600	25600	25600
CP Length (T_{CP})	Normal CP1	T_s	85	170	195
	Extended CP2	T_s	512	1024	682
	CP3	T_s	279	_	89
	CP4	T_s	796	_	398
Number of OFDM Symbols Per Subframe		N_{CP1}	12	6	21
		N_{CP2}	10	5	15
		N_{CP3}	11	_	23
		N_{CP4}	9	_	18
Extra Samples for Subframe Idle Time	n_{CP1}	T_S	4	4	1
	n_{CP2}		0	0	10
	n_{CP3}		3	_	1
	n_{CP4}		4	_	4

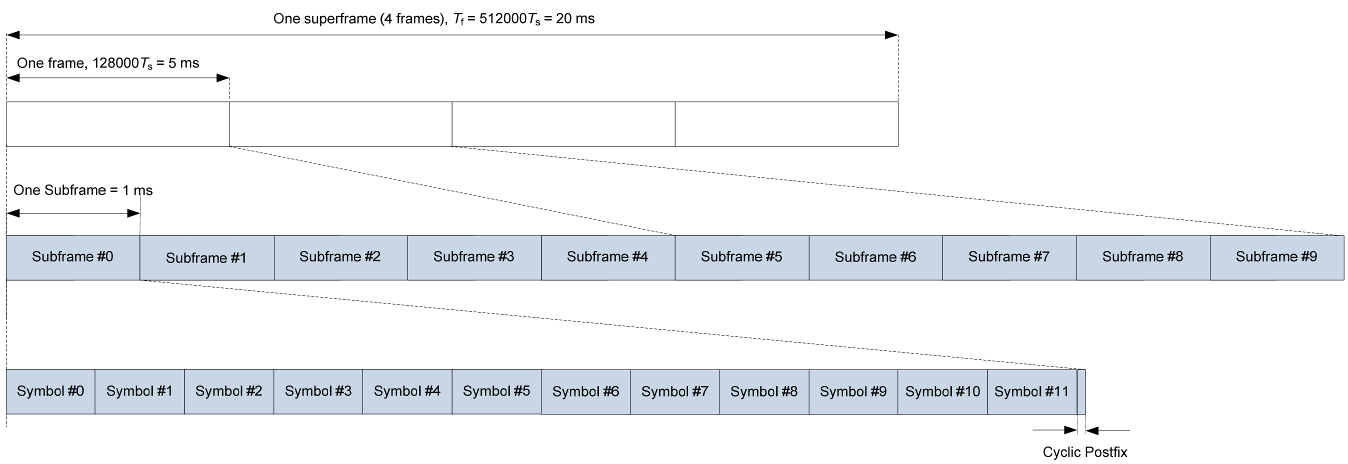

Figure eee Basic frame structure for FDD mode

For Type TDD mode, a subframe is also the smallest unit to be configurable for downlink and uplink transmission. As shown in Figure 7, Subframe# 0 is always reserved for downlink transmission. Starting from Subframe# 1, each subframe can be configurable for downlink or uplink transmission. For each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmission, "U" denotes the subframe is reserved for uplink transmission. The concept of slots is only used to describe the dimensions of resource blocks.

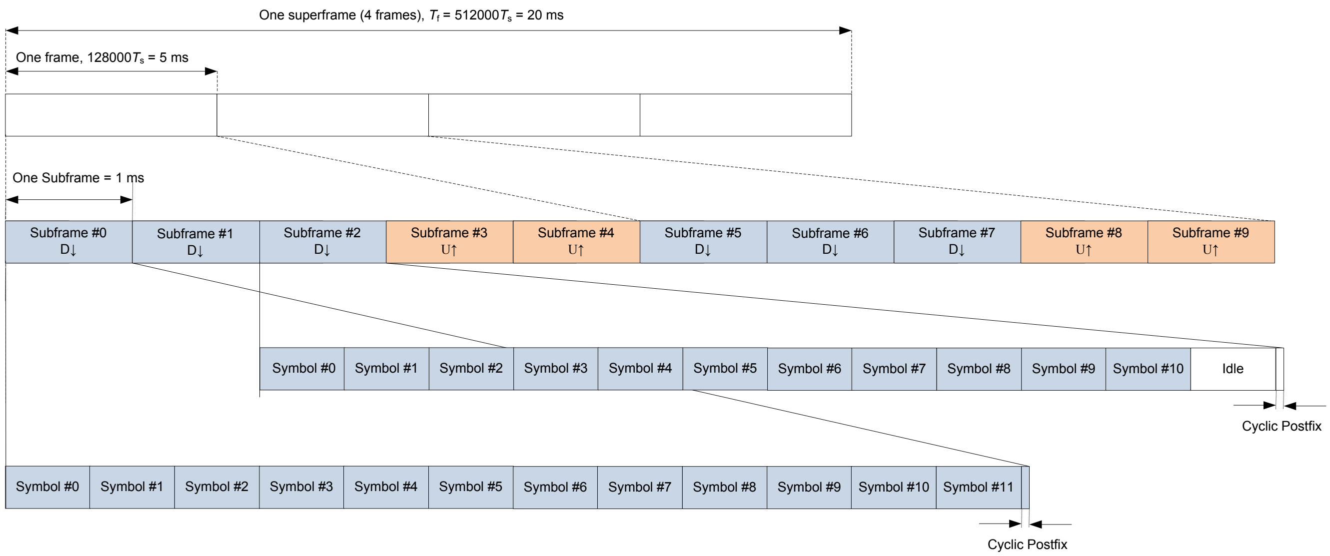

Figure fff. Frame Structure Type for TDD mode

Downlink-uplink configurations with 5 ms, 10 ms, and 20 ms downlink-to-uplink switch-point periodicity are supported. In case of 5 ms downlink-to-uplink switch-point periodicity, the switch-point exists in each frame. In case of 10 ms downlink-to-uplink switch-point periodicity, the switch-point exists in only one of the two frames. In case of 20 ms downlink-to-uplink switch-point periodicity, the switch-point only exists in one of the four frames. Multiple switch-points are also supported within a 5-ms frame as optional features to support such as extremely high mobility performance where very fast feedbacks are required.

Table ggg shows superframe configuration, where "D" denotes the frame is reserved for downlink transmission, "U" denotes the frame is reserved for uplink transmission. "X" and "Y" denotes the frame can be configured as indicated by the Frame Configuration Index. The detail frame configurations are shown in Table hhh.

Table ggg. TDD superframe configurations index

Superframe Configuration Index (SCI)	Frame number			
	0	1	2	3
0	X	Y	X	Y
1	X	D	X	D
2	D	D	D	X
3	X	U	X	U

Table hhh. Frame structure uplink-downlink configurations index

Frame Configuration Index (FCI)	Switch-point Periodicity	Subframe number of "X (0-4),Y (5-9)" frame									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	D	D	U	U	D	D	U	U	U
1	5 ms	D	D	D	U	U	D	D	D	U	U
2	5 ms	D	D	D	D	U	D	D	D	D	U
3	5 ms	D	D	U	U	U	D	D	U	U	U
4	>5 ms	D	D	D	D	D	D	D	D	D	D
5	≤3 ms	D	D	U	D	U	D	D	U	D	U
6	≤3 ms	D	D	U	D	U	D	U	U	D	U
7	2 ms	D	U	D	U	D	U	D	U	D	U
8	≤3 ms	D	U	U	D	U	D	U	U	D	U
9	5 ms	D	S	U	U	U	D	S	U	U	U
10	5 ms	D	S	U	U	D	D	S	U	U	D
11	5 ms	D	S	U	D	D	D	S	U	D	D
12	10 ms	D	S	U	U	U	D	D	D	D	D
13	10 ms	D	S	U	U	D	D	D	D	D	D
14	10 ms	D	S	U	D	D	D	D	D	D	D
15	5 ms	D	S	U	U	U	D	S	U	U	D

The TDD adjacent channel coexistence with other radio access technologies, such as Long Term Evolution (LTE), can also be resolved by TDD mode with Frame Configuration Index 9 to 15, where “S” denotes the subframe is configured as the special subframe. These configurations can be used to inline the downlink-to-uplink switch-points with that of LTE TDD system. The smallest switch-point periodicity is 2 ms to allow channel fast feedback mechanism.

When a network is deployed, a superframe is often configured to a default system profile. However, a superframe can change its frame structure via superframe control signaling. There are many different superframe and frame configurations are available for different networks deployment. However, it is believed that only limited set of configurations are practically used within a particular network. In order to minimize the number of bits for superframe and frame configurations to be transmitted in the air by superframe header the trie data structure is used to broadcast configurations information. If the network is operating in default configuration, only one bit is transmitted in the air to indicate that the superframe and frames are configured in default mode. The example is shown in Table iii; the values of Superframe Configuration Index (SCI) and Frame Configuration Index (FCI) in the Figure ggg are selected for illustration purpose.

Table iii. Trie data structure representation of superframe & frame configurations

Bit#0 = 0	System Default Configuration#0: SCI=x0, FCI=y0		
Bit#0 = 1	**Bit#1 = 0, Bit#2 = 0**	Configuration#1: SCI=x1, FCI=y1	
	Bit#1 = 0, Bit#2 = 1	Configuration#2: SCI=x2, FCI=y2	
	Bit#1 = 1, Bit#2 = 0	Configuration#3: SCI=x3, FCI=y3	
	Bit#1 = 1, Bit#2 = 1	**Bit#3 = 0, Bit#4 = 0, Bit#5 = 0**	Configuration#4: SCI=x4, FCI=y4
		Bit#3 = 0, Bit#4 = 0, Bit#5 = 1	Configuration#5: SCI=x5, FCI=y5
		Bit#3 = 0, Bit#4 = 1, Bit#5 = 0	Configuration#6: SCI=x6, FCI=y6
		Bit#3 = 0, Bit#4 = 1, Bit#5 = 1	Configuration#7: SCI=x7, FCI=y7
		Bit#3 = 1, Bit#4 = 0, Bit#5 = 0	Configuration#8: SCI=x8, FCI=y8
		Bit#3 = 1, Bit#4 = 0, Bit#5 = 1	Configuration#9: SCI=x9, FCI=y9
		Bit#3 = 1, Bit#4 = 1, Bit#5 = 0	Configuration#10: SCI=x10, FCI=y10
		Bit#3 = 1, Bit#4 = 1, Bit#5 = 1	Configuration#11: SCI=x11, FCI=y11

Note: Notations of x0 to x11 in above table are representation of Superframe Configuration Index values, and y0 to y11 are representation of Frame Configuration Index values.

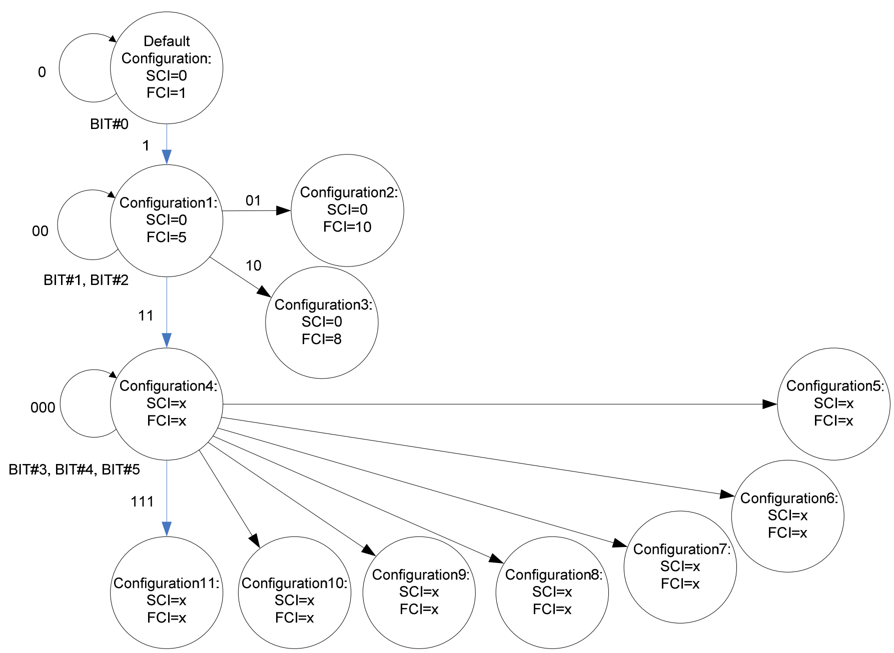

Figure ggg. Superframe & frame configurations with trie data structure

[On page 145, line 15, modify section 15.3.5.4.1.. as following]

The section specifies the pilot pattern except when the optional PHY mode with fixed subcarrier spacing is selected. When optional PHY mode with fixed subcarrier spacing is selected, the pilot patterns are defined in subclause 15.3.5.4.1.

[On page 151, line 45, insert section 15.3.5.4.1.1. as following]

15.3.2.4.1 Pilot patterns for fixed subcarrier spacing

The pilot patterns are specified within a PRU.

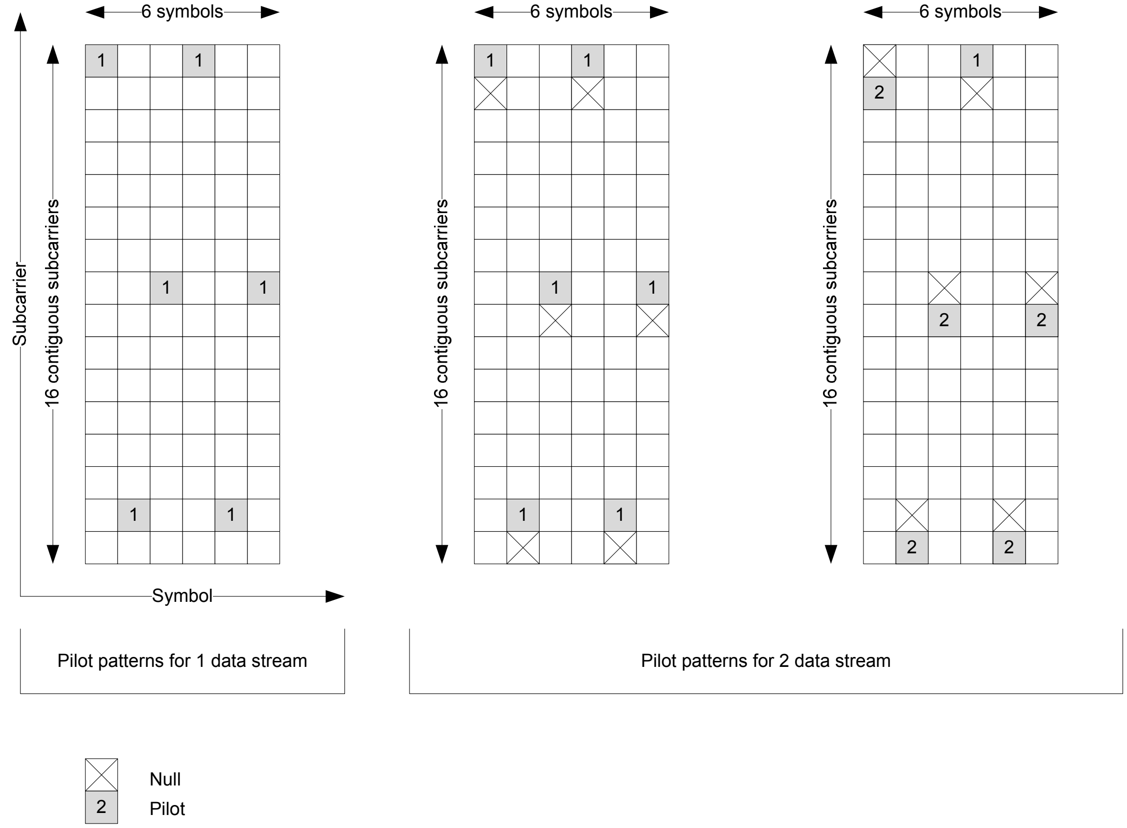

Figure iii. Pilot patterns for 1 and 2 data streams

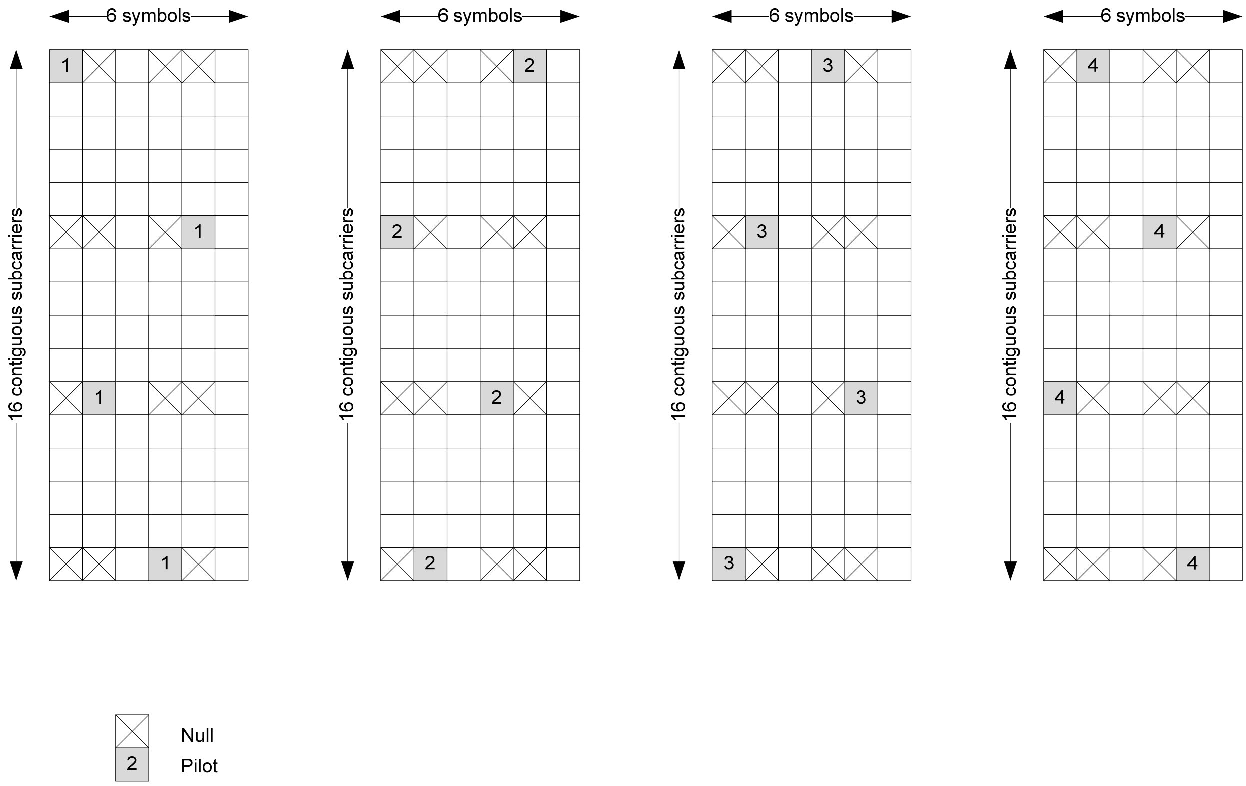

Figure jjj. Pilot patterns for 4 data streams

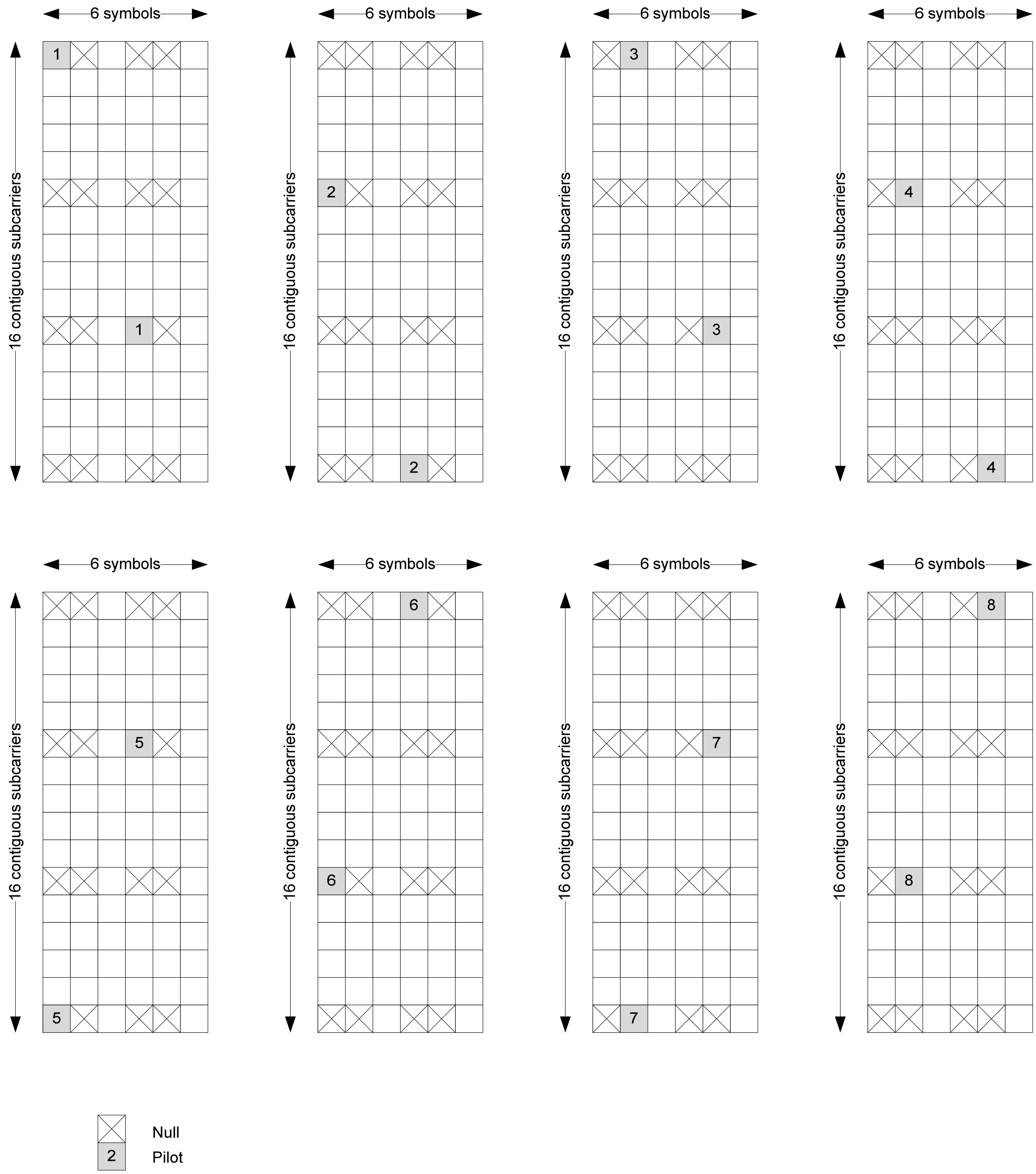

Figure kkk. Pilot patterns for 8 downlink only data streams

For N_{symb}=5, the last symbol of the pilot patterns as shown in Figure iii or Figure jjj is deleted. Similarly for N_{symb}=3, the last three symbols of the pilot patterns are deleted.

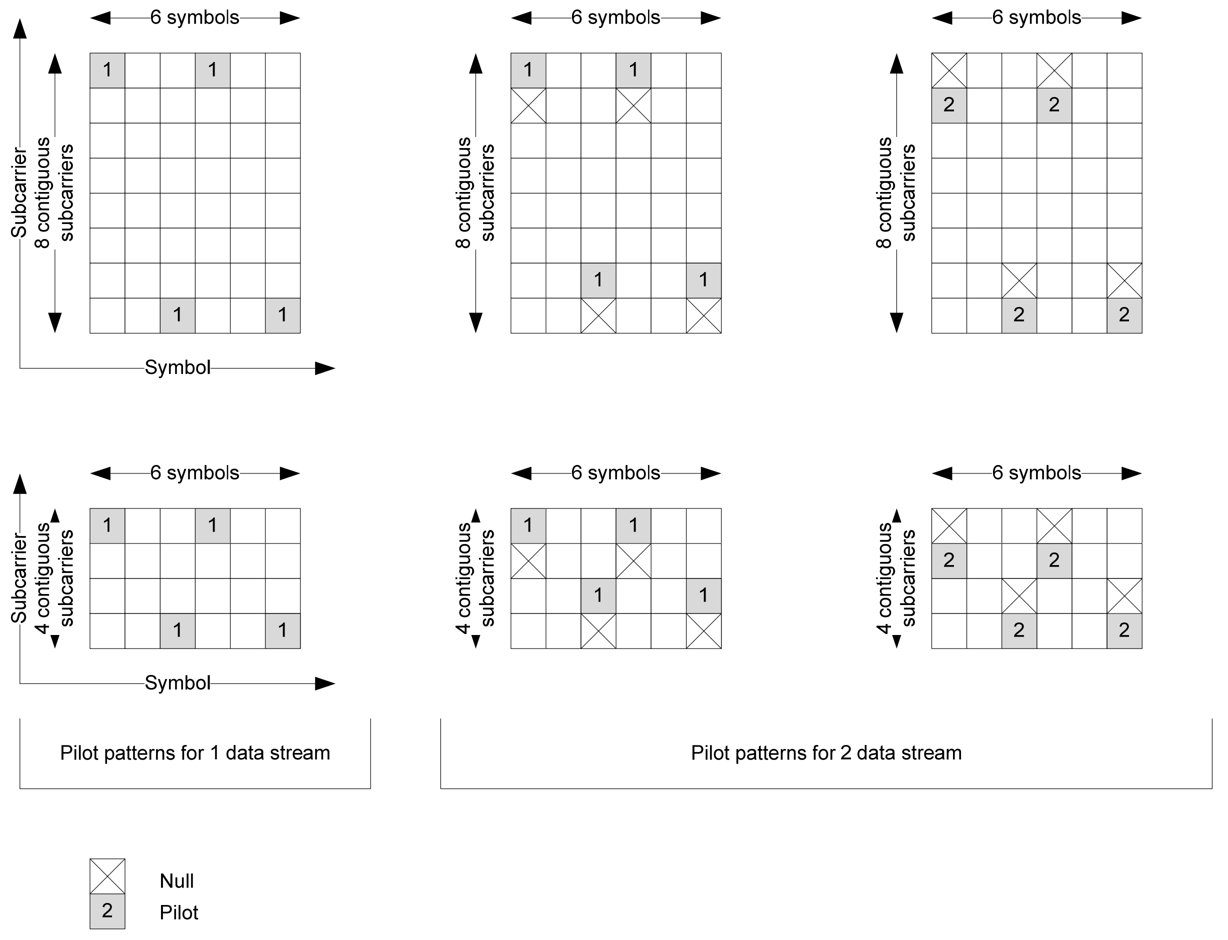

Figure lll. Pilot patterns for LRU

For N_{symb}=5, the last symbol of the pilot patterns as shown in Figure kkk, or Figure lll is deleted. Similarly for N_{symb}=3, the last three symbols of the pilot patterns are deleted.

[On page 193, modify section 15.3.6.5.1.1. as following]

15.3.6.5.1.1. P-SFH IE

The P-SFH IE contains essential system information and it is mapped to the P-SFH. The format of the P-SFH IE is shown in Table 661.

Syntax	Size (bit)	Notes
P-SFH IE format () {		
….		
S-SFH SP change bitmap	3	
Superframe/Frame Configuration	5	Used for 12.5kHz subcarrier spacing mode. Trie data structure as defined in section 15.3.3.1.1, Table iii.
Reserved	TBD	Note the size of P-SFH should be fixed. The reserved bits are for future extension

Reference

[1] IEEE802.16m-07/002r4, IEEE802.16m system requirements

[2] IEEE Std 802.16e-2005 and IEEE Std 802.16-2004/Cor1-2005 (Amendment and Corrigendum to IEEE Std 802.16-2004)

[3] WiMAX Forum Mobile System Profile Release 1.0 Approved Specification

[4] IEEE 802.16m-08/080r1, ‘Proposal for IEEE 802.16m OFDMA numerology’

[5] IEEE 802.16m-08/118r1, ‘Proposed 802.16m Frame Structure Baseline Content Suitable for Use in the 802.16m SDD’

[6] IEEE 802.16m-08/236r3, ‘Further Consideration on IEEE 802.16m OFDMA numerology’

[7] IEEE 802.16m-09/0010r3