3GPP TSG-RAN Working Group 1 #52 **Tdoc R1-081043**
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Source: **Broadcom**

Title: **LBRM procedure with a simplified RV definition on exact soft buffer**

Agenda Item: **Finalization of 36.212**

Document for: **Decision**

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1 Summary

In Sevilla meeting limited buffer rate matching (LBRM) [1] was adopted. It is stated in [1] that "(the soft buffer size for transport block (TB)) N_{IR} is signalled by higher layers". From the definition of N_{cb} (the soft buffer size for r-th code block) and the definition of rate matching output bit sequence e_k, N_{IR} is the size of extended buffer for that TB – the buffer that may contain the soft information of non-transmitted bits (namely, filling bits to meet QPP interleave size and dummy bits to match the size of sub-block interleave [3]). However, the "total number of soft channel bits" defined in the final conclusion [2] is the size of the exact soft buffer. This means the higher layers will give the size of the exact soft buffer. Therefore, we either have to change the "total number of soft channel bits" to a extended buffer size (which will cost the memory waste and complexity increase) or modify the LBRM procedure to reflect the exact soft buffer size.

Moreover, the RV (redundancy version) starting position current defined in [1] is also based on virtue circular buffer which includes filling bits and dummy bits. This leads to a complicated RV starting position definition

$$k_0 = R \cdot \left(2 \cdot \left\lceil \frac{N_{cb}}{8R} \right\rceil \cdot rv_{idx} + 2 \right) \tag{1}$$

which involves a division of number R, a non-fixed number defined by the rows of the matrix of sub-block interleaver. Furthermore, the starting position for the final exact buffer has to be modified based on the de-padding of filling and dummy bits.

In this document, we propose

1) Modify the LBRM procedure [1] to reflect the exact buffer size
2) Simplify RV starting position with only very simple constant division, namely 1/4 (right shifts two bits), i.e.

$$k_0 = \left\lceil \frac{N_{cb}}{4} \right\rceil \cdot rv_{idx} + 2R \,. \tag{2}$$

Our simulation results in Section 3 show this modification will not change the throughput of FBRM (full buffer rate matching). Compared to LBRM proposed in [1], the modification actually improves the throughput.

2 LBRM procedure on real soft buffer size

Commence text proposal

5.1.4.1.2 Bit collection, selection and transmission

Let N_{LBRM} be the number of soft buffer size, respectively. Then $N_{TB,LBRM} = N_{LBRM}/16$ is the soft buffer size for one transport block for UE Category 2-5 and $N_{TB,LBRM} = N_{LBRM}/8$ for UE Category 1.

The virtue circular buffer of length $K_w = 3K_\Pi$ for the *r*-th coded block is generated as follows:

$w_k = v_k^{(0)}$ for $k = 0,\ldots, K_\Pi - 1$

$w_{K_\Pi + 2k} = v_k^{(1)}$ for $k = 0,\ldots, K_\Pi - 1$

$w_{K_\Pi + 2k+1} = v_k^{(2)}$ for $k = 0,\ldots, K_\Pi - 1$

The full circular buffer without filling and dummy bits for the r-th code block will store the soft information of the following sequence,

Set $k = 0, j = 0, K_v = 0$

while { $k < K_w$ }

  if $w_k \neq < NULL >$

    $u_j = w_k$

    $j = j + 1$

    $K_v = K_v + 1$

  end if

    k=k+1

end while

Denote the soft buffer size for the *r*-th code block by N_{cb} bits. Size N_{cb} is obtained as follows, where *C* is the number of code blocks computed in subclause 5.1.2.

$$N_{cb} = \min\left(\left\lfloor \frac{N_{TB,LBRM}}{C} \right\rfloor, K_v\right)$$

Denoting by *E* the rate matching output sequence length for the r-th coded block, and rv_{idx} the redundancy version number for this transmission, the rate matching output bit sequence is e_k, $k = 0,1,\ldots, E-1$.

Define by *G* the total number of bits available for the transmission of one transport block.
Set $G' = G/(N_L \cdot Q_m)$ where Q_m is equal to 2 for QPSK, 4 for 16QAM and 6 for 64QAM, and where N_L is equal to 1 for blocks mapped onto one transmission layer and is equal to 2 for blocks mapped onto two or four transmission layers.

Set $\gamma = G' \bmod C$, where *C* is the number of code blocks computed in subclause 5.1.2.

if $r \le C - \gamma - 1$

  set $E = N_L \cdot Q_m \cdot \lfloor G'/C \rfloor$

else

  set $E = N_L \cdot Q_m \cdot \lceil G'/C \rceil$

end if

Set $k_0 = \left\lceil \frac{N_{cb}}{4} \right\rceil \cdot rv_{idx} + 2R$, where *R* is the number of rows defined in subclause 5.1.4.1.1.

Set $k = 0$ and $j = 0$
while { $k < E$ }
$e_k = u_{(k_0 + j) \bmod N_{cb}}$
$k = k + 1$
$j = j + 1$
end while

end of text proposal

3 Performance comparisons on two RV starting position definitions

Similar to [4], our simulation focuses on the performance of a TB composed of one code block, with TB size 6120 bits, which becomes the maximal QPP size 6144 bits after appending 24 cyclic redundancy check (CRC) bits. All HARQ transmissions of a given TB have the same code rate, i.e., equi-sized transmission is assumed. In the FBRM simulations no constraint was placed on the rate matching circular buffer. In the LBRM simulation 50% of FBRM is considered. The simulation is conducted on 64 QAM and on AWGN channel. The goodput (defined as the average number of information bits per channel use [4]) are plotted in Figure 1 through Figure 8. The RV sequences we use in this contribution include those selected in [4].

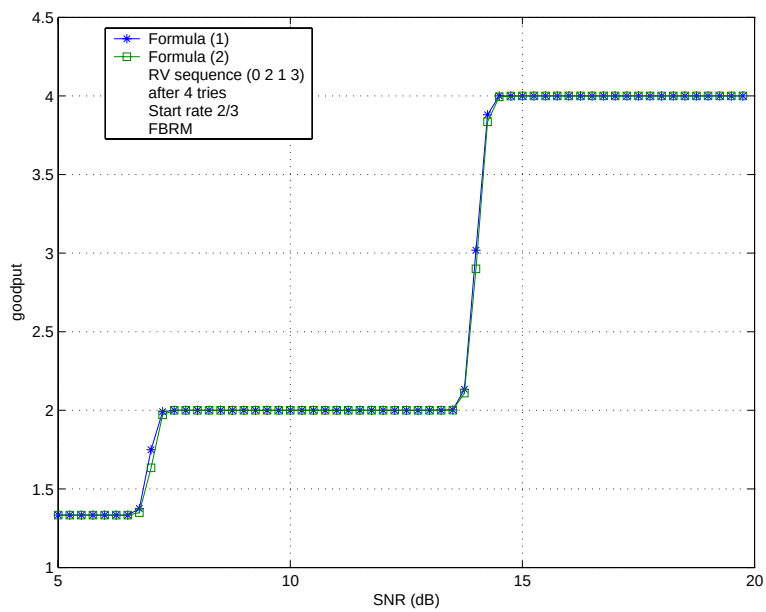

Figure 1 FBRM: Rate 2/3 for one transmission (3 re-transmission), 64 QAM, AWGN

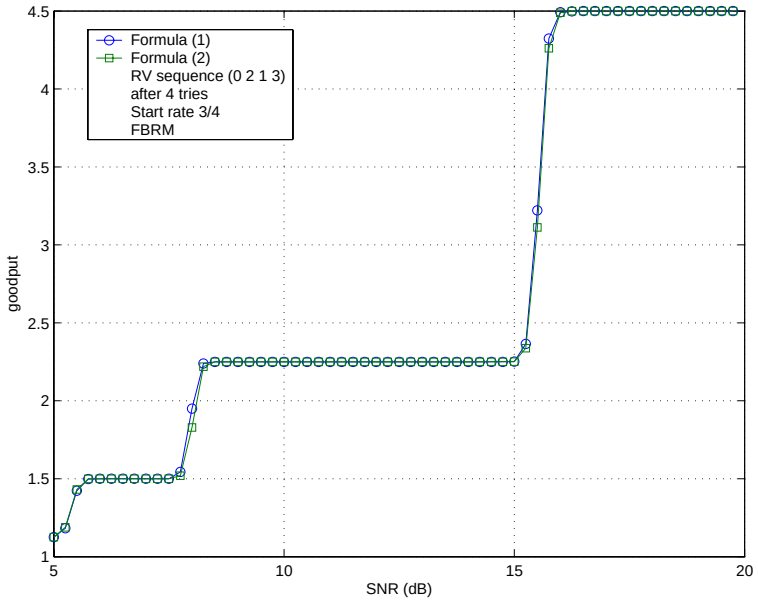

Figure 2 FBRM: Rate 3/4 for one transmission (3 re-transmission), 64 QAM, AWGN

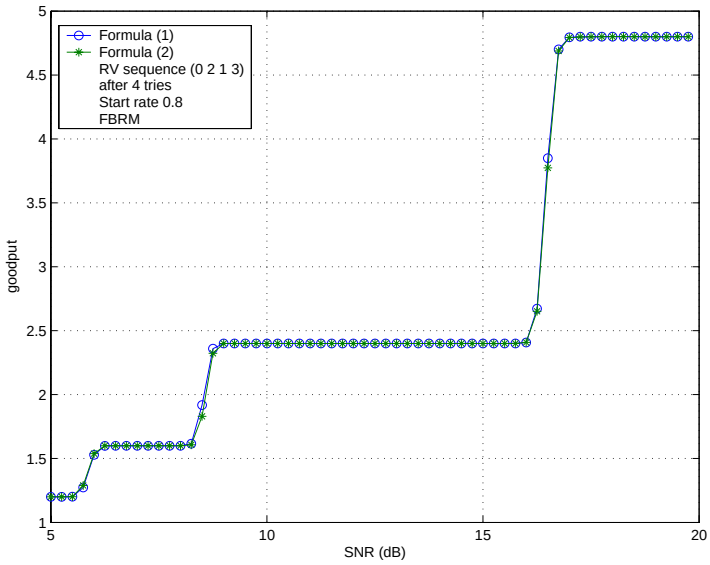

Figure 3 FBRM: Rate 0.8 for one transmission (3 re-transmission), 64 QAM, AWGN

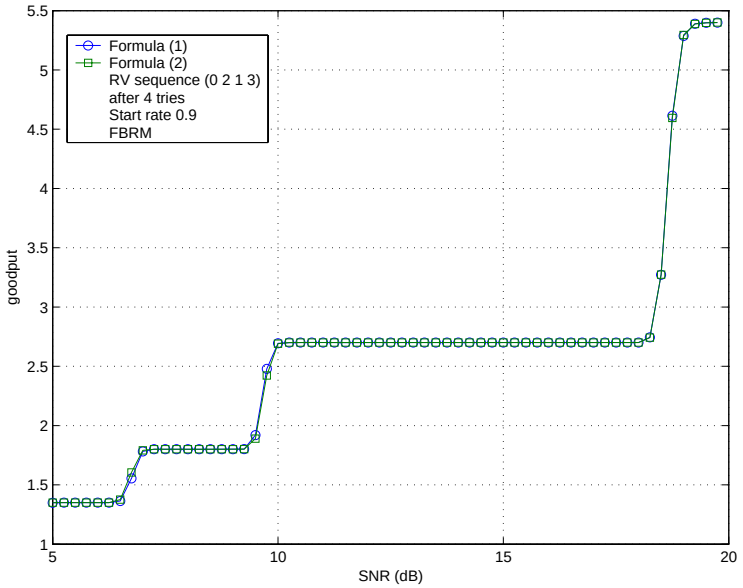

Figure 4 FBRM: Rate 0.9 for one transmission (3 re-transmission), 64 QAM, AWGN

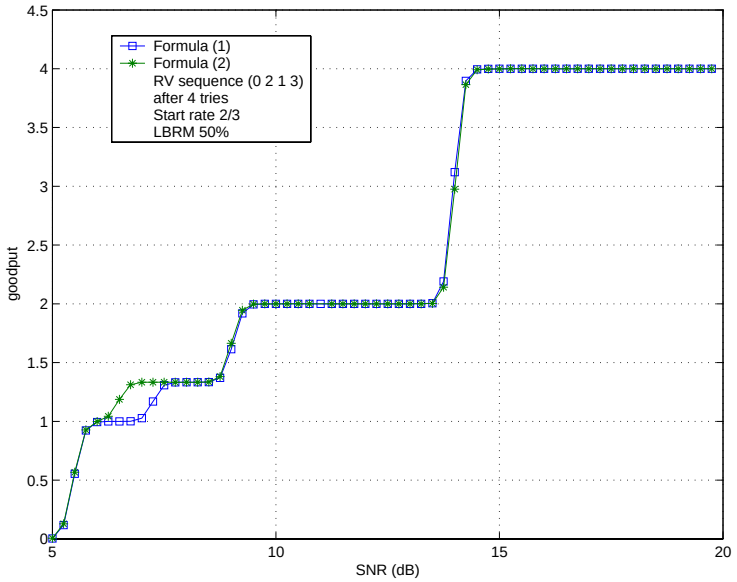

Figure 5 LBRM (50% of FBRM): Rate 2/3 for one transmission (3 re-transmission), 64 QAM, AWGN

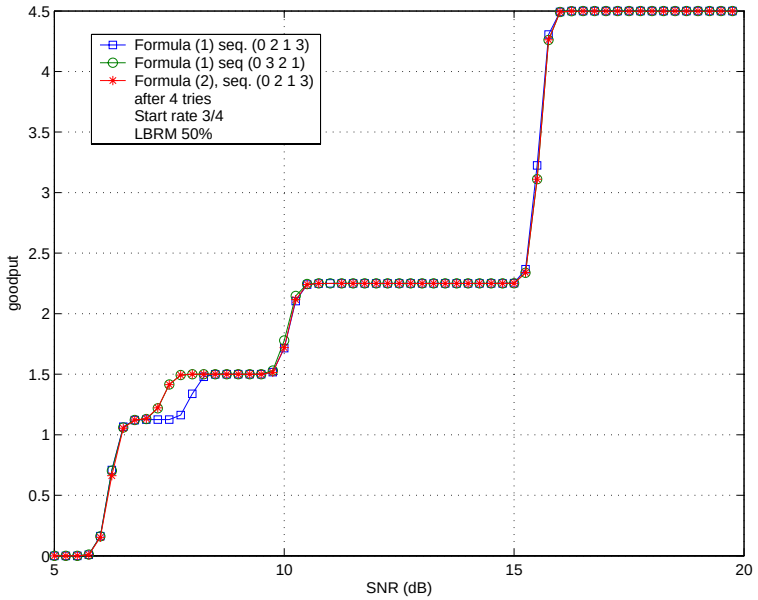

Figure 6 LBRM (50% FBRM): Rate 3/4 for one transmission (3 re-transmission), 64 QAM, AWGN

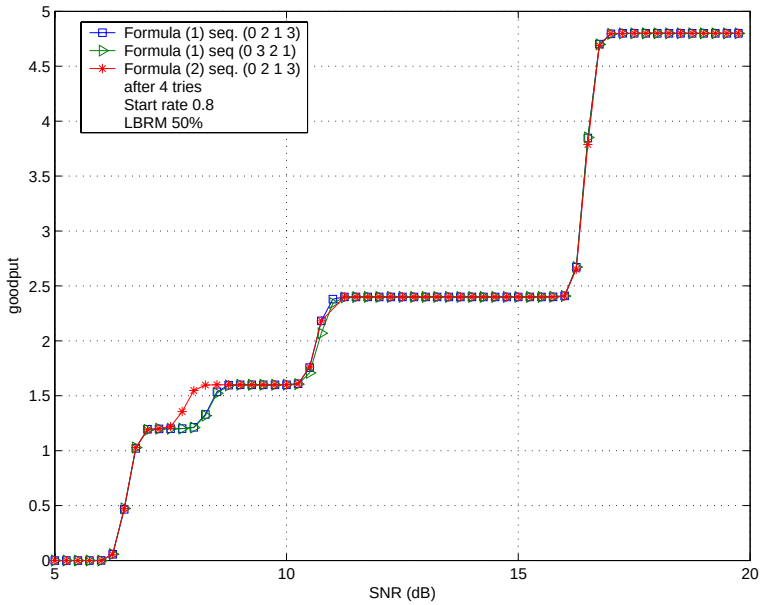

Figure 7 LBRM (50% FBRM): Rate 0.8 for one transmission (3 re-transmission), 64 QAM, AWGN

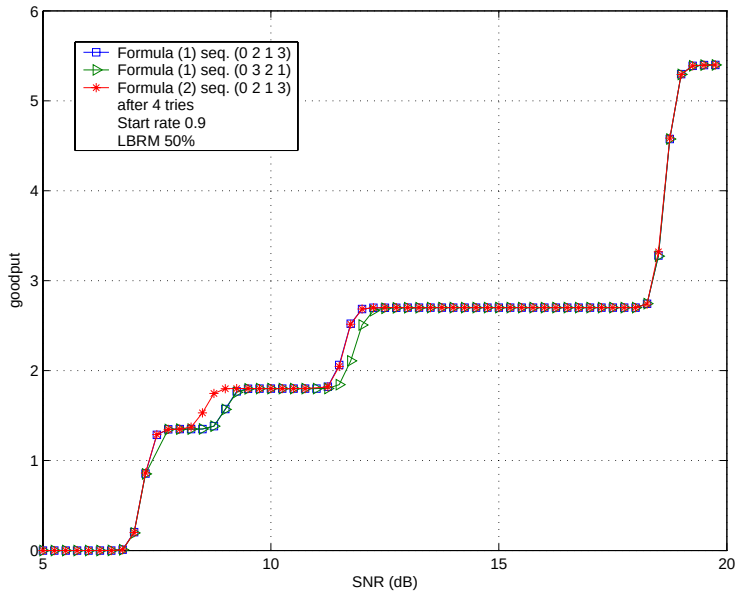

Figure 8 LBRM (50% FBRM): Rate 0.9 for one transmission (3 re-transmission), 64 QAM, AWGN

References

[1] R1-080515, "Proposal for Limited Buffer Rate Matching", Motorola, Freescale, LGE, Marvell, Nokia, NSN, Phillips, Samsung, Texas Instruments, Ericsson, Panasonic, NEC, NXP, RAN1#51bis, Seville, Spain, 14-18 January, 2008

[2] R1-08xxxx, "Draft Report of 3GPP TSG RAN WG1 #51bis v0.1.0".

[3] 3GPP TS 36.306v1.0.0 (2007-11), UE Radio Access Capabilities (Release 8)

[4] R1-080057, "Limited Buffer Rate Matching Performance Analysis," Motorola, RAN1#51bis, Seville, Spain, 14-18 January, 2008