IEEE P802.11
Wireless LANs

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| D2.0 PHY Comment Resolution |
| Date: 2018-01-17 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
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Abstract

This submission proposes resolutions for the following comments from the letter ballot on P802.11ax D2.0:

13427, 13433, 13441, 13430, 13429, 14050, 12878, 12686, 13612

NOTE – Set the Track Changes Viewing Option in the MS Word to “All Markup” to clearly see the proposed text edits.

**Revision History:**

R0: Initial version.

R1: Strawpoll had passed on CIDs 13430, 13429, 14050, 12686, 13612 based on R0. In R1, resolutions for CIDs 13427, 13433, 13441 and 12878 have been updated as per discussion during the January 2018 IEEE meeting.

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| **CID** | **Clause** | **Page** | **Comment** | **Proposed Change** |
| 13427 | 28.3.2 | 356.23 | The organization of the section looks wrong:- section 28.3.2 (MU transmission) only has one subsection (28.3.2.1 Introduction).- section 28.3.3 (OFDMA and SU tone allocation) looks like it belongs under 28.3.2 (MU). Renumber as 28.3.2.2- section 28.3.3.9 (DL MU-MIMO) is a subsection of "OFDMA and SU tone allocation". It looks like it should be a subsection of 28.3.2 instead (MU transmission). Renumber as 28.3.2.3- section 28.3.3.10 (UL MU transmission) is a subsection of "OFDMA and SU tone allocation". It looks like it should be a subsection of 28.3.2 instead (MU transmission).). Renumber as 28.3.2.4- section 28.3.3.11 (UL MU-MIMO) is a subsection of "OFDMA and SU tone allocation". It looks like it should be a subsection of 28.3.2 instead (MU transmission).). Renumber as 28.3.2.5. | Reorganize as described |
| 13433 | 28.3.3.9 | 368.07 | Why is DL MU-MIMO a subsection of "OFDMA and SU allocation"? | Reorganize section |
| 13441 | 28.3.3.11 | 369.46 | Why is "UL MU-MIMO" a subsection of "OFDMA and SU tone allocation" | reorganize section |

**Discussion**

Following table compares the table of contents between D2.1 and the proposal by the commenter (ignore the various colors for now – used in discussion after the table). Essentially, 28.3.3~28.3.3.8 gets pushed down one level.

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| **D2.1** | **Proposal by the Commenter** |
| 28.3 HE PHY 28.3.1 Introduction 28.3.2 MU transmission 28.3.2.1 Introduction 28.3.3 OFDMA and SU tone allocation  28.3.3.1 General  28.3.3.2 Resource unit, guard and DC subcarriers  28.3.3.3 Null subcarriers  28.3.3.4 Pilot subcarriers 28.3.3.5 20 MHz operating non-AP HE STAs  28.3.3.6 RU restrictions for 20 MHz operation  28.3.3.7 80 MHz operating non-AP HE STAs  28.3.3.8 DL MU transmission 28.3.3.9 DL MU-MIMO  28.3.3.9.1 Supported RU sizes in DL MU-MIMO 28.3.3.9.2 Maximum number of spatial streams in an HE MU 28.3.3.9.3 Resource indication and User identification in an HE MU PPDU 28.3.3.10 UL MU transmission 28.3.3.11 UL MU-MIMO 28.3.3.11.1 Introduction 28.3.3.11.2 Supported RU sizes in UL MU-MIMO 28.3.3.11.3 MU-MIMO LTF Mode 28.3.3.11.4 maximum number of spatial streams in UL 28.3.3.11.5 Resource allocation for an HE TB PPDU 28.3.4 HE PPDU formats | 28.3 HE PHY 28.3.1 Introduction 28.3.2 MU transmission 28.3.2.1 Introduction 28.3.2.2 OFDMA and SU tone allocation  28.3.2.2.1 General  28.3.2.2.2 Resource unit, guard and DC subcarriers  28.3.2.2.3 Null subcarriers  28.3.2.2.4 Pilot subcarriers 28.3.2.2.5 20 MHz operating non-AP HE STAs  28.3.2.2.6 RU restrictions for 20 MHz operation  28.3.2.2.7 80 MHz operating non-AP HE STAs  28.3.2.2.8 DL MU transmission 28.3.2.3 DL MU-MIMO  28.3.2.3.1 Supported RU sizes in DL MU-MIMO 28.3.2.3.2 Maximum number of spatial streams in an HE MU 28.3.2.3.3 Resource indication and User identification in an HE MU PPDU 28.3.2.4 UL MU transmission 28.3.2.5 UL MU-MIMO 28.3.2.5.1 Introduction 28.3.2.5.2 Supported RU sizes in UL MU-MIMO 28.3.2.5.3 MU-MIMO LTF Mode 28.3.2.5.4 maximum number of spatial streams in UL 28.3.2.5.5 Resource allocation for an HE TB PPDU 28.3.3 HE PPDU formats |

While the commenter is correct that sections in 28.3.2 and 28.3.3 are not organized properly, there are additional changes needed on top of the suggestion by the commenter.

First, 28.3.3.8 (DL MU transmission) covers both DL OFDMA and DL MU-MIMO, but the proposal by commenter puts it as a subsection of DL OFDMA. More importantly, 28.3.3.8 (DL MU transmission) has only one sentence, which is already stated in 28.3.2.1 (Introduction).

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Similarly, 28.3.3.10 (UL MU transmission) has three sentences, two of which are already present in 28.3.2.1 (Introduction).

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In addition, 28.3.3.11.5 (Resource allocation for an HE TB PPDU) applies to both UL OFDMA and UL MU-MIMO, but is currenly a subsection of UL MU-MIMO (28.3.3.11).

During the January 2018 IEEE meeting, it was also noted that moving “OFDMA and SU tone allocation” to be a subsection of “MU transmission” as had been proposed in 11-18/0057r0 is inappropriate.

The following table summarizes the proposed resolution taking into account the issues mentioned above.

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| **D2.1** | **End Result of Proposed Resolution** |
| 28.3 HE PHY 28.3.1 Introduction 28.3.2 MU transmission 28.3.2.1 Introduction 28.3.3 OFDMA and SU tone allocation  28.3.3.1 General  28.3.3.2 Resource unit, guard and DC subcarriers 28.3.3.3 Null subcarriers  28.3.3.4 Pilot subcarriers 28.3.3.5 20 MHz operating non-AP HE STAs  28.3.3.6 RU restrictions for 20 MHz operation  28.3.3.7 80 MHz operating non-AP HE STAs  28.3.3.8 DL MU transmission 28.3.3.9 DL MU-MIMO  28.3.3.9.1 Supported RU sizes in DL MU-MIMO 28.3.3.9.2 Maximum number of spatial streams in an HE MU 28.3.3.9.3 Resource indication and User identification in an HE MU PPDU 28.3.3.10 UL MU transmission 28.3.3.11 UL MU-MIMO 28.3.3.11.1 Introduction 28.3.3.11.2 Supported RU sizes in UL MU-MIMO 28.3.3.11.3 MU-MIMO LTF Mode 28.3.3.11.4 maximum number of spatial streams in UL 28.3.3.11.5 Resource allocation for an HE TB PPDU 28.3.4 HE PPDU formats | 28.3 HE PHY 28.3.1 Introduction 28.3.1.1 MU transmission 28.3.1.2 OFDMA 28.3.2 Subcarrier and resource allocation  28.3.2.1 General  28.3.2.2 Resource unit, guard and DC subcarriers  28.3.2.3 Null subcarriers  28.3.2.4 Pilot subcarriers 28.3.2.5 Resource indication and User identification in an HE MU PPDU 28.3.2.6 Resource allocation for an HE TB PPDU 28.3.2.7 20 MHz operating non-AP HE STAs  28.3.2.8 RU restrictions for 20 MHz operation  28.3.2.9 80 MHz operating non-AP HE STAs 28.3.3 MU-MIMO (Note: Covered in 28.3.1.1 MU transmission.) 28.3.3.1 DL MU-MIMO  28.3.3.1.1 Supported RU sizes in DL MU-MIMO 28.3.3.1.2 Maximum number of spatial streams in an HE MU (Note: Covered in 28.3.1.1 MU transmission.) 28.3.3.2 UL MU-MIMO 28.3.3.2.1 Introduction 28.3.3.2.2 Supported RU sizes in UL MU-MIMO 28.3.3.2.3 MU-MIMO LTF Mode 28.3.3.2.4 maximum number of spatial streams in UL 28.3.4 HE PPDU formats |

**Proposed Resolution: CID 13427, 13433, 13441**

**Revised**. Agree with the commenter that the organization of sections under 28.3.2 and 28.3.3 are inadequate. The proposed resolution makes additional improvements on top of the proposal from the commenter.

Instruction to Editor: Implement the proposed text changes in 11-18/0057r1 under CID 13427, 13433, 13441.

**Proposed Text Updates: CID 13427, 13433, 13441**

*TGax Editor: Update D2.1 sections 28.3~28.3.3.1 as shown below.*

28.3 HE PHY

28.3.1 Introduction

This subclause provides the procedure by which PSDUs are converted to and from transmissions on the wireless medium.

During transmission, a PSDU (in the SU case) or one or more PSDUs (in the MU case) are processed (i.e., scrambled and coded) and appended to the PHY preamble to create the PPDU. At the receiver, the PHY preamble is processed to aid in the detection, demodulation, and delivery of the PSDU.

28.3.1.1 MU transmission

The MU transmissions include DL MU transmissions and UL MU transmissions.

DL MU transmission allows an AP to simultaneously transmit information to more than one non-AP STA. For a DL MU transmission, the AP uses the HE MU PPDU format and employs either DL OFDMA, DL MU-MIMO, or a mixture of both. UL MU transmission allows an AP to simultaneously receive information from more than one non-AP STA. UL MU transmissions for UL MU-MIMO and UL OFDMA are preceded by a Trigger frame from the AP. The non-AP STAs transmit using the HE TB PPDU format and employ either UL OFDMA, UL MU-MIMO, or a mixture of both.

The HE PHY supports OFDMA transmissions, both in the DL and the UL where different users can occupy different RUs in a PPDU (see 28.3.9 (Mathematical description of signals)). The transmission within an RU in a PPDU may be single stream to one user, spatial multiplexed to one user (SU-MIMO), or spatial multiplexed to multiple users (MU-MIMO). Note that the VHT PHY supports only full bandwidth DL MU-MIMO as described in 21.3.11 (SU-MIMO and DL-MU-MIMO Beamforming). The HE PHY defines DL MU-MIMO and UL MU-MIMO, for both the full bandwidth case as well as for the partial bandwidth case where MU-MIMO is used only on certain RUs in the PPDU. The combination of SU transmissions and MU-MIMO transmissions on different RUs in one PPDU is also supported.

28.3.1.2 OFDMAOrthogonal Frequency Division Multiple Access (OFDMA) is an OFDM-based multiple access scheme where different subsets of subcarriers are allocated to different users, allowing simultaneous data transmission to or from one or more users. In OFDMA, users are allocated different subsets of subcarriers which can change from one PPDU to the next. The difference between OFDM and OFDMA is illustrated in Figure 28-4 (Illustration of OFDM and OFDMA concepts). Similar to OFDM, OFDMA employs multiple subcarriers, but the subcarriers are divided into several groups of subcarriers where each group is denoted as a resource unit (RU). With OFDMA, different transmit powers may be applied to different RUs.

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| * Illustration of OFDM and OFDMA concepts
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28.3.2 Subcarrier and resource allocation

28.3.2.1 General

An OFDM symbol is constructed of subcarriers, the number of which is a function of the PPDU bandwidth. There are several subcarrier types:

* Data subcarriers, which are used for data transmission (see 28.3.3.2 (Resource unit, guard and DC subcarriers))
* Pilot subcarriers, which are used for phase information and parameter tracking (see 28.3.3.4 (Pilot subcarriers))
* Unused subcarriers, which are not used for either data or pilot transmission. The unused subcarriers are the DC subcarrier (see 28.3.3.2 (Resource unit, guard and DC subcarriers)), the Guard band subcarriers at the band edges (see 28.3.3.2 (Resource unit, guard and DC subcarriers)), and the Null subcarriers (see 28.3.3.3 (Null subcarriers)).

*TGax Editor: Change the section numbers of 28.3.3.2~28.3.3.4 as shown below.*

28.3.2.2 Resource unit, guard and DC subcarriers

28.3.2.3 Null subcarriers

28.3.2.4 Pilot subcarriers

*TGax Editor: Add the following at D2.1 P368L15. (Note that the two sections being added below are moving 28.3.3.9.3 and 28.3.3.11.5 to be the new 28.3.2.5 and 28.3.2.5, respectively. There are no text changes other than moving those sections to this location.)*

28.3.2.5 Resource indication and User identification in an HE MU PPDU

An AP that transmits an HE MU PPDU shall set the UL/DL field in the HE-SIG-A field to 0.

A full bandwidth MU-MIMO transmission using the HE MU PPDU format has a value of 1 for the SIGB Compression field in HE-SIG-A and the Common field in HE-SIG-B is not present, and the HE modulated fields of the PPDU consists of one RU whose size spans the entire PPDU bandwidth. The number of users in the MU-MIMO group is indicated in the Number Of HE-SIG-B Symbols Or MU-MIMO Users field in HE-SIG-A. The allocated spatial streams for each user and the total number of spatial streams are indicated in the Spatial Configuration field of User field in HE-SIG-B containing the STA-ID of designated MU-MIMO STA as defined in Table 28-27 (Spatial Configuration field encoding).

If the value of SIGB Compression field in HE-SIG-A is 0, then the RU Allocation subfield in the Common field in each HE-SIG-B content channel indicates the combination of RUs in the current PPDU and the number of User fields included in the corresponding HE-SIG-B content channel for each RU. See 28.3.10.8.2 (Encoding and modulation) for a description of the HE-SIG-B content channel.

A 20 MHz HE MU PPDU has one HE-SIG-B content channel, while an HE MU PPDU with greater than 20 MHz PPDU bandwidth has two HE-SIG-B content channels. In each HE-SIG-B content channel, the number of spatial streams for a user in an RU is indicated by the NSTS field in the User field if there is only one User field (see Table 28-25) corresponding to the RU in the HE-SIG-B content channel.

If there are more than one User fields (see Table 28-26 (User field for an MU-MIMO allocation)) for an RU in the HE-SIG-B content channel, the number of allocated spatial streams for each user in the RU are indicated by the Spatial Configuration field of the User field in HE-SIG-B. Note that an RU with RU size greater than or equal to 484 subcarriers and having two or more intended users, the User fields corresponding to the RU may split between two HE-SIG-B content channels. In this case, the total number of users and the total number of spatial streams in the RU are the sum of the number of users and number of spatial streams per user, respectively, indicated in both HE-SIG-B content channels. In case of full bandwidth DL MU-MIMO with PPDU bandwidth greater than 20 MHz, see 28.3.10.8.6 (HE-SIG-B per-user content) on further details on how the User fields are split between the two HE-SIG-B content channels.

In each HE-SIG-B content channel, the User fields are first ordered in the order of RUs (from lower frequency to higher frequency) as described by the RU Allocation field if the HE-SIG-B contains the Common field. If an RU has multiple User fields in an HE-SIG-B content channel, the User fields of the RU are ordered in the order of spatial stream index, from lower to higher spatial stream, as indicated in the Spatial Configuration field. The STA-ID field in each User field indicates the intended recipient user of the corresponding spatial streams and the RU.

HE-LTF symbols in the DL HE MU PPDU are used to measure the channel for the space-time streams intended for the STA and can also be used to measure the channel for the interfering space-time streams. To successfully demodulate the space-time streams intended for the STA, it is recommended that the STA uses the channel knowledge for all space-time streams to reduce the effect of interfering space-time streams.

If a STA is included as a member of the MU-MIMO group in RU *r*, its corresponding *NSTS,r,u* contained in the User field in HE-SIG-B shall not be zero. If a STA finds that it is not a member of the MU-MIMO group in RU *r*, then the STA may elect not to process RU *r* in the remainder of the PPDU.

28.3.2.6 Resource allocation for an HE TB PPDU

UL MU transmissions are preceded by a Trigger frame from the AP. The Common Info field of the Trigger frame indicates to the STAs performing the UL MU transmissions when to transmit, and the duration of the payload and packet extension. The GI duration for UL MU transmissions shall also be explicitly indicated by AP in the Trigger frame. The value of GI duration for all users addressed by the Trigger frame shall be the same. The Trigger frame indicates whether the UL MU transmission following it uses HE single stream pilot HE LTF mode or HE masked HE LTF sequence mode or no pilots if a 1x LTF is used. When HE single stream pilot HE LTF mode is used, no masking is applied to the HE-LTF. HE single stream pilot HE LTF mode is used for any UL OFDMA transmission, including UL OFDMA with MU-MIMO transmissions. The appropriate MU-MIMO LTF mode indicated by the Trigger frame is used for full bandwidth UL MU-MIMO transmission except for 1x LTF. The allocated RU and spatial streams are carried in the RU Allocation subfield and SS Allocation subfield of the User Info field that has the AID12 subfield set as the AID of designated MU-MIMO STA.

If a STA finds that there is no User Info field in the Trigger frame carrying the STA’s AID in the AID12 subfield and there is no resource allocated for random access, then the STA shall not transmit in the following HE TB PPDU.

*TGax Editor: Change the section numbers of 28.3.3.5~28.3.3.7 as shown below.*

28.3.2.2.7 20 MHz operating non-AP HE STAs

28.3.2.2.8 RU restrictions for 20 MHz operation

28.3.2.2.9 80 MHz operating non-AP HE STAs

*TGax Editor: Update D2.1 P370L4 as shown below.*

28.3.3 MU-MIMO

*TGax Editor: Change the section numbers of 28.3.3.9~28.3.3.9.2 as shown below.*

 28.3.3.1 DL MU-MIMO

 28.3.3.1.1 Supported RU sizes in DL MU-MIMO

28.3.3.1.2 Maximum number of spatial streams in an HE MU

*TGax Editor: Delete sections 28.3.3.9.3 and 28.3.3.10.*

*TGax Editor: Change the section numbers of 28.3.3.11~28.3.3.11.4 as shown below.*

28.3.3.2 UL MU-MIMO

 28.3.3.2.1 Introduction

 28.3.3.2.2 Supported RU sizes in UL MU-MIMO

 28.3.3.2.3 MU-MIMO LTF Mode

 28.3.3.2.4 maximum number of spatial streams in UL

*TGax Editor: Delete section 28.3.3.11.5.*

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| **CID** | **Clause** | **Page** | **Comment** | **Proposed Change** |
| 13430 | 28.3.3.2 | 364.30 | "A 2x996-tone RU consists of two 996-tone ...". It looks like this should be a separate paragraph at the same level as the paragraphs starting at lines 5, 17 and 26. | Strat new pargraph at "A 2x996-ton RU ..." |

**Discussion:**

D2.1 P366L30:

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As the commenter has indicated, each RU size is given a separate paragraph. Hence, to be consistent, the 2x996-tone RU should be given a separate paragraph (though it would result in a one line paragraph).

**Proposed Resolution: CID 13430**

**Accepted**.

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| **CID** | **Clause** | **Page** | **Comment** | **Proposed Change** |
| 13429 | 28.3.3.3 | 364.65 | "The null subcarriers are located near the DC or edge tones to protect those tones near the DC or edge tones from the interference of a neighboring RU". Null carriers around DC are not intended for protection against neighboring RUs. There are no neighbors. | Clarify |

**Background:**

D2.1 P366L65:

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| The null subcarriers are located near the DC or edge tones to protect those tones near the DC or edge tones from the interference of a neighboring RU. |

**Proposed Resolution: CID 13429**

**Revised**.Propsed text update in 11-18/0057r0 clarifies that the null subcarriers near the DC tone are to protect from the transmit center frequency leakage and receiver DC offset.

Instruction to Editor: Implement the proposed text changes in 11-18/0057r0 under CID 13429.

**Proposed Text Updates: CID 13429**

*TGax Editor: Update D2.1 P366L65 as shown below.*

The null subcarriers are located near the DC or edge tones to provide protection from interferences such as transmit center frequency leakage, receiver DC offset, and interference from neighboring RUs.

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| **CID** | **Clause** | **Page** | **Comment** | **Proposed Change** |
| 14050 | 28.3.3.4 | 365.36 | There are only three LTF types - 1x, 2x and 4x. "Except 1x and 2x" is just 4x. | Change "same, except for the 1x HE-LTF and 2x HE-LTF." to "same for the 4x HE-LTF." |

**Discussion:**

D2.1 P366L30:

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| * Pilot subcarriers

If pilot subcarriers are present in the HE-LTF field of an HE SU PPDU, HE MU PPDU, HE ER SU PPDU, or HE TB PPDU, the pilot subcarrier locations in the HE-LTF field and Data field shall be the same, except for the 1x HE-LTF and 2x HE-LTF. In a 1x HE-LTF, the pilot subcarrier locations in the HE-LTF only consist of the pilot subcarriers for the Data field that are multiples of four. If pilot subcarriers are present in a 2x HE-LTF, then their locations shall be the same as those pilots in a 4x data symbol. All pilot subcarriers are at the even indices enumerated in Table 28-10 (Pilot subcarrier indices). |

Commenter is correct that “except for the 1x HE-LTF and 2x HE-LTF” is equivalent to “for the 4x HE-LTF”.

**Proposed Resolution: CID 14050**

**Accepted**.

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| **CID** | **Clause** | **Page** | **Comment** | **Proposed Change** |
| 12878 | 28.4.3 | 520.12 | "T\_HE\_PREAMBLE is defined as in Equation (28-114) and Equation (28-115)" -- neither of those equations defines T\_HE\_PREAMBLE | Number the T\_HE\_PREAMBLE equation and refer to this instead |

**Discussion:**

D2.1 P522:

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D2.1 P481-482:

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The commenter is correct that equations (28-114) and (28-115) do not define *THE-PREAMBLE*.

There was also discussion during the January 2018 IEEE meeting that *T*HE-PREAMBLE and *T*HE\_PREAMBLE (hyphen vs. underscore) are used in D2.1 interchangeably, and should be unified to one common terminology. In D2.1, there are 8 instances of *T*HE-PREAMBLE and 4 intances of *T*HE\_PREAMBLE. And there is an editorial comment (CID 12874) which proposes to change the 4 instances of *T*HE\_PREAMBLE to *T*HE-PREAMBLE. Hence, in this proposed resolution, we only fix the two *T*HE\_PREAMBLE related to this CID 12878. The other two instances of *T*HE\_PREAMBLE can/should be taken care of by the editor per CID 12874.

**Proposed Resolution: CID 12878**

**Revised**.Propsed text update in 11-18/0057r1 fixes the equation numbering as suggested by the commenter.

Instruction to Editor: Implement the proposed text changes in 11-18/0057r1 under CID 12878.

**Proposed Text Updates: CID 12878**

*TGax Editor: Add label to the equation at D2.1 P482L4 as shown below.*

 (28-115a)

*TGax Editor: Change “T*HE\_PREAMBLE*” to “T*HE-PREAMBLE*” (underscore to hyphen) in Equation (28-127) at D2.1 P522L7.*

*TGax Editor: Update D2.1 P522L12 as shown below.*

 *T*HE-PREAMBLE is defined as in Equation (28-115a), and *SignalExtension* takes the value of aSignalExtension as defined in Table 19-25 (HT PHY characteristics).

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| **CID** | **Clause** | **Page** | **Comment** | **Proposed Change** |
| 12686 | 28.4.3 | 521.26 | "NDBPS is defined in Table 28-15 (Frequently used parameters)" -- yes, but that table says it's N\_DBPS,0, which is not defined |  |

**Discussion:**

D2.1 P523:

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D2.1 P394 Table 28-15 – Frequently used parameters:

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*NDBPS,0* is the *NDBPS,u* for the user *u*=0. And *NDBPS,u* is defined in the same row as *NDBPS*.

**Proposed Resolution: CID 12686**

**Rejected**.NDBPS,0 is the NDBPSU,u for the user u=0. And NDBPS,u is defined in the same row of Table 28-15 as NDBPS.

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| **CID** | **Clause** | **Page** | **Comment** | **Proposed Change** |
| 13612 | 28.4.3 | 521.44 | In Equation (28-133), aRX >0 condition is not exclusive to other condition, and aRX is always positive since it is only one of 1,2,3,4 | Change the condition aRX > 0 to either otherwise or aRX \neq 4 in Eq (28-133) of D2.0 |

**Discussion:**

D2.1 P523:

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The commenter is correct the condition for the second row in Equation (28-133) is erroneous. “Otherwise” would be sufficient as suggested by the commenter.

**Proposed Resolution: CID 13612**

**Revised**.Agree with the commenter that the second condition for Equation (28-133) need to be fixed.

Instruction to Editor: At D2.1 P523L45 Equation (28-133), change “aRX > 0” to “otherwise”.

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