TSG-RAN Working Group1 meeting #7 *TSGR1#7(99)D70*
Hanover, Germany,
August 30 – September 3, 1999

Agenda Item: Ad Hoc 4 Report and Text Proposal

Source: Samsung Electronics Co. Ltd.

Title: **Text proposal regarding TFCI coding for TDD (rev. of R1-99b62)**

Document for: Approval

Abstract

In Ad Hoc 4 meeting, Samsung's new TFCI coding scheme was approved as working assumption. During the meeting several comments were raised and we revised the text proposal based on the comments. This document is the revised text proposal of Tdoc R1-99b62 regarding TFCI coding for TDD mode.

------------------------- Start of Proposed Text --------------------------

6.3 Coding for layer 1 control

6.3.1 Coding of transport format combination indicator (TFCI)

The number of TFCI bits is variable and is set at the beginning of the call via higher layer signalling. Encoding of the TFCI bits depends on the number of them. If there are 6-10 bits ~~at most 6 bits~~ of TFCI the channel encoding is done as described in section **Error! Reference source not found.** ~~!~~ ~~.6.3.1.1~~. ~~Correspondingly, if the TFCI word is extended to 7-10 bits the channel encoding is done as explained in the section 6.3.1.2.~~ Also specific coding of less than 6 bits is possible as explained in 6.3.1.~~3~~2. For improved TFCI detection reliability repetition is used to increase the number of TFCI bits. Additionally, with any TFCI coding scheme it is assumed that in the receiver combining of two successive TFCI words will be performed if the shortest transmission time interval of any TrCH is at least 20 ms.

6.3.1.1 Default TFCI word

If the number of TFCI bits is 6-10 ~~a biorthogonal (32, 6) block code~~ (32,10) sub-code of the second order Reed-Muller code is used.
If the TFCI consist of 6-9bits, it is padded with zeros to 10 bits by setting the most significant bits to zero. The receiver can use the information that not all 10 bits are used for the TFCI, thereby reducing the error rate in the TFCI decoder.
~~The code words of the biorthogonal (32, 6) code are from two mutually biorthogonal sets, $S_{C_5} = \{C_5(0), C_5(1),\ldots, C_5(31)\}$ and its binary complement, $\bar{S}_{C_5} = \{\bar{C}_5(0), \bar{C}_5(1),\ldots, \bar{C}_5(31)\}$. Words of set S_{C5} are from the level 5 of the code three, which is generated, using the short code generation method defined in chapter 6.2 of 25.213. The mapping of information bits to code words is shown in the Table 6.3.1-1~~

Table 6.3.1- 1 Mapping of information bits to code words for biorthogonal (32, 6) code.

Information bits	Code word
000000	$C_5(0)$
000001	$\overline{C_5(0)}$
000010	$C_5(1)$
...	...
111101	$\overline{C_5(30)}$
111110	$C_5(31)$
111111	$\overline{C_5(31)}$

6.3.1.2Extended TFCI word

If the number of TFCI bits is 7-10 the TFCI information field is split into two words of length 5 bits as shown in the following formula:

$n := \left\lfloor \sqrt{TFCI} \right\rfloor$; n is the largest integer being smaller than or equal to the square root of the transmitted TFCI value.

if $TFCI < n^2 + n$

then $Word1 := n$; $Word2 := TFCI - n^2$

else $Word2 := n$; $Word1 := n^2 + 2n - TFCI$

Both of the words are encoded using biorthogonal (16, 5) block code. The code words of the biorthogonal (16, 5) code are from two mutually biorthogonal sets, $S_{C_4} = \{C_4(0), C_4(1), \ldots, C_4(15)\}$ and its binary complement, $\overline{S}_{C_4} = \{\overline{C}_4(0), \overline{C}_4(1), \ldots, \overline{C}_4(15)\}$. Words of set S_{C_4} are from the level 4 of the code three, which is generated, using the short code generation method defined in TS 25.223. The mapping of information bits to code words is shown in theTable 6.3.1-2.

Table 6.3.1- 2 Mapping of information bits to code words for biorthogonal (16, 5) code.

Information bits	Code word
00000	$C_4(0)$
00001	$\overline{C_4(0)}$
00010	$C_4(1)$
...	...
11101	$\overline{C_4(14)}$
11110	$C_4(15)$
11111	$\overline{C_4(15)}$

TFCI is encoded by the (32,10) sub-code of second order Reed-Muller code. The code words of the (32,10) sub-code of second order Reed-Muller code are linear combination of some among 10 basis sequences: all 1's, 5 OVSF codes ($C_{32,2}$, $C_{32,3}$, $C_{32,5}$, $C_{32,9}$, $C_{32,17}$), and 4 masks (Mask1, Mask2, Mask3, Mask4). The 4 mask sequences are as following Table 6.3.1-1.

Mask 1	00101000011000111111000001110111
Mask 2	00000001110011010110110111000111
Mask 3	00001010111110010001101100101011
Mask 4	00011100001101110010111101010001

Table 6.3.1-1. Mask sequences

For information bits a_0, a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9 (a_0 is LSB and a_9 is MSB), the encoder structure is as following figure6.3.1-1.

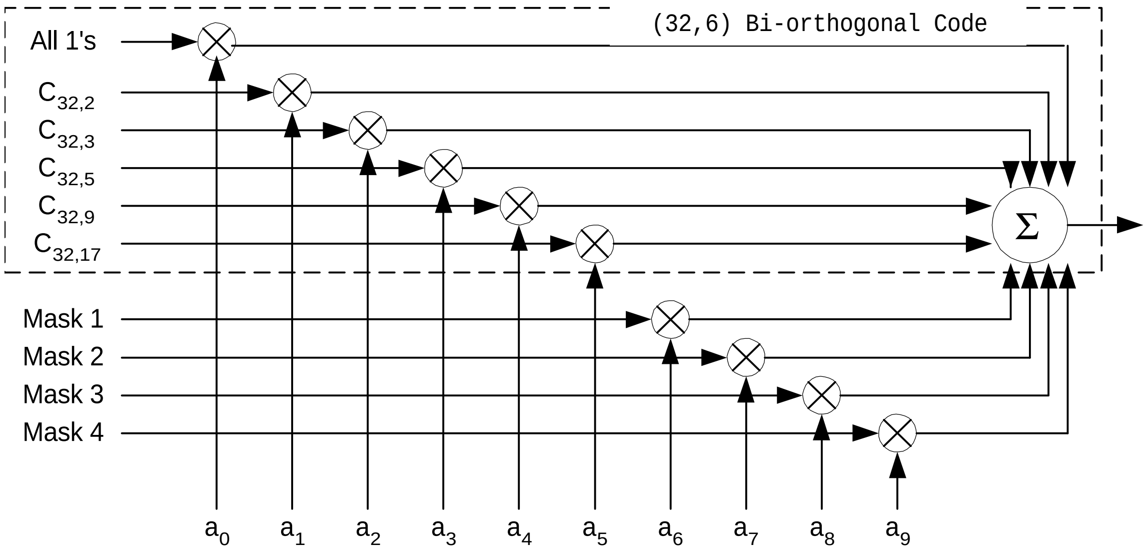

Figure 6.3.1-1. Encoder structure for (32,10) sub-code of second order Reed-Muller code

6.3.1.2 Coding of short TFCI lengths

If the number of TFCI bits is 1 or 2, then repetition will be used for coding. In this case each bit is repeated 3 times giving 4-bit transmission for a single TFCI bit and 8-bit transmission for 2 TFCI bits.
If the number of TFCI bits is in the range of 3 to 5, then one word of the biorthogonal (16,5) block code~~, as described in section 6.3.1.2,~~ will be used as follows.
The code words of the biorthogonal (16, 5) code are from two mutually biorthogonal sets, $S_{C_4} = \{C_4(0), C_4(1), \ldots, C_4(15)\}$ and its binary complement, $\bar{S}_{C_4} = \{\bar{C}_4(0), \bar{C}_4(1), \ldots, \bar{C}_4(15)\}$. Words of set S_{C_4} are from the level 4 of the code three, which is generated, using the short code generation method defined in TS 25.223. The mapping of information bits to code words is shown in the Table 6.3.1-2.

Table 6.3.1- 2 Mapping of information bits to code words for biorthogonal (16, 5) code.

Information bits	Code word
00000	$C_4(0)$
00001	$\bar{C}_4(0)$

00010	$C_4(1)$
...	...
11101	$\overline{C_4(14)}$
11110	$C_4(15)$
11111	$\overline{C_4(15)}$

6.3.2 Operation of Transport-format-combination indicator (TFCI) in Split Mode

In the case of DCH in Split Mode, the Node B shall operate with as follows:

- If one of the links is associated with a DSCH, the TFCI code word may be split into two code words of length 16. The use of such a functionality shall be indicated by higher layer signalling.

TFCI information is encoded by biorthogonal (16, 5) block code. The code words of the biorthogonal (16, 5) code are from two mutually biorthogonal sets, $S_{C_{16}} = \{C_{16,1}, C_{16,2}, \ldots, C_{16,16}\}$ and its binary complement, $\bar{S}_{C_{16}} = \{\bar{C}_{16,1}, \bar{C}_{16,2}, \ldots, \bar{C}_{16,16}\}$. Code words of set $S_{C_{16}}$ are from the level 16 of the code three of OVSF codes defined in document TS 25.213. The mapping of information bits to code words is shown in the Table 2.

Table 2: Mapping of information bits to code words for biorthogonal (16, 5) code

Information bits	Code word
00000	$C_{16,1}$
00001	$\bar{C}_{16,1}$
00010	$C_{16,2}$
...	...
11101	$\bar{C}_{16,15}$
11110	$C_{16,16}$
11111	$\bar{C}_{16,16}$

=============== End of Text Proposal ================

References

[1] 3GPP TSGR1#6 (99)970, 'Harmonization impact on TFCI and New Optimal Coding for extended TFCI with almost no Complexity increase(Rev1)', Source: Samsung

[2] 3GPP TSGR1#7 (99)a86, 'TS 25.222 V2.0.1 (1999-08) Multiplexing and channel coding (TDD)'

[3] 3GPP TSGR1#7 (99)b62, 'Text proposal regarding TFCI coding for TDD', Samsung