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Agenda item: HSDPA

Source: Nokia

Title: Simulation results for HSDPA DL control channels

Document for: Discussion

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1. Introduction

In [1] we have explained what kind of HSDPA related parameters are needed to be sent in downlink. In [2] we have further discussed, what kind of coding rates would be needed for the parameters sent before the HS-DSCH TTI. And finally in [3] we have discussed what kind of coding rates would be needed for the parameters sent simultaneously with HS-DSCH TTI.

This paper is a continuation of this downlink parameter study. We have run some link level simulations to see what kind of coding method could be used for :

- parameters sent before the HS-DSCH TTI, i.e. so called pointer channel, dedicated to each UE. The number of information bits currently proposed in [2] is ranging between 3-5. In these simulations the number of information bits is 5.
- parameters sent simultaneously with the HS-DSCH TTI, i.e. shared control channel. The number of information bits currently proposed in [3] is 11. However in this paper a somewhat higher value, 17-20 bits, is used, since these simulations are based on some earlier assumptions.

Even if we do not yet have a working assumption on the exact number of information bits for these two cases, these results might however show some indication, what might be a sensible coding method for HSDPA control channels.

2. Coding for parameters to be sent before HS-DSCH TTI

2.1 Parameters

- comparison of repetition coding and bi-orthogonal coding (5 bits in frame)
- pedestrian A channel, 3 km/h
- power control on
- (14,5)-code used for tfci coding
- 3.7 kbps reference channel (40 ms TTI and rate 1/3 CC)

Table 1. Parameters for simulation case (TTI = 1 slot)

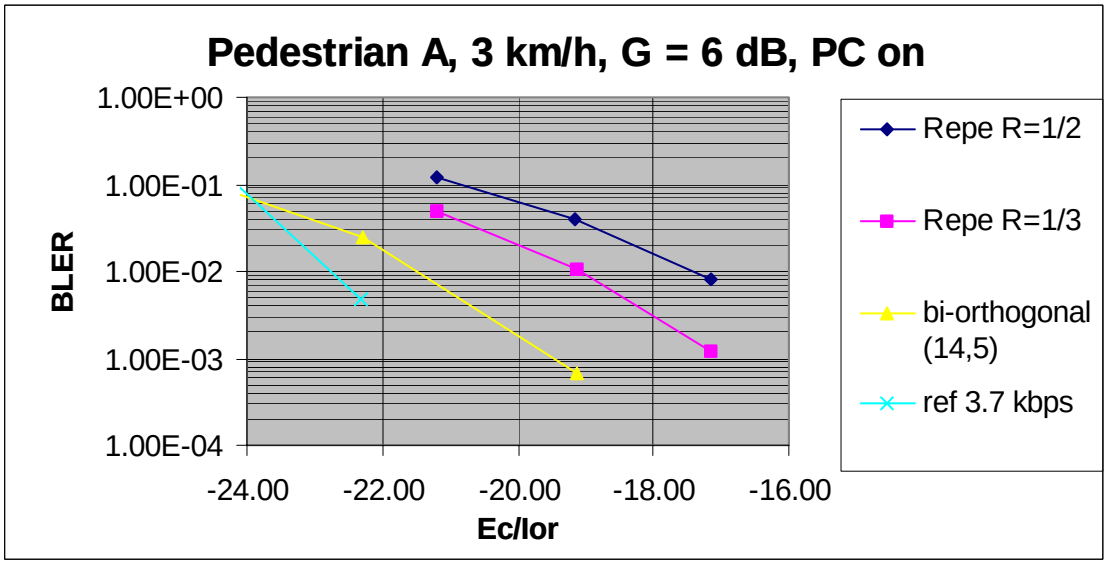
Channel model	Pedestrian A
Mobile Velocity	3 km/h
G	6 dB
SF	256
Fast power control	on
TTI Length	1 slot, sent every 5 slot
Information Bits	5
Coded Bits	14
CRC	no

Table 2. Parameters for reference channel. (TR 25.944)

TTI Length	40 ms
information bits in TTI	148
data rate	3.7 kbps
Encoding scheme	1/3 rate convolutional encoding
CRC bits	16

2.2 Simulation results

The results show that bi-orthogonal coding (14,5) is clearly having a better performance than repetition coding, which was quite an obvious result. As a reference, we simulated also a 3.7 kbit/s signaling bearer with 40 ms TTI using also SF=256 and convolutional coding. It can be seen from the results that bi-orthogonal coding (14,5) using 1 slot interleaving period and SF=256, will need about 1 dB increase in the Ec/Ior, compared to the reference signaling bearer.

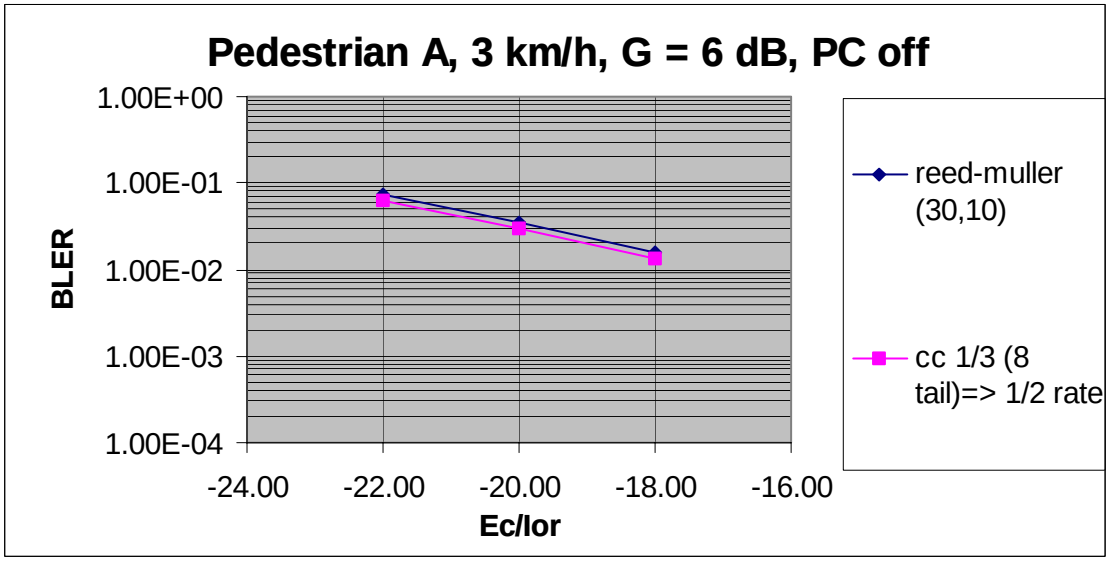


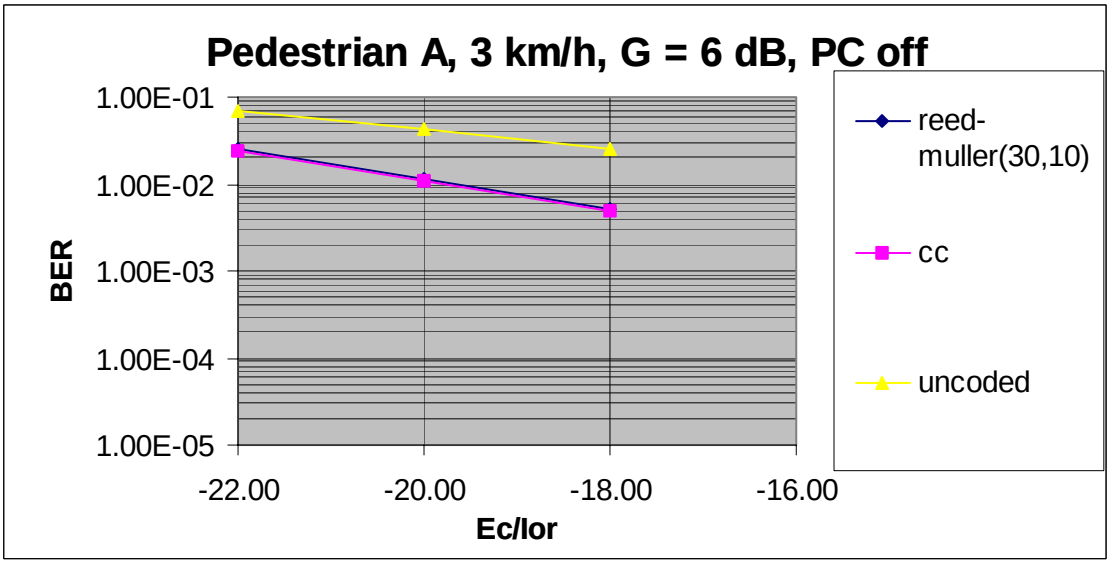
3. Coding for parameters to be sent simultaneously with HS-DSCH TTI

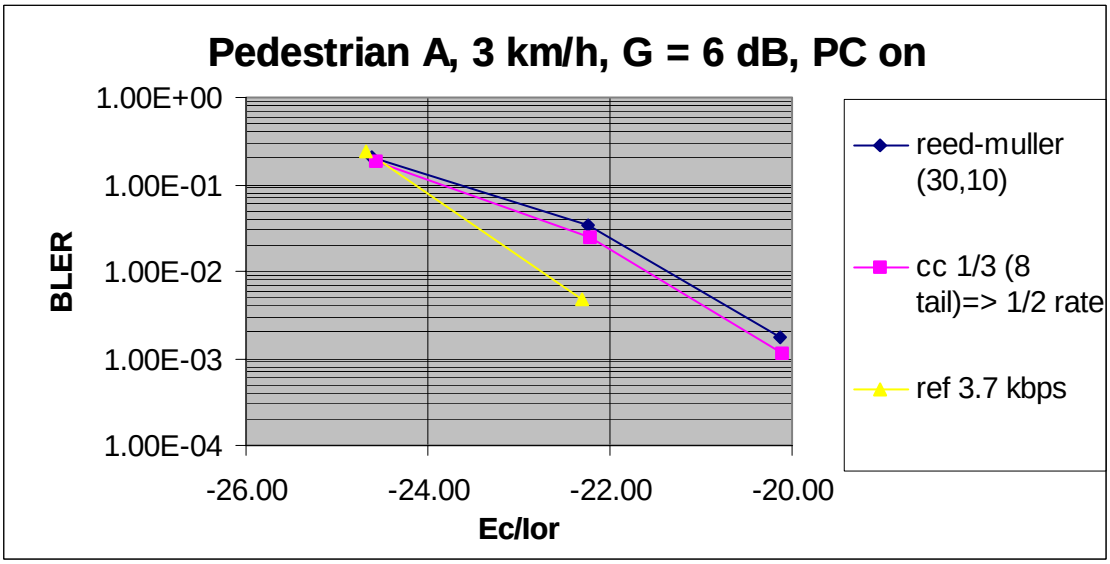
3.1 TTI=3 slots case : results

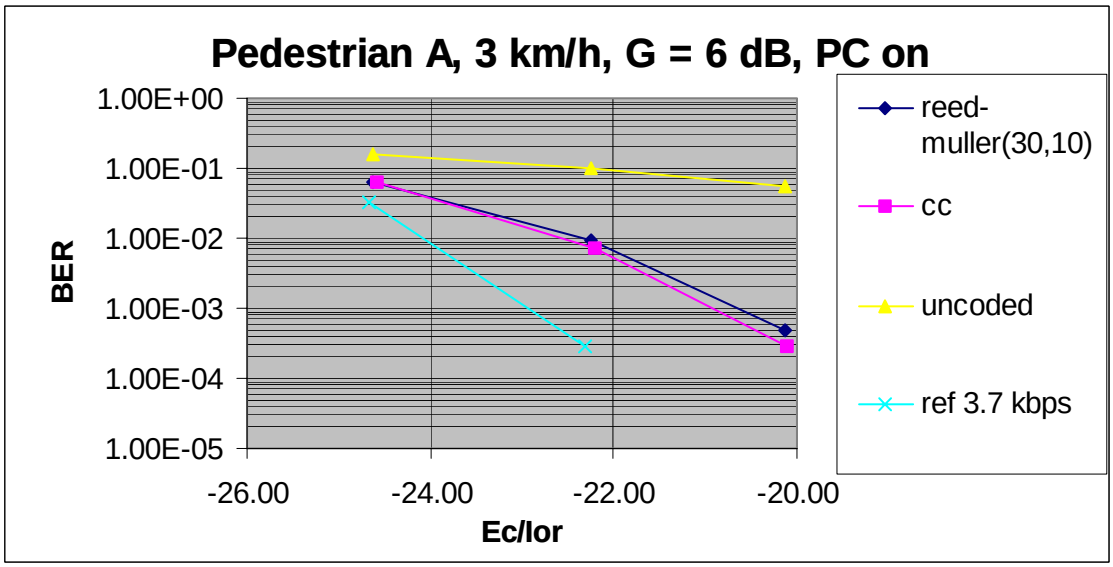
Table 3. Parameters for simulation case. (TTI = 3 slots)

Channel model	Pedestrian A
Mobile Velocity	3 km/h
G	6 dB
Sf	256
Fast power control	off/on
TTI Length	3 slots
Information Bits	20 (Note, this is just an example number of information bits. Actually in [2] the present proposal is to have only 11 information bits in the shared control channel.)
Coded Bits	60
Encoding scheme	2x(32,10) reed-muller code according to 25.212.
	punctured 1/3 – rate convolutional code with 8 tail bits (25.212)
CRC	no


Pedestrian A, 3 km/h, G = 6 dB, PC off
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
BLER
-24.00
-22.00
-20.00
-18.00
-16.00
Ec/Ior
reed-muller (30,10)
cc 1/3 (8 tail)=> 1/2 rate


Pedestrian A, 3 km/h, G = 6 dB, PC off
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
BER
-22.00
-20.00
-18.00
-16.00
Ec/Ior
reed-muller(30,10)
cc
uncoded

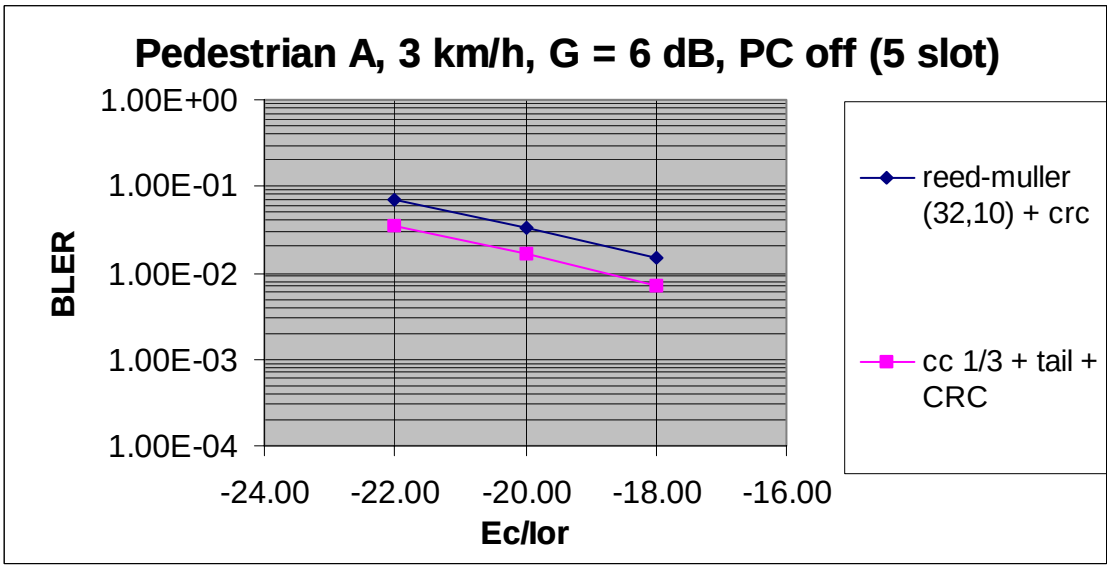

Pedestrian A, 3 km/h, G = 6 dB, PC on
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
BLER
-26.00
-24.00
-22.00
-20.00
Ec/Ior
reed-muller (30,10)
cc 1/3 (8 tail)=> 1/2 rate
ref 3.7 kbps

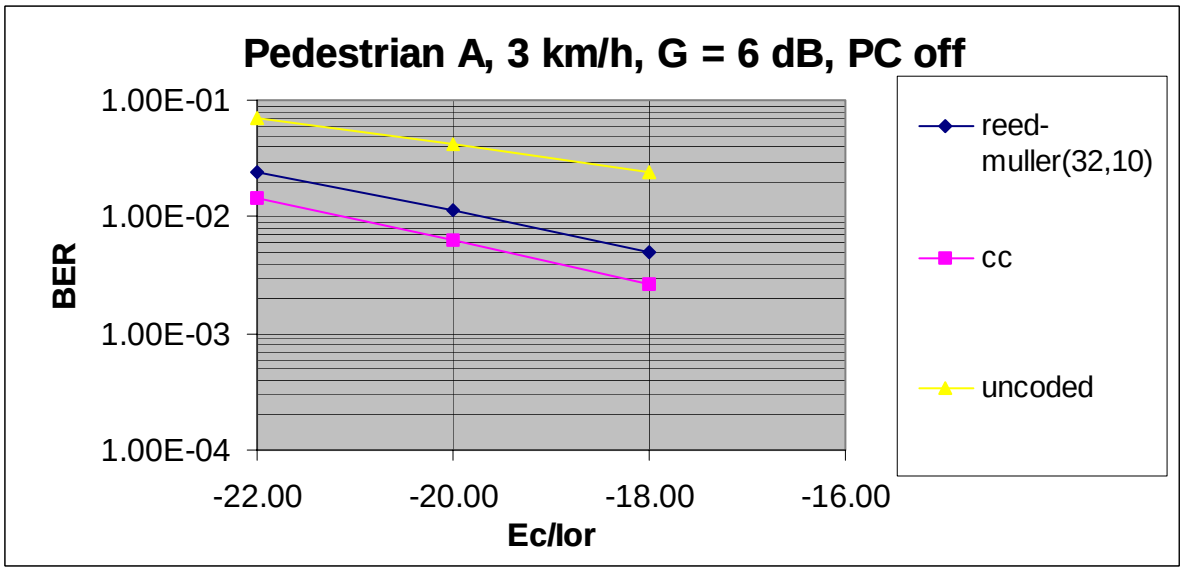


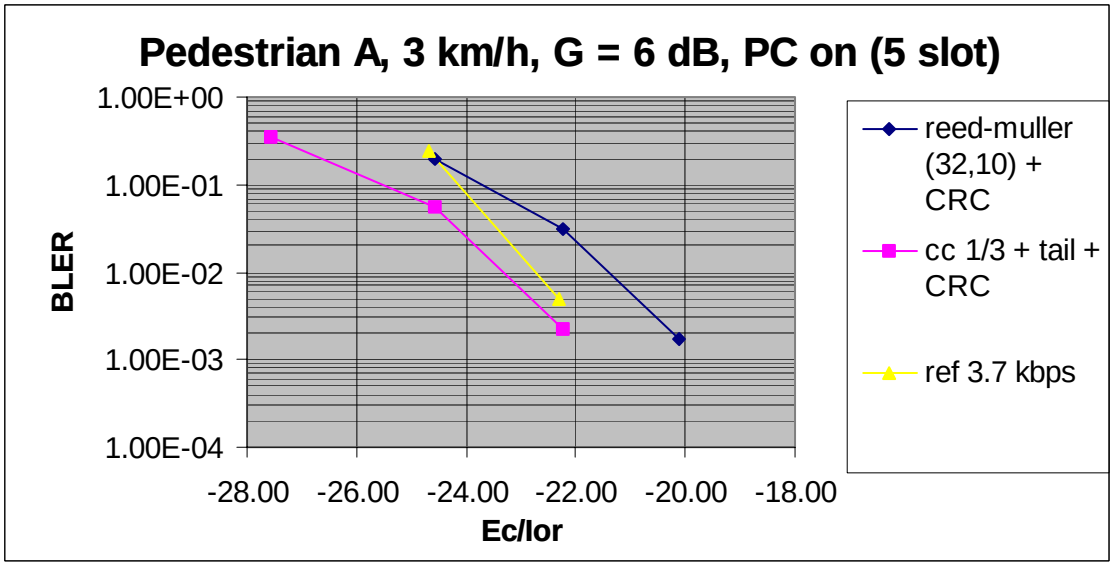
3.2 TTI=5 slots case

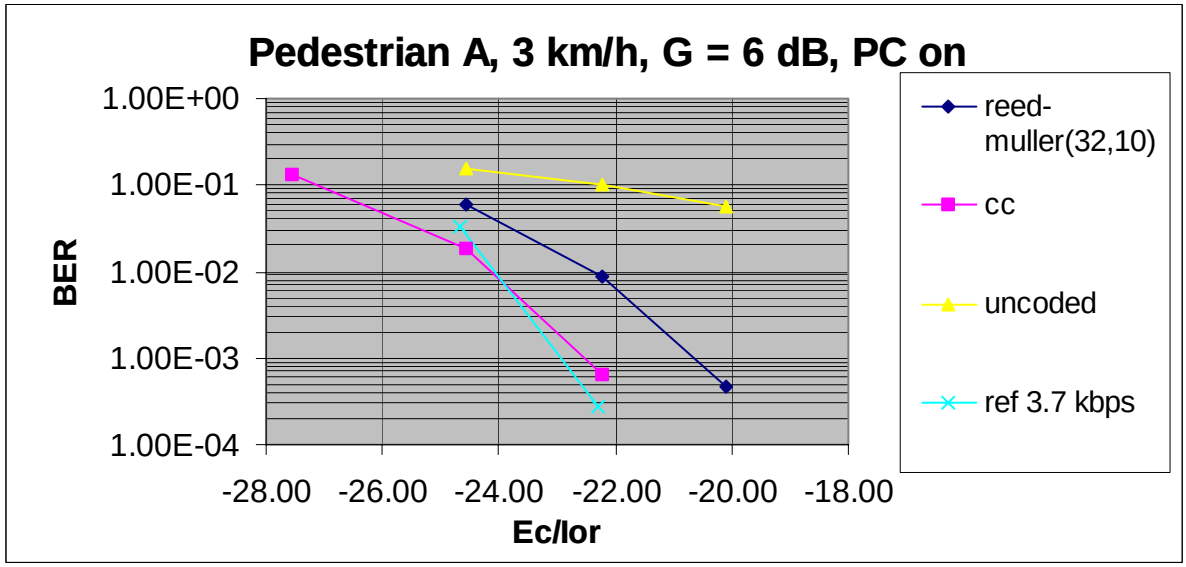
Table 4. Parameters for simulation case. (TTI = 5 slots)

Channel model	Pedestrian A
Mobile Velocity	3 km/h
G	6 dB
Sf	256
Fast power control	off/on
TTI Length	5 slots
Information Bits	17. (Note: this is just an example, actually in [2] the present proposal is to have only 11 information bits in the shared control channel.)
CRC	8 bits
Coded Bits	100
Encoding scheme	3x(32,10) reed-muller code according to 25.212.
	1/3 – rate convolutional code with 8 tail bits (25.212)




Pedestrian A, 3 km/h, G = 6 dB, PC off
1.00E-01
1.00E-02
1.00E-03
1.00E-04
BER
-22.00
-20.00
-18.00
-16.00
Ec/Ior
reed-muller(32,10)
cc
uncoded


Pedestrian A, 3 km/h, G = 6 dB, PC on (5 slot)
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
BLER
-28.00
-26.00
-24.00
-22.00
-20.00
-18.00
Ec/Ior
reed-muller (32,10) + CRC
cc 1/3 + tail + CRC
ref 3.7 kbps


Pedestrian A, 3 km/h, G = 6 dB, PC on
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
BER
-28.00
-26.00
-24.00
-22.00
-20.00
-18.00
Ec/Ior
reed-muller(32,10)
cc
uncoded
ref 3.7 kbps

3.3 Findings from the results

For the parameters to be sent simultaneously with the HS-DSCH TTI, the results show that

- With TTI=3 slots case and 20 information bits, Reed-Muller (32,10) and convolutional coding perform equally, both with and without power control. Here convolutional coding is punctured close to ½ coding rate.

- With TTI=5 slots case and 17 information bits, convolutional coding performs about 2 dB better than Reed-Muller (32,10) coding, at same target BLER level, both with and without power control. The reason is that in this case there is no puncturing for convolutional coding , i.e. coding rate is 1/3.

Thus selecting the coding method will depend on whether TTI=3 slots or 5 slots will be selected , and how many information bits will be needed.

One additional point to note was that the shared control channel can not be in soft handover. This was the reason why the simulations were run both with and without power control. However, probably the case with power control is more relevant case to look at, since when not in soft handover, it is possible to use power control in a normal way.

Another interesting point for the shared control channel is to look at the results again vs. the reference 3.7 kbit/s signaling bearer with TTI=40 ms. It seems that with TTI=3 slots and power control on, the shared control channel will need about 1 dB higher Ec/Ior than the reference 3.7 kbit/s channel. With TTI=5 slots the same Ec/Ior is required for the reference bearer and the shared control channel.

4. Conclusions

Our opinion is that for parameters to be sent before the HS-DSCH TTI, using bi-orthogonal coding is probably the most sensible solution. It allows to vary the input bits between 1-5, and has better performance than e.g. repetition coding.

For parameters to be sent simultaneously with HS-DSCH TTI, the results show that selecting the coding method will depend on whether we select TTI=3 slots or 5 slots, and how many information bits are needed. Our proposal is to use convolutional coding.

REFERENCES

[1] WG2 #21 meeting, R2-01-1177, "HSDPA related signaling parameters in downlink, version 2", Nokia.

[2] WG1 #20 meeting, R1-01-0549, "DL control channel structures for parameters sent before the HS-DSCH TTI", Nokia.

[3] WG1 #20 meeting, R1-01-0550, " DL control channel structures for parameters sent simultaneously with HS-DSCH TTI ", Nokia.