TSG-RAN Working Group 1 meeting #9 **TSGR1#9(99)K76**

Dresden, Germany, 30, Nov. - 3, Dec., 1999

Agenda Item :

Source : LG Information & Communications, Ltd.

Title : Optimum ID Codes for SSDT

Document for : Approval

Abstract

The new optimized codes for SSDT power control maximize the minimum Hamming distance and are robust to the AWGN channel as well as fading channel. We see that we can obtain about 0.2 ~ 0.8 dB gain in AWGN channel compared to the cell identification codes of current specification. And in the fading channel we also find about 0.5 ~ 2 dB performance gain. Thus the current ID codes [1] for SSDT should be replaced with the new one. This document requests the change of ID codes for 1 bit FBI and 2 bit FBI in 5.2.1.4 of TS 25.214.

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1. Introduction

Site selection diversity transmit (SSDT) is power control optionally used to reduce the multiple transmission in a soft handover mode. 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. 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.

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.

In this contribution, the new optimized ID code for SSDT is proposed to minimize the error rate in AWGN as well as in fading channel. We see that there are about 0.2 ~ 0.8 dB gain in AWGN channel compared to the cell identification codes of current specification as well as about 0.5 ~ 2 dB performance gain in fading channel.

2. Current ID Codes

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 current ID codes for 1-bit and 2-bit FBI are exhibited in table 1 and table 2, respectively.

Table 1: Settings of ID codes for 1 bit FBI (CURRENT)

	ID code		
ID label	**"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 2: Settings of ID codes for 2 bit FBI (CURRENT)

	ID code (Column and Row denote slot position and FBI-bit position.)		
ID label	**"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

From the table 1, we see that the minimum Hamming distance of ID codes for 1 bit FBI is:

- d_{min} = 7 for long code of length 15
- d_{min} = 4 for medium code of length 8
- d_{min} = 3 for punctured medium code of length 7
- d_{min} = 2 for short code of length 5

And from table 2, the minimum Hamming distance of ID codes for 2 bit FBI is:

- d_{min} = 8 for long code of length 16
- d_{min} = 6 for punctured long code of length 14
- d_{min} = 4 for medium code of length 8
- d_{min} = 2 for punctured medium code of length 6
- d_{min} = 2 for short code of length 6

3. Proposed ID codes

The following is the Hadamard codes of length 8 and 16, respectively.

Hadamard codes of length 8:
$H_{3,0}$ = 0000 0000
$H_{3,1}$ = 0101 0101
$H_{3,2}$ = 0011 0011
$H_{3,3}$ = 0110 0110
$H_{3,4}$ = 0000 1111
$H_{3,5}$ = 0101 1010
$H_{3,6}$ = 0011 1100
$H_{3,7}$ = 0110 1001

Hadamard codes of length 16:
$H_{4,0}$ = 0000 0000 0000 0000
$H_{4,1}$ = 0101 0101 0101 0101
$H_{4,2}$ = 0011 0011 0011 0011
$H_{4,3}$ = 0110 0110 0110 0110
$H_{4,4}$ = 0000 1111 0000 1111
$H_{4,5}$ = 0101 1010 0101 1010
$H_{4,6}$ = 0011 1100 0011 1100
$H_{4,7}$ = 0110 1001 0110 1001
$H_{4,8}$ = 0000 0000 1111 1111
$H_{4,9}$ = 0101 0101 1010 1010
$H_{4,10}$= 0011 0011 1100 1100
$H_{4,11}$= 0110 0110 1001 1001
$H_{4,12}$= 0000 1111 1111 0000
$H_{4,13}$= 0101 1010 1010 0101
$H_{4,14}$= 0011 1100 1100 0011
$H_{4,15}$= 0110 1001 1001 0110

From two Hadamard codes of length 8 and 16, we see that all the first bits are always zeros. Hence these first bits do not decrease the minimum Hamming distance after puncturing. Using this property, we propose the new ID codes for 1 bit and 2 bit FBI as following.

Table 3: Settings of ID codes for 1 bit FBI (Proposed)

ID label	ID code "long"	"medium"	"short"
A	000000000000000	(0)0000000	00000
B	101010101010101	(0)1010101	10111
C	011001100110011	(0)0110011	01101
D	110011001100110	(0)1100110	11010
E	000111100001111	(0)0001111	00011
F	101101001011010	(0)1011010	10100
G	011110000111100	(0)0111100	01110
H	110100101101001	(0)1101001	11001

Table 4: Settings of ID codes for 2 bit FBI (Proposed)

ID label	ID code (Column and Row denote slot position and FBI-bit position.) "long"	"medium"	"short"
A	(0)0000000 (0)0000000	(0)000 (0)000	000 000
B	(0)0000000 (1)1111111	(0)000 (1)111	000 111
C	(0)1010101 (0)1010101	(0)101 (0)101	101 101
D	(0)1010101 (1)0101010	(0)101 (1)010	101 010
E	(0)0110011 (0)0110011	(0)011 (0)011	011 011
F	(0)0110011 (1)1001100	(0)011 (1)100	011 100
G	(0)1100110 (0)1100110	(0)110 (0)110	110 110
H	(0)1100110 (1)0011001	(0)110 (1)001	110 001

From the table 3, we see that the minimum Hamming distance of proposed ID codes for 1 bit FBI is:

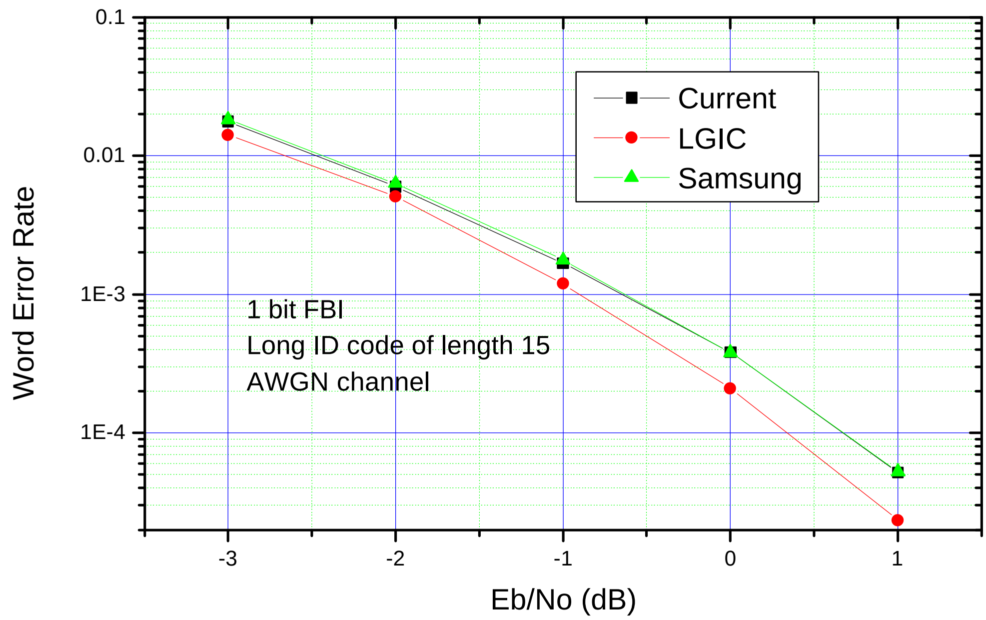
- d_{min} = 8 for long code of length 15
- d_{min} = 4 for medium code of length 8
- d_{min} = 4 for punctured medium code of length 7
- d_{min} = 2 for short code of length 5

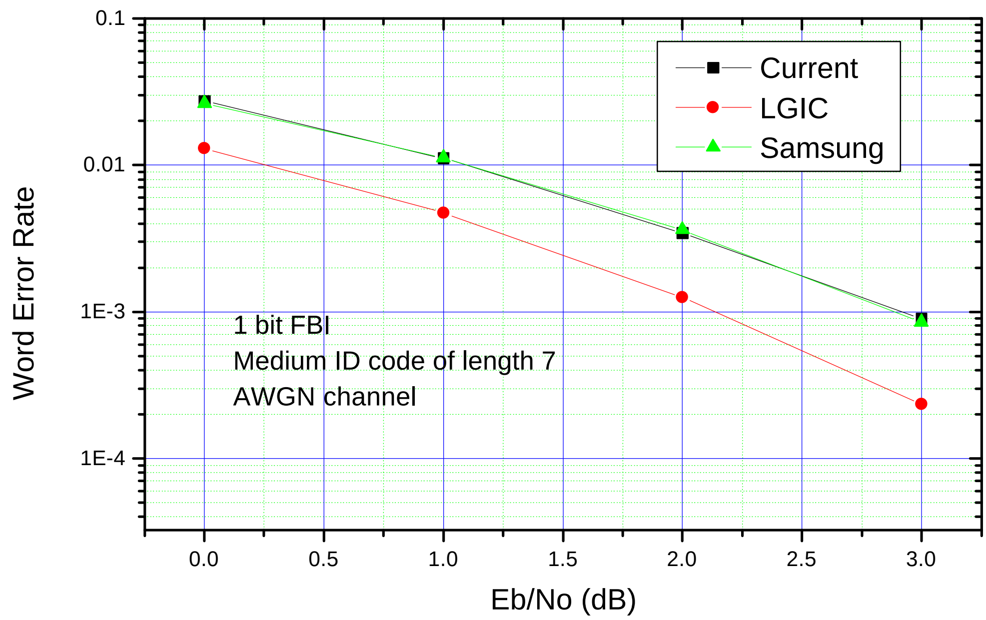
And from table 2, the minimum Hamming distance of ID codes for 2 bit FBI is:

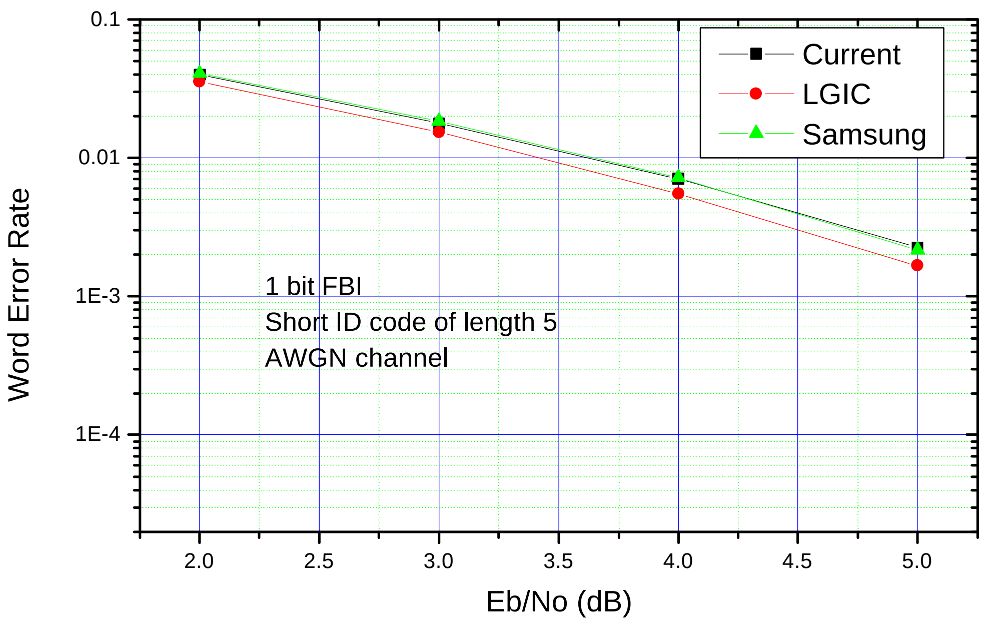
- d_{min} = 8 for long code of length 16
- d_{min} = 7 for punctured long code of length 14
- d_{min} = 4 for medium code of length 8
- d_{min} = 3 for punctured medium code of length 6
- d_{min} = 3 for short code of length 6

4. Performance evaluation

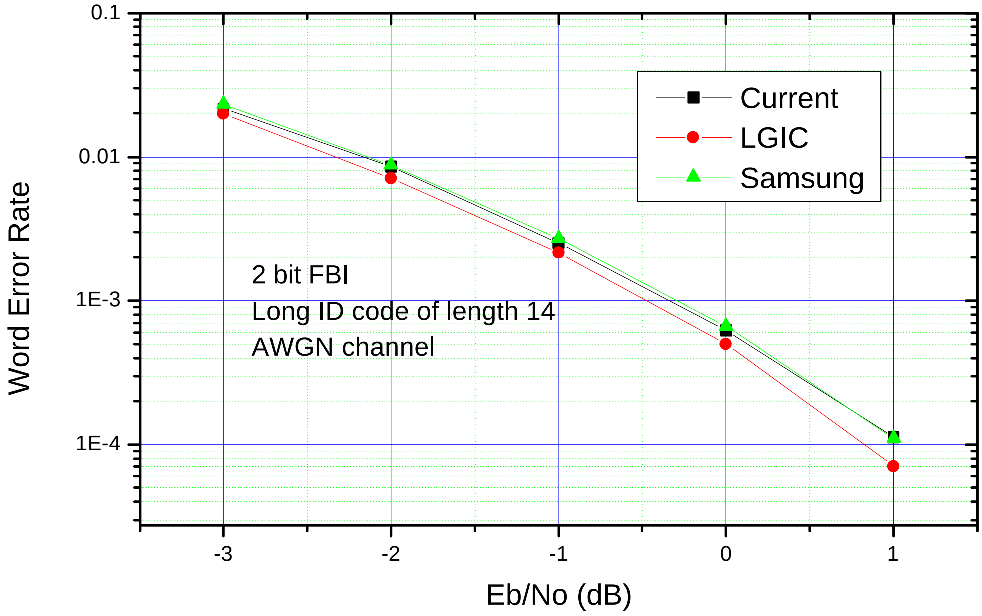
- **AWGN Channel (1 bit FBI)**






0.1
0.01
1E-3
1E-4
Word Error Rate
Current
LGIC
Samsung
1 bit FBI
Short ID code of length 5
AWGN channel
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Eb/No (dB)

- **AWGN Channel (2 bit FBI)**



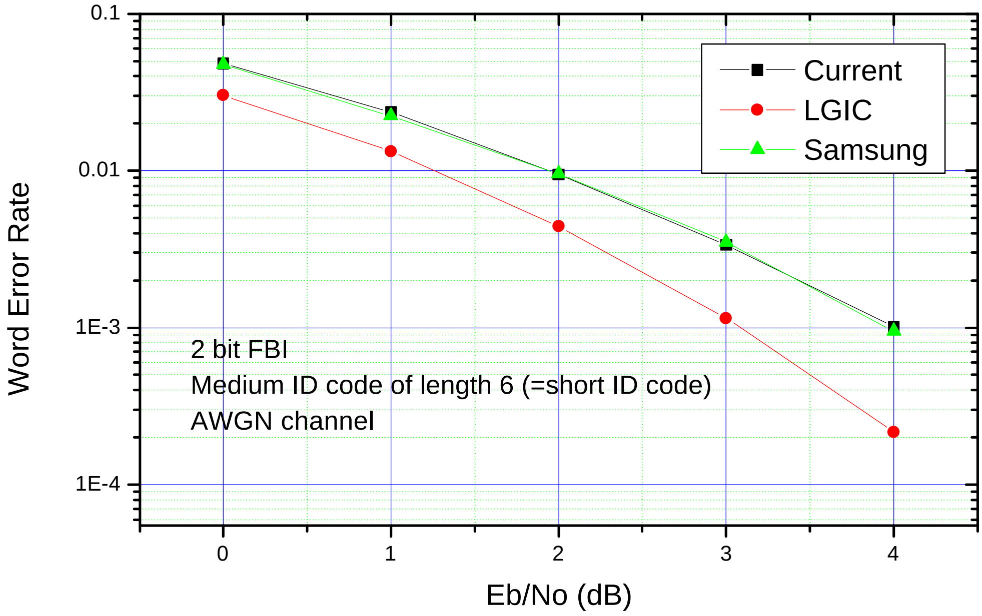
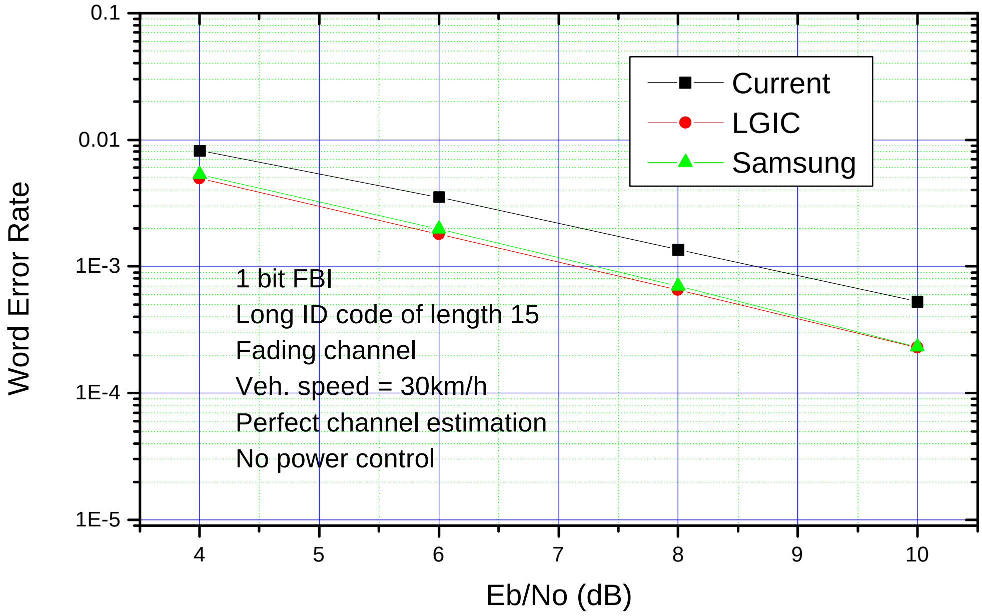


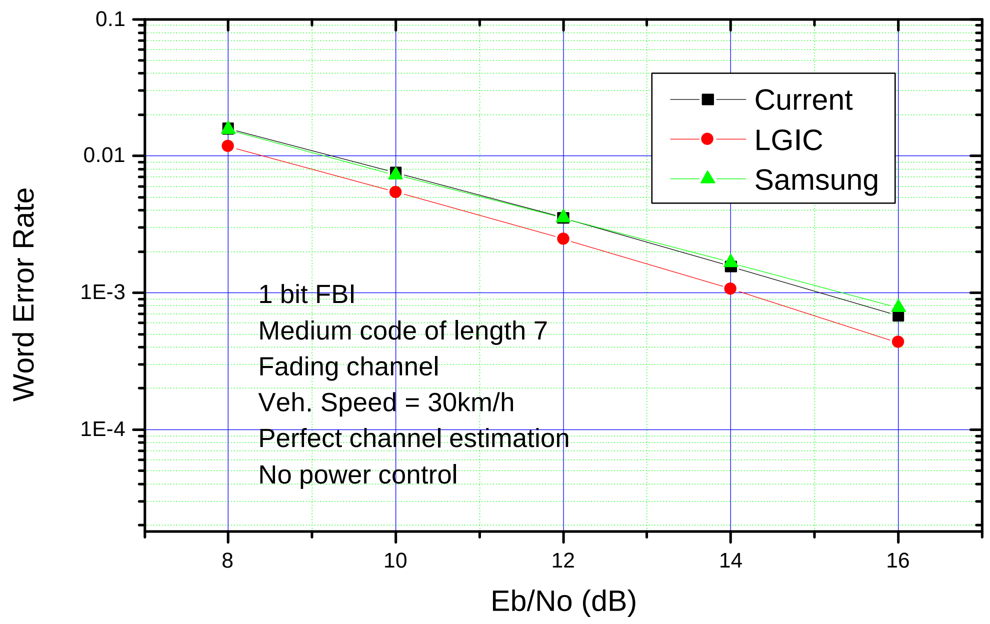
Table 5. Performance gain difference (dB) between different ID codes in AWGN channel, reference is Current ID codes.

AWGN channel	1 bit FBI			2 bit FBI		
	Long (15 bits)	Med. (7 bits)	Short (5 bits)	Long (14 bits)	Med. (6 bits)	Short (6 bits)
Current	0	0	0	0	0	0
Samsung	0	0	0	0	0	0
LGIC	0.3	0.7	0.25	0.2	0.8	0.8

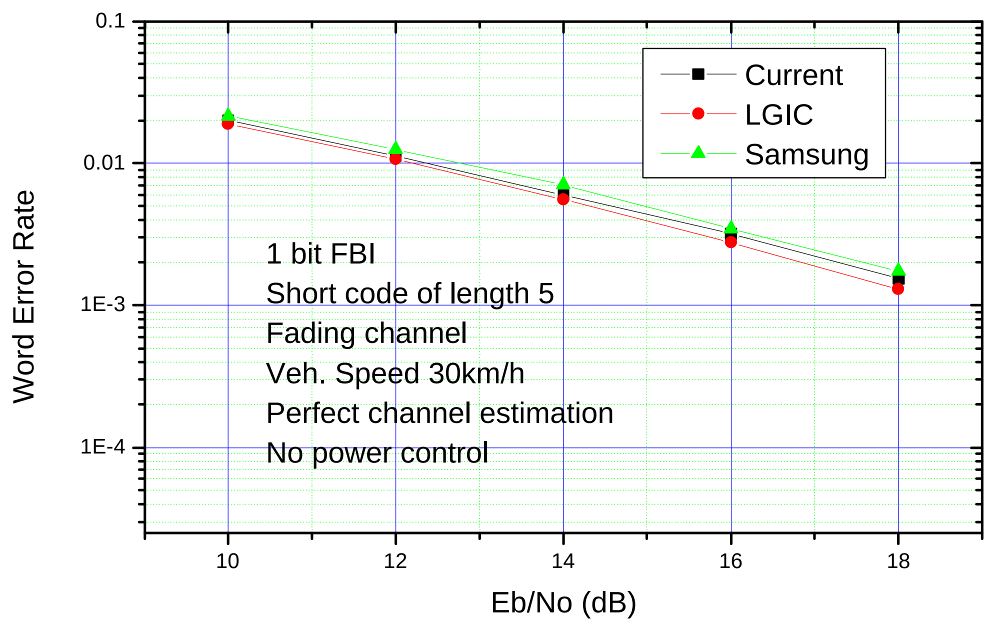
- **Fading Channel (1 bit FBI)**

Simulation condition:
- 1path
- Perfect channel estimation
- No power control
- Vehicular Speed = 30km/h



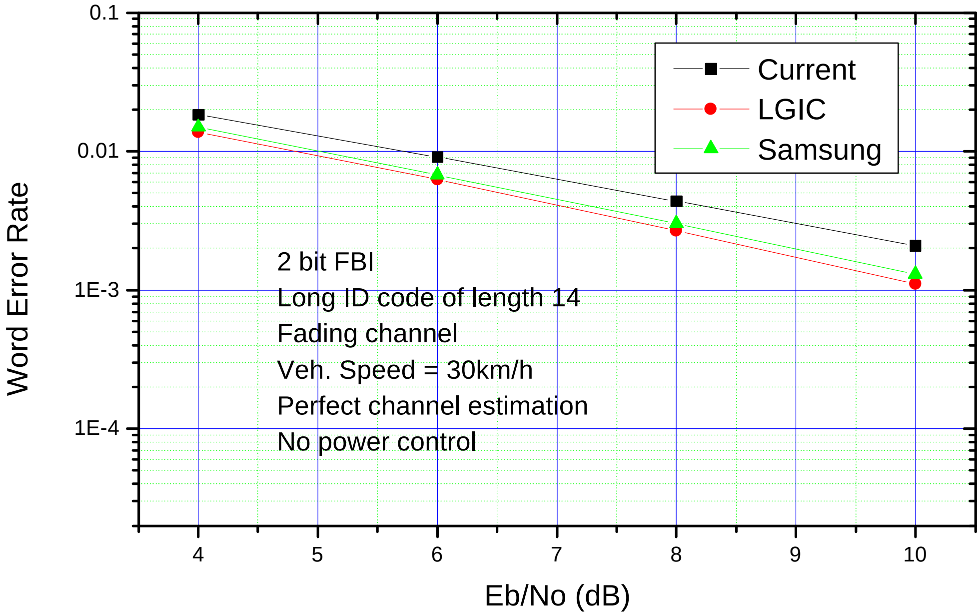


0.1
0.01
1E-3
1E-4
Word Error Rate
8
10
12
14
16
Eb/No (dB)
Current
LGIC
Samsung
1 bit FBI
Medium code of length 7
Fading channel
Veh. Speed = 30km/h
Perfect channel estimation
No power control



0.1
0.01
1E-3
1E-4
Word Error Rate
10
12
14
16
18
Eb/No (dB)
Current
LGIC
Samsung
1 bit FBI
Short code of length 5
Fading channel
Veh. Speed 30km/h
Perfect channel estimation
No power control

- **Fading channel (2 bit FBI)**



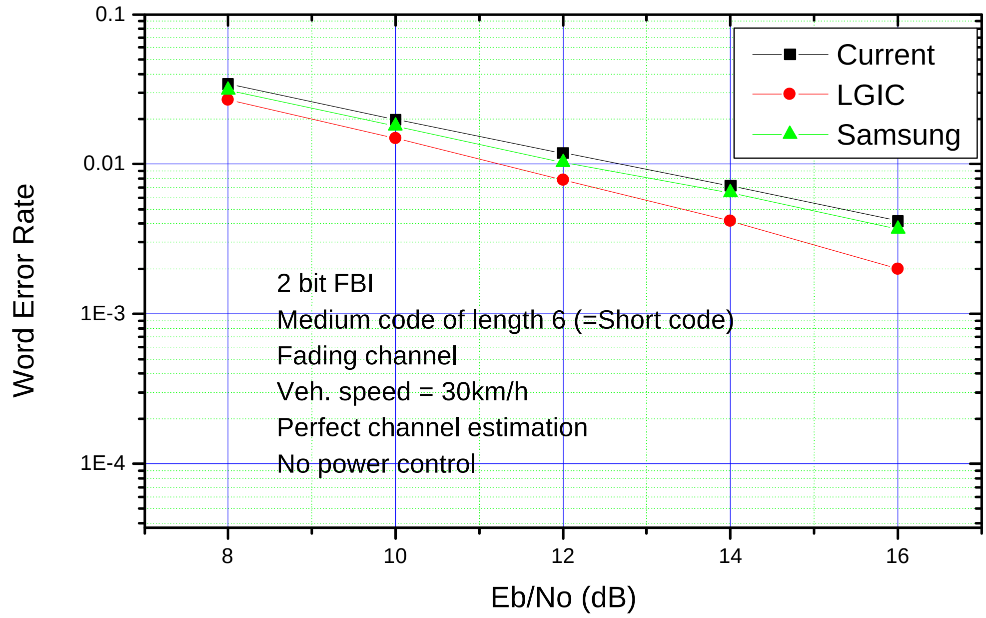


Table 6. Performance gain difference (dB) between different ID codes in Fading channel, reference is Current ID codes.

Fading channel	**1 bit FBI**			**2 bit FBI**		
	Long (15 bits)	**Med. (7 bits)**	**Short (5 bits)**	**Long (14 bits)**	**Med. (6 bits)**	**Short (6 bits)**
Current	**0**	**0**	**0**	**0**	**0**	**0**
Samsung	**1.2**	**0**	**0.3**	**1.0**	**0.2**	**0.2**
LGIC	**1.5**	**1.0**	**0.7**	**1.3**	**2**	**2**

6. Conclusion

In this contribution, we proposed the new optimized ID code for SSDT and we found that there is significant performance gain compared to the current ID codes. We found 0.2 ~ 0.8 dB performance gain in AWGN channel as well as 0.5 ~ 2 dB gain in fading channel.

References

[1] "UTRA FDD ; Multiplexing and channel coding", 3GPP TS25.212 v3.0.0 (1999-10).

[2] Samsung, "SSDT ID code", R1-99j40.

3GPP TSG RAN WG1 Meeting #9
Dresden, Germany, Nov 30 – Dec 3, 1999

***Document* R1-99K76**
e.g. for 3GPP use the format TP-99xxx
or for SMG, use the format P-99-xxx

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

25.214 CR 040 Current Version: 3.0.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to: TSG-RAN #6
list expected approval meeting # here ↑

for approval	X	strategic		*(for SMG use only)*
for information		non-strategic		

Form: CR cover sheet, version 2 for 3GPP and SMG The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

Proposed change affects: (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]
(at least one should be marked with an X)

Source: LGIC **Date:** 1999-12-2

Subject: ID Codes for SSDT Power Control

Work item:

Category:
(only one category shall be marked with an X)

F	Correction	X
A	Corresponds to a correction in an earlier release	
B	Addition of feature	
C	Functional modification of feature	
D	Editorial modification	

Release:

Phase 2	
Release 96	
Release 97	
Release 98	
Release 99	X
Release 00	

Reason for change: The current ID codes for SDDT power control is not optimised. This CR corrects the codes.

Clauses affected: 5.2.1.4

Other specs affected:

Other 3G core specifications		→ List of CRs:
Other GSM core specifications		→ List of CRs:
MS test specifications		→ List of CRs:
BSS test specifications		→ List of CRs:
O&M specifications		→ List of CRs:

Other comments:

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)~~ (0)0000000	00000
b	~~111111111111111~~ 101010101010101	~~1111111(1)~~ (0)1010101	~~11111~~ 10111
c	~~000000001111111~~ 011001100110011	~~0000111(1)~~ (0)0110011	~~00011~~ 01101
d	~~111111110000000~~ 110011001100110	~~1111000(0)~~ (0)1100110	~~11100~~ 11010
e	~~000011111111000~~ 000111100001111	~~0011110(0)~~ (0)0001111	~~00110~~ 00011
f	~~111100000000111~~ 101101001011010	~~1100001(1)~~ (0)1011010	~~11001~~ 10100
g	~~001111000011110~~ 011110000111100	~~0110011(0)~~ (0)0111100	~~01010~~ 01110
h	~~110000111100001~~ 110100101101001	~~1001100(1)~~ (0)1101001	~~10101~~ 11001

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)~~ (0)0000000 (0)0000000	~~000(0)~~ ~~000(0)~~ (0)000 (0)000	000 000
b	~~1111111(1)~~ ~~1111111(1)~~ (0)0000000 (1)1111111	~~111(1)~~ ~~111(1)~~ (0)000 (1)111	~~111~~ ~~111~~ 000 111
c	~~0000000(0)~~ ~~1111111(1)~~ (0)1010101 (0)1010101	~~000(0)~~ ~~111(1)~~ (0)101 (0)101	~~000~~ ~~111~~ 101 101
d	~~1111111(1)~~ ~~0000000(0)~~ (0)1010101 (1)0101010	~~111(1)~~ ~~000(0)~~ (0)101 (1)010	~~111~~ ~~000~~ 101 010
e	~~0000111(1)~~ ~~1111000(0)~~ (0)0110011 (0)0110011	~~001(1)~~ ~~110(0)~~ (0)011 (0)011	~~001~~ ~~100~~ 011 011
f	~~1111000(0)~~ ~~0000111(1)~~ (0)0110011 (1)1001100	~~110(0)~~ ~~001(1)~~ (0)011 (1)100	~~110~~ ~~011~~ 011 100
g	~~0011110(0)~~ ~~0011110(0)~~ (0)1100110 (0)1100110	~~011(0)~~ ~~011(0)~~ (0)110 (0)110	~~010~~ ~~010~~ 110 110
H	~~1100001(1)~~ ~~1100001(1)~~ (0)1100110 (1)0011001	~~100(1)~~ ~~100(1)~~ (0)110 (1)001	~~101~~ ~~101~~ 110 001

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~~first 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.

5.2.1.4.3 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.

Otherwise the cell recognises its state as primary.
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 5.2.3.2 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 5.2.3.1. 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

State of cell	P1 (DPCCH)	P2 (DPDCH)
non primary	Updated by the same way as specified in 5.2.3.2	Switched off
primary		= P1