International Telecommunication Union

# ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

# G.9963

**Corrigendum 1**

(04/2014)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Access networks – In premises networks

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## Unified high-speed wire-line based home networking transceivers – Multiple input/multiple output (MIMO) specification

## Corrigendum 1

Recommendation ITU-T G.9963 (2011) – Corrigendum 1

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# Recommendation ITU-T G.9963

## Unified high-speed wire-line based home networking transceivers – Multiple input/multiple output (MIMO) specification

## Corrigendum 1


**Summary**

Corrigendum 1 to Recommendation ITU-T G.9963 (2011) contains the following:

1) Revision of clause 4, "Abbreviations".
2) Revision of the text for clause 7.1.2.3.2.7.2.3.1, "PROBE frame BMAT_ID (PRB_BMAT_ID)".
3) Revision of the text for clause 8.12.1, "Channel estimation with ITU-T G.9963 transceivers using two spatial streams".
4) Revision of the text for clause 8.12.1.1.1, "Channel estimation initiation".
5) Revision of the text for clause 8.12.1.1.3, "Channel estimation initiation confirmation".
6) Revision of the text for clause 8.12.1.2.1, "Channel estimation request".
7) Revision of the text for clause 8.12.1.3.2, "Partial BMAT update".
8) Revision of the text for clause 8.12.1.4, "Channel estimation using PROBE frames".
9) Revision of the text for clause 8.12.1.7.1, "Format of MCE_ProbeSlotAssign.req".
10) Revision of the text for clause 8.12.1.7.3, "Format of MCE_ParamUpdate.req".
11) Revision of the text for clause 8.12.1.7.5, "Format of MCE_PartialBmatUpdate.req".
12) Revision of the text for clause 8.12.1.7.12, "Format of MCE_Initiation.req".
13) Revision of the text for clause 8.12.1.7.14, "Format of MCE_ProbeRequest.ind".
14) Addition of text for new clause 8.19, "Inter-bandplan interoperability".
15) Addition of text for new clause 8.20, "Version control and capabilities exchange".



**History**

| Edition | Recommendation | Approval | Study Group | Unique ID* |
|---|---|---|---|---|
| 1.0 | ITU-T G.9963 | 2011-12-16 | 15 | 11.1002/1000/11404 |
| 1.1 | ITU-T G.9963 (2011) Amd.1 | 2014-01-13 | 15 | 11.1002/1000/12083 |
| 1.2 | ITU-T G.9963 (2011) Cor.1 | 2014-04-04 | 15 | 11.1002/1000/12082 |


* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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# Recommendation ITU-T G.9963

## Unified high-speed wire-line based home networking transceivers – Multiple input/multiple output (MIMO) specification

## Corrigendum 1

### 1) Clause 4

*Revise clause 4 "Abbreviations" as follows:*

### 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ACE Additional Channel Estimation

~~AE Application Entity~~

APC Application Protocol Convergence

BAT Bit Allocation Table

BMAT Bit and ~~T~~tx port Mapping Allocation Table

~~CB Coax Baseband~~

~~CM Centralized Mode~~

DLL Data Link Layer

~~DSL Digital Subscriber Line~~

FEC Forward Error Correction

IDFT Inverse Discrete Fourier Transform

IDPS Inter-Domain Presence Signal

ISC Inactive Sub-Carrier

~~LCP Low-Complexity Profile~~

LFSR Linear Feedback Shift Register

LSB Least Significant Bit

MAC Medium Access Control

MAP Medium Access Plan

MAT Mapping Allocation Table

MDI Medium-Dependent Interface

MIMO Multiple Input/Multiple Output

MPDU Media access control Protocol Data Unit

MSC Masked Sub-Carrier

OFDM Orthogonal Frequency Division Multiplexing

PCS Physical Coding Sub-layer

PMA Physical Medium Attachment

PMD Physical Medium Dependent

PMI Physical Medium-independent Interface

PMSC Permanently Masked Sub-Carrier

PR Priority Resolution

PSD Power Spectral Density

~~PSDC Power Spectral Density Ceiling~~

QoS Quality of Service

RMAP Relayed Medium Access Plan

RMSC Regionally Masked Sub-Carrier

~~SC Security Controller~~

SM Sub-carrier Mark

SS Spatial Stream

SSC Supported Sub-Carrier

TPM ~~Transport Performance Metric~~Tx~~X~~ Port Mapping

TS Time Slot

TXOP Transmission Opportunity

**2) Clause 7.1.2.3.2.7.2.3.1**

*Revise clause 7.1.2.3.2.7.2.3.1 "PROBE frame BMAT_ID (PRB_BMAT_ID)" as follows:*

**7.1.2.3.2.7.2.3.1 PROBE frame BMAT_ID (PRB_BMAT_ID)**

This field indicates the BMAT_ID (predefined or runtime) whose MAT is used in the Tx port mapper to generate this 2 SS channel estimation PROBE frame. The BATs associated with the BMAT_ID are only relevant to infer the ~~transport performance metrics~~Tx port mapping (TPMs) used per sub-carrier (see Table 8-2) for 2 SS channel estimation probe symbol generation (see clause 7.1.4.2.4.3). Therefore, if the PRB_BMAT_ID conveys a predefined BMAT_ID, the valid values for channel estimation shall be 3, 7 and 11.

NOTE – The PRB_BMAT_ID field allows transmitting PROBES using the precoding parameters associated with a given runtime BMAT_ID.

**3) Clause 8.12.1**

*Revise clause 8.12.1 "Channel estimation with ITU-T G.9963 transceivers using two spatial streams" as follows:*

**8.12.1 Channel estimation with ITU-T G.9963 transceivers using two spatial streams**

The channel estimation protocol describes the procedure of measuring the characteristics of the channel between the transmitter (source) and the receiver (destination) nodes. The procedure involves initiation of channel estimation, transmissions of PROBE frames, and selection of parameters.

Channel estimation can be done in two phases:

- Channel discovery – initial channel estimation.
- Channel adaptation – subsequent channel estimation to adapt to a changing channel.

The protocols used for channel discovery and channel adaptation can be started either by the transmitter or by the receiver. The core part of the channel estimation protocol is identical in these

two cases, and is always initiated by the receiver (receiver-initiated channel estimation). The transmitter can request the receiver to initiate channel estimation (transmitter-requested channel estimation).

During the initiation process, the transmitter and receiver jointly determine input parameters for channel estimation such as channel estimation window (a fraction of a MAC cycle over which channel estimation should be executed), the value of *G* (see clause 7.1.4.2.3), the value of *PG* (see clause 7.1.4.4.2.3), and parameters for the PROBE frame. The receiver selects the BMAT_ID associated with the triplet of the two BATs (each associated with a different spatial stream) and MAT, termed BMAT, to be updated. This BMAT_ID is used as an identifier for a particular channel estimation process throughout the rest of the process. The receiver shall consider its own bandplan information (namely the StartSubCarrier & StopSubCarrier) and that of the transmitter when calculating the BMAT. More specifically, the range of sub-carriers of the BMAT sent in the MCE_ParamUpdate.req message shall be within the intersection of the sub-carrier ranges determined by the StartSubCarrier & StopSubCarrier of both the receiver and transmitter.

Once the channel estimation process is initiated, the receiver may request the transmitter to send one or more PROBE frames. The receiver can change parameters of a PROBE frame at each request. If the receiver requests a PROBE frame without specifying its parameters (e.g., request for PROBE frame transmission via ACK_CE_CTRL as described in clause 8.12.1.4), the transmitter transmits the PROBE frame using parameters previously selected by the receiver. The receiver is not required to request PROBE frames if it chooses other means such as MSG frames or PROBE frames transmitted to other nodes to estimate the channel.

The receiver terminates the channel estimation process by sending the outcome of channel estimation to the transmitter. This may include, but is not limited to, the following parameters:

- Bit allocation tables (BATs). A BAT for each one of the two possible spatial streams.
- MIMO mode indicator, indicating the MIMO mode used (see Table 8-5).
- Precoding feedback quantization indicator.
- Precoding parameters.
- FEC coding rate and block size.
- Guard interval for payload.
- PSD ceiling.

The receiver may cancel the channel estimation process without generating new channel estimation parameters.

The protocol provides several options to expedite the channel estimation process for faster channel adaptation. For example, the channel estimation initiation process (clause 8.12.1.1.1) can be omitted in case of channel adaptation where no new input parameter negotiation is necessary. The receiver can create a new BMAT by sending an unsolicited MCE_ParamUpdate.req (clause 8.12.1.3.1) or update the existing BMAT by sending an MCE_PartialBmatUpdate.req (clause 8.12.1.3.2). The receiver can request PROBE frame transmission without going through channel estimation initiation process (clause 8.12.1.4).

### 4) Clause 8.12.1.1.1

*Revise clause 8.12.1.1.1 "Channel estimation initiation" as follows:*

#### 8.12.1.1.1 Channel estimation initiation

The receiver initiates the channel estimation process by sending the transmitter an MCE_Initiation.req message.

The receiver shall select CE_BAT_GRP ~~_MIN~~ ($G_{\text{min}}$), which indicates the ~~minimum~~ value of GRP_ID ($G$) associated with the BATs to be updated (whenever two spatial streams are used, the same grouping applies to both streams). The receiver shall also select CE_PR_GRP ~~_MIN ($PG_{\text{min}}$)~~, which indicates the ~~minimum~~ value of precoding grouping ($PG$) associated with the precoding parameters to be updated. The receiver shall select CE_STIME and CE_ETIME, which determines the start and end time of the channel estimation window. During the rest of channel estimation process, the transmitter shall send PROBE frames inside this window. The receiver shall select CE_BMAT_ID from ones that are currently invalid. This value shall be used to differentiate multiple channel estimation processes being executed at the same time. The receiver may request PROBE frame transmission by setting CE_PRB_RQST field. The CE_PRB_PARM field specifies parameters for the default PROBE frame. If the CE_PRB_RQST field is not set to one, parameters for the default PROBE frame shall be as follows: CE_PR_PRBTYPE = $1000_2$; CE_PR_PRBFN = $0000_2$; CE_PR_PRBSYM = $0011_2$; CE_PR_PRBGI = $111_2$,CE_PR_APSDC = 31 and PRB_BMAT_ID = 11.

The receiver may resend the MCE_Initiation.req message, if it does not receive the MCE_Initiation.cnf message within 200 msec.

### 5) Clause 8.12.1.1.3

*Revise clause 8.12.1.1.3 "Channel estimation initiation confirmation" as follows:*

#### 8.12.1.1.3 Channel estimation initiation confirmation

The transmitter shall confirm the channel estimation initiation request by sending the receiver an MCE_Initiation.cnf message.

The transmitter shall indicate whether it grants or rejects the channel estimation initiation request. The transmitter shall set CE_BMAT_ID to the value selected by the receiver in the MCE_Initiation.req message. The transmitter shall finalize CE_BAT_GRP, which shall be ~~larger than or~~ equal to the one indicated by the receiver via channel estimation initiation request, and CE_PG_GRP, which shall be larger than or equal to the one indicated by the receiver via channel estimation initiation request.

The transmitter shall send an MCE_Initiation.cnf message within 100 msec after it receives the MCE_Initiation.req message. If the transmitter needs to request the bandwidth for PROBE frame transmission, the transmitter shall send an MCE_Initiation.cnf message within 200 msec.

### 6) Clause 8.12.1.2.1

*Revise clause 8.12.1.2.1 "Channel estimation request" as follows:*

#### 8.12.1.2.1 Channel estimation request

The transmitter triggers the channel estimation process by sending the receiver MCE_Request.ind message.

The transmitter can specify the channel estimation window (CE_STIME and CE_ETIME). In this case the receiver shall use the same channel estimation window as the transmitter requested in MCE_Initiation.req message. Otherwise, the receiver can determine the channel estimation window at its own discretion.

The receiver shall respond to a MCE_Request.ind message from the transmitter within 100 ms with either a MCE_Initiation.req message or a MCE_ParamUpdate.req message.

If the transmitter does not receive either the MCE_Initiation.req message ~~within~~ or the MCE_ParamUpdate.req message within 200 ms after MCE_Request.ind is sent, it may resend the channel estimation request message.

**7) Clause 8.12.1.3.2**

*Revise clause 8.12.1.3.2 "Partial BMAT update" as follows:*

**8.12.1.3.2 Partial BMAT update**

The transmitter and receiver that communicate with each other by establishing a common runtime BMAT may update a portion of the BMAT at any time during its usage. The receiver may initiate the partial BMAT update (PBMU) by sending PBMU information in the management message.

The process of partial BMAT update is described as follows:

1) At any time during communication, the receiver may send the PBMU request for any valid BMAT used by the transmitter. The PBMU request contains the new valid BMAT_ID (N_BMAT_ID), old BMAT_ID (O_BMAT_ID) associated with the BMAT to be updated, and bit allocation changes (see clause 8.12.1.3.2.1~~4.1~~).
2) Upon reception of the PBMU request, the transmitter shall update the BMAT associated with the O_BMAT_ID, and assign N_BMAT_ID to the updated BMAT and reply with the PBMU confirmation. After receiving the first frame carrying payload using the N_BMAT_ID, the receiver shall consider O_BMAT_ID as invalid (see clause 8.12.1.5).
3) The receiver may send another PBMU request after confirming that the transmitter incorporated the previous PBMU request or after inferring that the previous PBMU request was lost.

**8) Clause 8.12.1.4**

*Revise clause 8.12.1.4 "Channel estimation using PROBE frames" as follows:*

**8.12.1.4 Channel estimation using PROBE frames**

The receiver can request the transmitter for PROBE frame transmission at any time after registration without going through the channel estimation initiation process.

To request PROBE frames, the receiver may use MCE_ProbeRequest.ind messages or the ACK_CE_CTRL field in the PFH of an ACK frame (see clause 7.1.2.3.2.3.1). Upon reception of a request for PROBE frame transmission, the transmitter should transmit PROBE frames as soon as possible.

If the receiver requests a PROBE frame through a specific management message, the transmitter shall transmit the PROBE frame using parameters selected by the receiver, that is, the parameters selected in the latest request for PROBE frame transmission (MCE_ProbeRequest.ind) or channel estimation initiation (MCE_Initiation.req).

If the receiver requests a PROBE frame through an ACK frame, the transmitter shall use the default PROBE frame. The transmitter shall use the default PROBE frame for all ACK frame-based requests for PROBE frame transmission by the receiver regardless of the BAT_ID. In this case, the transmitter may ~~use entire MAC cycle to~~ transmit PROBE frames anywhere in a MAC cycle, regardless of a particular channel estimation window associated with the BMAT_ID under channel estimation.

The parameters for the default PROBE frame are determined by the receiver through the MCE_Initiation.req message as described in clause 8.12.2.1.1. Alternatively, they can be updated by setting a bit in the MCE_ProbeRequest.ind message as described in Table 8-18.

When a transmitter receives a request for PROBE frame transmission from a receiver while handling previous requests for PROBE frame transmission from the same receiver, it should ignore the new request if the requested parameters are the same as the old ones, regardless of the value of the BMAT_ID under estimation.

NOTE – The transmitter should try to cover as much of the channel estimation window as possible when generating PROBE frames.

When the receiver requests a PROBE frame via ACK frames, it may request multiple times by sending multiple ACK frames by setting ACK_CE_CTRL until it receives the PROBE frame. The transmitter should ignore new request for PROBE frame transmission coming from the receiver in order to avoid unnecessary PROBE frame transmissions.

After PROBE frame transmissions, the receiver may send the outcome of channel estimation to the transmitter in case it is needed, using an unsolicited MCE_ParamUpdate.req (clause 8.12.1.3.1) or a partial BMAT update (clause 8.12.1.3.2).

A PROBE frame should be considered as having an MPDU priority equal to 7.

### 9) Clause 8.12.1.7.1

*Revise clause 8.12.1.7.1 "Format of MCE_ProbeSlotAssign.req" as follows:*

#### 8.12.1.7.1 Format of MCE_ProbeSlotAssign.req

The format of the MMPL of the MCE_ProbeSlotAssign.req message shall be as shown in Table 8-3.

**Table 8-3 – Format of the MMPL of the MCE_ProbeSlotAssign.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| Transmitter ID | 0 | [7:0] | The DEVICE_ID of the node requesting the bandwidth allocation for PROBE frame transmissions. |
| Receiver_ID | 1 | [7:0] | The DEVICE ID of the receiver node in the channel estimation procedure. |
| CE_BMAT_ID | 2 | [4:0] | This field indicates the BMAT_ID associated with the runtime BMAT to be updated by channel estimation. It shall be formatted as shown in Table 7-3. |
| Reserved | | [7:5] | Reserved by ITU-T (Note). |
| CE_STIME | 3 | [7:0] | This field indicates time at which the transmitter can start PROBE frame transmissions, and it shall be coded as shown in Table 8-98 of [ITU-T G.9961]. |
| CE_ETIME | 4 | [7:0] | This field indicates time at which the transmitter shall end PROBE frame transmissions, and it shall be coded as shown in Table 8-99 of [ITU-T G.9961]. |
| CE_PRB_PARM | 5 to 9~~8~~ | [3~~9~~1:0] | This field specifies a set of parameters for PROBE frame. It shall be coded as shown in Table 8-22. |
| CE_PRIORITY | 10~~9~~ | [2:0] | This field specifies the highest user priority of the traffic the transmitter has to transmit to the specified receiver. |
| Reserved | | [7:3] | Reserved by ITU-T (Note). |
| NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. | | | |

### 10) Clause 8.12.1.7.3

*Revise clause 8.12.1.7.3 "Format of MCE_ParamUpdate.req" as follows:*

#### 8.12.1.7.3 Format of MCE_ParamUpdate.req

The format of the MMPL of the MCE_ParamUpdate.req message shall be as shown in Table 8-5.

**Table 8-5 – Format of the MMPL of the MCE_ParamUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| New BMAT ID | 0 and 1 | [4:0] | This field indicates the BMAT_ID associated with a new BMAT (CE_BMAT_ID). It shall be formatted as shown in Table 7-3. |
| Bandplan ID | | [7:5] | This field indicates the type of bandplan based on which the subsequent BAT entries are defined. It shall be formatted as shown in Table 7-10 of [ITU-T G.9960]. |
| CE_BAT_GRP | | [10:8] | This field indicates the BAT grouping (*G*) associated with the new BATs, and determined at the channel estimation initiation confirmation. It shall be formatted as shown in Table 8-6. |
| MIMO mode indicator | | [12:11] | This field indicates the usage of one of the following MIMO modes, for the BMAT_ID associated with the new BMAT (CE_BMAT_ID) (Note 10):<br>0 – Mode 0<br>1 – Mode 1<br>2 – Mode 2<br>3 – Reserved by ITU-T<br>See clause 8.11.2 for a description of the above modes. |
| BAT update indicator | | [13] | 0, when the BATs of SS 1 and SS 2 are not updated in the message, i.e., when the BAT fields, $B_1^{(1)},\ldots, B_Z^{(1)}$ and $B_1^{(2)},\ldots, B_Z^{(2)}$ are not present in the message<br>1, when the BATs of SS 1 and SS 2 are updated in the message, i.e., when the BAT fields are present in the message<br>Z is defined in the $TIDX_{MAX}$ field. |
| Precoding feedback update indicator | | [14] | 0, when the precoding parameters are not updated in the message, i.e., when the precoding parameters fields, $P_{1,\theta}$, $P_{1,\varphi},\ldots, P_{K,\theta}$ and, $P_{K,\varphi}$ are not present in the message<br>1, the precoding parameters are updated in the message, i.e., when the precoding parameters fields are present in the message.<br>This field shall be set to 0 in case the "MIMO mode indicator" field is set to 0.<br>K is defined in the $TIDX_{max}$ field. |

**Table 8-5 – Format of the MMPL of the MCE_ParamUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| Precoding feedback quantization indicator | | [15] | 0, when $P_{i,\theta}$ and $P_{i,\varphi}$ are quantized as 4-bit values<br>1, when $P_{i,\theta}$ and $P_{i,\varphi}$ are quantized as 8-bit values<br>Whenever the "Precoding feedback update indicator" field is set to 0 this field shall be ignored by the receiver of the message. |
| CE_PR_GRP | 2 | [2:0] | This field indicates the precoding grouping (*PG*) associated with the precoding feedback update indicator and the feedback parameters $P_{i,j}$, and determined at the channel estimation initiation confirmation. It shall be formatted as shown in Table 8-7 – Format of the CE_PR_GRP<br>Whenever the "Precoding feedback update indicator" field is set to 0 this field shall be ignored by the receiver of the message. |
| Reserved | | [7:3] | Reserved by ITU-T (Note 1). |
| VALID_BMAT_ID | 3 and 4 | [15:0] | This field contains a bitmap indicating which runtime BMATs are valid (including the New BMAT ID) for this node (SID) when receiving from the destination node (DID). Each bit is associated with one runtime BMAT. Bit 0 of the VALID_BMAT_ID shall be set to one if runtime BMAT_ID 16 is valid. Bit 11 of the VALID_BMAT_ID shall be set to one if runtime BMAT_ID 27 is valid. |
| NUM_TX_AVAIL_BMATS_NO_PREC | 5 | [3:0] | This field contains the number of available runtime BMATs, assuming $G = 1$ and no precoding, that this node (SID) can support when transmitting to the destination node (DID). Valid values are from 0 to 12. |
| NUM_TX_AVAIL_BMATS_PREC | | [7:4] | This field contains the number of available runtime BMATs, assuming $G = 1$ and $PG = 1$ (with the precoding parameters quantized to 8 bits), that this node (SID) can support when transmitting to the destination node (DID). Valid values are from 0 to 12. |
| New block size | 6 | [1:0] | This field indicates the proposed BLKSZ associated with the new BMAT. It shall be formatted as shown in Table 7-7 of [ITU-T G.9960] (Note 2). |
| New FEC rate | | [4:2] | This field indicates the proposed FEC_RATE associated with the new BMAT. It shall be formatted as shown in Table 7-12 of [ITU-T G.9960] (Note 3). |
| New GI | | [7:5] | This field indicates the proposed GI_ID associated with the new BMAT. It shall be formatted as shown in Table 7-14 of [ITU-T G.9960] (Note 4). |
| New PSD ceiling | 7 | [4:0] | This field is the value of APSDC-M in the PHY-frame header associated with the new BMAT. This field shall be formatted as shown in clause 7.1.2.3.2.2.11. |
| NUM_VALID_DUR | | [7:5] | This field indicates the number of valid durations specified for the new BMAT (*V*). The valid range of values for this field is from 0 ($V$=1) to 7 ($V$=8) (Note 5). |

**Table 8-5 – Format of the MMPL of the MCE_ParamUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| $CE\_STIME_1$ | 8 | [7:0] | This field indicates the start time of the first duration in which the new BMAT is valid. It shall be formatted as shown in Table 8-98 of [ITU-T G.9961]. |
| $CE\_ETIME_1$ | 9 | [7:0] | This field indicates the end time of the first duration in which the new BMAT is valid. It shall be formatted as shown in Table 8-99 of [ITU-T G.9961]. |
| … | … | … | … |
| $CE\_STIME_v$ | $2V$+6 | [7:0] | This field indicates the start time of the last duration in which the new BAT is valid. It shall be formatted as shown in Table 8-98 of [ITU-T G.9961]. |
| $CE\_ETIME_v$ | $2V$+7 | [7:0] | This field indicates the end time of the last duration in which the new BMAT is valid. It shall be formatted as shown in Table 8-99 of [ITU-T G.9961]. |
| $TIDX_{MIN}$ | ($2V$+8) to ($2V$+10) | [11:0] | 12-bit unsigned integer indicating the minimum of:<br>1) the first sub-carrier index of the first BAT group to which non-zero bits are assigned in spatial stream 1, and<br>2) the first sub-carrier index of the first BAT group to which non-zero bits are assigned in spatial stream 2.<br>It shall be an integer multiple of $G$ (Note 6).<br>The value of this field shall be associated with the BMAT and shall be used during partial BMAT updates (see Table 8-9). |
| $TIDX_{MAX}$ | | [23:11] | 12-bit unsigned integer indicating the maximum of:<br>1) the first sub-carrier index of the last BAT group to which non-zero bits are assigned in spatial stream 1, and<br>2) the first sub-carrier index of the last BAT group to which non-zero bits are assigned in spatial stream 2.<br>It shall be an integer multiple of $G$ (Note 6) and if bit-loading grouping is used ($G$>1) shall meet: $TIDX_{MAX} + G - 1 \leq$ StopSubCarrier, where StopSubCarrier is specified in Table 8-16.6 ("Bandplan Info Capability Value field) of [ITU-T G.9961].<br>Let $W$ denote the number of BAT entries, which is $(TIDX_{MAX} - TIDX_{MIN})/G + 1$.<br>Let $Z$ denote the smallest integer larger than or equal to $W/2$.<br>Let $K$ denote the number of precoding entries (i.e., the number of precoding groups), which is the smallest integer larger than or equal to $(TIDX_{MAX} + G - TIDX_{MIN})/PG$. |
| $B_1^{(1)}$ | $2V$+11 | [3:0] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 1 for sub-carrier indices from $TIDX_{MIN}$ to $TIDX_{MIN} + G - 1$ (Notes 6, 7). |
| | | [7:4] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits |

**Table 8-5 – Format of the MMPL of the MCE_ParamUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| | | | assigned to spatial stream 1 for sub-carrier indices from $TIDX_{MIN} + G$ to $TIDX_{MIN} + 2G - 1$ (Notes 6, 7, 8). |
| … | … | … | … |
| $B_Z^{(1)}$ | $2V+10+Z$ | [3:0] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 1 for sub-carrier indices from $TIDX_{MAX} - G$ to $TIDX_{MAX} - 1$ if W is even, or to sub-carrier indices $TIDX_{MAX}$ to $TIDX_{MAX} + G - 1$ if W is odd (Notes 6, 7). |
| | | [7:4] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 1 for sub-carrier indices from $TIDX_{MAX}$ to $TIDX_{MAX} + G - 1$ if W is even (Notes 6, 7, 9). |
| $B_1^{(2)}$ | variable | [3:0] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 2 for sub-carrier indices from $TIDX_{MIN}$ to $TIDX_{MIN} + G - 1$ (Notes 6, 7). |
| | | [7:4] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 2 for sub-carrier indices from $TIDX_{MIN} + G$ to $TIDX_{MIN} + 2G - 1$ (Notes 6, 7, 8). |
| … | … | … | … |
| $B_Z^{(2)}$ | variable | [3:0] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 2 for sub-carrier indices from $TIDX_{MAX} - G$ to $TIDX_{MAX} - 1$ if W is even, or to sub-carrier indices $TIDX_{MAX}$ to $TIDX_{MAX} + G - 1$ if W is odd (Notes 6, 7). |
| | | [7:4] | This field shall be present if and only if the "BAT update indicator" field is set to one. It shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 2 for sub-carrier indices from $TIDX_{MAX}$ to $TIDX_{MAX} + G - 1$ if W is even (Notes 6, 7, 9). |
| $P_{1,\theta}$ | variable | variable | This field shall be present if and only if the "precoding parameters update indicator" field is set to one (Note 13). It shall be represented as a 4-bit (Note 12) or 8-bit unsigned integer indicating the angle θ which is one of the parameters of the precoding matrix assigned to the first group of $PG$ sub-carriers, having sub-carrier indices $TIDX_{MIN}$ to $TIDX_{MIN} + PG - 1$. The value of θ, in units of radians, is equal to either (based on the Precoding feedback quantization indicator field): $\theta = \pi(2P_\theta + 1)/64$ where: $P_\theta = P_{1,\theta} = 0 \ldots 15$ (4-bit quantization), or |

**Table 8-5 – Format of the MMPL of the MCE_ParamUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| | | | $\theta = \pi(2P_\theta + 1)/1024$ where: $P_\theta = P_{1,\theta} = 0…255$ (8-bit quantization). |
| … | … | … | … |
| $P_{K,\theta}$ | variable | variable | This field shall be present if and only if the "precoding parameters update indicator" field is set to one (Note 13). It shall be represented as a 4-bit (Note 12) or 8-bit unsigned integer indicating the angle θ which is one of the parameters of the precoding matrix assigned to the last group of *PG* sub-carriers, having sub-carrier indices $TIDX_{MIN} + PG\times(K\text{-}1)$ to $TIDX_{MIN} + PG - 1 + PG\times(K\text{-}1)$. The value of θ, in units of radians, is equal to either (based on the Precoding feedback quantization indicator field):<br>• $\theta = \pi(2P_\theta + 1)/64$ where: $P_\theta = P_{K,\theta} = 0…15$ (4-bit quantization), or<br>• $\theta = \pi(2P_\theta + 1)/1024$ where: $P_\theta = P_{K,\theta} = 0…255$ (8-bit quantization). |
| $P_{1,\varphi}$ | variable | variable | This field shall be present if and only if the "precoding parameters update indicator" field is set to one (Note 13). It shall be represented as a 4-bit (Note 12) or 8-bit unsigned integer indicating the angle φ which is one of the parameters of the precoding matrix assigned to the first group of *PG* sub-carriers, having sub-carrier indices $TIDX_{MIN}$ to $TIDX_{MIN} + PG - 1$. The value of φ, in units of radians, is equal to either (based on the Precoding feedback quantization indicator field) (Note 11):<br>• $\varphi = \pi(2P_\varphi + 1)/16$ where: $P_\varphi = P_{1,\varphi} = 0…15$ (4-bit quantization), or<br>• $\varphi = \pi(2P_\varphi + 1)/256$ where: $P_\varphi = P_{1,\varphi} = 0…255$ (8-bit quantization). |
| … | … | … | … |
| $P_{K,\varphi}$ | variable | variable | This field shall be present if and only if the "precoding parameters update indicator" field is set to one (Note 13). It shall be represented as a 4-bit (Note 12) or 8-bit unsigned integer indicating the angle $\varphi$ which is one of the parameters of the precoding matrix assigned to the last group of *PG* sub-carriers, having sub-carrier indices $TIDX_{MIN} + PG\times(K\text{-}1)$ to $TIDX_{MIN} + PG - 1 + PG\times(K\text{-}1)$. The value of $\varphi$, in units of radians, is equal to either (based on the Precoding feedback quantization indicator field) (Note 11):<br>• $\varphi = \pi(2P_\varphi + 1)/16$ where: $P_\varphi = P_{K,\varphi} = 0…15$ (4-bit quantization), or<br>• $\varphi = \pi(2P_\varphi + 1)/256$ where: $P_\varphi = P_{K,\varphi} = 0…255$ (8-bit quantization). |
| NOTE 1 – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table 8-5 – Format of the MMPL of the MCE_ParamUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| NOTE 2 – The transmitter shall use the proposed block size or larger block size for a new connection. Once the block size is selected for a connection, it shall not be changed throughout the lifetime of the connection (clause 8.1.3.2 of [ITU-T G.9960]).<br>NOTE 3 – The transmitter shall use the proposed FEC rate or lower FEC rate.<br>NOTE 4 – The transmitter shall use the proposed GI or longer GI value.<br>NOTE 5 – A new BMAT shall only be used over specified non-overlapping durations (up to 8) within a MAC cycle, defined by $CE\_STIME_i$ and $CE\_ETIME_i$.<br>NOTE 6 – Sub-carrier index represents the physical index (clause 7.1.4.1). All BMATs entries outside [$TIDX_{MIN}$, $TIDX_{MAX}$ + $G$ – 1] shall be considered as unloaded.<br>NOTE 7 – If a sub-carrier is not loaded, the field shall be set to 0 or 15.<br>NOTE 8 – If $W$ = 1, this field shall be set to zero.<br>NOTE 9 – If $W$ is an odd number, this field shall be set to zero.<br>NOTE 10 – The Tx port mapping matrix (*TPM*) that shall be used by each sub-carrier is indicated by the coding of bits in the BATs assigned to the two spatial streams of the sub-carrier, and the MIMO mode indicator, according to Table 8-2.<br>NOTE 11 – The cyclic shift introduces a~~n~~ ~~in~~decrement of $2*\pi*T_{CS}*F_{SC}$=0.0981~~1~~75 radians (approximation of π/32 radians) to the angle φ from one sub-carrier to the next When $PG$>1 the value of $P_\varphi$ shall be referred to the lowest frequency sub-carrier in the group. The transmitter shall calculate the value of $\varphi$ for each sub-carrier of the group $i$ ($i$ = 0 … PG-1) as:<br>• $\varphi = \pi(2P'_\varphi + 1)/16$, where $P'_\varphi = (4P_\varphi - i)/4$ for the case of 4 bit quantization<br>• $\varphi = \pi(2P'_\varphi + 1)/256$, where $P'_\varphi = P_\varphi - 4i$ for the case of 8 bit quantization.<br>NOTE 12 – For 4-bit values, 2 values are packed into each octet with 4 LSBs corresponding to the lower sub-carrier index. If K is odd, the 4 MSBs of the octet containing $P_{K,\theta}$ and $P_{K,\varphi}$ shall be set to zero.<br>NOTE 13 – Precoding parameters are reported for all of the precoding groups, even those that include sub-carriers that are associated with Tx port mapping with no precoding. | | | |

**Table 8-6 – Format of the CE_BAT_GRP**

| BAT_GRP_ID value ($b_{10}b_9b_8$) | Description |
|---|---|
| 000 | Default – No BAT sub-carrier grouping ($G$ = 1) |
| 001 | BAT sub-carrier grouping of 2 sub-carriers ($G$ = 2) |
| 010 | BAT sub-carrier grouping of 4 sub-carriers ($G$ = 4) |
| 011 | BAT sub-carrier grouping of 8 sub-carriers ($G$ = 8) |
| 100 | BAT sub-carrier grouping of 16 sub-carriers ($G$ = 16) |
| 101 to 111 | Reserved by ITU-T |

**Table 8-7 – Format of the CE_PR_GRP**

| PR_GRP_ID value ($b_2b_1b_0$) | Description |
|---|---|
| 000 | Default – No precoding sub-carrier grouping (*PG* = 1) |
| 001 | Precoding sub-carrier grouping of 2 sub-carriers (*PG* = 2) |
| 010 | Precoding sub-carrier grouping of 4 sub-carriers (*PG* = 4) |
| 011 | Precoding sub-carrier grouping of 8 sub-carriers (*PG* = 8) |
| 100 | Precoding sub-carrier grouping of 16 sub-carriers (*PG* = 16) |
| 101 to 111 | Reserved by ITU-T |

**11) Clause 8.12.1.7.5**

*Revise clause 8.12.1.7.5 "Format of MCE_PartialBmatUpdate.req" as follows:*

**8.12.1.7.5 Format of MCE_PartialBmatUpdate.req**

The format of the MMPL of the MCE_PartialBmatUpdate.req message shall be as shown in Table 8-9.

**Table 8-9 – Format of the MMPL of the MCE_PartialBmatUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| O_BMAT_ID | 0 | [4:0] | This field indicates the BMAT_ID associated with the BMAT to be updated by the PBMU request. It shall be formatted as shown in Table 7-3. |
| Reserved | | [7:5] | Reserved by ITU-T (Note). |
| N_BMAT_ID | 1 | [4:0] | This field indicates the BMAT_ID associated with the BMAT updated by the PBMU request. It shall be formatted as shown in Table 7-3. |
| Reserved | | [7:5] | Reserved by ITU-T (Note). |
| NUM_BAT_ENT | 2 and 3 | [9:0] | This field indicates the number of BAT entries to be updated (*V*). The valid range of this field is from 0 (*V*=1) to 1023 (*V*=1024). |
| Reserved | | [15:10] | Reserved by ITU-T (Note). |
| NUM_PG_ENT | 4 and 5 | [9:0] | This field indicates the number of precoding group entries to be updated (*Q*). The valid range of this field is from 0 (*Q*=1) to 1023 (*Q*=1024).<br>Whenever the "Precoding feedback update indicator" field is set to 0 this field shall be ignored by the receiver of the message. |
| BAT SS 1 update indicator | | [10] | 0, when the BAT of SS 1 is not updated in the message, i.e., the BAT fields, $B_{T1}^{(1)}$,…, $B_{Tv}^{(1)}$ (including the reserved fields in the relevant octets) are not present in the message<br>1, when the BAT of SS 1 is updated in the message, i.e., the BAT fields are present in the message. |
| BAT SS 2 update indicator | | [11] | 0, when the BAT of SS 2 is not updated in the message, i.e., the BAT fields, $B_{T1}^{(2)}$,…, $B_{Tv}^{(2)}$ (including the reserved fields in the relevant octets) are not present in the message |

**Table 8-9 – Format of the MMPL of the MCE_PartialBmatUpdate.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| | | | 1, when the BAT of SS 2 is updated in the message, i.e., the BAT fields are present in the message. |
| Precoding feedback update indicator | | [12] | 0, when the precoding parameters are not updated in the message, i.e., the precoding parameters fields, $PT_1$, $P_{\theta, PT1}$, $P_{\varphi, PT1}$,…, $PT_Q$, $P_{\theta, PTQ}$, $P_{\varphi, PTV}$ are not present in the message<br>1, when the precoding parameters are updated in the message, i.e., the precoding parameters fields are present in the message<br>This field shall be set to 0 in case the "MIMO mode indicator" field associated with the O_BMAT_ID is set to 0. |
| Precoding feedback quantization indicator | | [13] | 0, when $P_{i,\theta}$ and $P_{i,\varphi}$ are quantized as 4-bit values<br>1, when $P_{i,\theta}$ and $P_{i,\varphi}$ are quantized as 8-bit values<br>Whenever the "Precoding feedback update indicator" field is set to 0 this field shall be ignored by the receiver of the message.<br>The quantization value shall be the same as one associated with O_BMAT_ID. |
| Reserved | | [15:14] | Reserved by ITU-T (Note). |
| 2SS BAT entry descriptor[*V*] | variable | [23:0] | This field shall be present if and only if both the fields "BAT SS 1 update indicator" and "BAT SS 2 update indicator" are set to one. It shall be formatted as shown in Table 8-10. |
| 1SS BAT entry descriptor[*V*] | variable | [15:0] | This field shall be present if and only if exactly one of the fields "BAT SS 1 update indicator" and "BAT SS 2 update indicator" is set to one. It shall be formatted as shown in Table 8-11. |
| Precoding entry descriptor[*Q*] | variable | variable | This field shall be present if and only if the "precoding parameters update indicator" field is set to one. It shall be formatted as shown in Table 8-12. |
| NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table 8-10 – Format of the 2SS BAT entry descriptor**

| Field | Octet | Bits | Description |
|---|---|---|---|
| $T_i$ | 0 to 2 | [11:0] | This field shall be represented as a 12-bit unsigned integer indicating the sub-carrier index (Note 1). It shall be an integer multiple of *G*.<br>$T_i$=TIDXmin+max(G,PG)*I; where I is an integer (Note 2), and TIDXmin is the value associated with the O_BMAT_ID (see Table 8-9). |
| $B_{Ti}^{(1)}$ | | [15:12] | This field shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 1 for sub-carrier indices from $T_i$ to $T_i$+*G*-1. |
| $B_{Ti}^{(2)}$ | | [19:16] | This field shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream 2 for sub-carrier indices from $T_i$ to $T_i$+*G*-1. |
| Reserved | | [23:20] | Reserved by ITU-T (Note 3). |
| NOTE 1 – Sub-carrier index represents the physical index (see clause 7.1.4.1).<br>NOTE 2 – Values of $T_i$ less than TIDXmin may be selected by using a negative value of I.<br>NOTE 3 – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table 8-11 – Format of the 1SS BAT entry descriptor**

| Field | Octet | Bits | Description |
|---|---|---|---|
| $T_i$ | 0 to 1 | [11:0] | This field shall be represented as a 12-bit unsigned integer indicating the sub-carrier index (Note 1).<br>$T_1$=TIDXmin+max(G,PG)*I; where I is an integer (Note 2), and TIDXmin is the value associated with the O_BMAT_ID (see Table 8-5). |
| $B_{Ti}^{(k)}$ | | [15:12] | This field shall be represented as a 4-bit unsigned integer indicating the number of bits assigned to spatial stream k for sub-carrier indices from $T_i$ to $T_i$+*G*-1.<br>The Value of k is:<br>1 if the field "BAT SS 1 update indicator" is set to one.<br>2 if the field "BAT SS 2 update indicator" is set to one. |
| NOTE 1 – Sub-carrier index represents the physical index (see clause 7.1.4.1).<br>NOTE 2 – Values of $T_i$ less than TIDXmin may be selected by using a negative value of I. | | | |

**Table 8-12 – Format of the Precoding entry descriptor**

| Field | Octet | Bits | Description |
|---|---|---|---|
| $PT_i$ | 0 and 1 | [11:0] | This field shall represent 12-bit unsigned integer indicating the sub-carrier index (Note 1).<br>$PT_1$=TIDXmin+PG*I; where I is an integer (Note 2), and TIDXmin is the value associated with the O_BMAT_ID (see Table 8-5). |
| Reserved | | [15:12] | Reserved by ITU-T. |
| $P_{\theta, PTi}$ | Variable | variable | This field shall represent a 4-bit or 8-bit unsigned integer indicating the angle θ, which is one of the parameters of the precoding matrix assigned to a group of *PG* sub-carriers with indices $PT_1$ to $PT_i$+*PG*-1. The value of θ, in units of radians, is equal to either (based on the Precoding feedback quantization indicator field) (Note 3):<br>• $\theta = \pi(2P_\theta + 1)/64$ where: $P_\theta = P_{\theta, PTi} = 0 \ldots 15$ (4-bit quantization), or<br>• $\theta = \pi(2P_\theta + 1)/1024$ where: $P_\theta = P_{\theta, PTi} = 0 \ldots 255$ (8-bit quantization). |
| $P_{\varphi, PTi}$ | Variable | Variable | This field shall represent a 4-bit or 8-bit unsigned integer indicating the angle φ, which is one of the parameters of the precoding matrix assigned to a group of *PG* sub-carriers with indices $PT_1$ to $PT_1$+*PG*-1. The value of φ, in units of radians, is equal to either (based on the Precoding feedback quantization indicator field) (Note 3, 4):<br>• $\varphi = \pi(2P_\varphi + 1)/16$ where: $P_\varphi = P_{\varphi, PTi} = 0 \ldots 15$ (4-bit quantization), or<br>• $\varphi = \pi(2P_\varphi + 1)/256$ where: $P_\varphi = P_{\varphi, PTi} = 0 \ldots 255$ (8-bit quantization). |
| NOTE 1 – Sub-carrier index represents the physical index (see clause 7.1.4.1).<br>NOTE 2 – Values of PT less than $TIDX_{min}$ may be selected by using a negative value of I.<br>NOTE 3 – For 4-bit quantization, the size of precoding entry descriptor is 3 bytes. For 8-bit quantization, the size of precoding entry descriptor is 4 bytes.<br>NOTE 4 – The cyclic shift introduces a~~n~~ ~~in~~decrement of $2*\pi*T_{CS}*F_{SC}=0.0981$~~1~~75 radians (approximation of π/32 radians) to the angle φ from one sub-carrier to the next When *PG*>1 the value of $P_\varphi$ shall be referred to the lowest frequency sub-carrier in the group. The transmitter shall calculate the value of φ for each sub-carrier of the group *i* (*i* = 0 … PG-1) as:<br>• $\varphi = \pi(2P'_\varphi + 1)/16$, where $P'_\varphi = (4P_\varphi - i)/4$ for the case of 4 bit quantization.<br>• $\varphi = \pi(2P'_\varphi + 1)/256$, where $P'_\varphi = P_\varphi - 4i$ for the case of 8 bit quantization. | | | |

## 12) Clause 8.12.1.7.12

*Revise clause 8.12.1.7.12 "Format of MCE_Initiation.req" as follows:*

### 8.12.1.7.12 Format of MCE_Initiation.req

The format of the MMPL of the MCE_Initiation.req message shall be as shown in Table 8-19.

**Table 8-19 – Format of the MMPL of the MCE_Initiation.req message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| CE_BMAT_ID | 0 and 1 | [4:0] | This field indicates the BMAT_ID associated with the runtime BMAT to be created by channel estimation. It shall be formatted as shown in Table 7-3. |
| CE_BAT_GRP~~_MIN~~ | | [7:5] | This field indicates the ~~minimum~~ value of BAT sub-carrier grouping. It shall be formatted as shown in Table 8-6. |
| CE_PR_GRP~~_MIN~~ | | [10:8] | This field indicates the ~~minimum~~ value of precoding sub-carrier grouping. It shall be formatted as shown in Table 8-2. |
| Reserved | | [15:11] | Reserved by ITU-T (Note). |
| CE_STIME | 2 | [7:0] | This field indicates time at which the transmitter can start PROBE frame transmissions, and it shall be coded as shown in Table 8-98 of [ITU-T G.9961]. |
| CE_ETIME | 3 | [7:0] | This field indicates time at which the transmitter shall end PROBE frame transmissions, and it shall be coded as shown in Table 8-99 of [ITU-T G.9961]. |
| CE_PRB_RQST | 4 | [0] | This field shall be set to one if the receiver wants PROBE frames along with channel estimation initiation confirmation. It shall be set to zero otherwise. |
| Reserved | | [7:1] | Reserved by ITU-T (Note). |
| CE_PRB_PARM | 5 to 9~~8~~ | [39~~1~~:0] | This field specifies a set of parameters for PROBE frame. It shall be coded as shown in Table 8-22. This field shall be set to $000000_{16}$ if CE_PRB_RQST is set to zero. |
| NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. | | | |

**13) Clause 8.12.1.7.14**

*Revise clause 8.12.1.7.14 "Format of MCE_ProbeRequest.ind" as follows:*

#### 8.12.1.7.14 Format of MCE_ProbeRequest.ind

The format of the MMPL of the MCE_ProbeRequest.ind message shall be as shown in Table 8-21.

**Table 8-21 – Format of the MMPL of the MCE_ProbeRequest.ind message**

| Field | Octet | Bits | Description |
|---|---|---|---|
| CE_BMAT_ID | 0 | [4:0] | This field indicates the BMAT_ID associated with the runtime BMAT to be created by channel estimation. It shall be formatted as shown in Table 7-3. |
| CE_PRB_DEFAULT_IND | | [5] | When this field is set to one, the parameters provided in this message (CE_PRB_PARM) replace the existing parameters for the default PROBE frame for this node (SID) when receiving from the destination node (DID). |
| Reserved | | [7:6] | Reserved by ITU-T (Note). |
| CE_PRB_PARM | 1 to 5~~4~~ | [3~~91~~:0] | See Table 8-22. |
| NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table 8-22 – Format of the CE_PRB_PARM field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| CE_PR_PRBTYPE | 0 | [3:0] | This field indicates the PRBTYPE requested by the receiver. It shall be formatted as shown in Table 7-8. |
| CE_PR_PRBFN | | [7:4] | This field indicates the number of PROBE frames that shall be sent by the transmitter at each request for PROBE frame transmission. The field shall be coded as shown in Table 8-103 of [ITU-T G.9961]. The transmitter may send multiple PROBE frames within a single channel estimation window. |
| CE_PR_PRBSYM | 1 | [3:0] | This field indicates the PRBSYM requested by the receiver. It shall be formatted as shown in Table 7-41 of [ITU-T G.9960]. |
| CE_PR_PRBGI | | [6:4] | This field indicates the PRBGI requested by the receiver. It shall be formatted as shown in Table 7-14 of [ITU-T G.9960]. |
| Reserved | | [7] | Reserved by ITU-T (Note 1). |
| CE_PR_APSDC | 2 | [4:0] | This field indicates the APSDC-P requested by the receiver. It shall be formatted as described in clause 7.1.2.3.2.7.4. |
| Reserved | | [7:5] | Reserved by ITU-T (Note 1). |
| PRB_BMAT_ID | 3 | [4:0] | This field indicates the BMAT_ID (predefined or runtime) whose MAT shall be used by the transmitter of the PROBE frame in the Tx port mapper in case a 2 SS channel estimation PROBE frame is requested in the CE_PR_PRBTYPE field.<br>The BMAT_ID indicated in this field shall be a valid BMAT_ID.<br>If this field conveys a predefined BMAT_ID, the valid values for channel estimation shall be 3, 7 and 11.<br>This field is only valid if 2 SS channel estimation PROBE is requested in the CE_PR_PRBTYPE field (PRBTYPE = $1000_2$). Otherwise, this field shall be set to 0 and ignored by the receiver. |
| Reserved | | [7:5] | Reserved by ITU-T (Note 1). |
| CE_PR_NUM_SILENT_SYM | 4 | [5:0] | This field indicates the number of silent symbols requested by the receiver. It shall be formatted as described in clause 7.1.2.3.2.7.2.3.3.<br>This field is only valid if 2 SS channel estimation PROBE is requested in the CE_PR_PRBTYPE field (PRBTYPE = $1000_2$). Otherwise, this field shall be set to 0 and ignored by the receiver. |
| Reserved | | [7:6] | Reserved by ITU-T (Note 1) |
| NOTE 1 – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver.<br>NOTE 2 – First (CE_PR_PRBSYM-CE_PR_NUM_SILENT_SYM) symbols of the 2 SS channel estimation PROBE frame are normal (non-silent) probe symbols. | | | |

**14) Clause 8.19 (New)**

*Add new clause 8.19 "Inter-bandplan interoperability" as follows:*

**8.19 Inter-bandplan interoperability**

See clause 8.18 of [ITU-T G.9961].

**15) Clause 8.20 (New)**

*Add new clause 8.20 "Version control and capabilities exchange" as follows:*

**8.20 Version control and capabilities exchange**

See clause 8.19 of [ITU-T G.9961].

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Printed in Switzerland
Geneva, 2015