
Project	IEEE 802.16 Broadband Wireless Access Working Group < http://ieee802.org/16 >		
Title	Some Modifications on the Procedure of New sub-frame Creation		
Date Submitted	2006-11-10		
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Re:	IEEE 802.16 Letter Ballot #24 (on P802.16h/D1) is now open		
Abstract	This contribution gives some analysis about the new sub-frame creation and suggests modifying the procedure of new sub-frame creation.		
Purpose	Modify the procedure of new sub-frame creation.		
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Some Modifications on the Procedure of New Sub-frame Creation

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Introduction

In the current 16h draft, when WirelessMAN-CX system has to share one channel with its neighbor system, it will first find a free sub-frame using sub-frame distribution optimization. If the optimization procedure fails and none of the existing sub-frame can be used, the IBS will request its neighbors to create new sub-frame. The current 16h draft specifies the procedure of the new sub-frame creation. And we suggest some modifications including:

- Which BSs does the new BS send request to?
 - o Send request to some neighbor BS, not all member BSs in community
- How to select master sub-frame?
 - o New BS is responsible for the sub-frame optimization
- Cancellation of sub-frame creation.
- Consist the procedure in 15.4.2.5 with the message defined in 15.5.2.25/26.

Which BSs does the new BS send request to?

In the current 16h draft, new BS will send the request of new sub-frame creation to all member BSs of the community. Because the new BS only knows its neighbor BS, to implement this function may need some additional message. For the interference relationship shown in figure 1, when system D enters interference community, it will know system A and system B are its interference neighbors and not know the existence of system C in the same community unless the system B informs it. If the system D is requested to send requests to all member BSs in the community, system B must inform system D of the existence of system C or system B must forward the request to system C.

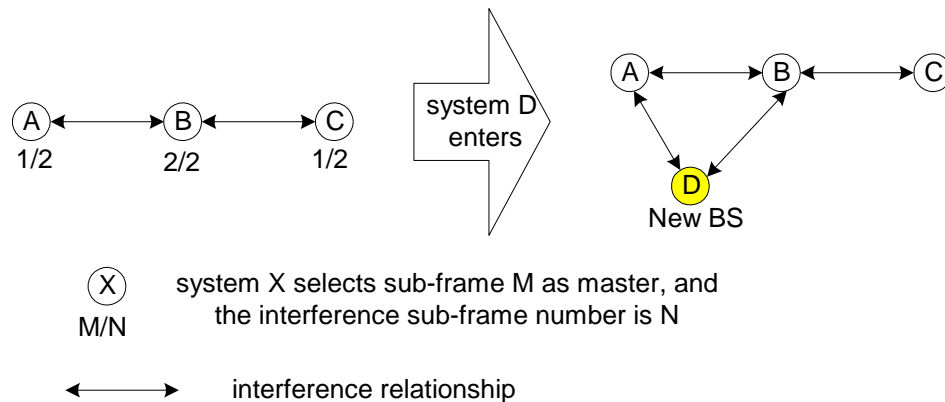


Figure 1

Furthermore, adding new sub-frame to all member BSs in the community may decrease the resource efficiency as shown in figure 2. In this case, and as the definition of sub-frame (15.4.2.1.2), system C may select sub-frame 1 or sub-frame 3 as its master. This is not an efficient way.

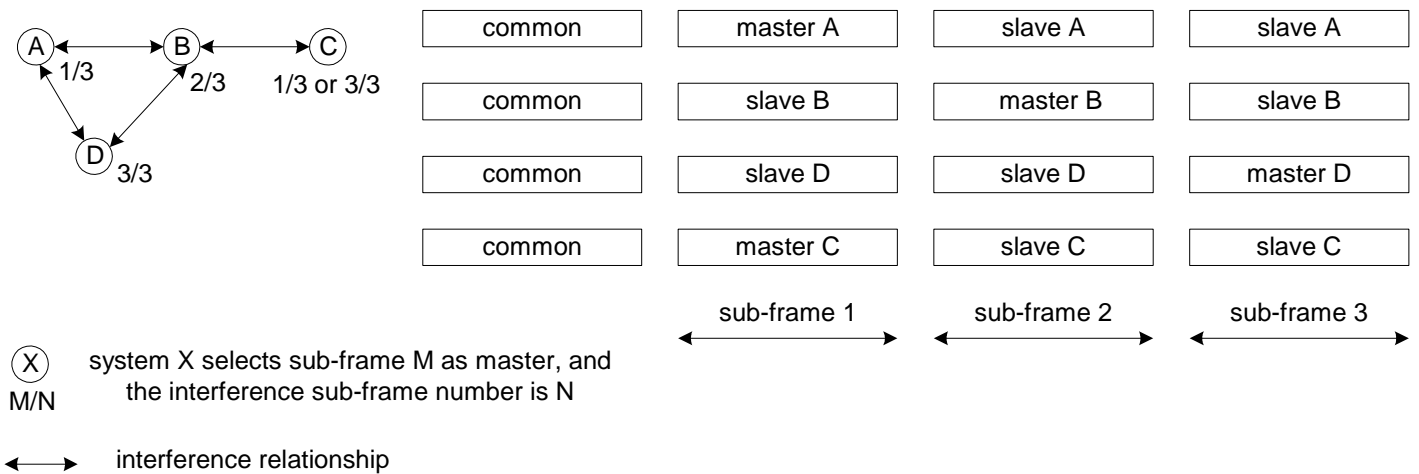


Figure 2

If system C selects both sub-frame 1 and sub-frame 3 as its mater, then efficiency can be improved but we must do some modifications to the current protocol, such as the information database.

Furthermore if the interference community is more complex, then every system in the community must change its frame structure. The request message must forward to every system in the community and the coordination between systems may be intolerable. The signaling

overhead is increased and the resource efficiency may decrease.

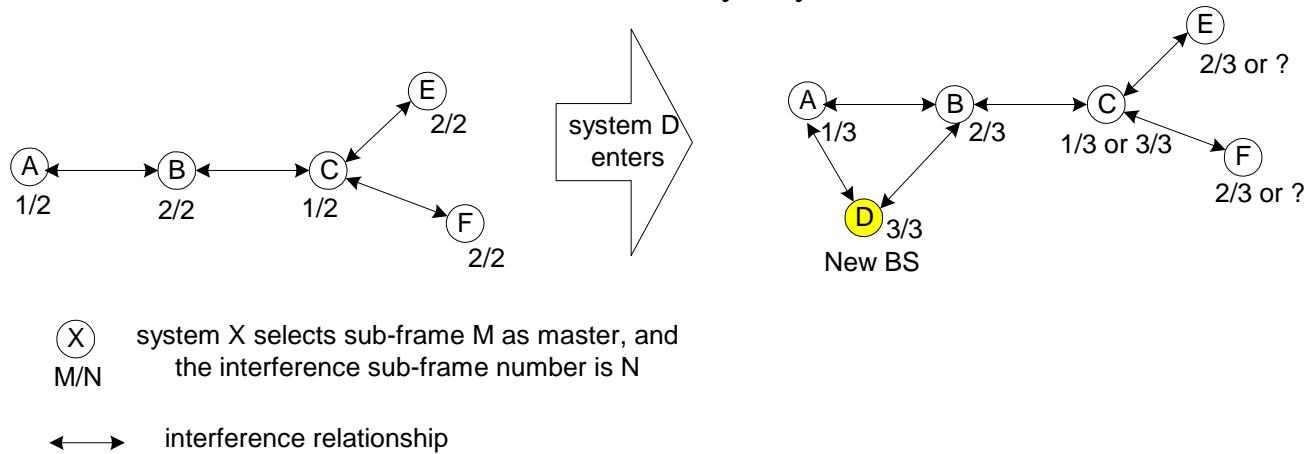


Figure 3

For some cases, when the sub-frame number of interference of neighbor is not same, it needs not to request all neighbor BSs to increase the sub-frame number of their own. For example, when system E enters community, it needs not to request system D to increase its sub-frame number as shown in below figure.

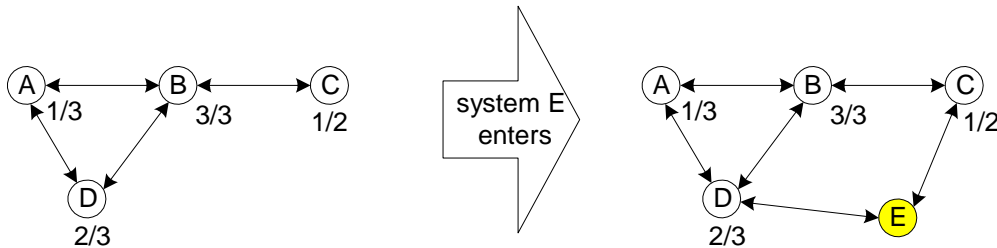


Figure 4

So if none of the existing sub-frames can be used, the new BS may request some of its neighbor BSs to increase their sub-frame number only. If all neighbor BSs have same sub-frame number, then the new BS may request all its neighbors to add a new sub-frame. And the BSs which have not direct interference with new BS may remain their frame structure unchanged. If the sub-frame number is not the same, then the new BS may request the neighbors which have lower sub-frame number to add new sub-frame so that all neighbors use same sub-frame number. And the BSs which have maximum sub-frame number or the BSs which have not direct interference with new BS may remain their frame structure unchanged. Figure 5, 6 and 7 give some

examples.

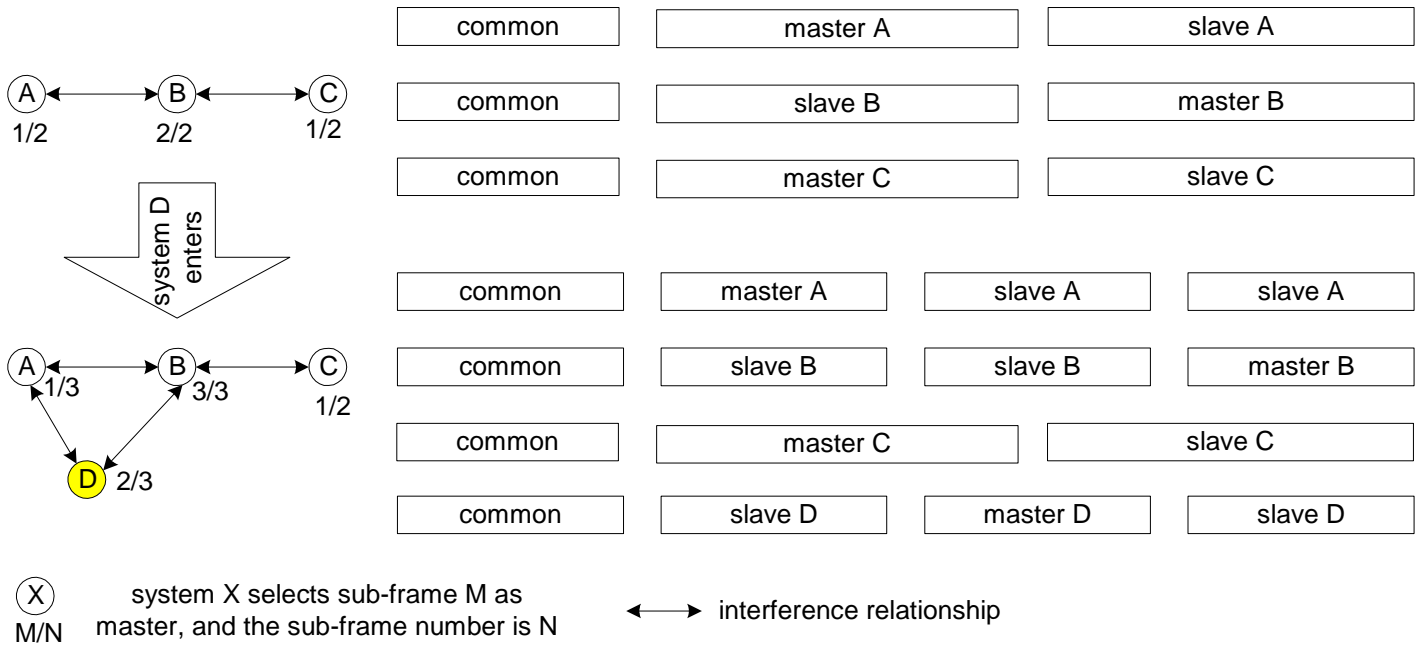


Figure 5

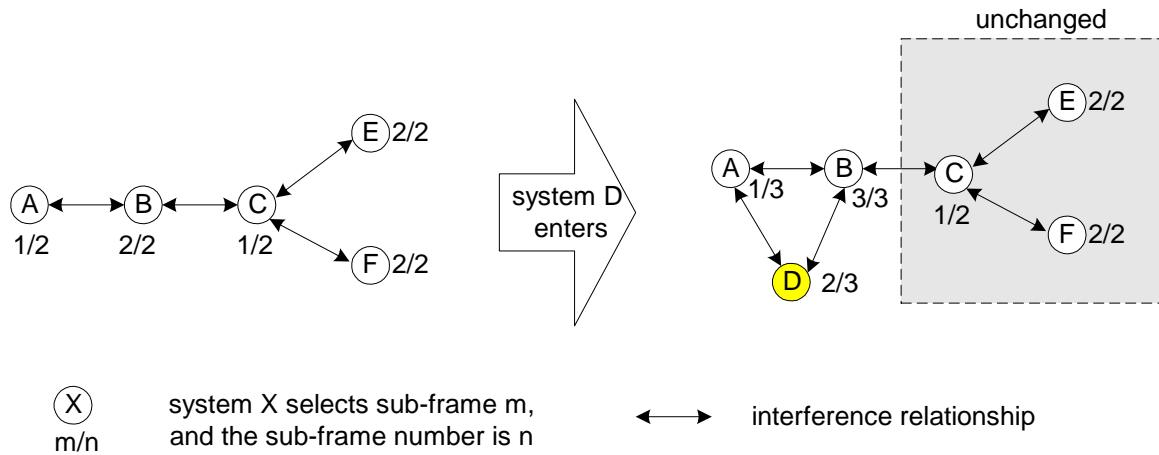


Figure 6

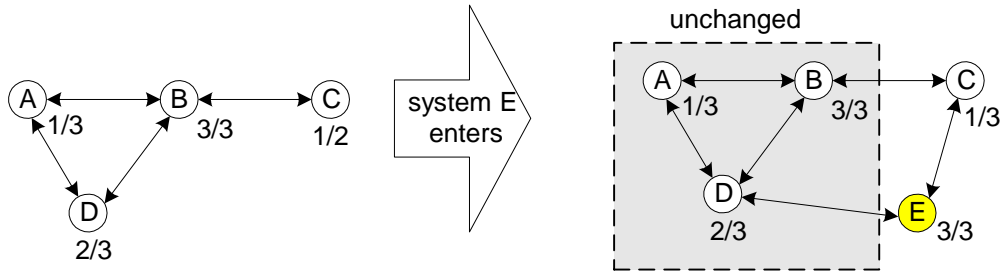
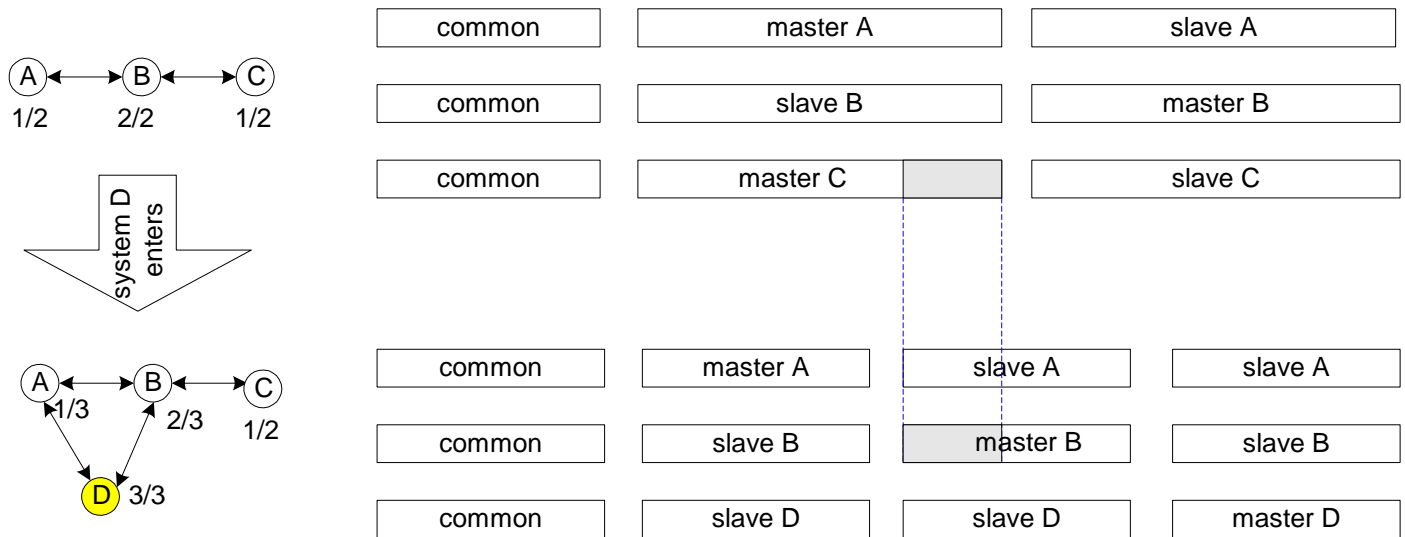


Figure 7

How to select master sub-frame?

When creating new sub-frame, the master sub-frame index distribution needs to be optimized in involved BSs to avoid interference. For example, if system B selects sub-frame number 2 as its master sub-frame, then system B and system C will interference each other, as shown in below figure.



(X) system X selects sub-frame M as M/N master, and the sub-frame number is N ←→ interference relationship interferenced area

Before the new BS enters network, if the community is interference free and all information is accumulated by the new BS, the new BS is responsible for the optimization of master sub-frame. If the maximum sub-frame number is limited to 3, the optimization mentioned above may be easier to be implemented. Text below gives the master sub-frame optimization for maximum sub-frame number 3.

First, the new BS will determine which BS in the community is the requested neighbor BSs. If all neighbor BSs have same sub-frame number, then all neighbor BSs will be requested to add a new sub-frame, and the sub-frame number after creation is the old sub-frame number add to 1, i.e., $N=N+1$. If neighbor BSs have different sub-frame number, then only the neighbor BSs with lower sub-frame number need to add new sub-frame. The new sub-frame number is the maximum sub-frame number of all neighbor BSs in this case.

Second, the new BS will allocate new master sub-frame index for each neighbor BSs which need to add new sub-frame according to its interference neighbor relationship. Considering the maximum sub-frame number is limited to 3, the selecting procedure may be follow,

- If all neighbor BSs need to add a new sub-frame, there are two cases, the sub-frame number changes from 1 to 2 and the sub-frame number changes from 2 to 3.
 - For the first case,
 - ◇ all requested BSs will select sub-frame index 1 as their master sub-frame
 - ◇ the new BS will select sub-frame index 2 as its master sub-frame.
 - For second case,
 - ◇ the requested BSs which the old master sub-frame index is 1 will select index 1 as new master sub-frame index,
 - ◇ the requested BSs which the old master sub-frame index is 2 will select index 3 as the new master sub-frame index.
 - ◇ the new BS will select sub-frame index 2 as its master sub-frame
- If only neighbor BSs with low sub-frame number need to add new sub-frame,
 - The neighbor BSs with largest sub-frame number will remain their master sub-frame index unchanged first.
 - For the neighbors which sub-frame number increase from 2 to 3,
 - the requested BSs which the old master sub-frame index is 1 will select index 1 as new master sub-frame index,
 - the requested BSs which the old master sub-frame index is 2 will select index 3 as the new master sub-frame index.

- ◇ New BS selects a free sub-frame as its master.
- ◇ The neighbors which old sub-frame number is 1 will be allocated master sub-frame finally.

Cancellation of sub-frame creation

During the creation of new sub-frame, the new BS may cancel the creation of sub-frame for the reasons if some neighbor BSs reject its request or find more suitable channel. It is necessary to define the cancellation procedure and message.

Consist the procedure in 15.4.2.5 with the message defined in 15.5.2.25/26.

In the current 16h draft, the new sub-frame creation procedure described in 15.4.2.5 is not consistent with the message defined in section 15.5.2.25 and 15.5.2.26. It is necessary to consist them.

Proposed Text

15.4.2.3 Creation of a new sub-frame

If none of the existing sub-frames can be used, a *new Base Station may request the addition of another sub-frame*. The effect of such a request will be the reduction of operating time for those Base Stations that interfere with the new system. However, all the others, which do not interfere with it, may work in parallel and use the same operating time as before the introduction of the new BS.

First, the new BS will determine which BS in the community is the requested neighbor BSs. If all neighbor BSs have same sub-frame number, then all neighbor BSs will be requested to add a new sub-frame, and the sub-frame number after creation is the old sub-frame number add to 1, i.e., $N=N+1$. If neighbor BSs have different sub-frame number, then only the neighbor BSs with lower sub-frame number need to add new sub-frame. The new sub-frame number is the maximum sub-frame number of all neighbor BSs in this case.

Second, the new BS will allocate new master sub-frame index for each neighbor BSs which need to add new sub-frame according to its interference neighbor relationship. Considering the maximum sub-frame number is limited to 3, the selecting procedure may be as follow,

□ If all neighbor BSs need to add a new sub-frame, there are two cases, the sub-frame number

changes from 1 to 2 and the sub-frame number changes from 2 to 3.

- For the first case,
 - ◇ all requested BSs will select sub-frame index 1 as their master sub-frame
 - ◇ the new BS will select sub-frame index 2 as its master sub-frame.
- For second case,
 - ◇ the requested BSs which the old master sub-frame index is 1 will select index 1 as new master sub-frame index,
 - ◇ the requested BSs which the old master sub-frame index is 2 will select index 3 as the new master sub-frame index.
 - ◇ the new BS will select sub-frame index 2 as its master sub-frame
- If only neighbor BSs with low sub-frame number need to add new sub-frame,
 - The neighbor BSs with largest sub-frame number will remain their master sub-frame index unchanged first.
 - For the neighbors which sub-frame number increase from 2 to 3,
 - the requested BSs which the old master sub-frame index is 1 will select index 1 as new master sub-frame index,
 - the requested BSs which the old master sub-frame index is 2 will select index 3 as the new master sub-frame index.
 - ◇ New BS selects a free sub-frame as its master.
 - ◇ The neighbors which old sub-frame number is 1 will be allocated master sub-frame finally.

After a new Base Station determines the new sub-frame number and allocate new master sub-frame index for each neighbor BSs which need to add new sub-frame number according to its interference neighbor relationship, it will request the creation of a new sub-frame by:

- Sending IP messages to ~~all the member BSs of the community~~ all its interference neighbors that need to create a new sub-frame, indicating:
 - o The interfering operator ID and BS ID
 - o The MAC frame-number in which the addition of a new sub-frame will take place.
 - o The master sub-frame index of requested BS
 - o The new sub-frame number
- After receiving the request, all the requested BSs will acknowledge reply the request, by acceptance indication
 - o ~~Sending back a message having as parameters:~~
 - o ~~Frame number for the change (must be the same as the requested one)~~

~~o Master sub-frame number for the new BS ($SF = \text{old } SF + 1$).~~

— ~~o~~ If a neighbor BS fails to response acknowledge, it will be asked again, for additional M attempts, that other means (such as cognitive radio signaling) should be applied, or it will be considered as a non WirelessMAN-CX compliant;

— If the requested BS rejected the request or for some other reason, the new BS will send request to the requested BSs to cancel the procedure of new sub-frame request so that the requested BSs remain their frame structure unchanged.

— ~~o~~ At the above specified MAC frame number, a new sub-frame partition will take place, by inserting in the sub-frame calculation relation $N=N+1$

— ~~o~~ The BSs up-date their own SSs about the change

— Start to use the created Master sub-frame.

15.5.2.25 Create_New_Sub_Frame_Request message

A message sent by a BSs to all the member BSs of the community all its interference neighbors that need to create a new sub-frame, to request the creation of a new Master sub-frame; the message will include the intended operating channel and the frame-number in which the change will take place.

Code:25

The attributes are indicated in the *Table h 30*.

Table h30—**Create_New_Sub_Frame_Request** Parameter set

Attribute	Contents
Base Channel Reference (BaseChRef)	Intended Base Channel Reference of the requesting BS
Extended Channel Number (ExChNr)	Intended Extended Channel Number (ExChNr) of the requesting BS
Type of sub-frame allocation	The type of requested sub-frame scheduling (15.4.2.1.2)
Sub-frame number	The number of Master sub-frames per MAC Frame
Repetition interval between two Master sub-frames, measured in MAC-frames	The repetition interval between two Master sub-frames
MAC Frame number	The first MAC Frame number which contains the change
<u>Master sub-frame index</u>	<u>The master sub-frame index of requested BS</u>

<u>Operator ID</u>	<u>The operator identifier of requesting BS</u>
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15.5.2.25 Create_New_Sub_Frame_Reply message

A message sent in response to the Create_New_Sub_Frame_Request message. [In case of reject](#)

Code:26

The attributes are indicated in the *Table h 31*.

Table h31—Create_New_Sub_Frame_Reply Parameter set

Attribute	Contents
Acceptance indication	Acceptance code: 1, if the request is fully accepted 3, rejected due to unacceptable type of Frame allocation 4, rejected due to un-acceptable repetition interval 5, rejected due to other causes

15.5.2.59 Create New Sub Frame Cancel Request message

A message sent by a BSs to cancel the creation of new sub-frame..

Code: 59

The attributes are indicated in the *Table h 60*.

Table h60 —Create New Sub Frame Cancel Request Parameter set

<u>Attribute</u>	<u>Contents</u>
<u>Base Channel Reference (BaseChRef)</u>	<u>Intended Base Channel Reference of the requesting BS</u>
<u>Extended Channel Number (ExChNr)</u>	<u>Intended Extended Channel Number (ExChNr) of the requesting BS</u>

15.5.2.60 Create New Sub Frame Cancel Reply message

A message sent in response to the Create New Sub Frame Cancel Request message.

Code: 60

No Attributes.

Reference

[1] IEEE P80216h-D1: Air Interface for Fixed Broadband Wireless Access Systems: Amendment for Improved Coexistence Mechanisms for License-Exempt Operation,