3GPP TSG-RAN WG1 meeting #18 **TSGR1#18(*01)0123***

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Agenda Item: AH21

Source: LG Electronics Inc.

Title: FPACH structure and coding for 1.28 Mcps TDD

Document for: Discussion

Introduction

In 1.28Mcps TDD, there is a special physical channel named FPACH (a single burst/sub-frame message) which is used for uplink timing adjustment and power adjustment. In addition, FPACH plays a role of the acknowledgement of UpPCH. When there are data to be transmitted, UE transmits UpPCH that contains one SYNC-UL code that is similar to the access signature in FDD. After UTRAN receives the UpPCH, it transmits FPACH burst containing information regarding random access acknowledgement, uplink timing adjustment and uplink power adjustment. Then UE transmits PRACH burst.

Currently, FPACH structure and coding are not completed yet. Only the functions of FPACH were described. Now we could consider several possible solutions for FPACH structure. One is to propose a new transport channel for FPACH. However, this approach was currently excluded. (It is probably because fast acknowledgement is required for responding to UpPCH.) Namely, FPACH isn't mapped to any transport channel. Whereby FPACH should have its own coding scheme like AICH, other than coding used by other physical channels such as S-CCPCH and DPCH. Therefore, we propose one possible solution for the FPACH structure and coding in this document. We think our scheme makes fast acknowledgement possible.

The important characteristic of our scheme is that only two or three channelisation codes in a cell are used for FPACH. As we know, FPACH is required to send several information bits to several UEs. In our opinion, it is not desirable that too many channelisation codes are assigned to FPACH because of downlink code shortage problem. To avoid this problem, we propose that the information data sent over FPACH for each UE is coded by an orthogonal code before they are spread by the channelisation code. This method is similar to the AICH coding in FDD.

Proposal

In the random access mechanism, the function of FPACH is similar to that of AICH in FDD. In case of AICH in FDD, 16 signatures with acknowledgements for access preambles can be transmitted to several UEs. These 16 signatures are spread by one channelisation code and scrambled by one scrambling code. The proposed structure and coding of FPACH are basically based on those of AICH in FDD.

Our proposed FPACH has 8 orthogonal codes of length 8 symbols. The proposed orthogonal code is called FPACH signature. It seems appropriate that we adopt the Hadamard sequence of length 8 used for AICH in FDD as FPACH signature. FPACH signature has one-to-one correspondence to SYNC-UL code of UpPCH. In the random access procedure, responses to UpPCHs are transmitted over FPACH. We call this response data FPACH indicator. FPACH indicator is a bit sequence including information about random access acknowledgement, uplink timing adjustment and uplink power adjustment (FPACH Information Bit).

FPACH indicator for one user consists of 20-30 FPACH information bits, and in 1.28 Mcps TDD, one SF=16 FPACH channel can carry 10 FPACH information bits for a user. Thus, we need 2 or 3 SF=16 channel. FPACH indicator is segmented by FPACH Mapping Block and each segmented FPACH indicators are coded by the same allocated FPACH signature and are mapped to the data symbols of the allocated N (N=2 or 3) FPACH channels. Figure 1 shows FPACH Mapping Block.

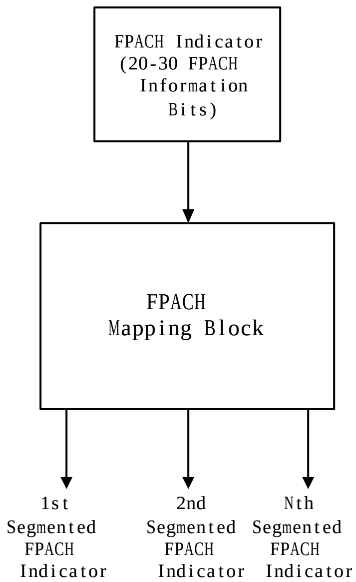

Figure 1. The FPACH Mapping Block (N = 2 or 3)

In the proposed random access procedure, when Node B receives one UpPCH, it will prepare for a FPACH indicator in response to UpPCH. In case that Node B receives several UpPCHs, the segmented FPACH indicators coded by their own FPACH signatures are combined and then are spread by the channelisation codes assigned to FPACHs and scrambled by the cell-specific scrambling code. Hence, when one UE receives FPACH, UE can decode its own segmented FPACH indicators by its own FPACH signature. FPACH signature corresponds to SYNC-UL code selected by UE.

Figure 2 shows the proposed coding of FPACH. We consider the FPACH of the spreading factor 16. As we mentioned above, FPACH indicator is a bit sequence obtaining information regarding random access acknowledgement, uplink timing adjustment and uplink power adjustment. In case of SF=16, FPACH indicator for one user is a 20-30 bit sequence. In Figure 1, FPACH indicators of length 20-30 bits are segmented by FPACH Mapping Block. And each segmented FPACH Indicator of length 10 bits is passed through Serial-to-Parallel block. Then each I and Q bit are spread by the same FPACH signature of length 8 Hadamard sequence. After FPACH signature coding, FPACH Information Symbols in response to every UpPCH are code-combined. The code-combined 5 symbol sequence is denoted by $\{b_0, b_1, \ldots b_n\}$ where n = 39 In cases of SF = 16, the $\{b_0, b_1, \ldots b_i, \ldots, b_n\}$ sequence are given by

$$b_i = \sum_{j=0}^{7} FIS_{\lfloor i/8 \rfloor, j} H_{j,(i \bmod 8)}$$

where $FIS_{i,j}$ is i th FPACH information symbol responding to j th SYNC-UL code in a cell and $H_{i,j}$ is i th element of the j th Hadamard sequence that is the j th FPACH signature. $\lfloor a \rfloor$ means maximum integer which is not over a.

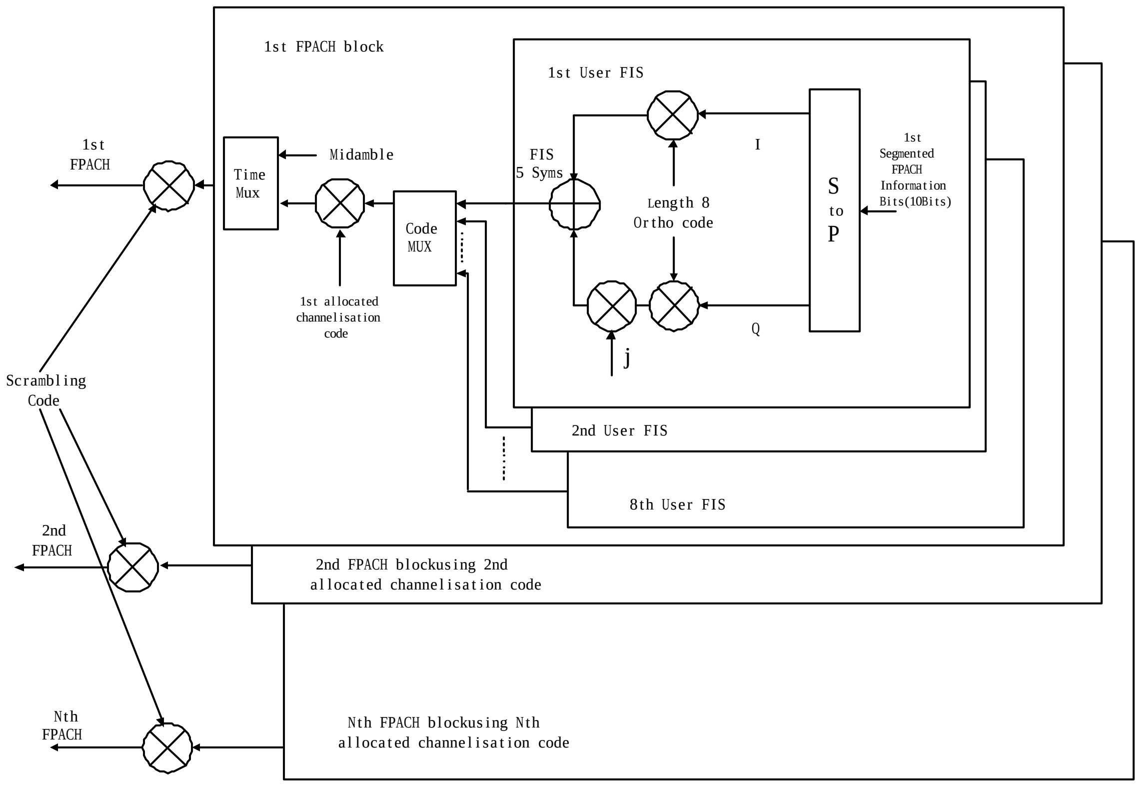

Figure 2. The FPACH coding (N = 2 or 3)

After that, $\{b_0, b_1, \ldots b_n\}$ sequence is mapped to the data field of FPACH burst. Figure 3 shows FPACH burst formats in case of SF 16. The formats are the same as the current burst format in 1.28Mcps TDD. In case of SF = 16, the first $\{b_0, b_1, \ldots b_{21}\}$ sequence are mapped to the first data symbols, $\{a_0, a_1, \ldots a_{21}\}$ and the second $\{b_{22}, b_{21}, \ldots b_{39}\}$ sequence are mapped to the second data symbols, $\{a_{22}, a_{23}, \ldots a_{39}\}$ in figure 3.

a_0	a_1	-------------------	a_{21}	Midamble 144 chips	a_{22}	-----------------	a_{39}	Padding 64 chips	GP 16 chips

Figure 3. The FPACH burst format (SF=16)

Therefore, the $\{a_0, a_1, \ldots a_i, \ldots, a_n\}$ sequence are given as follows:

$$a_i = b_i \quad where\ i = 0 \ldots 39$$

As we know, P-CCPCH always uses 2 channelisation codes, and S-CCPCH uses one or more than two channelisation codes. Therefore, it is reasonable that FPACH use more than one channelisation code. It is not determined yet how many bits FPACH needs for each user, but the proposed FPACH structure can carry sufficient data bits using only 2 or 3 channelisation code of SF=16.

Conclusion

FPACH is required to send an early information to several UEs. Currently FPACH structure and coding were not completely described yet. In this document, we propose the detailed FPACH structure and coding. Though the proposed FPACH coding is based on the AICH coding in FDD, we believe that it could be easily adopted into 1.28Mcps TDD.