TSG-RAN Working Group1 meeting #9 **TSGR1#8(99)j03**
Dresden, Germany, 30 November – 3 December 1999

Agenda Item:
Source: **Nokia**
Title: **Means for compressed mode by puncturing in downlink**
Document for: **Decision**

1. INTRODUCTION

In RAN WG1#8 meeting Ericsson proposed the removal of compressed mode Method A from downlink specification [1]. At that moment the description of Method A was inadequate in L1 specification. Based on reflector discussions there are basically three locations in the downlink multiplexing chain where the puncturing for this Method can be added:

1. The first one is after 2nd Interleaver as proposed by Mitsubishi in [2] :
   + This scheme provides a simple implementation
   – It does not ensure that the different TrCHs are punctured in a way that retains the ratio between them set by the static rate matching parameter
   – Systematic bits may be punctured when turbo coding is used

2. After Radio frame segmentation, before TrCH multiplexing
   + A common puncturing rate for different TrCHs makes it possible to retain the ratio established by static rate matching parameter
   – Systematic bits may be punctured when turbo coding is used.

3. Perform the rate matching for compressed mode at the same stage with normal rate matching.
   + This scheme retains the balancing between TrCHs.
   + Prevents puncturing the systematic bits of turbo codes.
   + Enables global rate matching and does not puncture bits that have already been repeated
   – It is complicated to address TTIs of different lengths

The simulations in section 3 show performance comparison between schemes 1 and 3.

2. POSSIBLE PROBLEMS WITH USING ONLY METHOD B

Having only compressed mode Method B for real-time services in downlink seems to have its limitations. With Method B there is a chance of code limitation, which forces the UE to use a secondary scrambling code.

The impact of having only Method B to choose from is considered next. The case depends on the geometry, i.e. where the UE is located in the cell with respect to the base station. See the cases below. G=10 dB means that UE is close to its serving base station, G=0 that it is further away from it. BS peak ptx = increase in the required SIR due to secondary scrambling code + 3 dB due to SF/2 in Method B. In this case a static channel is used, i.e. the interference from neighboring cell does not fade independently from transmission power in UE's own cell.

Nice case:
(geometry) G=0dB, orthogonality = 0.5, => SIR = S/(0.5*Ior + Ior),

change scrambling code => SIR = S/(Ior + Ior) => 1.25dB jump => BS peak ptx 4.25dB higher

Worse case:
G=0dB, orthogonality = 0.9 => SIR = S/(0.1*Ior + Ior)
change scrambling code => SIR = S/(I+I) => 2.6 dB jump => BS peak ptx 5.6dB higher

Worst case:
G=10dB, orthogonality = 0.9 => SIR = S/(0.1*Ior + 0.1*Ior)
change scrambling code => SIR = S/(Ior+0.1*Ior)=>7.4dB jump! => BS peak ptx 10.4dB higher

Since the G value that defines where the UE is in the cell is not known, the SIR target can probably only be increased by 3 dB during the compressed frame. However, in the worst case that is still 7 dB below the required SIR. Naturally the SIR estimator and the closed loop power control will eventually lift the power to the desired level, but it is questionable what the quality will then be in the compressed frames.

3. SIMULATION RESULTS

Puncturing for compressed mode Method A was modeled for two scenarios. On the one hand, CCTrCH was punctured after 2nd interleaver and 5 slots of transmission gap were created here. On the other hand, a 5-slot transmission gap was created during the rate matching stage. Consequently, interleavers were also shorter than in the first case. DTX was added after 2nd interleaver to introduce the actual transmission gap. In order to keep the simulation model simple; a transmission gap was introduced in each frame. During transmission gap, power control was disconnected. The transmission power in the first slots after the transmission gap was initially the same as during the last slot before the transmission gap.

The simulation results in Figures 1 –4 are depicting different simulation assumptions as follows:

-normal:
No puncturing for compressed mode. The information data rate is calculated from channel rate so that the frame is filled totally. With 1/2 coding it is 101.0 kbps and with 1/3 66.8 kbps.

-puncturing after 2nd interleaver:
5 last slots from every frame are compressed after the 2nd interleaver. In Pedestrian A cases power control is off during this period (All Vehicular A results are without power control). The transmission of both DPDCH and DPCCH are off during this period.

-CC punctured during RM :
Here bits are punctured in the rate matching block. However, DTX indication symbols are inserted *after* the 2nd interleaver. The interleaving depth in this method is (10*2/3) ms.

-Turbo - punctured during RM - only parity bits:
Puncturing algorithm is implemented as it should be according to the specification in TS 25.212, i.e. no systematic bits are punctured.

Table 1. Simulation parameters

	CC 1/3	CC ½	Turbo 1/3
G	6 dB	6 dB	6 dB
Chip Rate	3.84 Mchips	3.84 Mchips	3.84 Mchips
Slots In Frame	15	15	15
CPiCH included, code number	255	255	255
Interferers	20	20	20
PC Step size	1 dB	1 dB	1 dB
PC error rate	1%	1%	1%
Data rate	66800	101000	68000
Information Bits in frame	668	1010	680
TTI Length	10 ms	10 ms	10 ms
Transport blocks in TTI	1	1	1
SF	32	32	32
Code blocks in transport block	2	3	1
CRC	16	16	16
Tail	8	8	4
CodeRate	0.333	0.333	0.333
TFCI	8	8	8
TPC	4	4	4
Pilot	8	8	8
DPDCH1	20	20	20
DPDCH2	120	120	120
Channel estimation	Flat 10 tap FIR, length 20 cp symbols (every 2 adjacent cp symbols summed before filtering)		
SIR estimation	S non-coherently from dedicated pilot symbols, I from CPiCH with MVU method. IIR filter (alpha tracker), alphaS 0.5 and alphaI 0.16		
Compressed mode modelling:	Every frame is compressed; 5 last slots from every frame are punctured.		
Puncturing method	After 2^{nd} interleaver the 5 last slots are punctured		
PC	The Tx power for traffic channel is the same after the cm as it is right before it.		
Powers (Ec/Ior)	In the charts, the powers are averages unless otherwise stated (Ec/Iors are powers needed for every transmitted chip). In compressed mode, that means the average is calculated from every frame.		

Table 2. Channel models

Channel models (dB's): delay	Pedestrian A	Vehicular A	Channel models (abs) Pedestrian A	VehicularA
0	0.2	0	1.047128548	1
1	-12.3	-2.4	0.058884366	0.575439937
2		-6.5		0.223872114
3		-9.4		0.114815362
4		-12.7		0.05370318
5		-13.4		0.045708819
7		-15.4		0.028840315

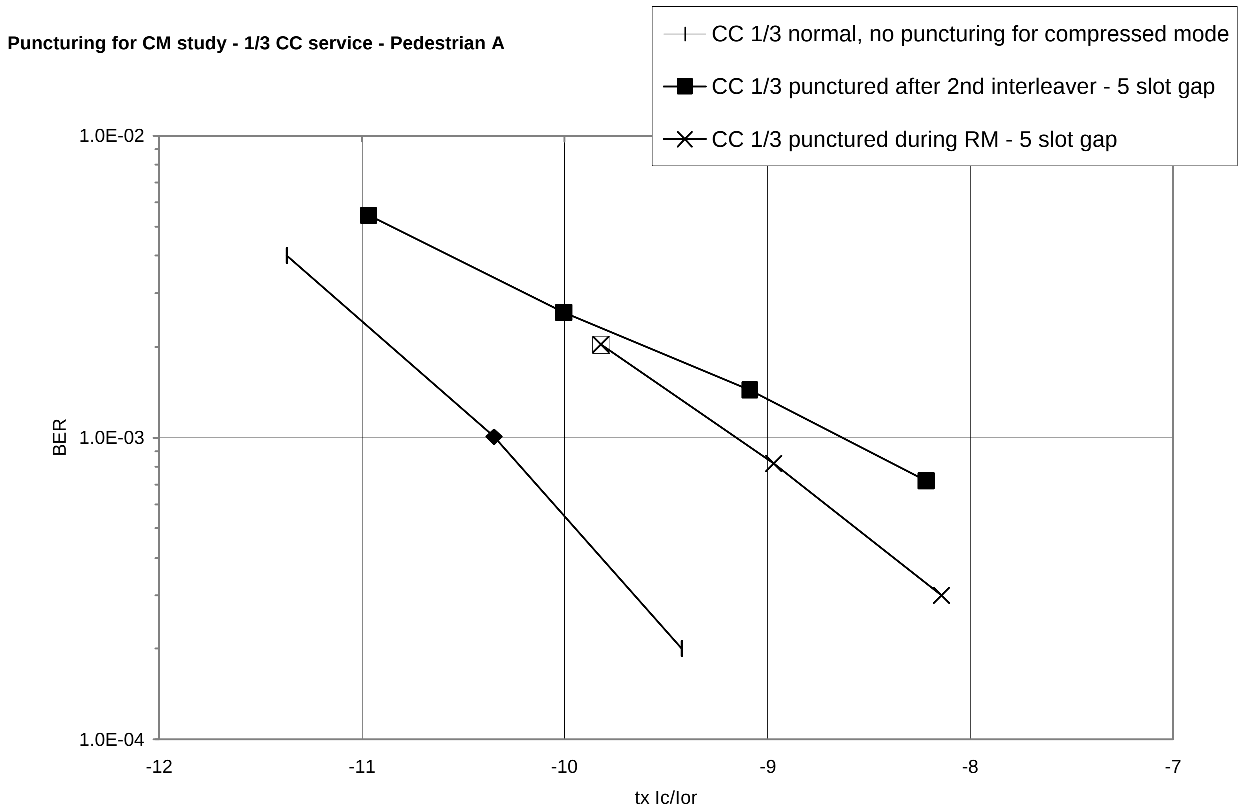

Figure 1. Compressed mode with Method A – 1/3 CC (Ped A)

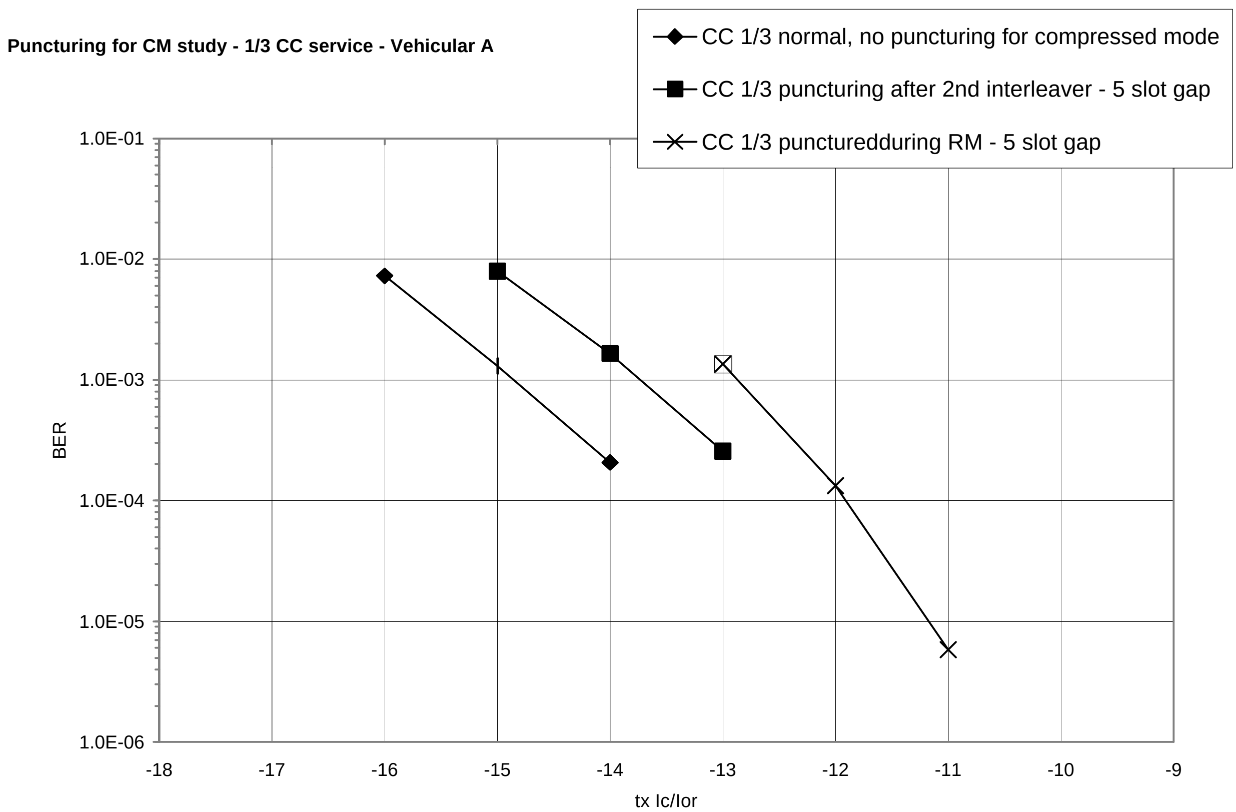

Figure 2. Compressed mode with Method A – 1/3 CC (Veh A)

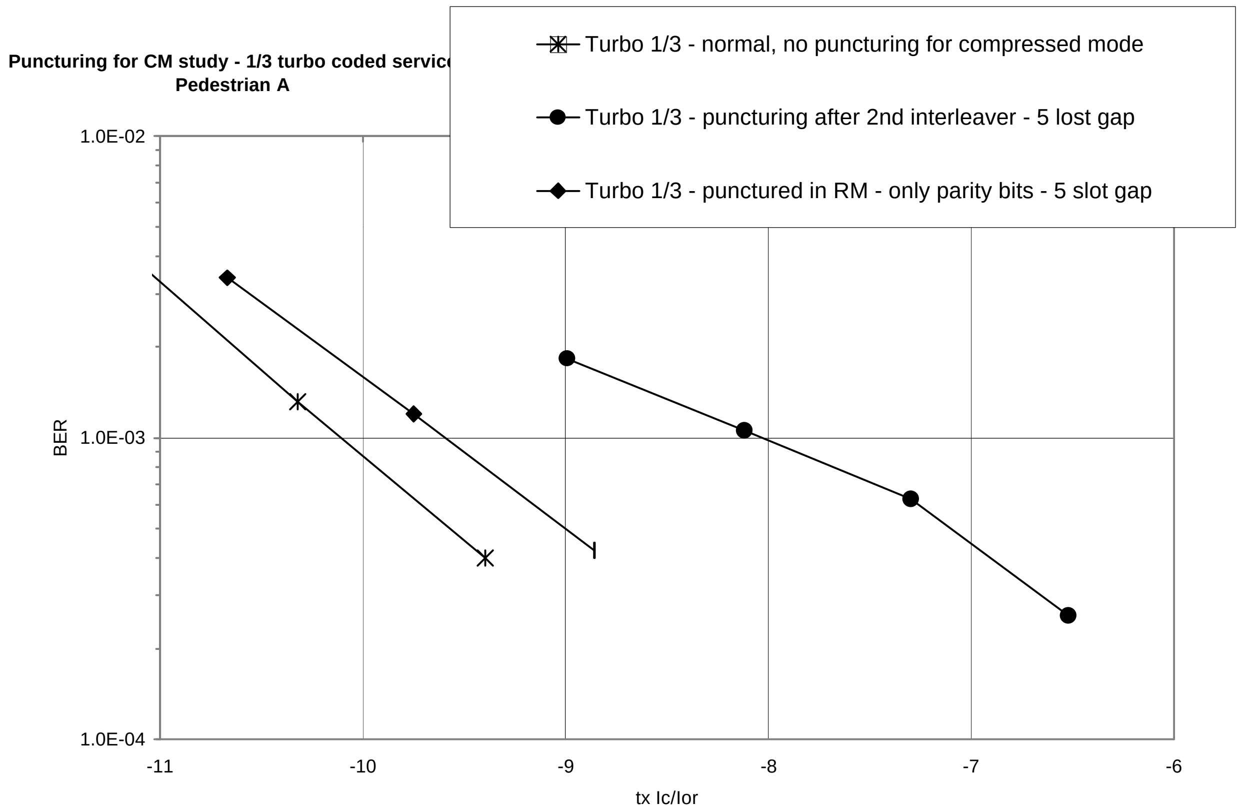

Figure 3. Compressed mode with Method A – 1/3 PCCC (Ped A)

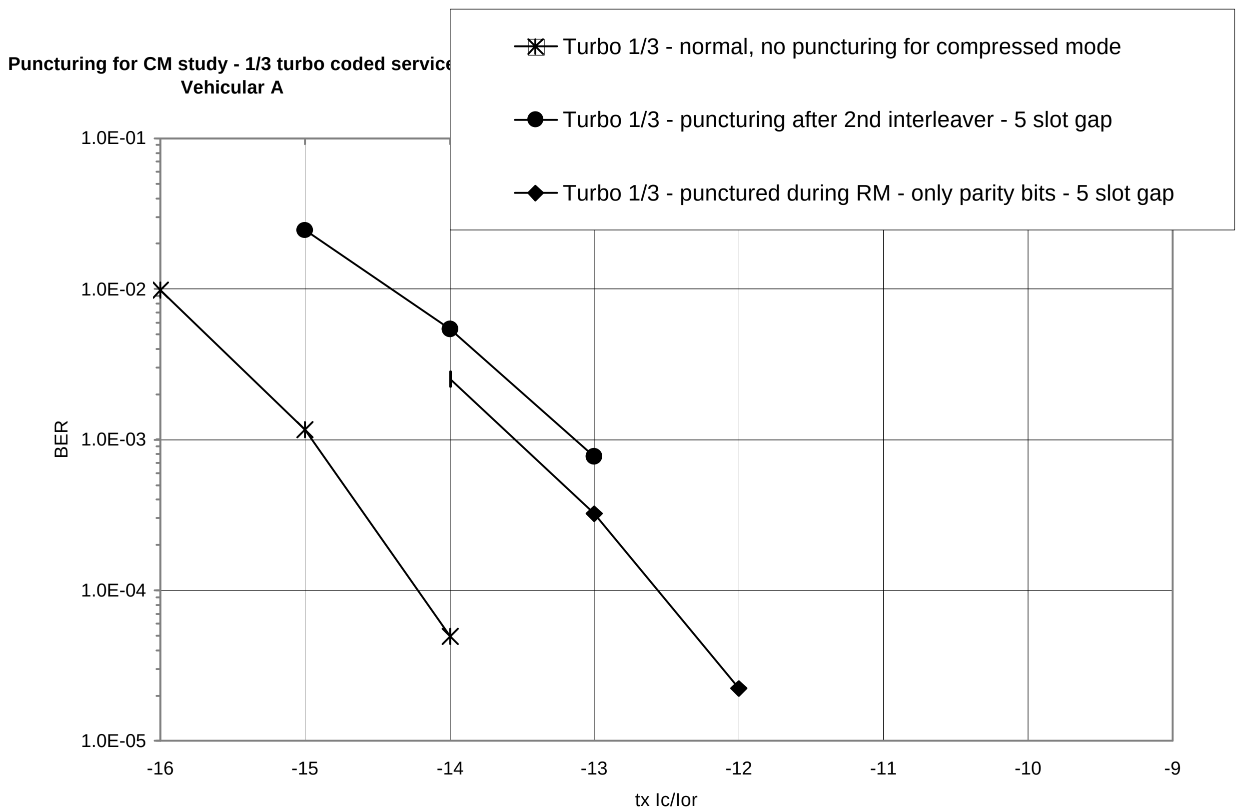

Figure 4. Compressed mode with Method A – 1/3 PCCC (Veh A)

It can be seen from the figures 1-4 that implementing puncturing in the rate matching stage brings about 0.5 – 1.5 dB loss in these simulation cases. Now it has to be remembered that there was a transmission gap in *each* frame, i.e. compressed mode was on always during the simulation. This worst case study does allow comparison between two possible schemes for making the puncturing. In Figure 3 it can be seen that turbo coding performance suffers from the loss of systematic bits when puncturing is done after 2nd interleaver.

4. CONCLUSIONS

It is suggested that the combined rate matching and compressed mode puncturing method described in Tdoc r1-99j04 is adopted to TS 25.212.

5. REFERENCES

[1] Ericsson, "Compressed mode by puncturing", R1-99g78
[2] Mitsubishi, "Text proposal to TS 25.212 for Implementation of compressed mode in the IL & MUX chain", R1-99g01