

**Agenda Item:** AH21  
**Source:** Siemens AG  
**To:** TSG RAN WG1  
**Title:** Layer 1 RACH procedure for 1.28 Mcps TDD  
**Document for:** Decision

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## **1. Summary**

This paper gives the description of the Random Access Channel Procedure at Layer 1 for 1.28 Mcps TDD option.

## **2. Introduction**

The random access procedure for 1.28Mcps TDD is a two-step procedure; the first step allows the UE to get the uplink synchronisation and to set its transmit power level by exchanging with the network signatures and FPACH bursts, while in the second step the UE sends on the relevant PRACH channel the RACH message so that collision on that channel can be avoided.

Due to the payload requirement for the RACH a random access message can last 1 to 4 sub-frames and the PRACH can have the spreading factors 4, 8, and 16. In order to allow an efficient use of the FPACH resources the more than one PRACH can be associated to the FPACH. The access to these PRACH can only be granted at special sub-frames on the FPACH.

For examples see the Annex in the proposal.

For the use and generation of the information fields transmitted in the FPACH amendments have been done ensuring that the specifications mandate no specific algorithm for generating and processing the UpPCHpos information field in the FPACH.

## **3 Proposal**

It's proposed to discuss and include the following text proposal into the clause 5.6 'Random Access Procedure' of working CR of TS25.224.

## 5.6 Random Access procedure

The physical random access procedure described below is invoked whenever a higher layer requests transmission of a message on the RACH. The physical random access procedure is controlled by primitives from RRC and MAC.

### 5.6.1 Definitions

FPACH<sub>i</sub> : FPACH number i

L<sub>i</sub> : Length of RACH message associated to FPACH<sub>i</sub> in sub-frames

N<sub>RACHi</sub> : The number of PRACHs associated to the i<sup>th</sup> FPACH

∏<sub>RACHi</sub> : The number of a PRACH associated to the i<sup>th</sup> FPACH ranging from 0 to N<sub>RACHi</sub>-1

M : Maximum number transmissions in the UpPCH

WT : Maximum number of sub-frames to wait for the network acknowledgement to a sent signature

SFN' : The sub-frame number counting the sub-frames. At the beginning of the frame with the system frame number SFN=0 the sub-frame number is set to zero.

### 5.6.1-2 Preparation of random access

When the UE is in Idle mode, it will keep the downlink synchronisation and read the cell broadcast information. From the used SYNC-DL code in DwPCH, the UE will get the code set of 8 SYNC-UL codes (signatures) assigned to UpPCH for random access.

The description (codes, spreading factor, midambles, time slots) of the P-RACH, FPACH, and S-CCPCH (carrying the FACH logical channel) channel is broadcast on the BCH.

Thus, when sending a SYNC-UL sequence, the UE knows which FPACH resources, P-RACH resources and CCPCH resources will be used for the access.

The UE needs to decode the BCH information regarding the random access prior to transmission on the UpPCH.

The physical random access procedure described in this sub-clause is initiated upon request of a PHY-Data-REQ primitive from the MAC sub-layer (see [18] and [19]).

Before the physical random-access procedure can be initiated, Layer 1 shall receive the following information by a CPHY-TrCH-Config-REQ from the RRC layer:

- The association between which signatures and which FPACHs; which FPACHs and which PRACHs; which PRACHs and which CCPCHs; including the parameter values for each listed physical channel.
- The length L<sub>i</sub> of a RACH message associated to FPACH<sub>i</sub> can be configured to be either 1 or 2 or 4 sub-frames corresponding to a length in time of either 5 ms or 10 ms or 20 ms.

NOTE 1: N<sub>RACHi</sub> PRACHs can be associated with to FPACH<sub>i</sub>. The maximum allowed N<sub>RACHi</sub> is L<sub>i</sub>.
- The available UpPCH sub-channels for each Access Service Class (ASC):

NOTE 2: An UpPCH sub-channel is defined by a (sub-set of) signature(s) and sub-frame numbers.
- The set of Transport Format parameters for the PRACH message:
- The “M” maximum number transmissions in the UpPCH;
- The “WT” maximum number of sub-frames to wait for the network acknowledgement to a sent signature: (1..4) the maximum value supported by Layer 1 is 4 sub-frames.
- The initial signature power “Signature Initial Power”;

NOTE 2: The above parameters may be updated from higher layers before each physical random access procedure is initiated.

At each initiation of the physical random access procedure, Layer 1 shall receive the following information from the higher layers (MAC):

- The Transport Format to be used for the specific PRACH message;
- The ASC for the specific Random Access procedure with the timing and power level indication;
- The data to be transmitted (Transport Block Set).

## 5.6.23 Random access procedures

The physical random-access procedure shall be performed as follows:

UE side:

- 1 Set the Signature Re-Transmission Counter to M.
- 2 Set the Signature transmission power to Signature Initial Power.
- 3 Randomly select the UpPCH sub-channel from the available ones for the given ASC. The random function shall be such that each of the allowed selections is chosen with equal probability.
- 4 Transmit a signature using the selected UpPCH sub-channel at the signature transmission power.
- 5 After sending a signature, listen to the relevant FPACH for the next WT sub-frames to get the network acknowledgement. The UE will read the FPACH<sub>i</sub> associated to the transmitted UpPCH only in the sub-frames fulfilling the following relation:

$$\text{(SFN' mod } L_i) = n_{\text{RACH}_i}; n_{\text{RACH}_i} = 0, \dots, N_{\text{RACH}_i} - 1.$$

- 6 In case no valid answer is detected in the due time: decrease the Signature Re-transmission counter by one and if it is still greater than 0, then repeat from step 3; else report a random access failure to the MAC sub-layer.
- 7 In case a valid answer is detected in the due time
  - a) set the timing and power level values according to the indication received by the network in the FPACH<sub>i</sub>;
  - b) send at the sub-frame coming 2 sub-frames after the one carrying the signature acknowledgement, the RACH message on the relevant PRACH. In case L<sub>i</sub> is bigger than one and the sub-frame number of the acknowledgement is odd the UE will wait one more sub-frame. The relevant PRACH is the n<sub>RACH<sub>i</sub></sub><sup>th</sup> PRACH associated to the FPACH<sub>i</sub> if the following equation is fulfilled:

$$\text{(SFN' mod } L) = n_{\text{RACH}_i};$$

Here SFN' is the sub-frame number of the arrival of the acknowledgement.

Both on the UpPCH and on the PRACH, the transmit power level shall never exceed the indicated value signalled by the network.

Network side:

- The node B will transmit the FPACH<sub>i</sub> associated the transmitted UpPCH only in the sub-frames fulfilling the following relation:

$$\text{(SFN' mod } L) = n_{\text{RACH}_i}; n_{\text{RACH}_i} = 0, \dots, N_{\text{RACH}_i} - 1.$$

- The Node B will not acknowledge UpPCHs transmitted more than WT sub-frames ago

At the reception of a valid signature:

- Measure the timing deviation with respect to the reference time T<sub>ref</sub> of the received first path in time from the UpPCH and acknowledge the detected signature sending the FPACH burst on the relevant FPACH.

For examples on the random access procedure refer to Annex E.

## 5.6.23.1. The use and generation of the information fields transmitted in the FPACH

The Fast Physical Access CHannel (FPACH) is used by the Node B to carry, in a single burst, the acknowledgement of a detected signature with timing and power level adjustment indication to a user equipment.

The length and coding of the information fields is explained in TS25.221 sub-clause 6.3.3.1.

### 5.6.23.1.1 Signature Reference Number

The Signature Reference Number field contains the number of the acknowledged signature. The user equipment shall use this information to verify whether it is the recipient of the FPACH message.

### 5.6.23.1.2 Relative Sub-Frame Number

The Relative Sub-Frame Number field indicates the current sub-frame number with respect to the sub-frame at which the acknowledged signature has been detected.

The user equipment shall use this information to verify whether it is the recipient of the FPACH message.

### 5.6.23.1.3 Received starting position of the UpPCH ( $UpPCH_{POS}$ )

The *received starting position of the UpPCH ( $UpPCH_{POS}$ )* field indirectly indicates to the user equipment the timing adjustment it has to implement for the following transmission to the network.

The ~~network node B~~ computes the proper value for this parameter, ~~based on the correlation instant to the acknowledged signature from the UpPCH~~ according to the following rules:  $UpPCH_{POS} = UpPTS_{R_{xpath}} - UpPTS_{TS}$

where

$UpPTS_{R_{xpath}}$ : time of the reception in the Node B of the SYNC\_UL to be used in the uplink synchronization process

$UpPTS_{TS}$ : time instance two symbols prior to the end of the DwPCH according to the Node B internal timing

This information shall be used by the UE to adjust its timing when accessing the network.

The UE ~~can~~ shall use the *received starting position of the UpPCH ( $UpPCH_{POS}$ )* to estimate the propagation delay ( $T_{propagation\ delay}$ ) according to the following law:

$$T_{propagation\ delay} = (UpPCH_{adv} + UpPCH_{POS} - 8 * 16 T_c) / 2$$

where:

- $UpPCH_{adv}$  is the difference between the RX timing (received DL at UE) and initial TX timing (transmitted UL at UE) of a UE for UpPCH transmission (timing advance of the UpPCH);
- $T_c$  is the Time chip duration.

The timing advance for the RACH  $RACH_{ADV}$  is  $2 * T_{propagation\ delay}$ .

### 5.6.23.1.4 Transmit Power Level Command for the RACH message

This field indicates to the user equipment the power level to use for the RACH message transmission on the FPACH associated P-RACH.

The network may set this value based on the measured interference level (I) (in dBm) on the specific PRACH and on the desired signal to interference ratio (SIR) (in dB) on this channel as follows:

*Transmit Power Level Command for the PRACH ( $PRX_{PRACH,des}$ )*

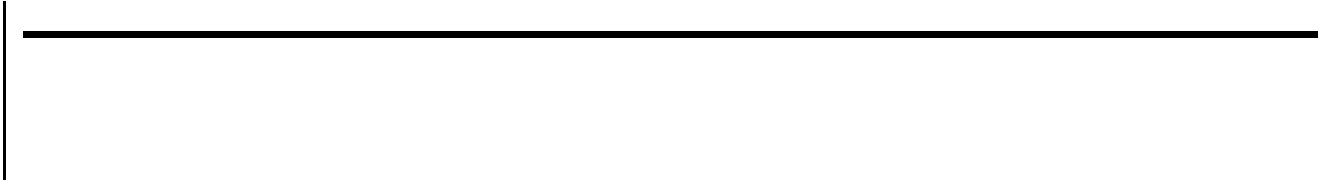
$PRX_{PRACH,des}$  is the desired receive power level on the PRACH.

The UE shall add to this value the estimated path-loss to compute the power level to transmit for the PRACH.

## 5.6.34 Random access collision

When a collision is very likely or in bad propagation environment, the Node B does not transmit the FPACH or cannot receive the SYNC-UL. In this case, the UE will not get any response from the Node B. Thus the UE will have to adjust its Tx time and Tx power level based on a new measurement and send a SYNC-UL again after a random delay. Note that at each (re-)transmission, the SYNC-UL sequence will be randomly selected again by the UE.

Note : Due to the two-step approach a collision most likely happens on the UpPCH. The RACH RUs are virtually collision free. This two-step approach will guarantee that the RACH RUs can be handled with conventional traffic on the same UL time slots.



# Annex E (informative): Examples random access procedure for 1.28Mcps TDD

**Figure D-1 Single burst RACH WT=4, L =1, SF4 PRACH**

Sub-frame Number	0	1	2	3	4	5	6	7	8	9	10
Users sending on UpPCH	1	3	5	7							
	2	4	6	8							
Acknowledged user on FPACH		1	2	3	4	5	6	7			
User sending RACH 0				1	2	3	4	5	6	7	

User 8 is not granted because more than 5 frames would have passed since the UpPCH.

**Figure D-2 Two burst RACH WT=4, L =2, SF8 RACH**

Sub-frame Number	0	1	2	3	4	5	6	7	8	9	10	11
Users sending on UpPCH	1	3	5	7								
	2	4	6	8								
Acknowledged user on FPACH		1	2	3	4	5	6	7				
User sending RACH 0					2	2	4	4	6	6		
User sending RACH 1					1	1	3	3	5	5	7	7

User 8 is not granted because more than 5 frames would have passed since the UpPCH.

**Figure D-3 four burst RACH WT=4, L =4, SF16 RACH**

Sub-frame Number	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Users sending on UpPCH	1	3	5	7										
	2	4	6	8										
Acknowledged user on FPACH		1	2	3	4	5	6	7						
User sending RACH 0						4	4	4	4					
User sending RACH 1				1	1	1	1	5	5	5	5			
User sending RACH 2				2	2	2	2	6	6	6	6			
User sending RACH 3						3	3	3	3	7	7	7	7	

User 8 is not granted because more than 5 frames would have passed since the UpPCH.

**Figure D-4 four burst RACH WT=4, L =4, SF16 RACH**

Sub-frame Number	0	1	2	3	4	5	6	7	8	9	10	11	12
Users sending on UpPCH	1	3	5	7									
	2	4	6	8									
Acknowledged user on FPACH	X	1			2	3			X	X			
User sending RACH 0							2	2	2	2			
User sending RACH 1					1	1	1	1	3	3	3	3	

The FPACH is used ONLY in sub-frames 0, 1, 4, 5, 8, 9... because they correspond to the used RACH resources.

The FPACH in sub-frame 0 is not used because no UpPCH is preceding.

The FPACH in sub-frames 8,9 is not used because no UpPCH is preceding in the last 4 sub-frames.

In contrast to the previous examples users 4,5,6,7 are not granted because they would no lead to a RACH anyway. In this example their grand would come too late.

User 8 is not granted because more than 4 frames would have passed since the UpPCH.

----- Changes to working CR of 25.224 end -----