3GPP TSG GERAN Adhoc on release 2000 and beyond #1 **Tdoc 2g00-058**
Helsinki, Finland
August 7 – 11, 2000

Source: Ericsson

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] 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.

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

In the simulations below, parity-encoding of the data bits is not used for the MCS coding schemes. Instead of the parity bits, twelve extra data bits are added and this gives the data rates in Table 1.

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 40 bit header is added for a fair comparison. Note that a 40-bit header was assumed as a worst-case. There is no need for a full EGPRS RLC/MAC header for a dedicated unacknowledged bearer. A more realistic header-size is presented in [2]. In unacknowledged mode, there is no need to protect the header more than the data, therefore the channel coding can be kept from ECSD.

For comparison reasons only, the scheme ECSD 29.2 is created, which is the E-TCH/F28.8 coding used with a modified puncturing so that an EGPRS-encoded header of 124 bits is added to the encoded and punctured radio block. Thus, ECSD 29.2 reuses ECSD data-encoding and EGPRS header-encoding.

ECSD 27.2 is the E-TCH/F28.8 coding used with a 40 bit header included in the data part of the radio block. ECSD 30.0 is the E-TCH/F32.0 coding used with a 40 bit header included in the data-part of the radio-block. ECSD 41.5 is the E-TCH/F43.2 coding used with a 40 bit header included in the data part of the radio-block.
The ECSD coding schemes use a 22 burst diagonal interleaving (110 ms). The ECSD coding schemes are also simulated with an 8 burst diagonal interleaving (same as GSM full-rate) for comparison reasons.

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.
Note that the scheme naming in the table below (ECSD xx) denotes the bit rate offered above RLC layer. The radio interface rate is higher.

	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	20.4 kbps		14.2	11.7
Rep 2MCS7	40 ms	23.1 kbps		14.9	12.1
MCS6	20 ms	30.3 kbps		17.4	14.0
Rep 2MCS9	40 ms	30.3 kbps		19.5	15.5
ECSD 29.2	40 ms	29.2 kbps	29.2 kbps	16.0	13.4
Rep 2MCS8	40 ms	27.3 kbps		18.5	15.1
ECSD 27.2	40 ms	27.2 kbps	29.2 kbps	15.2	12.3
ECSD 27.2	110 ms	27.2 kbps	29.2 kbps	14.6	11.3
ECSD 30.0	40 ms	30.0 kbps	32.0 kbps	15.8	13.1
ECSD 30.0	110 ms	30.0 kbps	32.0 kbps	14.8	12.4
ECSD 41.5	40 ms	41.5 kbps	43.5 kbps	18.3	17.0
ECSD 41.5	110 ms	41.5 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 40-bit header encoded together with the data block.

Comparing the performance of the repeated MCS schemes with the ECSD scheme show that the ECSD coding schemes are better. For example, the repeated 2MCS8 can be compared with ECSD 27.2 (data rates 27.3 kbps and 27.2 kbps, respectively). ECSD 27.2 outperforms repeated 2MCS8 with 3.3 dB at BER=0.001. With 110 ms interleaving the difference is even larger.

Further, the repeated 2MCS9, MCS6, and ECSD 30.0 can be compared (data rates 30.3 kbps, 30.3 kbps, and 30.0 kbps, respectively). ECSD 30.0 outperforms repeated 2MCS9 with 3.7 dB with 40 ms interleaving and outperformes MCS6 with 1.6 dB at BER=0.001.

At C/I around 15.0 dB the repeated MCS schemes give data rates of about 23 kbps and the ECSD schemes data rates of about 27 kbps. At C/I around 18.5 dB the repeated MCS schemes give data rates of about 27 kbps and the ECSD schemes data rates of about 41 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. With the repeated MCS construction, the maximal data rate (for 2MCS9) is 30.3 kbps, while ECSD gives 41.5 kbps.

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 [2].

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] ”RAB Design using ECSD channel coding”, Tdoc 3GPP TSG GERAN Adhoc 063/00, Helsinki, Finland, August 7 – 11, 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 block error rate performance is almost identical for the different coding schemes, however, the repeated 2MCS9 coding scheme has the best bit error rate performance. This is probably due to a longer interleaving depth.

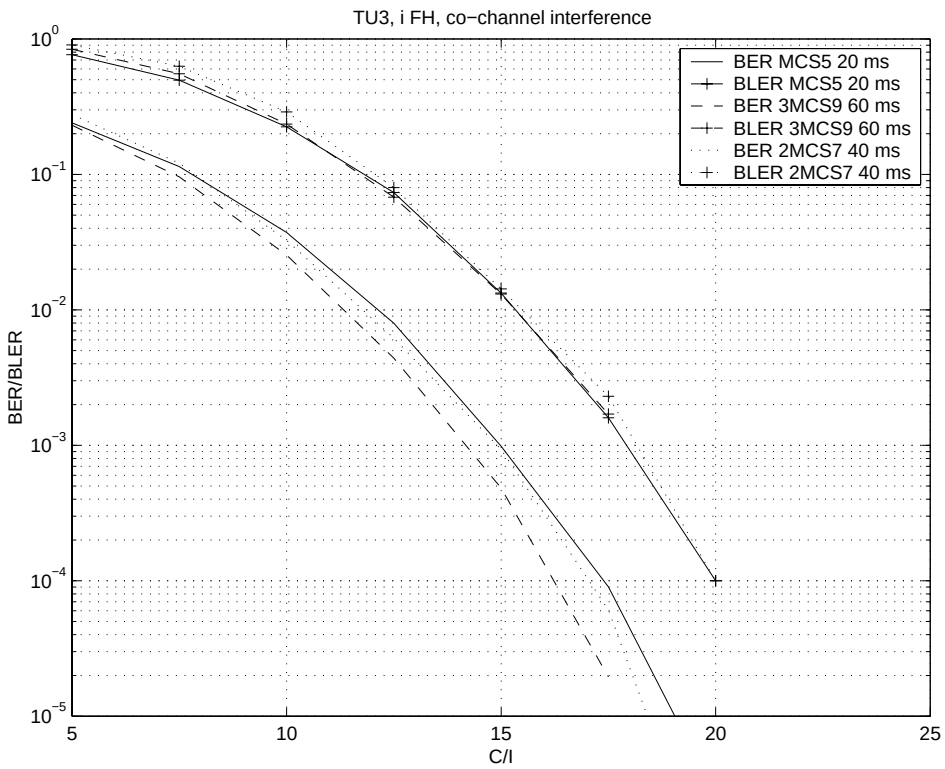

Figure 1. Bit error rate and block error rate for repeated MCS schemes with data rates 22.4 kbps (MCS5), 20.4 kbps (3MCS9), and 23,1 kbps (2MCS7), respectively.

In Figure 2 the EGPRS coding schemes MCS6, repeated 2MCS8, and repeated 2MCS9 are compared with the ECSD 29.2 coding. These coding schemes give approximately the same throughput and, except for MCS6, the same interleaving depth. The ECSD coding-scheme has an EGPRS header added, but the data part is encoded with a concatenated code (Reed-Solomon code and convolutional code). The concatenated code gives a better performance both in terms of block error rate and bit error rate.

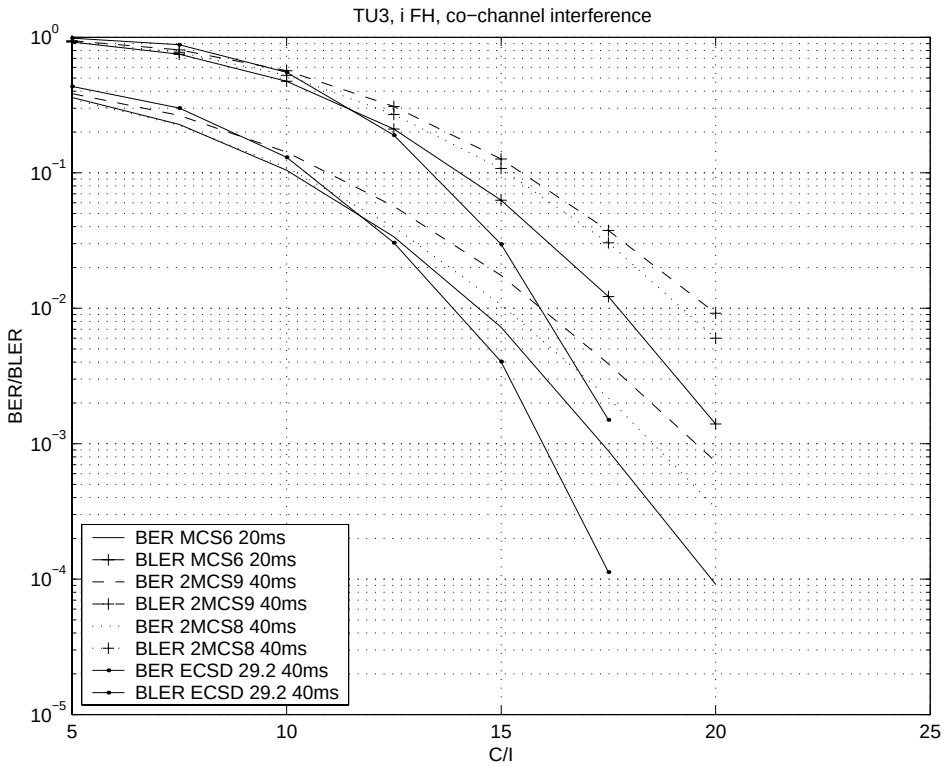

Figure 2. Bit error rate and block error rate for repeated MCS and ECSD schemes with data rates 30.3 kbps (MCS6), 30.3 kbps (2MCS9), 27.3 kbps (2MCS8), and 29.2 kbps (ECSD), respectively.

Performance for the ECSD 27.2 coding scheme is given in Figure 3 for both 40 ms interleaving and 110 ms interleaving.

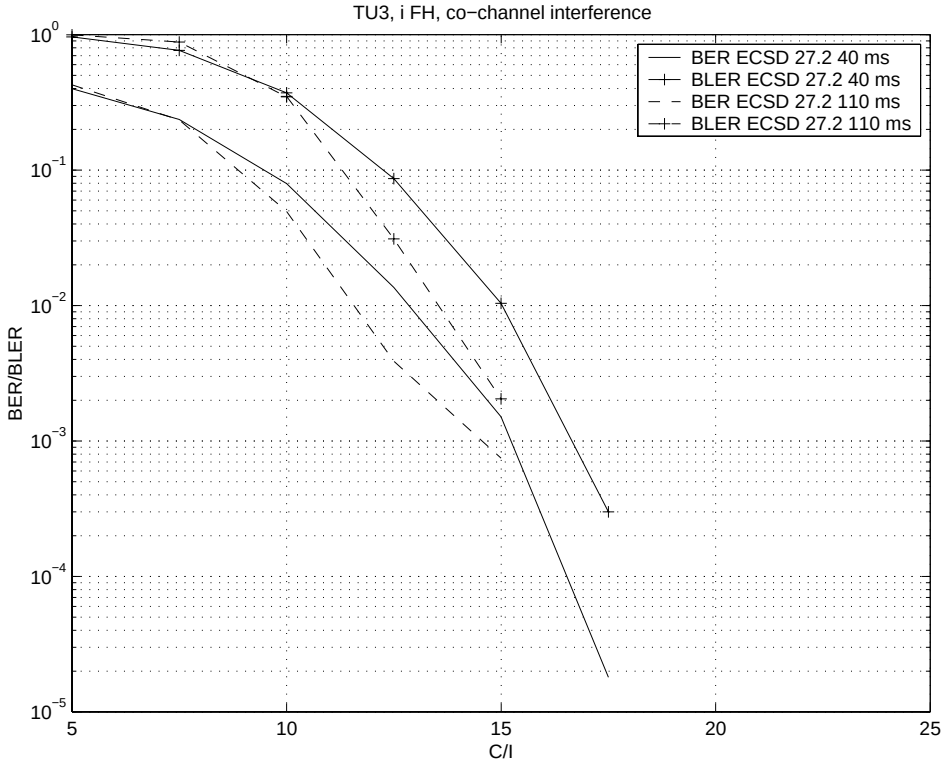

Figure 3. Bit error rate and block error rate for ECSD coding scheme with data rate 27.2 kbps and 40 ms interleaving compared with 110 ms interleaving.

Performance for the ECSD 30.0 coding scheme is given in Figure 4 for both 40 ms interleaving and 110 ms interleaving.

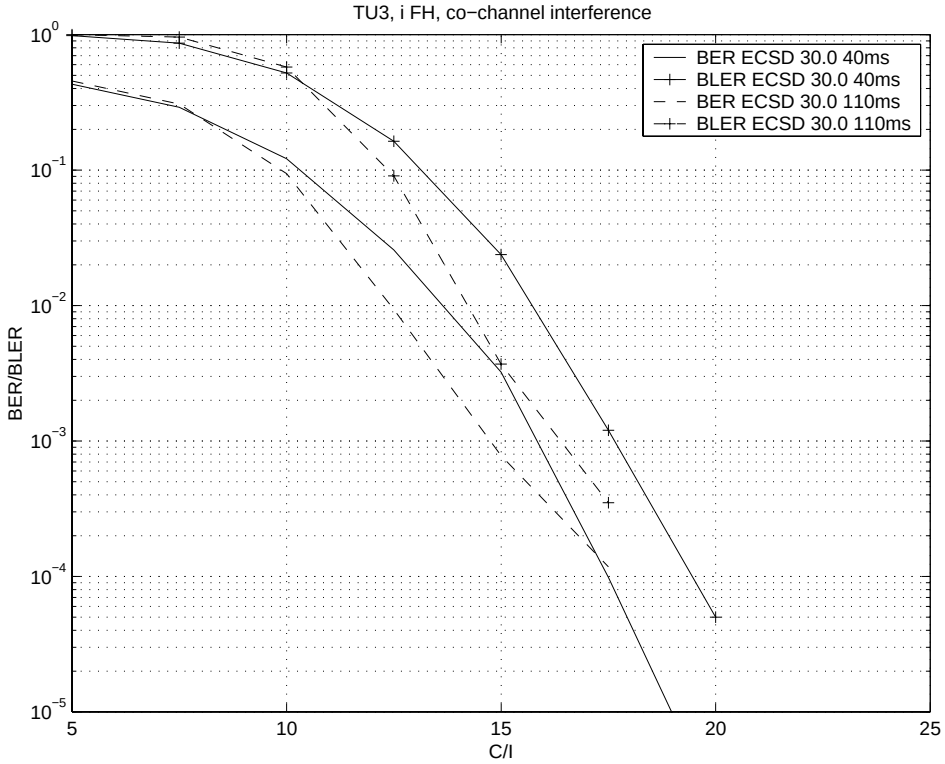

Figure 4. Bit error rate and block error rate for ECSD coding scheme with data rate 30.0 kbps and 40 ms interleaving compared with 110 ms interleaving.

Performance for the ECSD 41.5 coding scheme is given in Figure 6 for both 40 ms interleaving and 110 ms interleaving.

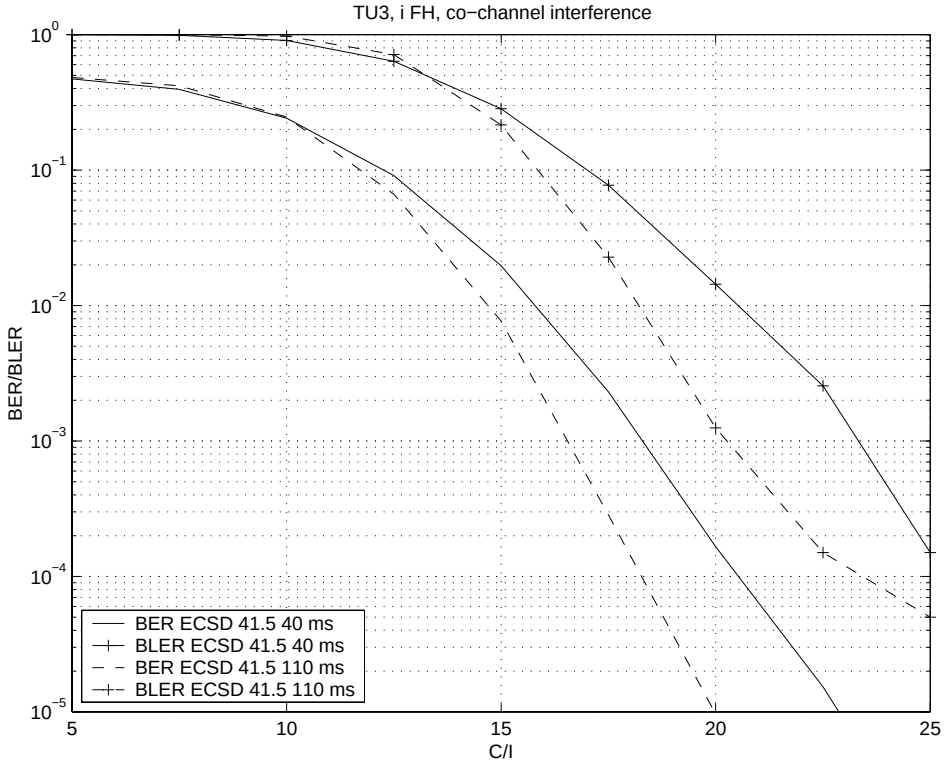

Figure 6. Bit error rate and block error rate for ECSD coding scheme with data rate 41.5 kbps and 40 ms interleaving compared with 110 ms interleaving.