Agenda Item:

Source: Nortel Networks

Title: Method to provide RACH partitioning using access slots, compatible with sub channel approach

Document for: Approval

1. Introduction

The concept of prioritisation through access class has been accepted in last WG1 meeting and by WG2. However, up to now, only access class through signature partitioning has been described in WG1, while WG2 considers both signatures and access slots partitioning. However, at the last meeting, sub channel approach has been defined, which would limit the flexibility of the access slot partitioning approach. This document proposes a way to jointly support the access slot partitioning and support the sub channel definition approach. This method has been presented in WG2, and is seen as workable by this group. It is presented in WG1 as an example since its definition is more a WG2 issue. Enabling this approach requires three modifications in L1 specifications, which are described in the last paragraph of this document.

## 2. Partitioning using PRACH access slots

There are 15 access slots per two frames for the PRACH.

The principle is to divide to PRACH into a certain number of sub-channels. One class of service is mapped to one or more sub-channels.
The sub-channels are defined as follows :
- The cycle of a sub-channel is 60 slots, i.e. 4 times 2-frames of 15 access slots
- The distance between two access slots of the same sub-channel is 12. There are therefore 5 access slots per sub-channel cycle.
- The SFN of the current frame is used to determine the access slots in that frame.

Ex : Sub-channel number 0
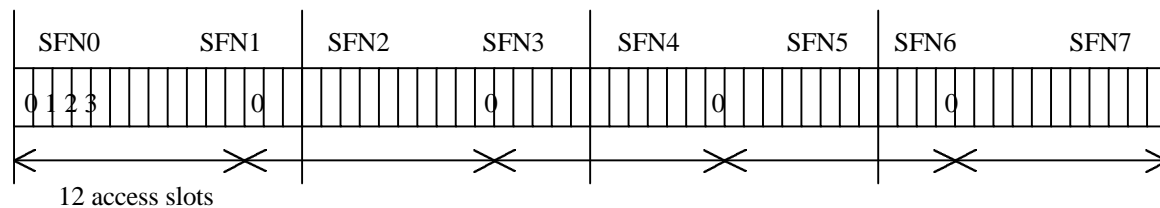
12 access slots

Groups of access slots for each sub-channel at each frame :

	Sub-channel Number											
Frame number	0	1	2	3	4	5	6	7	8	9	10	11
SFN modulo 8=0	0	1	2	3	4	5	6	7				
SFN modulo 8=1	12	13	14						8	9	10	11
SFN modulo 8=2				0	1	2	3	4	5	6	7	
SFN modulo 8=3	9	10	11	12	13	14						8
SFN modulo 8=4	6	7					0	1	2	3	4	5
SFN modulo 8=5			8	9	10	11	12	13	14			
SFN modulo 8=6	3	4	5	6	7					0	1	2

SFN modulo 8=7						8	9	10	11	12	13	14

This sub-division allows to support the L1 preamble ramping sequence, both when the minimum distance between two Access Preambles is three (AICH transmission timing parameter=0) and four (AICH transmission timing =1) access slots. The maximum distance between two access slots for a certain ASC is 12 access slots (for one sub-channel), but can be less when there is more than one sub-channel in the ASC.

For a given Access Service Class, the first preamble is transmitted in the next access slot that belongs to one of the sub-channels that are mapped to that ASC. After the first preamble, the consecutive preambles are transmitted in the next access slot that belongs to the ASC group of sub-channels, with a minimum of three or four AS.

3.Compatibility with the sub-channel approach

The sub channel approach proposed in Tdoc R1#6(99) "XXX", which aims at using less than the maximum of 15 access slots per two frames, can still be met by restricting the number of available sub-channels for each ASC, so that the total sum is less than 12.

Example :
If AICH timing leads to at least 3 slots distance between two transmissions
Access Class 1 with 4 sub-channels number : 0, 3, 6, 9
Access Class 2 with 2 sub-channels number : 1, 7
Access Class 3 with 1 sub-channels number : 2
Not used : 4, 5, 8, 10, 11

If AICH timing leads to at least 4 slots distance between retransmission :
Access Class 1 with 3 sub-channels number : 0, 4, 8 (and/or 2, 6, 10)
Access Class 2 with 2 sub-channels number : 1, 7,
Access Class 3 with 1 sub-channels number : 3,
Not used : 5, 9, 11

4. Modifications to L1 specifications

In order to have the desired flexibility with the access slot partitioning, the access slot for re transmission of a preamble should be set to a minimum of 3 or 4, but not fixed to 3 or 4.
When transmitting a preamble, the UE has to select an access slot among the sub-channels defined for its ASC and supported by the BTS as well as a signature.
The sub-channels have a little bit different definition.

5. Conclusion

A way of benefiting of the access slot partitioning together with the sub channel approach is proposed and the necessary modifications in L1 specifications are listed. It is recommended that these modifications are adopted in WG1.

----------------------Text proposal----------------------

Random access procedure

Before the random-access procedure is executed, the UE should acquire the following information from the BCH :

- The preamble spreading code(s) / message scrambling code(s) used in the cell

- The available signatures, and sub channel(s) for each ASC

- The available sub-RACH channels, defined by parameter A. A contains four bits. The A parameter values 0000≤A≤0111 are used with AICH transmission timing parameter value 0, and values 0000≤A≤1111 with AICH transmission timing parameter value 1. If a certain bit position in parameter A has value 1, it means that corresponding sub-RACH channel is available. Sub-RACH channel_# can have a value among {0,1,2,3}. The LSB of parameter A corresponds to sub-RACH channel_# = 0, and the MSB of parameter A corresponds to sub-RACH_channel_# = 3. The available access slots for different sub-RACH channels are shown in tables 5 and 6 for transmission timing parameter values 0 and 1, respectively.

- The available spreading factors for the message part

- The uplink interference level in the cell

- The primary CCPCH transmit power level

- The AICH transmission timing parameter as defined in 25.211.

- The power offsets ΔP_0 (power step when no acquisition indicator is received, step 7.3) and ΔP_1 (power step when negative acquisition is received, see step 8.3)

The random-access procedure is:

1.   . The UE randomly selects a preamble spreading code from the set of available spreading codes. The random function is TBD.

2.   . The UE sets the preamble transmit power to the value P_{RACH} given in Section 5.1.1. [*Editor's note: Here it is assumed that the initial power back-off is included in the "Constant Value" of 5.1.1*]

3.   The UE implements the dynamic persistence algorithm by:

    3.1   Reading the current dynamic persistence value from the BCH.

    3.2   Perform a random draw against the current dynamic persistence value. The randome function is TBD.

    3.3   Defer transmission for one frame and repeat step 3 if the result of the random draw is negative, otherwise proceed to step 4.

    [*Editor's note: The dynamic persistence value may not be transmitted every frame, depending on the BCH scheduling, i.e step 3.1 cannot be executed every iteration.*]

4   The UE:

    4.1   Randomly selects the sub RACH channel from the available ones, included in the set corresponding to its ASC-, with the help of A parameter and AICH transmission timing parameter. The A parameter values 0000≤A≤0111 are used with AICH transmission timing parameter value 0, and values 0000≤A≤1111 with AICH transmission timing parameter value 1. If a certain bit position in parameter A has value 1, it means that corresponding sub-RACH channel is available, among the possible {0,1,2,3}.The random function, for selecting the sub RACH channel from the available ones is TBD.

    4.2   Derives the available access slots of frame SFN in the selected sub-RACH channel -with the help of SFN and AICH transmission timing parameter value.

        • If AICH transmission timing parameter value is 0, the access slots of frame SFN are defined by Access= 3*N +(SFN modulo2) + sub RACH channel_#, where N has values of the range 0 ≤N≤ 4, and sub_RACH_channel_# is the selected sub_RACH_channel, with the condition that only the values between 0 ≤ Access ≤ 7 are valid in frames with even SFN and only the values between 8 ≤ Access ≤ 14 are valid in frames with odd SFN. UE selects the available access slot to which there is smallest distance.

        • If AICH transmission timing parameter value is 1, the access slots of frame SFN are defined by Access = 4*N +(SFN modulo8) + sub RACH channel_#, where N has values of the range 0 ≤N≤ 3, and sub_RACH_channel_# is the selected sub_RACH_channel, with the condition that

only the values between $0 \le$ Access ≤ 7 are valid in frames with even SFN and only the values between $8 \le$ Access ≤ 14 are valid in frames with odd SFN. UE selects the available access slot to which there is smallest distance.

    4.3   Randomly selects a signature from the available signatures within the ASC given by higher layers. Random function is TBD.

5   The UE sets the Preamble Retransmission Counter to Preamble_Retrans_Max (value TBD).

6   The UE transmits its preamble using the selected uplink access slot, signature, and preamble transmission power..

7   If the UE does not detect the positive or negative acquisition indicator corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE:

    7.1   Selects a new uplink access slot, ~~by using the timing requirements for τ_{p-p} defined in TS 25.211, where it is defined that τ_{p-p} =3 access slots if AICH transmission timing value is set to 0, and τ_{p-p} =4 access slots if AICH transmission timing value is set to 1~~ as next available access slot, i.e. next slot in sub-channel used.

    7.2   Randomly selects a new signature from the available signatures within the ASC given by higher layers. Random function is TBD.

    7.3   Increases the preamble transmission power with the specified offset ΔP_0.

    7.4   Decrease the Preamble Retransmission Counter by one.

    7.5   If the Preamble Retransmission Counter > 0, the UE repeats from step 6 otherwise an error indication is passed to the higher layers and the random-access procedure is exited.

8.   If the UE detects the negative acquisition indicator corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE:

    8.1   Selects a new uplink access slot as in 7.1

    8.2   Randomly selects a new signature from the available signatures within the ASC given by higher layers. Random function is TBD.

    8.3   Modifies the preamble transmission power with the specified offset ΔP_1.

[*Editor's note: Note clear if the Preamble Retransmission Counter should be decremented and tested in this case*]

    8.4   Repeats from step 6

9.   The UE transmits its random access message three or four uplink access slots after the uplink access slot of the last transmitted preamble depending on the AICH transmission timing parameter…

10. A indication of successful random-access transmission is passed to the higher layers.

Dynamic persistence is provided for managing interference and minimising delay by controlling access to the RACH channel. The system will publish a dynamic persistence value on the BCH, the value of which is dependent on the estimated backlog of users in the system.

Table 1 The available access slots, Access, for different sub-RACH channels

	Sub-channel Number											
Frame number	0	1	2	3	4	5	6	7	8	9	10	11
SFN modulo 8=0	0	1	2	3	4	5	6	7				
SFN modulo 8=1	12	13	14						8	9	10	11
SFN modulo 8=2				0	1	2	3	4	5	6	7	
SFN modulo 8=3	9	10	11	12	13	14						8
SFN modulo 8=4	6	7					0	1	2	3	4	5
SFN modulo 8=5			8	9	10	11	12	13	14			
SFN modulo 8=6	3	4	5	6	7					0	1	2

SFN modulo 8=7						8	9	10	11	12	13	14

Table 1 The available access slots, Access, for different sub-RACH channels, when AICH transmission timing parameter = 0.

Frame number	Sub-RACH channel_#=0 (A=001) Access	Sub-RACH channel_#=1 (A=010) Access	Sub-RACH channel_#=2 (A=100) Access
SFN modulo 2 = 0	0, 3, 6	1, 4, 7	2, 5
SFN modulo 2 = 1	9, 12	10, 13	8, 11, 14

Table 2 The available access slots, Access, for different sub-RACH channels, when AICH transmission timing parameter = 1.

Frame number	Sub-RACH channel_#=0 (A=0001) Access	Sub-RACH channel_#=1 (A=0010) Access	Sub-RACH channel_#=2 (A=0100) Access	Sub-RACH channel_#=3 (A=1000) Access
SFN modulo 8 =0	0, 4	1, 5	2, 6	3, 7
SFN modulo 8= 1	8, 12	9, 13	10, 14	11
SFN modulo 8= 2	1, 5	2, 6	3, 7	0, 4
SFN modulo 8= 3	9, 13	10, 14	11	8, 12
SFN modulo 8= 4	2, 6	3, 7	0, 4	1, 5
SFN modulo 8= 5	10, 14	11	8, 12	9, 13
SFN modulo 8= 6	3, 7	0, 4	1, 5	2, 6
SFN modulo 8= 7	11	8, 12	9, 13	10, 14