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Coding Scheme Comparison for GERAN

1. Introduction

GERAN R'00 will provide a dedicated unacknowledged radio bearer towards the Iu-ps interface. This bearer could be used by services having a fairly constant bit rate, e.g. streaming.

It was proposed in [1] and [2] that a so-called repeated MCS scheme could be used for coding of dedicated unacknowledged bearer. The motivation for this construction was mainly the small impact on existing standards. In this paper we show that by using the circuit switched coding schemes instead, the standards changes are also small and the performance is enhanced compared to the repeated MCS scheme.

The content of this paper was first presented in [3]; the paper is updated with new simulation results on the repeated MCS coding schemes.

2. Compared Coding Schemes

A number of coding schemes from EGPRS and ECSD together with new coding schemes developed from EGPRS and ECSD have been simulated to compare performance and data rates.

The repeated MCS coding schemes were suggested in [1,2]. In [1,2], the EGPRS coding schemes are reused and several punctured blocks are transmitted consecutively to enhance the performance. One disadvantage with the scheme in [1,2] is that the EGPRS RLC/MAC header is transmitted several times for each radio block.

Two of the three ECSD coding schemes use a concatenated code that enhances the bit error rate performance. Since there is no RLC/MAC header included in the ECSD coding schemes, a header is added to the payload when doing the simulation. The header is in the simulations assumed to be 16 bits long, but could of course be longer if necessary. However, there is no need for a full EGPRS RLC/MAC header for a dedicated unacknowledged bearer. An optimized RLC header design is presented in [4]. In unacknowledged mode, there is no need to protect the header more than the data, therefore the channel coding can be kept from ECSD.

ECSD28.8 is the E-TCH/F28.8 coding used with a 16-bit header included in the data part of the radio block. ECSD32.0 is the E-TCH/F32.0 coding used with a 16-bit header included in the data-part of the radio-block. ECSD42.3 is the E-TCH/F43.2 coding used with a 16-bit header included in the data part of the radio-block.
The ECSD coding schemes use a 22-burst diagonal interleaving (110 ms).

3. Performance Results

In Table 1, both bit error rate performance (at BER=0.001) and block error rate performance (at BLER=0.1) are summarized. However, the bit error rate performance is the more important one of the two. Detailed simulation results are given in Annex A.

	Interleaving	RLC data rate	Radio interface data rate	BER=0.001	BLER=0.1
MCS5	20 ms	22.4 kbps		15.0	11.8
Rep 3MCS9	60 ms	19.7 kbps		12.8	10.3
Rep 2MCS7	40 ms	22.4 kbps		12.9	10.8
MCS6	20 ms	29.6 kbps		17.4	14.0
Rep 2MCS9	40 ms	29.6 kbps		17.8	14.1
Rep 2MCS8	40 ms	27.2 kbps		16.8	13.6
ECSD28.8	110 ms	28.4 kbps	29.2 kbps	14.6	11.3
ECSD32.0	110 ms	31.2 kbps	32.0 kbps	14.8	12.4
ECSD43.2	110 ms	42.7 kbps	43.5 kbps	16.5	15.9

Table 1. Performance in terms of C/I at 0.1% bit error rate and 10% block error rate. The coding schemes in the upper part of the table have a separately encoded EGPRS RLC/MAC header and the coding schemes in the lower part of the table have a 16-bit header encoded together with the data block.

Comparing the performance of the repeated MCS coding schemes with the ECSD coding schemes show that the ECSD coding schemes perform better. ECSD28.8 (data rate 28.4 kbps) outperforms repeated 2MCS8 (data rate 27.2 kbps) with 2.2 dB at BER=0.001 and with 2.3 dB at BLER=0.1.

At C/I around 15 dB, the repeated MCS schemes give a data rate of about 23 kbps and the ECSD schemes a data rate of about 31 kbps. At C/I around 16.5 dB, the repeated MCS schemes give a data rate of about 27 kbps and the ECSD schemes a data rate of about 42 kbps.

The results in Table 1 all show that the ECSD coding schemes require lower C/I for a given data rate. Another advantage with the ECSD coding schemes is that higher data rates can be reached for a given C/I.

4. Conclusions

The simulation results presented in this document all show that the ECSD-based coding schemes give better performance than the repeated-MCS-based coding schemes. Furthermore, the ECSD-based coding schemes have a smaller overhead in terms of header than the repeated MCS schemes. The impact on the existing standard with the two constructions are about the same, hence, we propose that ECSD based coding schemes are used for the dedicated unacknowledged bearer in GERAN Release 2000. For more details, see [4].

5. References

[1] ”Repeated MCS9 Scheme for Streaming and Conversational Bearers in GERAN”, Tdoc SMG2 1028/00, Biarritz, France, May 22 – 26, 2000, source Lucent Technologies.

[2] ”Repeated MCS7 and MCS9 for Streaming and Conversational Bearers”, Tdoc GERAN 084/00, Helsinki, Finland, August 7 – 11, 2000, source Lucent Technologies.

[3] “Coding Scheme Comparisons for GERAN”, Tdoc GERAN 058/00, Helsinki, Finland, August 7 – 11, 2000, source Ericsson.

[4] ”RAB Design using ECSD channel coding”, Tdoc 3GPP TSG GERAN #1 GP-000167, Seattle, USA, August 28 – September 1, 2000, source Ericsson.

Annex A Simulation Results

The EGPRS coding schemes MCS5, repeated 2MCS7, and repeated 3MCS9 are compared in Figure 1. These coding schemes give approximately the same throughput, but they have different interleaving depths. The repeated 2MCS7 and repeated 3MCS9 coding schemes have the best performance in terms of bit error rate and block error rate. This is probably due to the longer interleaving depth of the repeated coding schemes and the somewhat lower data rate of repeated 3MCS9.

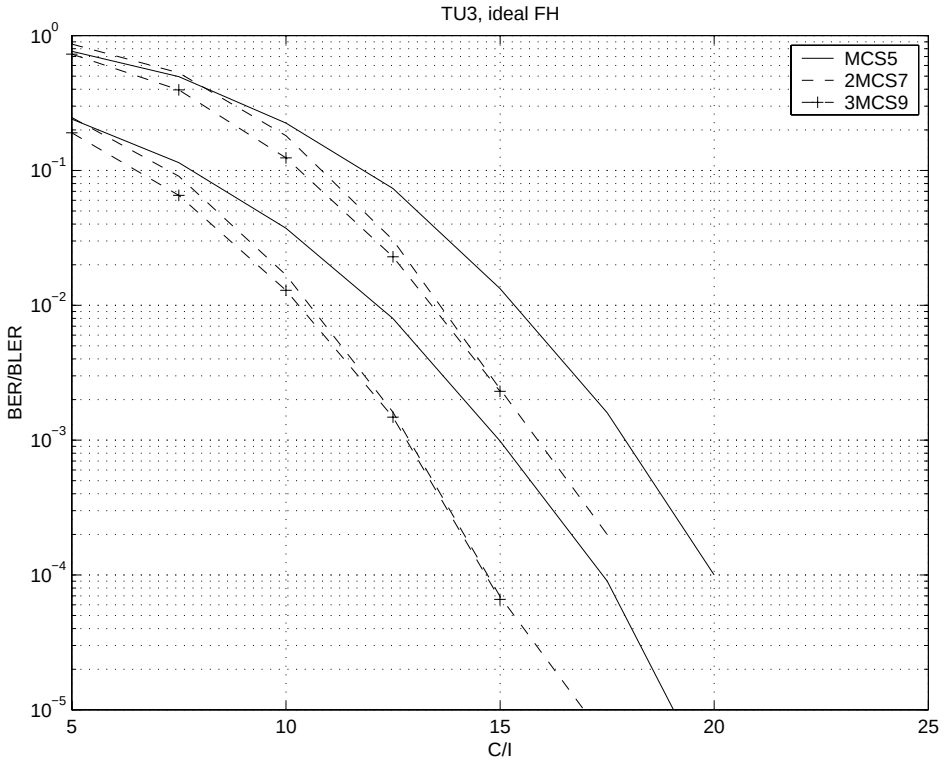

Figure 1. Bit error rate and block error rate for repeated MCS schemes with data rates 22.4 kbps (MCS5), 19.7 kbps (3MCS9), and 22.4 kbps (2MCS7), respectively.

The coding schemes MCS6, repeated 2MCS8, repeated 2MCS9, and ECSD28.8 are compared in Figure 2. These coding schemes give approximately the same data throughput, but the ECSD28.8 outperformes all three EGPRS coding schemes.

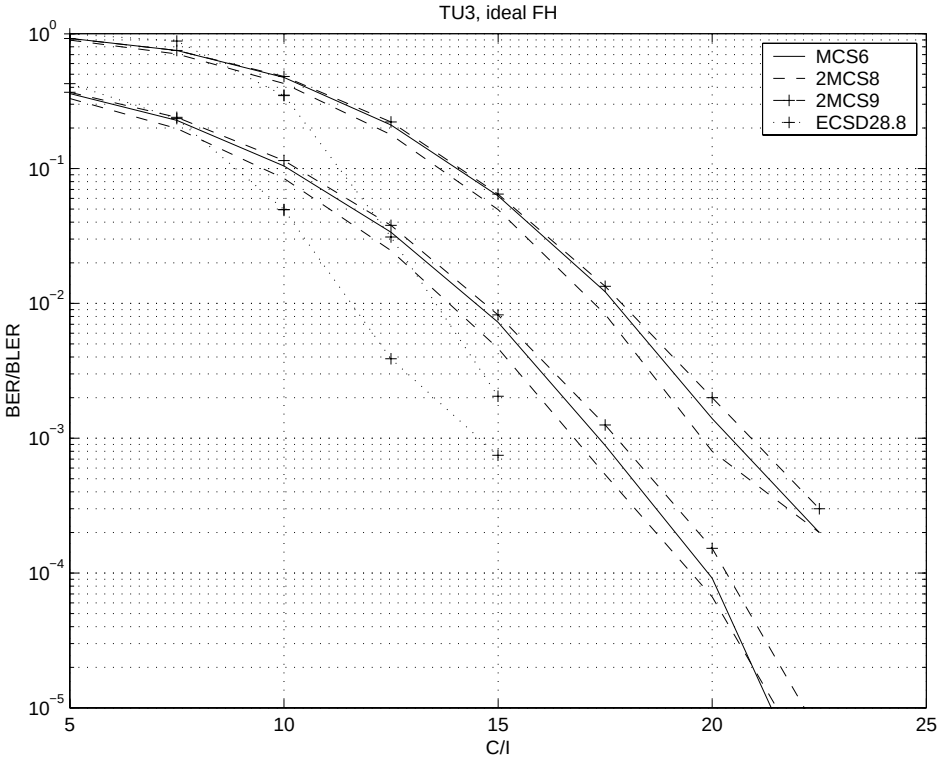

Figure 2. Bit error rate and block error rate for repeated MCS and ECSD coding schemes with data rates 29.6 kbps (MCS6), 27.2 kbps (2MCS8), 29.6 kbps (2MCS9), and 28.4 kbps (ECSD28.8) respectively.

The performance of ECSD32.0 and ECSD43.2 are given in Figures 3 and 4 respectively.

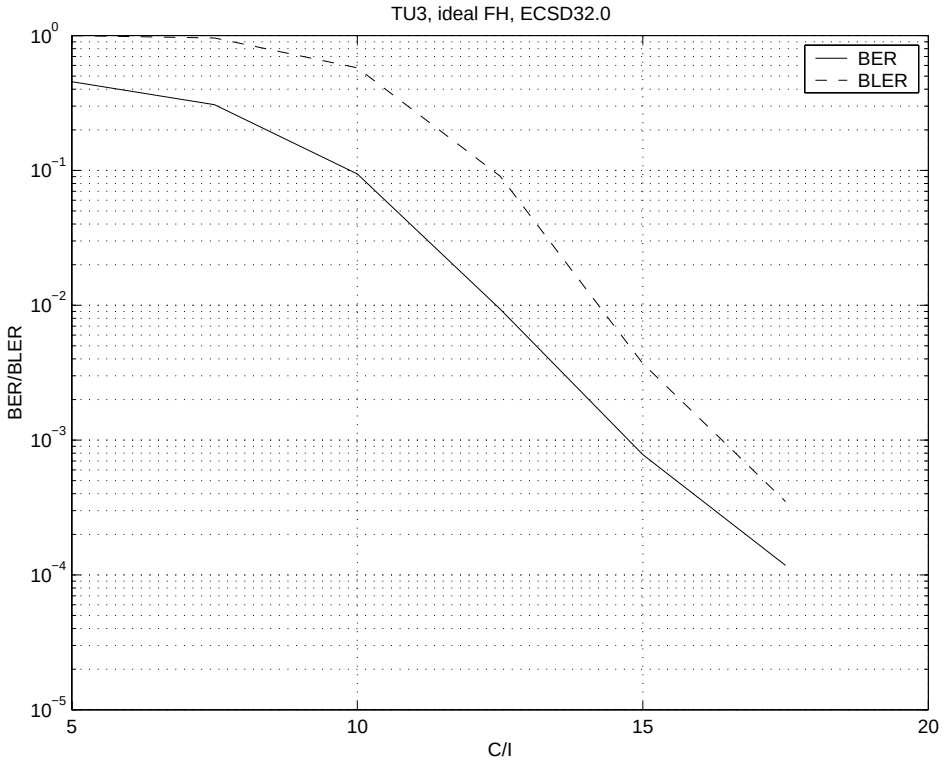

Figure 3. Bit error rate and block error rate for ECSD coding scheme with data rate 31.2 kbps (ECSD32.0).

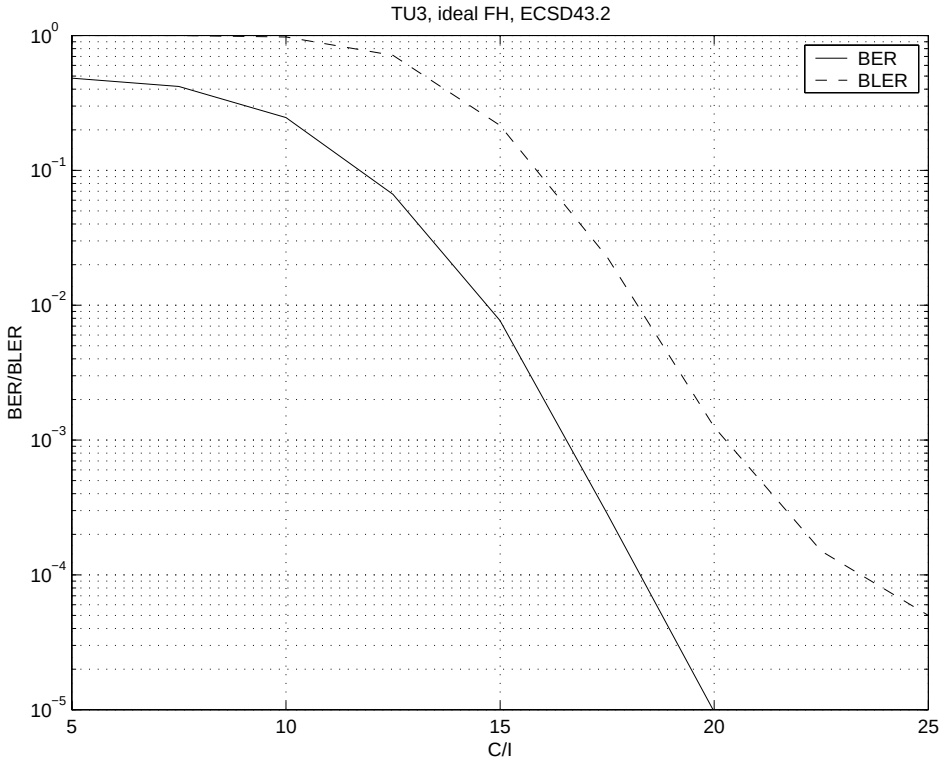

Figure 4. Bit error rate and block error rate for ECSD coding scheme with data rate 42.7 kbps (ECSD43.2).