TSG-RAN Working Group 1 meeting #9 **_TSGR1#9(99)i80_**
Dresden, Germany, 30, Nov. - 3, Dec., 1999

Agenda Item : Ad Hoc 09

Source : LG Information & Communications, Ltd.

Title : Optimum ID Codes for Site Selection Diversity Transmission Power Control

Document for : Proposal of Optimum ID Codes for SSDT

Abstract

In this contribution, we propose the new optimum identification codes for SSDT (Site Selection Diversity Transmission), which maximizes the minimum Hamming distance and robust to fading channel environment. Thus 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.

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 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 2: Settings of ID codes for 2 bit FBI (CURRENT)

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

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	10110
C	011001100110011	(0)0110011	01101
D	110011001100110	(0)1100110	11011
E	000111100001111	(0)0001111	00011
F	101101001011010	(0)1011010	10101
G	011110000111100	(0)0111100	01110
H	110100101101001	(0)1101001	11000

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:

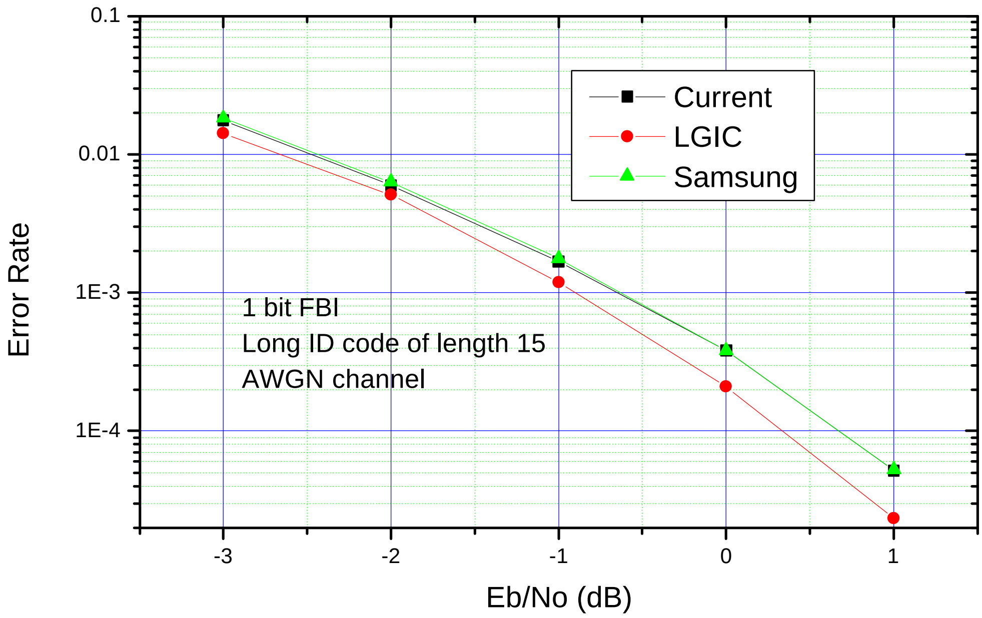
- d_{min} = 8 for long code of length 15
- d_{min} = 4 for medium code of length 8
- d_{min} = 4 for punctured medium code of length 8
- d_{min} = 2 for short code of length 5

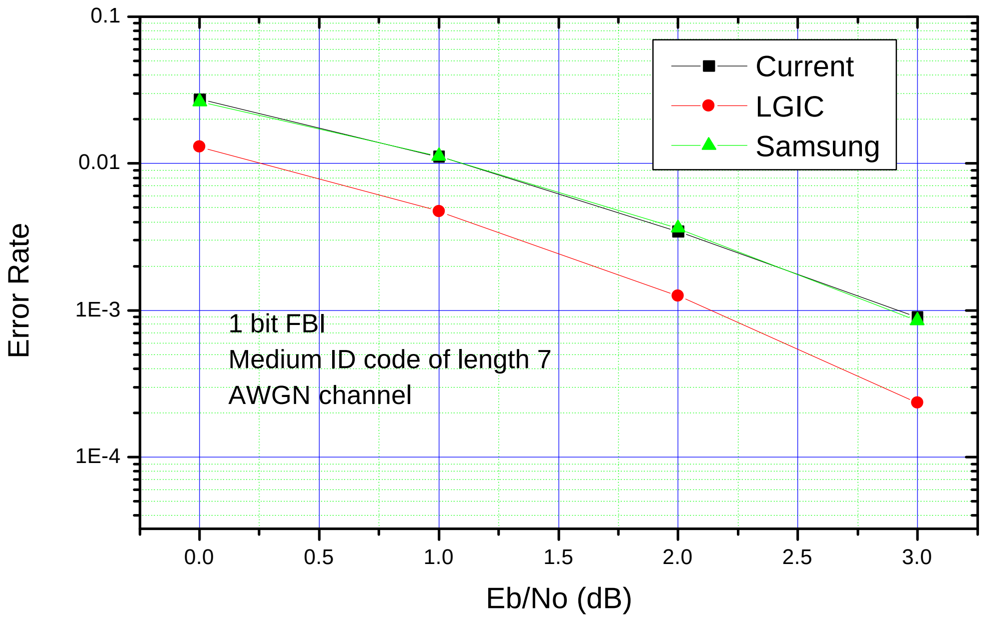
And from table 2, the minimum Hamming distance of ID codes for 2 bit FBI is:

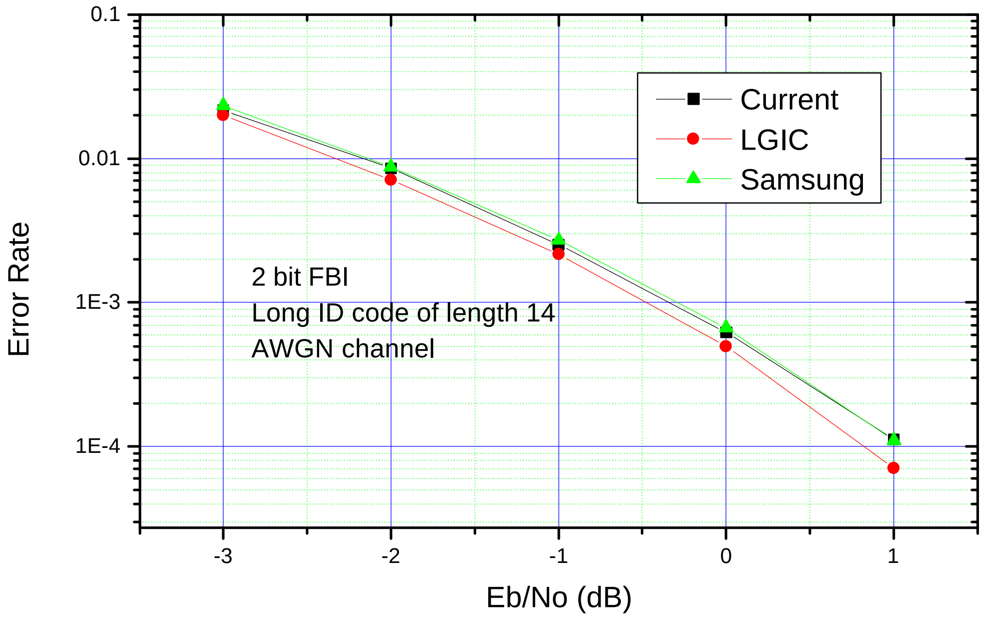
- d_{min} = 8 for long code of length 16
- d_{min} = 7 for punctured long code of length 14
- d_{min} = 4 for medium code of length 8
- d_{min} = 3 for punctured medium code of length 6
- d_{min} = 3 for short code of length 6

4. Performance evaluation

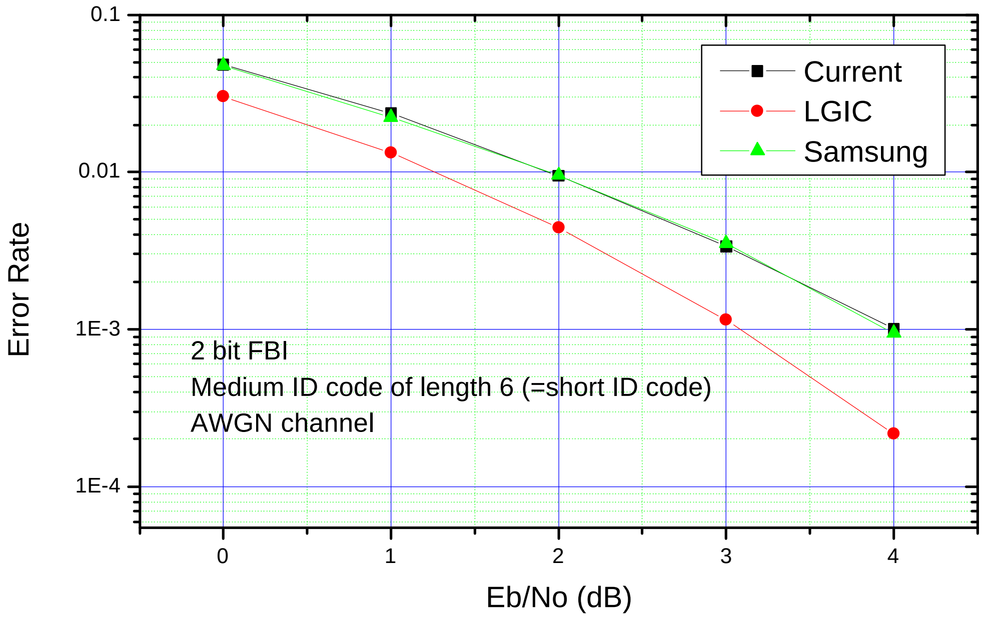
AWGN Channel







0.1
0.01
1E-3
1E-4
Error Rate
-3
-2
-1
0
1
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Long ID code of length 14
AWGN channel



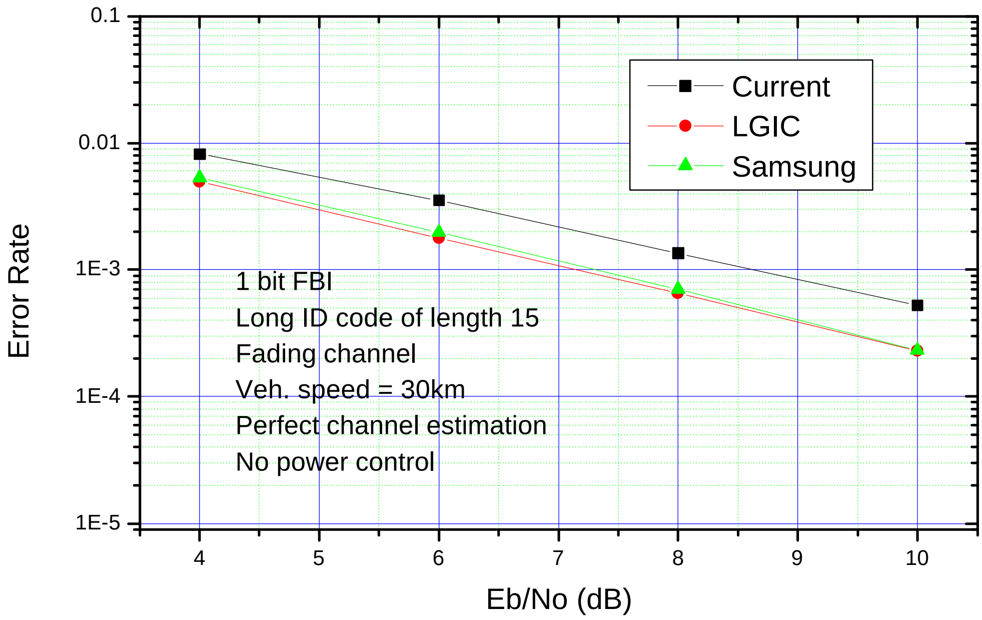
0.1
0.01
1E-3
1E-4
Error Rate
0
1
2
3
4
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Medium ID code of length 6 (=short ID code)
AWGN channel

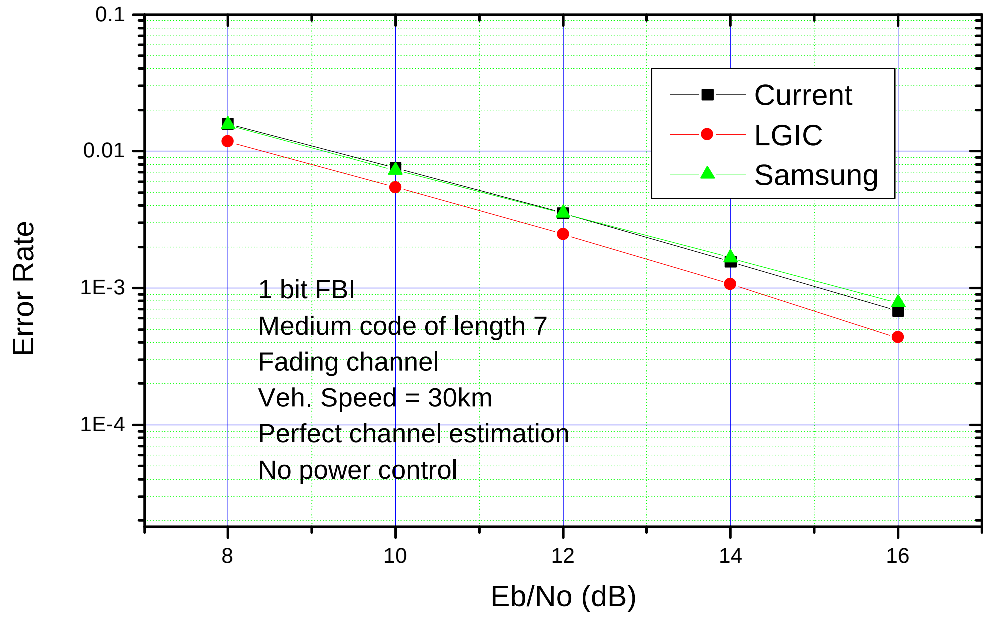
Table 5. Performance gain difference (dB) between different ID codes in AWGN channel, reference is Current ID codes.

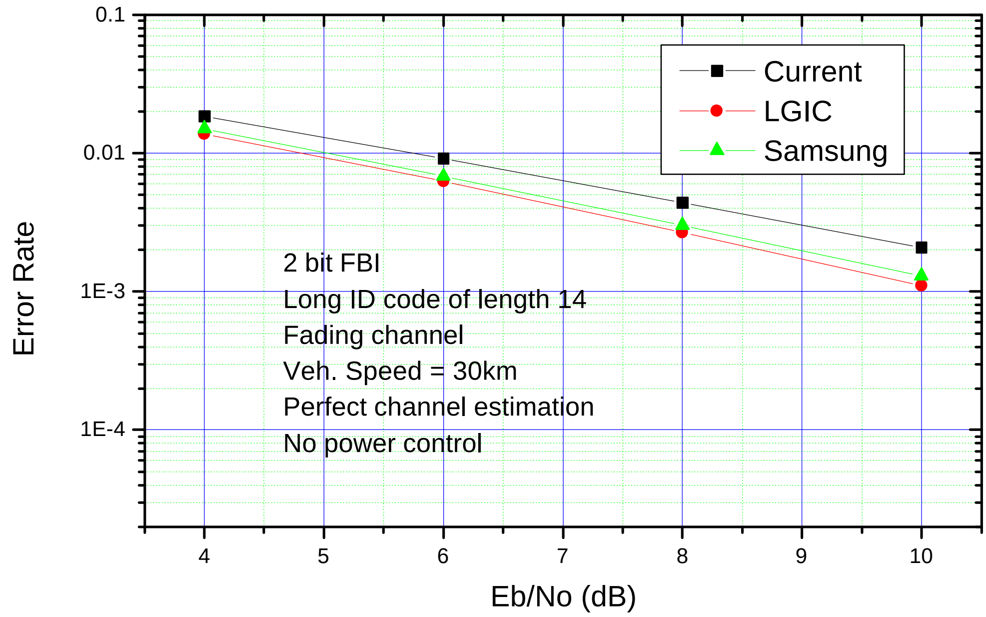
AWGN channel	1 bit FBI		2 bit FBI	
	Long (15 bits)	Medium (7 bits)	Long (14 bits)	Medium (6 bits)
Current	0	0	0	0
SS	0	0	0	0
LG	0.3	0.7	0.2	0.8

Fading Channel

Simulation condition:
- 1path
- Perfect channel estimation
- No power control
- Veh. Speed = 30km




0.1
0.01
1E-3
1E-4
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
Perfect channel estimation
No power control


0.1
0.01
1E-3
1E-4
Error Rate
4
5
6
7
8
9
10
Eb/No (dB)
Current
LGIC
Samsung
2 bit FBI
Long ID code of length 14
Fading channel
Veh. Speed = 30km
Perfect channel estimation
No power control

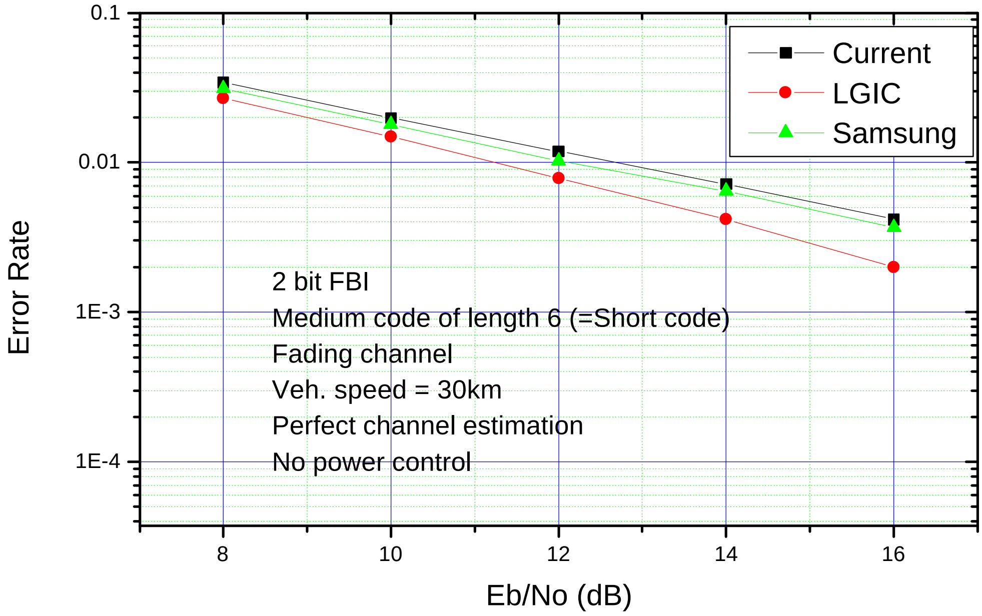


Table 6. Performance gain difference (dB) between different ID codes in Fading channel, reference is Current ID codes.

Fading channel	1 bit FBI		2 bit FBI	
	Long (15 bits)	Medium (7 bits)	Long (14 bits)	Medium (6 bits)
Current	0	0	0	0
SS	1.2	0	1	0.2
LG	1.5	0.5	1.3	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 dB gain in fading channel.

References

[1] "UTRA FDD ; Multiplexing and channel coding", 3GPP TS25.212 v3.0.0 (1999-10), TSGRAN#5(99)588.
[2] Samsung, "SSDT ID code", R1-99j40.