TSG-RAN Working Group 1 meeting #9 **TSGW1#9(99) R1-99j55**
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Agenda Item:
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Title: Primary state update rule in SSDT operation
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1. Introduction

The current SSDT specification in TS25.214 ver3.0.0 slightly mentions about primary state update rule in section 5.2.1.4.3. However, more detailed rule should be specified by incorporating the compressed mode and state update timing among active cells. This document discusses how we should handle the compressed mode and state update timing in SSDT and then text proposal of more detailed primary state update rule is given for TS25.214.

2. Compressed mode handling in state update rule

2.1 Hamming distance evaluation of CW during compressed mode

We have three compressed modes as follows.

- Uplink compressed mode
- Downlink compressed mode
- Uplink and downlink compressed mode

In case of downlink compressed mode only, SSDT operation will not be impacted because site selection can be done irrespective of downlink DPCH transmission state. However, when uplink compressed mode is activated, primary ID information is to be punctured due to transmission gap. Since primary IDs are made by code words with a number of bits, the ID itself has some tolerance to the puncturing . However, if the CW is punctured excessively, site selection can be no longer carried out correctly. In order to get rid of the issue during uplink compressed mode, firstly we would like to investigate the Hamming distance of the punctured CWs.

According to the section 4.4 of TS25.212 version 3.0.0, the gap can take variable length and an arbitrary position. We investigated all possible gap positions versus minimum hamming distance for each gap length and then identified the worst minimum hamming distance defined such as a Hamming distance which gives the smallest minimum Hamming distance by particular gap position(s). The results are shown in the following table.

Table 1 The worst minimum Hamming distance
(1) The cases for 1 bit FBI (S field with 1bit)

ID length	Transmission Gap length (unit is [slots])														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Punctured bits number														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Short (5bits)	2	1	0	0	0	-	-	-	-	-	-	-	-	-	-
Medium (8bits / 7bits)	4/3	3/2	2/1	1/0	0/0	0/0	0/0	0/-	-/	-/-	-/-	-/-	-/-	-/-	-/-
Long (15bits)	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0

(2) The cases for 2 bit FBI (S field with 2bit)

ID length	Transmission Gap length (unit is [slots])								
	0	1	2	3	4	5	6	7	8
	Punctured bits number								
	0	2	4	6	8	10	12	14	16
Short (6bits)	2	0	-	-	-	-	-	-	-
Medium (8bits / 6bits)	4/2	2/0	0/-	-/-	-/-	-/-	-/-	-/-	-/-
Long (16bits / 14bits)	8/6	6/4	4/2	2/0	0/0	0/0	0/0	0/0	0/0

Since the minimum Hamming distance of short length CW is designed to be 2, the worst minimum Hamming distance should also satisfy more that 2. In Table 2, we colored by red the cases in which the worst minimum Hamming distance was less than 2.

2.2 State update rule in compressed mode

From the discussion regarding the worst minimum Hamming distance in the previous section, we would like to introduce the following SSDT state update rule during uplink compressed mode.

SSDT state update rule in uplink compressed mode:

If the punctured bit number of received CW is greater than or equal to (int) Nb/3 bits, then cells act as primary regardless of actual signaling of cell ID. (int) and Nb respectively denote omission of fraction and CW bits.

From Table 1, we can describe the relation between intolerable number of punctured bits and (int) Nb/3 as follows.

Table 2 Intolerable punctured bit number

CW bits, Nb	Intolerable punctured bit number, Nib	(int)Nb/3
5	1	1
6	2	2
7	2	2
8	3 or 4	2
14	6	4
15	6	5
16	8	5

As shown in Table 2, intolerable punctured bit number is not necessarily equal to (int) Nb/3, but (int) Nb/3 holds to be less than or equal to Nb. This means that we can hold a minimum Hamming distance greater than or equal to 2 for any gap positions by employing the criteria of (int)Nb/3.

The above rule is applied regardless of downlink compressed mode activation. When only downlink compressed mode is activated but uplink one is not activated, SSDT can be operated normally.

3. State update timing in SSDT operation

In SSDT mode, Node-B periodically receives site selection message (SSDT message) transmitted by UE and then gets to know its state of primary or non-primary in the next transmission cycle. For Node-B, the state update timing from the end of one SSDT command reception is not specified in the present TS25.214. In this case, UE cannot know the state update timing and thus it must be needed to implement an additional function such as a blind state update timing detection. In addition, it may happen that the Node-Bs (made by different vendors for example) within the same active set change its state at different timing.

In order to resolve such an inconvenience, we would like to define a fixed state update timing in the specification. The transmission state should be changed as quickly as possible, but there is a limitation due to 1024 chips uplink/downlink transmission timing offset at UE and propagation delay. This relation can be illustrated in Fig.1.

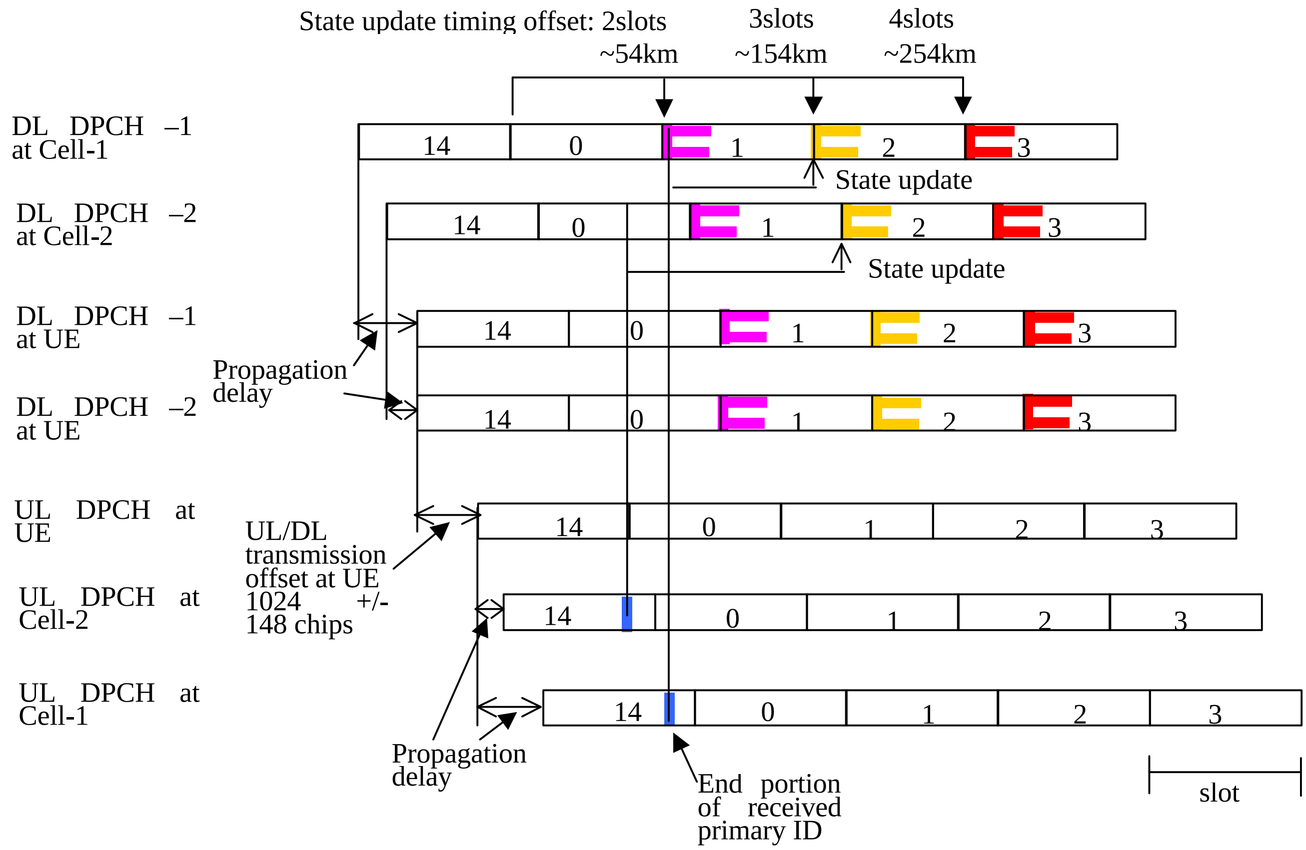

Fig.1 DL/UL DPCH timing relationship

The longer the propagation delay, the larger is the state update timing offset. As shown in Fig.1, the tolerable distance for the state update timing offset of 2, 3 and 4 slots can be 54km, 154km and 254km, respectively. In practice, the distance between UE and active BTSs will hardly take over 100km, so it will be large enough to choose the state update timing offset of 3 slots.

4. Text Proposal to TS25.214 version 3.0.0

5.2.1.4 Site selection diversity transmit power control

5.2.1.4.1 General

Site selection diversity transmit power control (SSDT) is an optional macro diversity method in soft handover mode.

Operation is summarised as follows. The UE selects one of the cells from its active set to be ‘primary’, all other cells are classed as ‘non primary’. The main objective is to transmit on the downlink from the primary cell, thus reducing the interference caused by multiple transmissions in a soft handover mode. A second objective is to achieve fast site selection without network intervention, thus maintaining the advantage of the soft handover. In order to select a primary cell, each cell is assigned a temporary identification (ID) and UE periodically informs a primary cell ID to the connecting cells. The non-primary cells selected by UE switch off the transmission power. The primary cell ID is delivered by UE to the active cells via uplink FBI field. SSDT activation, SSDT termination and ID assignment are all carried out by higher layer signalling.

5.2.1.4.1.1 Definition of temporary cell identification

Each cell is given a temporary ID during SSDT and the ID is utilised as site selection signal. The ID is given a binary bit sequence. There are three different lengths of coded ID available denoted as "long", "medium" and "short". The network decides which length of coded ID is used. Settings of ID codes for 1-bit and 2-bit FBI are exhibited in table 3 and table 4, respectively.

Table 3: Settings of ID codes for 1 bit FBI

ID label	ID code		
	"long"	"medium"	"short"
a	000000000000000	0000000(0)	00000
b	111111111111111	1111111(1)	11111
c	000000001111111	0000111(1)	00011
d	111111110000000	1111000(0)	11100
e	000011111111000	0011110(0)	00110
f	111100000000111	1100001(1)	11001
g	001111000011110	0110011(0)	01010
h	110000111100001	1001100(1)	10101

Table 4: Settings of ID codes for 2 bit FBI

ID label	ID code (Column and Row denote slot position and FBI-bit position.)		
	"long"	"medium"	"short"
a	0000000(0) 0000000(0)	000(0) 000(0)	000 000
b	1111111(1) 1111111(1)	111(1) 111(1)	111 111
c	0000000(0) 1111111(1)	000(0) 111(1)	000 111
d	1111111(1) 0000000(0)	111(1) 000(0)	111 000
e	0000111(1) 1111000(0)	001(1) 110(0)	001 100
f	1111000(0) 0000111(1)	110(0) 001(1)	110 011
g	0011110(0) 0011110(0)	011(0) 011(0)	010 010
h	1100001(1) 1100001(1)	100(1) 100(1)	101 101

ID must be terminated within a frame. If FBI space for sending a given ID cannot be obtained within a frame, hence if the entire ID is not transmitted within a frame but must be split over two frames, the last bit(s) of the ID is(are) punctured. The relating bit(s) to be punctured are shown with brackets in table 3 and table 4.

5.2.1.4.2 TPC procedure in UE

The TPC procedure of the UE in SSDT is identical to that described in subclause ~~5.2.3.2~~5.2.1.2 or 5.2.1.3 in compressed mode.

5.2.1.4.3 Selection of primary cell

The UE selects a primary cell periodically by measuring the RSCP of CPICHs transmitted by the active cells. The cell with the highest CPICH RSCP is detected as a primary cell.

5.2.1.4.4 Delivery of primary cell ID

The UE periodically sends the ID code of the primary cell via portion of the uplink FBI field assigned for SSDT use (FBI S field). A cell recognises its state as non-primary if the following two conditions are fulfilled simultaneously:

- the received primary ID code does not match with the own ID code,
- and the received uplink signal quality satisfies a quality threshold, Qth, a parameter defined by the network.
- and whenever uplink compressed mode is activated regardless of downlink one, the number of bits in FBI S field punctured by transmission gap is less than x bits. x is calculated by (int)N_{ID}/3 where operation (int) and N_{ID} mean omission of fractions and the number of bits that would be contained in the received primary ID if uplink compressed mode would not be activated.

Otherwise the cell recognises its state as primary. The cells in the active set change its primary or non-primary state with synchronous. If a cell receives the last portion of ID in uplink slot #j, the state of cell is updated from downlink slot#{(j+T_{os}) mod 15}. T_{os} is a constant defined to be 3 slots. In case downlink compressed mode is activated but uplink one is not activated, the cell state is updated normally in accordance with SSDT operation..

At the UE, the primary ID code to be sent to the cells is segmented into a number of portions. These portions are distributed in the uplink FBI S-field. The cell in SSDT collects the distributed portions of the primary ID code and then detects the transmitted ID. Period of primary cell update depends on the settings of code length and the number of FBI bits assigned for SSDT use as shown in table 5

Table 5: Period of primary cell update

code length	The number of FBI bits per slot assigned for SSDT	
	1	2
"long"	1 update per frame	2 updates per frame
"medium"	2 updates per frame	4 updates per frame
"short"	3 updates per frame	5 updates per frame

5.2.1.4.5 TPC procedure in the network

In SSDT, a non-primary cell can switch off its DPDCH output (i.e. no transmissions).

The cell manages two downlink transmission power levels, P1, and P2. Power level P1 is used for downlink DPCCH transmission power level and this level is updated as the same way specified in 5.2.3.25.2.1.2 or 5.2.1.3 in compressed mode regardless of the selected state (primary or non-primary). The actual transmission power of TFCI, TPC and pilot fields of DPCCH is set by adding P1 and the offsets PO1, PO2 and PO3, respectively, as specified in 5.2.3.15.2.1.1. P2 is used for downlink DPDCH transmission power level and this level is set to P1 if the cell is selected as primary, otherwise P2 is switched off. The cell updates P1 first and P2 next, and then the two power settings P1 and P2 are maintained within the power control dynamic range. Table 6 summarizes the updating method of P1 and P2.

Table 6: Updating of P1 and P2

<table>
<tr><th>State of cell</th><th>P1 (DPCCH)</th><th>P2 (DPDCH)</th></tr>
<tr><td>non primary</td><td rowspan="2">Updated by the same way as specified in ~~5.2.3.2~~5.2.1.2 or 5.2.1.3 in compressed mode</td><td>Switched off</td></tr>
<tr><td>Primary</td><td>= P1</td></tr>
</table>