TSG-RAN Working Group meeting #5   **TSGR1#5(99)551**

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Agenda Item :

Source : LG Information & Communications, Ltd.

Title : Pilot Patterns for Downlink DPCH, PCCPCH, and SCCPCH

Document for : Proposal of Pilot Patterns for Downlink Channels

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1. Introduction

The pilot patterns of R1-332 and R1-440 [1]-[2] for uplink DPCH were added to S1.11 v2.0.0 [3] at the last TSG RAN meeting in Shin-Yokohama. Since some concerns such as orthogonality between the ordinary pilot symbols and diversity pilot symbols were presented for downlink pilot patterns when using STTD, Ad Hoc #7 did not accepted the downlink pilot patterns. We expressed that we will submit downlink pilot patterns considering STTD [4].

This document proposes downlink DPCH and SCCPCH pilot patterns of [1] and corresponding diversity pilot symbol patterns for [3] considering STTD. The shadowed pilot symbol patterns of downlink DPCH and SCCPCH for the diversity antenna are STTD encoded, whereas the non-shadowed pilot symbol patterns of the channels are designed to be orthogonal to the ordinary pilot symbol pattern. However the diversity pilot pattern for downlink DPCH with $N_{pilot} = 4$ are STTD encoded since STTD encoding requires two symbols.

According to current S1.11 [3], the ordinary pilot symbols of PCCPCH and SCCPCH are the same, and the diversity antenna pilot pattern of PCCPCH is encoded to be orthogonal to the ordinary pilot pattern since STTD is not applied to the pilot pattern of PCCPCH. Therefore we also propose PCCPCH pilot pattern using the same method.

2. New Frame Synchronization Words

The following frame synchronization words are used to design the ordinary pilot patterns and diversity antenna pilot patterns of downlink DPCH, PCCPCH, and SCCPCH.

Table 1. New frame synchronization words

Frame Synchronization Words
C_1 = (1 1 0 1 1 1 1 1 0 0 1 0 0 0 0 0)
C_2 = (1 0 0 0 1 0 1 0 0 1 1 1 0 1 0 1)
C_3 = (1 1 0 1 1 1 0 0 0 0 1 0 0 0 1 1)
C_4 = (0 1 1 1 0 1 1 0 1 0 0 0 1 0 0 1)
C_5 = (1 0 1 1 0 0 0 0 0 1 0 0 1 1 1 1)
C_6 = (1 1 1 0 0 1 0 1 0 0 0 1 1 0 1 0)
C_7 = (0 1 0 0 0 0 1 1 1 0 1 1 1 1 0 0)
C_8 = (1 1 1 0 1 0 0 1 0 0 0 1 0 1 1 0)

3. New pilot patterns for downlink DPCH

Table 2 shows the proposed new pilot symbol patterns on downlink DPCH with N_{pilot} = 4, 8, and 16 [1]. The shadowed parts of the table can be used for frame synchronization words, and the value of pilot symbol other than the frame synchronization word is "1". Table 3 describes the mapping relationship between the 8 words of table 1 and shadowed column pilot symbol patterns of table 2.

Table 2 : New pilot symbol patterns of Downlink DPCH.

	N_{pilot} = 4		N_{pilot} = 8				N_{pilot} = 16							
Symbol #	0	1	0	1	2	3	0	1	2	3	4	5	6	7

Slot #1	11	11	11	11	11	10	11	11	11	10	11	11	11	01
2	11	10	11	10	11	11	11	10	11	11	11	01	11	11
3	11	00	11	00	11	01	11	00	11	01	11	11	11	01
4	11	10	11	10	11	11	11	10	11	11	11	10	11	00
5	11	11	11	11	11	10	11	11	11	10	11	00	11	01
6	11	10	11	10	11	11	11	10	11	11	11	01	11	00
7	11	11	11	11	11	01	11	11	11	01	11	00	11	10
8	11	10	11	10	11	00	11	10	11	00	11	01	11	11
9	11	00	11	00	11	01	11	00	11	01	11	00	11	10
10	11	01	11	01	11	00	11	01	11	00	11	10	11	00
11	11	11	11	11	11	10	11	11	11	10	11	00	11	10
12	11	01	11	01	11	00	11	01	11	00	11	01	11	11
13	11	00	11	00	11	01	11	00	11	01	11	11	11	10
14	11	01	11	01	11	00	11	01	11	00	11	10	11	11
15	11	00	11	00	11	10	11	00	11	10	11	11	11	01
16	11	01	11	01	11	11	11	01	11	11	11	10	11	00

Table 3 : Mapping relationship between the 8 sequences of table 1 and shadowed column pilot patterns of downlink DPCH with $N_{pilot} = 4$, 8, and 16.

Symbol rate	Symbol #	Channel	Corresponding column sequence of length 16
$N_{pilot} = 4$	1	I-CH	C_1
		Q-CH	C_2
$N_{pilot} = 8$	1	I-CH	C_1

		Q-CH	C_2
	3	I-CH	C_3
		Q-CH	C_4
$N_{pilot} = 16$	1	I-CH	C_1
		Q-CH	C_2
	3	I-CH	C_3
		Q-CH	C_4
	5	I-CH	C_5
		Q-CH	C_6
	7	I-CH	C_7
		Q-CH	C_8

Table 4 shows new pilot symbol patterns of Downlink DPCH for the diversity antenna using STTD. For the diversity pilot symbol pattern on downlink DPCH, STTD is applied to the shadowed pilot symbols of columns 1, 3 and 1, 3, 5, 7 for N_{pilot} = 8 and 16, respectively. However the non-shadowed pilot symbols of columns 0, 2 and 0, 2, 4, 6 for N_{pilot} = 8 and 16 are encoded to be orthogonal to the pilot symbol of table 2. However the diversity pilot pattern for downlink DPCH with N_{pilot} = 4 are STTD encoded since STTD encoding requires two symbols. Table 5 describes the mapping relationship between the 8 words of table 1 and shadowed column pilot symbol patterns of table 4.

Table 4 : New pilot symbol patterns of Downlink DPCH for the diversity antenna using STTD.

	$N_{pilot} = 4$		$N_{pilot} = 8$				$N_{pilot} = 16$							
Symbol #	0	1	0	1	2	3	0	1	2	3	4	5	6	7

Slot #1	01	10	11	00	00	10	11	00	00	10	11	11	00	10
2	00	10	11	01	00	11	11	01	00	11	11	01	00	00
3	10	10	11	11	00	01	11	11	00	01	11	11	00	10
4	00	10	11	01	00	11	11	01	00	11	11	10	00	11
5	01	10	11	00	00	10	11	00	00	10	11	11	00	01
6	00	10	11	01	00	11	11	01	00	11	11	10	00	00
7	01	10	11	11	00	10	11	11	00	10	11	00	00	01
8	00	10	11	10	00	11	11	10	00	11	11	01	00	00
9	10	10	11	11	00	01	11	11	00	01	11	00	00	01
10	11	10	11	10	00	00	11	10	00	00	11	10	00	11
11	01	10	11	00	00	10	11	00	00	10	11	00	00	01
12	11	10	11	10	00	00	11	10	00	00	11	01	00	00
13	10	10	11	11	00	01	11	11	00	01	11	00	00	10
14	11	10	11	10	00	00	11	10	00	00	11	01	00	11
15	10	10	11	00	00	01	11	00	00	01	11	11	00	10
16	11	10	11	01	00	00	11	01	00	00	11	10	00	11

Table 5 : Mapping relationship between the 8 sequences of table 1 and shadowed column pilot patterns of downlink DPCH for STTD diversity with N_{pilot} = 4, 8, and 16.

Symbol rate	Symbol #	Channel	Corresponding column sequence of length 16
N_{pilot} = 4	0	I-CH	$-C_1$
		Q-CH	C_2
N_{pilot} = 8	1	I-CH	$-C_3$
		Q-CH	C_4
	3	I-CH	C_1
		Q-CH	$-C_2$

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$N_{pilot} = 16$	1	I-CH	$-C_3$
		Q-CH	C_4
	3	I-CH	C_1
		Q-CH	$-C_2$
	5	I-CH	$-C_7$
		Q-CH	C_8
	7	I-CH	C_5
		Q-CH	$-C_6$

4. New pilot patterns for SCCPCH

    Table 6 shows the proposed new pilot patterns on Secondary CCPCH. The shadowed parts of table 6 can be used for frame synchronization words, and the value of pilot symbol other than the frame synchronization word is "1". Table 7 shows the mapping relationship between the words of table 1 and shadowed column pilot symbol patterns of table 6.

Table 6 : New pilot symbol patterns of SCCPCH.

	$N_{pilot} = 8$				$N_{pilot} = 16$							
Symbol #	0	1	2	3	0	1	2	3	4	5	6	7

Slot #1	11	11	11	10	11	11	11	10	11	11	11	01
2	11	10	11	11	11	10	11	11	11	01	11	11
3	11	00	11	01	11	00	11	01	11	11	11	01
4	11	10	11	11	11	10	11	11	11	10	11	00
5	11	11	11	10	11	11	11	10	11	00	11	01
6	11	10	11	11	11	10	11	11	11	01	11	00
7	11	11	11	01	11	11	11	01	11	00	11	10
8	11	10	11	00	11	10	11	00	11	01	11	11
9	11	00	11	01	11	00	11	01	11	00	11	10
10	11	01	11	00	11	01	11	00	11	10	11	00
11	11	11	11	10	11	11	11	10	11	00	11	10
12	11	01	11	00	11	01	11	00	11	01	11	11
13	11	00	11	01	11	00	11	01	11	11	11	10
14	11	01	11	00	11	01	11	00	11	10	11	11
15	11	00	11	10	11	00	11	10	11	11	11	01
16	11	01	11	11	11	01	11	11	11	10	11	00

Table 7 : Mapping relationship between the 8 sequences of table 1 and shadowed column pilot patterns of SCCPCH with $N_{pilot} = 8$ and 16.

Symbol rate	Symbol #	Channel	Corresponding column sequence of length 16
$N_{pilot} = 8$	1	I-CH	C_1
		Q-CH	C_2
	3	I-CH	C_3

		Q-CH	C_4
$N_{pilot} = 16$	1	I-CH	C_1
		Q-CH	C_2
	3	I-CH	C_3
		Q-CH	C_4
	5	I-CH	C_5
		Q-CH	C_6
	7	I-CH	C_7
		Q-CH	C_8

Table 8 denotes the new pilot symbol pattern for the diversity antenna when STTD encoding is used on the SCCPCH. For the diversity pilot symbol pattern on SCCPCH, STTD is applied to the shadowed pilot symbols of columns 1, 3 of $N_{pilot} = 8$, and 1, 3, 5, 7 of $N_{pilot} = 16$ in table 8, whereas the non-shadowed pilot symbols of columns 0, 2 of $N_{pilot} = 8$, and 0, 2, 4, 6 of $N_{pilot} = 16$ are encoded to be orthogonal to those of table 6. Table 9 shows the mapping relationship between the words of table 1 and shadowed column pilot symbol patterns of table 8.

Table 8 : New pilot symbol patterns of SCCPCH for the diversity antenna using STTD.

	$N_{pilot} = 8$				$N_{pilot} = 16$							
Symbol #	0	1	2	3	0	1	2	3	4	5	6	7

Slot #1	11	00	00	10	11	00	00	10	11	11	00	10
2	11	01	00	11	11	01	00	11	11	01	00	00
3	11	11	00	01	11	11	00	01	11	11	00	10
4	11	01	00	11	11	01	00	11	11	10	00	11
5	11	00	00	10	11	00	00	10	11	11	00	01
6	11	01	00	11	11	01	00	11	11	10	00	00
7	11	11	00	10	11	11	00	10	11	00	00	01
8	11	10	00	11	11	10	00	11	11	01	00	00
9	11	11	00	01	11	11	00	01	11	00	00	01
10	11	10	00	00	11	10	00	00	11	10	00	11
11	11	00	00	10	11	00	00	10	11	00	00	01
12	11	10	00	00	11	10	00	00	11	01	00	00
13	11	11	00	01	11	11	00	01	11	00	00	10
14	11	10	00	00	11	10	00	00	11	01	00	11
15	11	00	00	01	11	00	00	01	11	11	00	10
16	11	01	00	00	11	01	00	00	11	10	00	11

Table 9 : Mapping relationship between the 8 sequences of table 1 and shadowed column pilot patterns of PCCPCH for STTD diversity with $N_{pilot} = 8$ and 16.

Symbol rate	Symbol #	Channel	Corresponding column sequence of length 16
$N_{pilot} = 8$	1	I-CH	$-C_3$
		Q-CH	C_4
	3	I-CH	C_1
		Q-CH	$-C_2$
$N_{pilot} = 16$	1	I-CH	$-C_3$

		Q-CH	C_4
	3	I-CH	C_1
		Q-CH	$-C_2$
	5	I-CH	$-C_7$
		Q-CH	C_8
	7	I-CH	C_5
		Q-CH	$-C_6$

5. New Pilot Patterns for PCCPCH

 Table 10 denotes the new pilot symbol pattern of PCCPCH, which is the same as SCCPCH. Table 11 shows the mapping relationship between the words of table 1 and shadowed column pilot symbol patterns of table 10.

Table 10. New pilot symbol pattern of PCCPCH

Symbol #	0	1	2	3

Slot #1	11	11	11	10
2	11	10	11	11
3	11	00	11	01
4	11	10	11	11
5	11	11	11	10
6	11	10	11	11
7	11	11	11	01
8	11	10	11	00
9	11	00	11	01
10	11	01	11	00
11	11	11	11	10
12	11	01	11	00
13	11	00	11	01
14	11	01	11	00
15	11	00	11	10
16	11	01	11	11

Table 11. Mapping relationship between the 4 sequences of table 1

and shadowed column pilot patterns of table 10.

Symbol #	Channel	Corresponding column Sequence of length 16
1	I-CH	C_1
	Q-CH	C_2
3	I-CH	C_3
	Q-CH	C_4

Table 12 shows the new diversity antenna pilot symbol pattern for PCCPCH. The pilot symbols of table 12 are encoded to be orthogonal to the ordinary pilot symbols of table 10. Table 13 shows the mapping relationship between the words of table 1 and shadowed column pilot symbol patterns of table 12.

Table 12. New diversity antenna pilot symbol pattern for PCCPCH

Symbol #	0	1	2	3

Slot #1	11	11	00	01
2	11	10	00	00
3	11	00	00	10
4	11	10	00	00
5	11	11	00	01
6	11	10	00	00
7	11	11	00	10
8	11	10	00	11
9	11	00	00	10
10	11	01	00	11
11	11	11	00	01
12	11	01	00	11
13	11	00	00	10
14	11	01	00	11
15	11	00	00	01
16	11	01	00	00

Table 13. Mapping relationship between the 4 sequences of table 1

and shadowed column pilot patterns of table 12.

Symbol #	Channel	Corresponding column sequence of length 16
1	I-CH	C_1
	Q-CH	C_2
3	I-CH	$-C_3$
	Q-CH	$-C_4$

References

[1] LGIC, "Frame Synchronization Words on DPCHs and SCCPCH", TSGR1#4(99)332.

[2] LGIC, "Pilot Patterns on Uplink DPCCH", TSGR1#4(99)440.

[3] "UTRA FDD ; Physical layer procedures", 3GPP RAN S1.11 v2.0.0 (1999-04), TSGR1#4(99)527.

[4] Ad Hoc #7, "Updated Report from Ad Hoc #7 : Slot structure", TSGR1#4(99)479.