TSG-RAN Working Group 1 meeting #6
Espoo, Finland
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TSGR1#6(99)903

Agenda item:

Source: Ericsson

Title: Channelization code allocation for RACH message part

Document for: Decision

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1 Background

In UTRA/FDD the RACH burst message part consists of a data part and a control part. The message part carries the actual codes transport blocks, while the control channel includes pilot bits for channel estimation and TFCI to signal the transport format (coding used, number of bits in message, spreading factor on data part etc.) used on the messaged part. There is an one-to-one correspondence between the preamble spreading code and the scrambling code used on the message part. Furthermore, there is a one-to-one correspondence between the preamble signature and the channelization codes to use for spreading the data and control parts of the message, see TS 25.213 V2.1.0, sub-clause 4.3.3.3. The channelization code assignment for the data and control parts of the message are described in Figure 10 in TS 25.213 V2.1.0, reproduced in Figure 1 below.

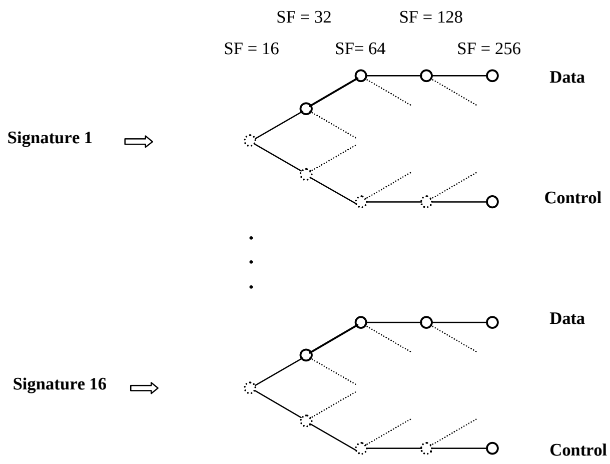


Figure 1: Channelization code assignment for RACH message part.

As can be seen in Figure 1, different signatures correspond to different channelization code sub-trees. Unfortunately, as can be understood from the picture, with 16 signatures and spreading factors between 256 and 32 on the data part, not only codes belonging to the top half of the channelization code tree (Figure 3 in TS 25.213 V2.1.0) are used. This means that for signatures 9-16, the channelization codes selected will have rather bad peak-to-average power characteristics, since HPSK is not working when codes from the bottom-half of the code tree are used.

Since HPSK is applied to all other channels, the terminal PA is designed for use with HPSK. If we get no HPSK effect for the RACH message part, this will mean that the output power that can be achieved for RACH will be lower than for the other channels, due to the higher back-off needed.

This contribution addresses the problem described above, and proposes a solution. A text proposal is included.

2 Proposal

To overcome the problem with HPSK, it is proposed that two scrambling codes are used instead of one for the message part. Then the channelization codes from the top-half of the code tree can always be used with optimum HPSK performance, while signatures 1-8 means that one scrambling code should be used, while signature 9-16 means that the other scrambling code should be used.

Since the users in the uplink are anyway more or less asynchronous, the proposal will not introduce more non-orthogonal interference between the signatures. Also, since a very small subset (256 or 512) of the 16 million uplink scrambling codes are used for the RACH message parts, the impact on the available codes for the dedicated channels is negligible. From the terminal point of view, there is no impact on complexity, since the UE knows which scrambling code to generate, it does not have to generate both at the same time. Also from the UTRAN point of view the impact in complexity is negligible. One anyway has to have a scrambling code generator for each signature, due to the asynchronous nature of the uplink transmissions.

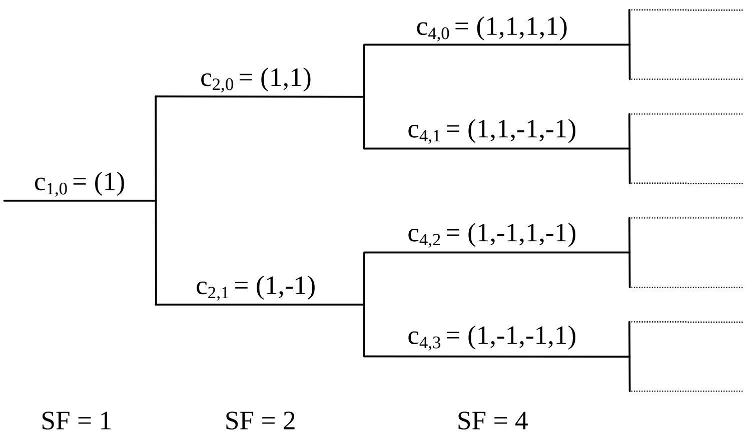
3 Conclusion

It is proposed to associate each preamble spreading code with two scrambling codes, one corresponding to signatures 1-8, and one corresponding to signatures 9-16. It is also proposed to only use the top-half of the code tree for channelization of the message part. This optimizes HPSK performance for low peak-to-average power ratios, and gives more efficient power amplifiers.

It is shown that there is no impact on complexity in UE or UTRAN.

4 Text proposal for TS 25.213 V2.1.1

The text proposal in the following assumes the numbering of channelization codes proposed by Ericsson in TSGR1#6(99)845, i.e. the following numbering of the codes in the code tree:



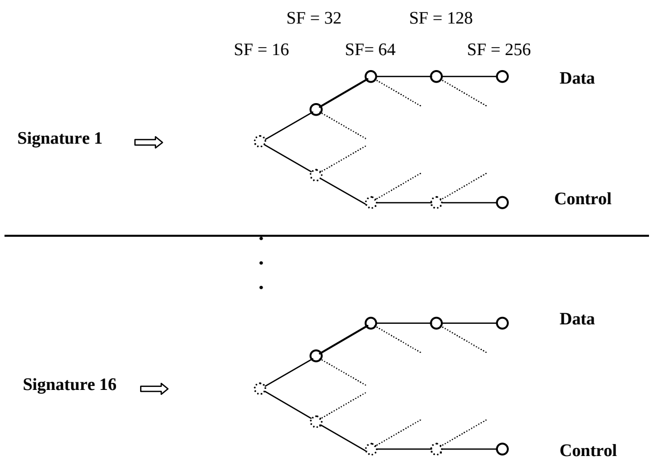
4.3.3.3 Channelization codes for the message part

The preamble signature s, $1 \le s \le 16$, ~~in the preamble specifies~~points to one of~~ the~~ the 8~~16~~ top-most nodes in the code-tree that corresponds to channelization codes of length 16~~, as shown in Figure 10~~. The sub-tree below the specified node is used for spreading of the message part. The sub-tree is indicated by the parameter k, $0 \le k \le 7$, where

$$\begin{cases} k = s - 1, & 1 \le s \le 8, \\ k = s - 9, & 9 \le s \le 16. \end{cases}$$

The control part ~~(Q-branch)~~ is spread with the channelization code $C_{ch,c}$ of spreading factor 256 in the lowest branch of the sub-tree, i.e. $C_{ch,c} = c_{256,m}$ where $m = 16k + 15$. The spread control part is mapped to the Q-branch, similar to the DPCCH for dedicated channels.

The data part~~ (I-branch)~~ can use any of the channelization codes from spreading factor 32 to 256 in the upper-most branch of the sub-tree. However, the system may restrict the set of codes (spreading factors) actually allowed in the cell, through the use of a BCH message. To be exact, the data part is spread by channelization code $C_{ch,d}$, where $C_{ch,d} = c_{SF,m}$, where SF is the spreading factor used for the data part and $m = SF \times k/16$.



~~**Figure 10. Channelization codes for the random access message part.**~~

~~Since the control part is always spread with a known channelization code of length 256, it can be detected by the NodeB. The rate information field of the control part informs the base station about the spreading factor used on the data part. With knowledge of the sub-tree (obtained from the preamble signature) and the spreading factor (obtained from the rate information), the NodeB knows which channelization code is used for the data part.~~

~~<Editor’s note: possibly the replacement term for BS should be cell.>~~

4.3.3.4 Scrambling code for the message part

In addition to spreading, the message part is also subject to scrambling with a ~~10 ms~~ 38400 chip long complex code. ~~The scrambling code is cell-specific and has a one-to-one correspondence to the spreading code used for the preamble part.~~

The scrambling codes used are from the same set of codes as is used for the other dedicated uplink channels when the long scrambling codes are used for these channels. 512~~The first 256~~ of the long scrambling codes are used for the random access channel. The generation of these codes is explained in Section 4.3.2.2. The mapping of these codes to provide a complex scrambling code is also the same as for the other dedicated uplink channels and is described in Section 4.3.2.

For each preamble spreading code, there are two corresponding scrambling codes for the message part. The message part is scrambled using the first code if signature 1, 2, …, 8 was transmitted, while the message part is scrambled using the second code if signature 9, 10, …, 16 was transmitted. The detailed correspondence between preamble spreading code, signature and message scrambling code remains TBD.